The following appendix accompanies Verbeek and Grout (2025) Chapter 3. Fault History of the Sterling Zinc Mine, Ogdensburg, Sussex County, New Jersey, with Appendices: *in* DiMao, M., Verbeek, E. R, and Herman, G.C., eds., Geological Association of New Jersey Annual Meeting 41, Ogdensburg, NJ. p. 117-140.

Appendix A. Quantitative Fault-Slip Data and Field Descriptions for 1,158 Faults in the Sterling mine, Ogdensburg, Sussex County, New Jersey

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Introduction

The following pages contain quantitative and descriptive data for 1,158 faults exposed at Sterling Hill, both in the underground mine workings of the Sterling mine (1200 level to adit level) and in surface exposures (Passaic and Noble pits, Fill quarry, etc.). Most work in the mine was done between November 1989 and October 1993, while the authors were employed by the U.S. Geological Survey in Lakewood, Colorado. A lengthy hiatus followed before one of the authors (ERV) moved back east and eventually, in late 2001, became employed by the Sterling Hill Mining Museum. Further work on the field aspects of the fault study then progressed in increments until its completion in summer 2015.

Information recorded for each fault includes as much of the following as possible (the first three are imperative):

1. Locality
2. Fault orientation
3. Slip direction(s) (slickenside striations, axes of accretionary mineral fibers, etc.)
4. Rock type
5. Character of fault surface (planar, curved, grooved, smooth, rough, etc.)
6. Minor structures associated with fault (deformed mineral grains, drag features, fault breccias, alteration zones)
7. Mineralization history of fault
8. Age relative to other faults in same area

Information on features other than faults is included here and there, including a few mineral localities of particular significance, but the focus of this study was overwhelmingly on the fault history of the area, and (sadly) little time was available for much else.

This document is basically a transcription of our field notes. The descriptions have been reworded here and there for clarity, and errors were corrected where noted, but little interpretation of fault history is offered here beyond occasional comments that we provided "on the fly," as the data were being gathered. The interpretive aspects of this study constitute a separate phase.

The following example shows the form in which the data for each fault are given:

Fault no. 718

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-61	N20E/60SE	S21E	51	

In this example the Field Number (430-61) corresponds to the 61st fault measured on 430 level and is the number by which that fault is identified in our original field notes. Later, for purposes of assigning to each fault a simple numerical identifier for entry into the computer files, the faults were renumbered as shown above (Fault no. 718). These numbers range from 1 to 1,158, the latter

being the total number of faults in the dataset. Determination of slickenline orientation involved judging, for each fault, which component(s) of the orientation (bearing, plunge, pitch) could most accurately be measured. Measurements of bearing, for example, in some places were compromised by magnetic materials nearby, such as franklinite in the zinc ore, steel air doors, air or water lines adjacent to the fault, rock bolts, etc. In those places, mercifully few, a determination of pitch was strongly preferred. In other places the position of the fault relative to the observer dictated how slickenlines were to be measured. For inaccessible faults in the back, for example, measurement of bearing is usually a straightforward exercise, but not so for plunge or pitch.

For many faults we measured both bearing and plunge, or bearing and pitch, sometimes all three, as internal checks on accuracy, and in most cases we noted which of those measurements we regarded as probably the most reliable. Again in reference to fault no. 718, measurement of both the bearing and the plunge of the slickenlines allowed us to calculate the bearing from the measured plunge, and vice versa, and also to calculate the pitch from both. Those calculated values are shown in parentheses:

Fault no. 718

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-61	N20E/60SE	S21E (S26E)	51 (49)	(60 SW) (64 SW)

The agreement (or lack thereof) between the measured and calculated values for any of these orientation components provides a means of judging one's degree of confidence in the data.

Readers should note that in any study of this type, a mix of metric and English units is unavoidable. Mine levels, for example, are designated by their depth in feet below the main entry to the mine at the surface; e.g. 180 level, 340 level, etc. The mine coordinate system, too, is based on the foot as the unit of measure, and topographic maps of the mine site show land-surface elevations in feet. For other purposes, such as describing the width of a shear zone or the thickness of mineral coatings on fault surfaces, metric units (centimeter, millimeter) are much preferred. The authors freely used both systems of measure and were not everywhere consistent in doing so.

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ADIT LEVEL AND SURFACE WORKINGS

STATION 1 – Surface, at mine coordinates 1055N, 1425W, elevation 670 ft, in a small (15-ft diameter) pit excavated into a steep hillslope north of the east end of the Passaic pit.

Fault no. 1

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-1	N15W/18SW	N64W	(14)	(50 NW)

Comments: Irregular, low-angle fault through low- to medium-grade ore consisting of coarse-grained, manganoan calcite with abundant disseminated grains of franklinite. Very well-developed accretionary steps on overhanging fault surface show that upper plate moved to the NW. The accretionary material is white, coarsely fibrous to splintery, fine-grained calcite mixed with a white to pale brown, flexible, finely fibrous mineral (chrysotile? An amphibole?).

Fault no. 2

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-2	N22W/14SW	N57W	(08)	(36 NW)

Comments: Same rock type and fault character as for fault no. 1 above. Well-developed step faces in accretionary calcite show that upper plate moved to the NW. Both faults are exposed in the rear (west) steep wall of the small pit here. Also preserved in open spaces along this fault is a 1-3 mm thick coating of post-movement hemimorphite(?) in tightly intergrown, bladed crystals perpendicular to the fault surface.

STATION 2 – Surface, at mine coordinates 960N, 1445W, elevation 658 ft, about midway up the east end of the north wall of the Passaic pit. This area is part of the original solution surface that forms the north wall of the Passaic pit and slopes about 50^{o}.

Fault no. 3

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-3	N58E/63NW	N03W	55 (60)	76 NE (76 NE)

Comments: Minor fault through pyroxene-garnet-calcite-feldspar gneiss, in part highly weathered. The fault surface is prominently striated (scratched), but it is too weathered, and too little of it is exposed, for the slip sense to be apparent. *Note:* The bearing measurement is probably more accurate than the plunge.

STATION 3 – Surface, at mine coordinates 1055N, 1325W, elevation 623 ft, low on the East limb about 8 ft above the parking lot.

Fault no. 4

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-4	N26E/63SE	S52E	(62)	(84 SW)

Comments: Nason fault. Weathered mylonite zone, the main part of which is 20-30 cm thick, through coarse-grained marble of the hanging wall of the East limb. The hanging-wall contact of brown manganoan calcite is only about 50 cm west of the fault; the fault just misses cutting off the orebody here. The mylonite

is quite fine-grained. The slickenlines record a stretching lineation, but the sense of slip along this fault was not determinable here from direct evidence.

STATION 4 – Surface, at mine coordinates 1070N, 1340W, elevation 620 ft, low on the East limb, about 5 ft above the parking lot.

Fault no. 5

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-5	N53E/71SE	S64E	(69)	(81 NE)

Comments: Minor fault through marble (with dark mica resembling biotite) near the footwall contact of the East limb. Semipolished and striated fault surface; sense of slip unknown.

Fault no. 6

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-6	N45E/77SE	(S24E)	(76)	85 SW

Comments: Different part of fault no. 5 above; the fault is exposed over an area of about 1.5 m^2. Fibrous to splintery calcite accretionary fibers on the fault surface show slip sense to be normal.

Fault no. 7

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-7	N56E/74SE	S34E	(74)	(90)

Comments: Different part of the same fault as nos. 5 and 6. Fibrous accretionary calcite shows the slip sense definitely to be normal; the broken steps face downward and the attachment points of the individual calcite fibers are on the updip side. The fault moved in several different directions as indicated by the nos. 5 through 7 readings, but all may have been during the same broad episode of normal fault movement.

STATION 5 – Surface, at mine coordinates 710N, 1310W, elevation 618 ft, at northeast corner of the Fill quarry. Readings extend from the north side of the quarry entrance to about 40 ft northwest of that point.

Note: Much grading has taken place in the Fill quarry at various points in time, and some of the faults measured in this quarry, as documented for stations 5-15 below, may no longer be reachable from the present level of the ground.

Fault no. 8

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-8	N35W/70SW	S38E (S34E)	03	(03 SE)

Comments: Graphite-smeared, almost planar fault in fine- to medium-grained, sparsely graphitic marble. The fault surface is coated with accretionary calcite; prominent step faces in this material indicate right-lateral slip.

Fault no. 9

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-9	N42W/82SW	(S40E)	(12)	12 SE

Comments: Nearly planar fault in pale gray, fine- to medium-grained, sparsely graphitic marble. White- to cream-colored accretionary calcite fibers coat fault surface; step faces indicate right-lateral slip. This is the dominant set of accretionary fibers on this surface; for subordinate set see fault no. 10 below.

Fault no. 10

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-10	N42W/82SW	(N43W)	(08 NW)	08 NW

Comments: Same as fault no. 9 above, but the pitch reading refers to a subordinate set of calcite accretionary fibers that underlie and seemingly are older than those mentioned above. Very minor set of fibers; sense of slip indeterminate.

Fault no. 11

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-11	N38W/67SW	S35E (S36E)	04 (04)	(04 SE)

Comments: Minor, nearly planar fault through fine- to medium-grained, sparsely graphitic marble. Step faces in accretionary calcite indicate right-lateral movement.

Fault no. 12

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-12	N47W/69SW	S46E (S45E)	04 (04)	(05 SE) (04 SE)

Comments: Same rock type and fault character as the two faults above; step faces in accretionary calcite indicate right-lateral movement. *Note:* The plunge measurement is more accurate than the bearing.

Fault no. 13

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-13	N30W/65SW	S29E (S29E)	03 (03)	(03 SE) (03 SE)

Comments: Same rock type and fault character as the three faults above; step faces in accretionary calcite indicate right-lateral movement.

Fault no. 14

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-14	N49W/63SW	S47E (S49E)	01 (04)	(04 SE) (01 SE)

Comments: Nearly planar fault through medium- to coarse-grained, sparsely graphitic marble. Step faces in accretionary calcite indicate right-lateral movement.

Fault no. 15

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-15	N32W/72SW	(N35W)	09 NW	(09 NW)

Comments: Same rock type and fault character as the five faults above; step faces in accretionary calcite indicate right-lateral movement.

Fault no. 16

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-16	N02E/56SE	N76E	(55)	(81 NE)

Comments: Fault in fine- to medium-grained, sparsely graphitic marble, exposed for about 15 m along strike. This fault clearly cuts off and is younger than the southwest-dipping faults documented above. White accretionary calcite fibers on fault surface indicate probable normal sense of slip.

Fault no. 17

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-17	N07E/55SE	N26E	(25)	(31 NE)

Comments: Same fault as no. 16, but a different set of calcite accretionary fibers. Both sets are common. The hanging wall probably moved down and to the north, but step faces in the accretionary calcite here are neither abundant nor convincing.

Fault no. 18

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-18	N10E/58SE	N28E	(27)	(32 NE)

Comments: Fault in same rock type as above. Step faces in accretionary calcite suggest hanging wall moved down and to the north.

Fault no. 19

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-19	N10E/58SE	N80E	(56)	(79 NE)

Comments: Same fault as no. 18 above, but a different set of calcite accretionary fibers. These seem to be plated on top of the more gently plunging fibers documented above. Parallel to these steeply plunging fibers are scratches across the gently plunging ones, suggesting that the dip-slip movement is the younger phase. Step faces suggest normal sense of slip.

Fault no. 20

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-20	N38E/52SE	N81E	(41)	(57 NE)

Comments: Fault in fine- to medium-grained, sparsely graphitic marble. Step faces in accretionary calcite suggest normal sense of slip.

Fault no. 21

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-21	N45E/89NW	(N43E)	(59)	59 NE

Comments: Fault in fine- to medium-grained, sparsely graphitic marble. Well-developed step faces in accretionary calcite show that the southeast block of this fault moved down.

Fault no. 22

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-22	N39E/81SE	(N51E)	(52)	53 NE

Comments: This is a more steeply dipping portion of fault no. 20, in the same rock type. Very well-developed step faces in splintery accretionary calcite show clearly that the southeast block moved down. The average dip of this fault is about 50º SE, as documented for no. 20; the readings given here are on an abnormally steep portion, but where the sense of slip is undoubted.

Fault no. 23

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-23	N00E/76E	N86E	(76)	(89 N)

Comments: Very well-developed, splintery, white calcite accretionary fibers, locally 6 cm thick in aggregate, plunge nearly downdip on the fault surface and indicate definite normal sense of slip. This fault terminates against fault no. 20 and either moved before or in tandem with it.

Fault no. 24

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-24	N38E/81NW	(N08E)	(73)	75 NE

Comments: Minor fault in fine- to medium-grained, sparsely graphitic marble. Well-developed step faces in calcite accretionary fibers show that the southeast block moved downward, so this is a high-angle reverse fault. This fault appears to be cut off by fault no. 20 and thus is probably older.

Fault no. 25

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-25	N43E/54SE	(N58E)	20 NE	(25 NE)

Comments: Fault in medium-grained graphitic marble. Fault bears thin coating of accretionary calcite, but sense of slip was indeterminable.

Fault no. 26

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-26	N43E/54SE	S66E	(53)	(79 NE)

Comments: Same fault as no. 25 above, but this set of calcite accretionary fibers records the dominant slip and was measured in almost the same place. Sense of slip unknown.

Fault no. 27

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-27	N05W/63NE	N48E	(57)	(71 NW)

Comments: Graphite-streaked fault surface in fine- to medium-grained graphitic marble. Minor accretionary calcite on fault surface suggests normal sense of slip.

Fault no. 28

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-28	N25W/55NE	N49E	(54)	(81 NW)

Comments: Same comments as for fault no. 27 above.

Fault no. 29

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-29	N10W/58NE	N66E	(57)	(82 NW)

Comments: Fault in medium-grained marble with minor pale-colored mica and norbergite. Small fault, total slip probably on the order of 1 cm; sense of slip unknown.

Fault no. 30

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-30	N04W/61NE	N78E	(61)	(86 NW)

Comments: Graphite-smeared fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 31

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-31	N18W/57NE	N39E	(52)	(71 NW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Minor step faces in thin, probable accretionary calcite on fault surface suggest normal sense of slip.

Fault no. 32

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-32	N10W/59NE	N56E	(57)	(77 NW)

Comments: Graphite-streaked fault surface in marble. Probable accretionary calcite on fault surface suggests normal sense of slip. Films of violet fluorite coat part of fault surface.

Fault no. 33

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-33	N17W/75NE	(N39E)	(72)	80 NW

Comments: Graphite-streaked fault surface in medium-grained, sparsely graphitic marble. Sense of slip unknown.

Fault no. 34

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-34	N14W/69SW	N14W	(00)	(00)

Comments: Fault in pale gray, fine-grained, graphitic marble with thin layers of norbergite. Well-developed calcite accretionary fibers coat fault surface; prominent step faces show clear right-lateral sense of slip.

Fault no. 35

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-35	N17W/67SW	S13W	47 (approx.) (50)	(56 SE)

Comments: A different portion of fault no. 34 above. Prominent calcite accretionary fibers with well-defined step faces show clearly that the hanging wall moved up and northward.

Fault no. 36

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-36	N21W/65SW	S12W (S07W)	45 (49)	(57 SE) (51 SE)

Comments: This is a different portion of the same fault as in the previous two readings. In at least seven areas on the fault surface, calcite fibers curve fairly abruptly from the reverse sense of motion to the strike-slip sense, showing clearly that the strike-slip phase of movement was the younger one. In each area a continuous and consistent sense of fiber curvature was seen.

Fault no. 37

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-37	N09W/73NE	N15E	(56)	(60 NW)

Comments: Minor graphite-streaked fault surface through fine-grained graphitic marble with scattered grains of norbergite. Sense of slip unknown, though probably normal because shallowly dipping portions of the fault surface are more heavily striated (graphite-streaked) than the more steeply dipping portions.

Note: Measured bearing was given as S15W, an impossibility for this fault. Undoubtedly the wrong end of compass needle was read, and the bearing should have been recorded as N15E. The data given above were calculated accordingly.

STATION 6 – Southeast wall of the Fill quarry, south of the eastern entrance to the quarry from the core shed. Elevation 618 ft, at mine coordinates 660N, 1315W.

Fault no. 38

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-38	N60W/72NE	N38W (N40W)	46 (49)	(53 NW) (49 NW)

Comments: Graphite-streaked fault surface through fine-grained graphitic marble. Apparent step faces in a thin coating interpreted to be accretionary calcite suggest a reverse sense of slip, but the relations here are subtle at best. *Note:* The bearing measurement is probably more accurate than the plunge.

Fault no. 39

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-39	N69W/76NE	N10W* (N18W)	72 (74)	(82 NW) (79 NW)

Comments: A different portion of the same fault, through the same rock type, as no. 38 above. Probable thin accretionary calcite on fault surface shows tiny step faces, readily visible with a hand lens, that suggest reverse sense of slip. Minor violet fluorite also coats this fault surface. The calcite accretionary material is superimposed on the graphite-smeared fault surface and the accretionary calcite of fault no. 38, making this dip-slip reverse movement the younger phase. The age relations appear fairly certain here.
* The bearing measurement as originally recorded in our field notes was S10E, an impossibility. Because we mention that this fault shows dip-slip movement, almost certainly the wrong end of the compass needle was read, and the intended bearing measurement was N10W. This results in a calculated plunge angle of 74°, in good agreement with the measured plunge angle of 72°.

Fault no. 40

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-40	N49W/63SW	N48W (N52W)	05 (02)	(06 NW) (02 SE)

Comments: Fault in medium- to coarse-grained, sparsely graphitic marble. White accretionary calcite on the fault surface is weathered, but tiny step faces in this material suggest right-lateral slip. *Note:* The plunge measurement is probably more accurate than the bearing.

Fault no. 41

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-41	N54W/64SW	S58W (S54W)	63 (62)	(80 NW) (82 NW)

Comments: Same fault as no. 40 above. White accretionary calcite in patches on the fault surface reveal, upon inspection with a hand lens, tiny step faces that suggest the hanging wall moved down (later note: incorrect interpretation; these are reverse faults). In two places the steeply plunging fibers curve to horizontal through a tight bend. Step directions indicate strike-slip movement followed the dip-slip movement. This is consistent with observations elsewhere on the fault surface that steeply plunging calcite fibers are plated over by apparently younger calcite showing horizontal fibers, and that locally the steeply plunging fibers appear to bear nearly horizontal scratches.

STATION 7 – Southeast wall of Fill quarry, about 40 to 75 ft SW of quarry entrance from core shed area, southwest of station 6, at mine coordinates 620N, 1325W.

Fault no. 42

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-42	N52W/83SW	(S02W)	(81)	85 SE

Comments: Minor fault through coarse-grained marble with blocky cleavage. Thin coating of probable accretionary calcite fibers is poorly exposed; sense of slip unknown.

Fault no. 43

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-43	N44E/57NW	S76W (S73W)	37 (39)	(49 SW) (46 SW)

Comments: Fault in medium- to coarse-grained marble. Well-defined step faces in a thin coating of calcite accretionary fibers show that the hanging wall moved down and to the southwest.

Fault no. 44

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-44	N56W/79SW	(S05W)	(77)	84 SE

Comments: Fault in medium- to coarse-grained marble. Minor accretionary calcite on fault surface; sense of slip unknown.

Fault no. 45

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-45	N55W/71SW	(S09W)	(69)	81 SE

Comments: Graphite-streaked fault surface in medium- to coarse-grained, sparsely graphitic marble. Step faces in probable accretionary calcite suggest reverse sense of slip.

Fault no. 46

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-46	N57W/81SW	(S30E)	(71)	73 SE

Comments: Graphite-streaked fault surface in medium- to coarse-grained graphitic marble. Sparse accretionary calcite in tiny patches show minute step faces that suggest reverse sense of slip.

STATION 8 – Fill quarry, southeast wall, about 100 ft southwest of east entrance from core shed area, southwest of stations 6 and 7. Center of station is at mine coordinates 560N, 1355W.

Fault no. 47

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-47	N52E/45SE	S18E	50* (43)	(75 SW)

Comments: Fault in medium- to coarse-grained graphitic marble with local norbergite. Fault surface is weathered, coated with accretionary calcite, and lightly limonite-stained. Step faces in the accretionary calcite indicate normal sense of slip.

* A plunge angle of 50^{o} is impossible for a fault dipping 45^{o}. Most faults in the mine, however, are nonplanar, so the plunge as here recorded was probably measured on a more steeply dipping portion.

Because plunge is measured at a point on the fault, whereas we normally measured the *average* dip of the fault surface, we accepted the dip as accurate and calculated an average plunge of 43º from the measured bearing.

Fault no. 48

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-48	N38E/45NW	N71W	(43)	(76 SW)

Comments: Minor fault through medium-grained graphitic marble with scattered tremolite. Sense of slip unknown.

Fault no. 49

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-49	N61W/73SW	S23W	(73)	(88 SE)

Comments: Fault in medium-grained graphitic marble with minor phlogopite. Graphite-streaked fault surface; sense of slip unknown. The graphite streaks are minimal and are on a semipolished fault surface.

Fault no. 50

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-50	N46W/76SW	N52W (N59W)	42	(44 NW)

Comments: A different portion of the same fault as no. 49; this fault curves fairly markedly along strike. The fault here is coated with a second generation of calcite accretionary fibers that appear younger than those described above. Small step faces in the accretionary calcite suggest the hanging wall moved to the northwest, indicating a substantial right-lateral component of movement. The fault surface is undulatory and "corrugated" in shape, with the axes of the undulations parallel to the calcite fibers of no. 49, again suggesting that the dip-parallel slip was the earlier phase of movement. In addition, the steeply pitching calcite fibers are locally scratched parallel to the fibers documented here, and the accretionary calcite of fault no. 50 appears plated over the dip-parallel graphite streaks of fault no. 49. *Note:* Calculating the bearing from the measured plunge of 42º results in only a 7º difference between the measured and calculated bearing values – a reasonable result. Calculating the plunge from the measured bearing, however, results in a plunge of only 22º, and it is highly unlikely that our actual plunge measurement of 42º was in error by a full 20º. (Small differences in bearing for a steeply dipping fault result in large differences in calculated plunge angles). We have therefore accepted the measured plunge of 42º and the calculated bearing of N59W.

Fault no. 51

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-51	N30E/60SE	S59E (S58E)	60 (approx.) (60)	(89 SW)

Comments: Graphite-smeared and calcite-coated fault surface through fine- to medium-grained graphitic marble. Step faces in probable accretionary calcite suggest normal sense of slip.

Fault no. 52

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-52	N27W/77NE	(S52E)	(61)	64 SE

Comments: Graphite-streaked fault surface through fine-grained graphitic marble. Sense of slip unknown.

Fault no. 53

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-53	N60E/73SE	S20E	(73)	(87 SW)

Comments: Fault through medium-grained graphic marble. Fault is exposed along strike for about 20 m. The fault surface is highly undulatory along strike, but the orientation given here is close to the overall average. Fault no. 52 terminates against this one (but see fault no. 54 for data on a younger slip event along this fault.). The calcite along this fault has an extremely fine-grained, porcelain-like appearance and is streaky, pale to dark gray, due to sheared-out graphite; this is a mylonitic foliation. Sense of slip unknown.

Fault no. 54

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-54	N57E/67SE	S61E (S67E)	63 (64)	(78 NE) (75 NE)

Comments: Same fault as no. 53, but a second set of slickenlines defined by fibrous minerals plated on the mylonitic foliation, and thus recording a later phase of movement. These slickenlines are present only at scattered places on the fault surface. The accretionary material defining the slickenlines is calcite, locally mixed with a finely fibrous mineral, perhaps an amphibole. Minute step faces in one area suggest a normal sense of offset, but the evidence is not strong. *Note:* The bearing measurement is probably more accurate than the plunge.

Fault no. 55

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-55	N60E/65SE	S10E (S07E)	63 (64)	(81 SW) (80 SW)

Comments: Same fault as no. 53, but about 8 m farther to the southwest. The slickenlines define a stretching lineation on mylonitic foliation, again much like that of no. 53. Sense of slip unknown.

STATION 9 – Fill quarry, southeast side, about 50 ft from the southwest end of the southeast wall, at mine coordinates 460N, 1380W.

Fault no. 56

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-56	N40E/68SE	S68E	(67)	(83 NE)

Comments: Graphite-streaked fault surface through fine- to medium-grained, sparsely graphitic marble with scattered grains of a pale-colored mica and tremolite. The striated portions of the fault surface dip less steeply than the overall fault, which, for a fault that is undulatory in dip, would imply a normal sense of slip. Our notes also indicate that the fault surface is stepped rather than undulatory – that is, it is composed of a series of *en echelon*, striated segments that have a slightly lesser dip than that of the overall fault surface. If these were Riedel shears, a reverse sense of slip would be implied instead. However, we have also noted, throughout this study, that similar *en echelon*, striated surfaces, if interpreted as Riedel shears, imply a sense of slip opposite to that known to have occurred as documented by step faces in accretionary minerals, attachment points of accretionary fibers, offsets of marker horizons, etc. We are thereby forced to conclude that these are not Riedel shears and the slip sense is indeed normal. See comments after fault no. 68 for additional examples on another set of faults.

Fault no. 57

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-57	N04E/55SE	S82E	(55)	(88 SW)

Comments: Graphite-streaked fault surface through medium-grained graphitic marble. The fault surface and its striae have the same character as in fault no. 56 above.

Fault no. 58

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-58	N05W/55NE	N85E	(55)	(90)

Comments: Minor fault through fine-grained, graphitic and locally micaceous marble. Graphite-streaked fault surface; sense of slip unknown. Total slip probably only a few centimeters.

Fault no. 59

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-59	N02E/66SE	S81E	(66)	(87 SW)

Comments: Fault through fine- to medium-grained, tremolitic and sparsely micaceous marble. Sense of slip unknown. A small area of white calcite accretionary fibers is apparent under a hand lens, but there is too little of it for the sense of slip to be apparent.

STATION 10 – Fill quarry, southeast side, about 8 m from southwest corner of southeast wall, at mine coordinates 430N, 1420W.

Fault no. 60

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-60	N37W/64SW	N42W (N39W)	03 (10)	(03 NW) (11 NW)

Comments: Minor fault in medium-grained graphitic marble with scattered tremolite. Abundant white calcite accretionary fibers with well-defined step faces indicate right-lateral movement; very clear indication of this slip sense here.

Fault no. 61

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-61	N36W/67SW	N42W (N40W)	08 (14)	(09 NW) (15 NW)

Comments: All remarks for fault no. 60 apply here as well. *Note:* The plunge measurement for this fault is probably more accurate than the bearing.

Fault no. 62

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-62	N46W/61SW	N52W (N49W)	06 (10)	(07 NW) (12 NW)

Comments: Minor fault through medium-grained graphitic marble. Graphite-streaked fault surface; sense of slip undetermined. *Note:* The plunge measurement for this fault is probably more accurate than the bearing.

STATION 11 – Fill quarry, northeast side, near southeast corner, at mine coordinates 430N, 1460W.

Fault no. 63

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-63	N35W/62NE	N26W (N27W)	14 (13)	(16 NW) (15 NW)

Comments: Fault in fine- to medium-grained graphitic marble with tremolite-rich layers. Graphite-streaked fault surface; sense of slip unknown. *Note:* The plunge measurement is probably more accurate than the bearing.

Fault no. 64

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-64	N48W/80NE	N40W (N46W)	14	(14 NW)

Comments: The same comments for fault no. 63 apply here also. Minor violet fluorite coats the fault surface.

Fault no. 65

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-65	N22W/65NE	N23W (N22W)	01	(01 NW)

Comments: The same comments apply here as for fault no. 63.

Fault no. 66

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-66	N40W/71NE	(N38W)	05 NW	(05 NW)

Comments: The same comments apply here as for fault no. 63.

Fault no. 67

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-67	N05W/59NE	(N03E)	13 N	(15 NW)

Comments: The same comments apply here as for fault no. 63.

Fault no. 68

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-68	N78W/69SW	N80W (N76W)	05	(05 NW)

Comments: Fault in fine- to medium-grained, graphitic to locally micaceous marble. Graphite-streaked fault surface; sense of slip unknown. *Note:* The plunge measurement is probably more accurate than the bearing because the fault is slightly irregular along strike.

General comment on faults no. 63 through no. 68 above: The northeast-facing hanging-wall surface of each of these faults is exposed. Each of these surfaces is composed of multiple *en echelon* segments, all graphite-streaked, with the low steps between adjacent segments facing southeast – that is, the individual *en echelon* segments have slightly more westerly strikes than does the overall fault surface.

Note that the streaked surfaces and the low steps between them are in *rock*, not in accretionary minerals deposited upon the fault surface, and have an entirely different mechanical significance. The edge of each step as it crops out on the fault surface is irregular, much more so than the broken edges on accretionary minerals, where the step faces are more uniformly perpendicular to the slip direction. The rock-cut surfaces here, if interpreted as classic Riedel shears, would be indicative of left-lateral slip. However, undoubted

calcite accretionary fibers, wherever they are well preserved on the NNW-striking faults in this same general area, consistently indicate a right-lateral sense of slip, and they are much the more definitive slip indicator. Further study is needed to more fully understand the mechanical significance of the *en echelon* fault segments.

Fault no. 69

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-69	N48W/83NE	(N46W)	17	(17 NW)

Comments: Fault in fine- to medium-grained graphitic marble with scattered tremolite. Highly weathered, mineral-streaked and scratched fault surface with sparse fibrous accretionary calcite. Poorly preserved step faces in the accretionary calcite, exposed in an area of only 1 cm^2, suggest right-lateral slip, but the evidence is weak here. The low, rock-cut step surfaces between adjacent *en echelon* parts of the fault surface itself (see discussion above) face southeast, as on the other strike-slip fault surfaces in this area.

STATION 12 – Fill quarry, southwest (rear) wall, near center of wall at base of quarry. Station is centered on mine coordinates 445N, 1490W.

Fault no. 70

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-70	N57W/52SW	(S40E)	20 SE	(26 SE)

Comments: Fault in fine-grained graphitic marble. The fault surface preserves thin patches of finely fibrous accretionary calcite, within which delicate step faces and points of attachment of individual fibers to the wallrock are clearly displayed. These fibers consistently indicate a right-lateral sense of slip.

Fault no. 71

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-71	N71W/50SW	S12E	(46)	(69 SE)

Comments: Graphite-streaked fault surface in marble bears thin, patchy films of finely fibrous accretionary material, possibly calcite mixed with an amphibole. Apparent step faces in the accretionary material suggest a reverse sense of slip (hanging wall moved up and to the northwest), but another part of this fault seemingly suggests the opposite; the accretionary calcite is just too thin to preserve definitive step faces to infer slip sense with any confidence. This is another portion of the same fault as no. 70, but the steeply plunging striations documented here are the most common over the greatest area of the fault surface and seem to record the dominant episode of slip along it.

Fault no. 72

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-72	N71W/50SW	S14W	(50)	(87 SE)

Comments: This is the same fault as nos. 70 and 71 above, but the bearing is for a third, very minor set of finely fibrous, patchy accretionary material on small portions of the fault surface. This material appears to have been plated onto the accretionary material of fault no. 71 and thus is interpreted as recording a later phase of movement. Moreover, the ends of the calcite fibers of this phase appear to be attached to the accretionary material of fault no. 71, again suggesting that these fibers record the youngest episode of slip along this fault.

Fault no. 73

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-73	N18W/81NE	N16W (N13W)	(28)	28 NW

Comments: This fault, in fine-grained graphitic marble, cuts across and offsets the fault recorded in nos. 70 through 72 above; thus at least some movement along it postdates creation of that fault. However, small strands of the previous fault intersect this one and can be traced across it, so some movement on the previous fault probably postdated creation of this one. Minor, thin films of accretionary calcite line the fault surface, but this material is too thin and sparse for the slip sense to be apparent. *Note:* For such a steeply dipping fault, the pitch measurement is more trustworthy than the bearing. However, the two are in excellent agreement; the calculated bearing is only 3º different from that measured.

Fault no. 74

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-74	N37W/32SW	N47W	04 to 10 (06)	(12 NW)

Comments: Graphite-streaked fault surface through fine- to medium-grained graphitic marble. The upper plate of this fault moved northwest about 1.5 cm, as shown by offsets of multiple, thin compositional layers in the marble. This fault is abruptly cut off by another fault of orientation N37E/70SE, but no slip indicators were evident on this later fault.

Fault no. 75

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-75	N72W/52SW	S28E	(42)	(58 SE)

Comments: Minor fault through fine-grained, graphitic marble with minor tremolite. Patchy, very thin films of fibrous accretionary material are preserved on a few square centimeters of the fault surface; also present is minor violet fluorite. The sense of slip is probably oblique-slip reverse (hanging wall moved up and to northwest), but step faces in the accretionary material are so low and delicate that the evidence is uncertain.

Fault no. 76

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-76	N32E/50NW	N74W	(49)	(80 SW)

Comments: Minor fault through fine-grained graphitic, tremolitic marble. Well-developed step faces in white accretionary calcite clearly indicate reverse sense of slip, as does observed offset of compositional layers in the marble. This fault offsets the fault of nos. 70-72, again confirming the reverse sense of slip.

Fault no. 77

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-77	N19E/50NW	N80W	(50)	(84 SW)

Comments: Minor fault through fine-grained graphitic marble with local tremolite. Step faces in thin coating of accretionary calcite suggest reverse sense of slip.

Fault no. 78

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-78	N33E/52NW	N72W	(51)	(81 SW)

Comments: Minor fault through fine-grained graphitic marble with local tremolite. Step faces in thin coating of accretionary calcite suggest reverse sense of slip.

Fault no. 79

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-79	N26E/55NW	N75W	(55)	(84 SW)

Comments: Minor fault through fine-grained graphitic marble with local tremolite. Films of accretionary calcite on fault surface are too thin for slip sense to be apparent.

Fault no. 80

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-80	N53E/50NW	N55W	(49)	(78 SW)

Comments: Minor fault, total slip only 2 mm, in fine- to medium-grained graphitic marble with scattered tremolite. Tiny bundles of calcite accretionary fibers coat the fault surface; step faces in this material indicate reverse sense of slip.

Fault no. 81

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-81	N34E/50NW	N67W	(49)	(83 SW)

Comments: Fault in fine- to medium-grained graphitic marble. Step faces in thin films of fibrous accretionary calcite suggest reverse sense of slip.

Fault no. 82

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-82	N62W/47SW	S07W	(45)	(75 SE)

Comments: Minor fault in fine- to medium-grained graphitic marble with local tremolite. Delicate films of calcite and amphibole(?) accretionary fibers are present on fault surface, but there is too little for sense of slip to be determined.

Fault no. 83

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-83	N42E/57NW	N20W	(54)	(74 NE)

Comments: Fault in fine- to medium-grained graphitic marble with abundant tremolite. Well-developed calcite accretionary fibers on fault surface; step faces and attachment points of individual fibers are clearly visible and indicate reverse sense of slip.

Fault no. 84

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-84	N63E/56NW	N02E	(52)	(73 NE)

Comments: Fault in medium-grained tremolite-mica-graphite marble. Calcite accretionary fibers on fault surface indicate reverse sense of slip.

Fault no. 85

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-85	N56W/33NE	N73E	(27)	(56 SE)

Comments: Minor fault with total offset probably 1 cm or less. The trace length of this fault as measured perpendicular to the transport direction is only 30 cm. Abundant accretionary fibers, probably of an amphibole, coat the fault surface; step faces in this mineral suggest the upper plate moved up and to the WSW. Minor violet fluorite is also present on the fault surface.

STATION 13 – Fill quarry, northwest wall, footwall of East limb, near SW end and extending northward to the ore pillar, between mine coordinates 480N, 1540W and 595N, 1460W.

Fault no. 86

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-86	N27E/32NW	N70W	(32)	(84 SW)

Comments: Highly weathered fault surface through coarse-grained franklinite-calcite ore near footwall of East limb. Minute step faces in remnants of probable accretionary fibrous material on fault surface suggest upper plate moved to the NW. Also lining this fault is a 1-mm-thick layer of post-faulting calcite in tiny, flattened, tightly intergrown crystals.

Fault no. 87

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-87	N60E/37NW	N66W	(31)	(60 SW)

Comments: A different portion of same fault as no. 86 above, in very coarse-grained, lean franklinite-calcite ore, along the footwall of the East limb. Readings were taken on a small, smooth portion of the fault surface which elsewhere is moderately to highly weathered. Visible striae are probably due to accretionary material on the fault but are inaccessible to close study. The ore in places here is highly magnetic and markedly deflects a compass needle. Sense of slip unknown.

Fault no. 88

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-88	N69W/75SW	(S16E)	(71)	79 SE

Comments: Fault in medium- to coarse-grained, medium- to high-grade franklinite-calcite ore. The slickenlines represent scratches in the fault surface. Upon the fault are coatings of post-movement white calcite and brilliant blue azurite, the latter in radiating, bladed crystal rosettes as much as 1 cm across. This fault surface is exposed over a height of at least 10 m. Sense of slip unknown.

Fault no. 89

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-89	N81E/32NW	N72W	(16)	(31 SW)

Comments: Fault in medium- to coarse-grained, medium- to high-grade franklinite-calcite ore. This fault is exposed along almost the entire length of the northwest wall of the Fill quarry. In places along it the wallrock is visibly highly sheared, showing extreme smearing-out of minerals. Calcite accretionary fibers are locally present within a zone 5/16 inch thick. Sense of slip unknown.

Fault no. 90

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-90	N73W/68SW	(S04W)	(67)	85 SE

Comments: Fault in medium- to high-grade franklinite-calcite ore near footwall of East limb. Slickenlines represent mechanical scratches on fault surface. Minor accretionary material is also present, but too little for the sense of slip to be determined.

Fault no. 91

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-91	N37W/69SW	(N39W)	(05)	05 NW

Comments: Fault in lean, very coarse-grained ore consisting of calcite and disseminated franklinite. Calcite accretionary fibers on fault surface suggest probable right-lateral slip.

Fault no. 92

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-92	N55E/29NW	N64W	(26)	(64 SW)

Comments: Irregular fault surface through low- to moderate-grade, very coarse-grained ore consisting of calcite with disseminated franklinite, near footwall of East limb. This is another strand of the same long, multistranded, low-angle fault mentioned above (fault no. 89). Calcite accretionary fibers on fault surface indicate that upper plate moved to the NW. A layer 1 mm thick of white, post-movement calcite also lines the fault surface here.

Fault no. 93

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-93	N20W/60SW	(S10E)	(16)	19 SE

Comments: Fault in high-grade ore consisting of franklinite, willemite, and sparse zincite. The ore here is not perceptibly magnetic, in contrast to that closer to the footwall marble contact. The slickenlines represent mechanical scratches on the fault surface; also present is minor accretionary material in delicate, flexible fibers. The sense of slip is probably right-lateral, but the evidence is hardly convincing, and the accreted material is too thin for step faces to be visibly well defined.

Fault no. 94

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-94	N24W/68SW	S17W	(59)	(67 SE)

Comments: Fault through high-grade franklinite-willemite-calcite ore. Prominently scratched fault surface; sense of slip unknown.

Fault no. 95

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-95	N59W/41NE	N36E	(41)	(86 SE)

Comments: Fault through high-grade franklinite-willemite-calcite ore. This fault cuts across and offsets fault no. 94. Weakly defined steps in calcite accretionary fibers on fault surface suggest upper plate moved SW, consistent with the observed offset of fault no. 94. Total slip is a few centimeters at most, in a reverse sense.

Fault no. 96

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-96	N08E/07SE	S19E	(03)	(27 SW)

Comments: Fault through medium- to high-grade, medium-grained franklinite-calcite ore near the hanging wall of the East limb. Finely matted fibers of an unidentified mineral coat the fault surface; attachment points of these fibers on individual franklinite grains on the fault surface suggest the upper plate moved to the NW.

STATION 14 – Within and northeast of the ore pillar (East limb ore) along the northwest wall of the Fill quarry, thence extending northward to the dirt road connecting the Fill quarry to the Passaic pit, between mine coordinates 615N, 1455W and 720N, 1440W.

Fault no. 97

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-97	N49W/58SW	(S35E)	22 SE	(26 SE)

Comments: Fault through medium- to high-grade, medium-grained franklinite-calcite ore near the hanging wall of the East limb. Well-developed calcite accretionary fibers on fault surface indicate right-lateral slip; very clear evidence here.

Fault no. 98

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-98	N85E/25NW	N76W	(09)	(21 SW)

Comments: Fault through medium- to high-grade, medium-grained franklinite-calcite ore. This fault cuts the hanging-wall contact of the ore and extends into the very coarse-grained, blocky calcite above. Well-developed step faces in accretionary calcite coating the fault surface show the upper plate moved to the WNW; very clear evidence here. Some post-movement calcite is also present as a thin film atop the fibrous accretionary material.

Fault no. 99

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-99	N63W/35NE	N22E	(35)	(86 NW)

Comments: Fault through medium-grained, medium- to high-grade franklinite-calcite ore. Thin accretionary material on the fault surface consists of finely fibrous calcite, perhaps mixed with a fibrous amphibole; this material is too thin for the slip sense on the fault to be apparent. Abundant post-movement calcite also coats the fault surface here and largely obscures the earlier accretionary material.

Fault no. 100

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-100	N36W/60SW	(S31E)	09 SE	(10 SE)

Comments: Fault through medium-grained, high-grade franklinite-calcite ore. Calcite accretionary fibers coat much of the fault surface, though little of this surface is exposed. Slip sense undetermined.

Fault no. 101

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-101	N36W/55SW	(S22E)	19 SE	(23 SE)

Comments: Fault through medium-grained, high-grade franklinite-calcite ore. Steps in calcite accretionary material on small part of fault surface suggest right-lateral sense of slip, but not convincingly so; other parts of the fault could be read the opposite way.

Fault no. 102

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-102	N29W/73SW	(N29W)	01 NW	(01 NW)

Comments: Fault in coarse-grained calcite-franklinite ore. The fault surface is coated with thin films of accretionary calcite. Slip sense probably right-lateral, but evidence is not convincing, and little of the fault is exposed.

Fault no. 103

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-103	N38W/57SW	(S26E)	18 SE	(22 SE)

Comments: Fault in medium-grained, medium-grade franklinite-calcite ore. Calcite accretionary fibers are exposed over several cm^2 of fault surface; attachment points of the fibers fairly confidently indicate right-lateral sense of slip.

Fault no. 104

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-104	N42W/79SW	S23W	(78)	(85 SE)

Comments: Fault in medium-grained, medium-grade franklinite-calcite ore. This is another strand of fault no. 103 above and shows two orientations of calcite accretionary fibers on the fault surface, one set shallowly plunging as recorded for fault no. 103, and the other set steeply plunging as recorded here. A reverse sense of slip is indicated for the fibers of the more steeply plunging set. Some of the fibers are seen to curve in continuity from steep to shallow plunges, but they are not well exposed, so the age relation between the steep and shallow portions remains undefined here. *Note:* Our original field notes indicate an approximate plunge angle of 46º, an obvious recordation error, especially since we specified that this set of fibers plunges steeply. The measured bearing of S23W gives a plunge of 78º, almost as steep as the fault plane dip of 79º, in accordance with our description.

Fault no. 105

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-105	N24W/65SW	(S22W)	(57)	68 SE

Comments: Fault in highly magnetic, high-grade, medium- to coarse-grained franklinite-calcite ore. The fault surface bears mechanical scratches and is thinly coated with accretionary fibers of an undetermined mineral. Sense of slip unknown.

Fault no. 106

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-106	N74E/24NW	N69W	(15)	(40 SW)

Comments: Fault in highly magnetic, high-grade, medium- to coarse-grained franklinite-calcite ore. Poorly exposed step faces in thin coating of calcite accretionary fibers suggest upper plate moved to the NW.

Fault no. 107

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-107	N18W/60SW	(S14W)	(42)	51 SE

Comments: Fault in high-grade, medium-grained franklinite-calcite ore. Step faces in calcite accretionary material on fault surface clearly indicate reverse sense of slip.

Fault no. 108

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-108	N33W/69SW	(S27E)	15 SE	(16 SE)

Comments: Fault in high-grade, medium-grained franklinite-calcite ore. Well-developed step faces in calcite accretionary material clearly indicate a right-lateral sense of slip.

Fault no. 109

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-109	N28W/65SW	S04W	(49)	68 SE (approx.) (56)

Comments: Fault in high-grade, medium-grained franklinite-calcite ore. Scratched and lightly calcite-coated fault surface, little of which is exposed. Minute step faces on apparent accretionary material on fault suggest reverse sense of slip.

Fault no. 110

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-110	N28W/65SW	S14E (S25E)	07	(08 SE)

Comments: Same fault and rock type as no. 109 above. Patchy calcite accretionary fibers here record an apparently minor phase of movement along this fault. These fibers appear to have grown atop those recorded in fault no. 109 and thus probably are younger. *Note:* The plunge measurement given here is probably more accurate than the bearing.

Fault no. 111

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-111	N43W/57SW	S21E (S14E)	36	(45 SE)

Comments: Fault in medium-grained, lean to moderate-grade franklinite-calcite ore. Fibrous white accretionary material on fault surface shows only a weak reaction to dilute HCl and is possibly willemite mixed with calcite (see note after fault no. 112 below). Step faces in this accretionary material indicate an oblique reverse sense of slip. *Note:* The plunge measurement given here is probably more accurate than the bearing.

Fault no. 112

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-112	N33W/65SW	S26E (S29E)	08	(09 SE)

Comments: Fault in lean to moderate-grade franklinite-calcite ore. Accretionary material on fault surface is probably calcite mixed with some other white fibrous mineral, likely willemite. Step faces in this material indicate right-lateral sense of slip.

Note: Within the semidark interior of the ore pillar, an ultraviolet lamp reveals finely fibrous secondary willemite on many fault surfaces, but the willemite is difficult to identify in the bright glare of daylight.

Fault no. 113

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-113	N85E/24NW	N64W	(13)	(33 SW)

Comments: Fault in medium-grained, moderate-grade franklinite-calcite ore with disseminated secondary copper minerals, probably derived from original sulfides (likely chalcocite). White accretionary material, some of it calcite, is preserved on part of the fault surface but is weathered. Sense of slip unknown; only a tiny part of the fault surface is exposed.

Fault no. 114

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-114	N21W/60SW	S02W (S02W)	34	(40 SE)

Comments: Fault in medium-grained, moderate- to high-grade franklinite-calcite ore. Accretionary fibers on fault surface clearly indicate oblique reverse sense of slip with a right-lateral component; the hanging wall moved up and to the NW. The accretionary material is calcite only in part and is mixed with two other fibrous minerals, one white (likely willemite) and the other brown and resembling serpentine. *Note:* The plunge measurement given here is more accurate than the bearing.

Fault no. 115

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-115	N28E/60NW	S47W (S46W)	28 SW	(33 SW)

Comments: Fault in medium-grained, moderate- to high-grade franklinite-calcite ore. Steps in fibrous calcite accretionary material indicate with fair certainty that the hanging wall moved up and to the NE. Thin films of post-movement calcite also line this fault surface. *Note:* The bearing measurement was approximate only, but agrees well with that calculated from the plunge.

Note: This area, a couple of meters SW of the large indentation in the rock wall near the NW entrance to the Fill quarry, is a good place to measure fault abundances and thicknesses of fault-filling minerals to gain some idea of the percentage of open space created by faulting.

Fault no. 116

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-116	N36E/40NW	S48W (S48W)	10	(16 SW)

Comments: Minor fault in high-grade, medium- to coarse-grained franklinite-calcite ore. Step faces in accretionary material show clearly that the upper plate moved to the NE (right-lateral slip). The accretionary material on this fault was not identified; it is white to brown, much discolored by weathering, and shows almost no reaction to dilute HCl.

Fault no. 117

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-117	N06E/33NW	N49W	(28)	(60 NE)

Comments: Fault in high-grade, medium- to coarse-grained franklinite-calcite ore. Well-developed step faces in accretionary material, at least in part calcite, show clearly that the upper plate moved to the NW. This is a minor low-angle fault with a trace length, as measured perpendicular to the transport direction, of only 28 cm.

Fault no. 118

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-118	N67E/27NW	N47W	05 (25)	(68 SW)

Comments: Fault in high-grade, medium- to coarse-grained franklinite-calcite ore. Abundant, large, well-developed step faces in thick accretionary calcite lining this fault surface show that upper plate moved to the NW. Malachite in places is locally intergrown with the fibrous accretionary calcite on the fault surface. *Note:* The bearing measurement given here is probably more accurate than the plunge.

Fault no. 119

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-119	N17W/63SW	(S29W)	(54)	66 SE

Comments: Fault in high-grade, medium- to coarse-grained franklinite-calcite ore. Large, well-exposed fault surface. Abundant, well-developed step faces in accretionary material, in part calcite, clearly indicate reverse sense of slip. Much of the accretionary material is translucent, honey-brown serpentine. This fault cuts across the thrust fault noted above, no. 118, and the accretionary material coating it is unbroken across that fault, so fault no. 119 appears to be the younger of the two.

Fault no. 120

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-120	N69E/38NW	N64W	(30)	(54 SW)

Comments: Well-exposed, low-angle fault through moderate- to high-grade, medium-grained franklinite-willemite-calcite ore with abundant scattered malachite and azurite on oxidized surfaces. The secondary copper minerals were derived from original chalcocite, small masses of which are preserved in the rock. Abundant, large, well-formed step faces in accretionary material on the fault surface indicate that the upper plate moved to the NW.

Fault no. 121

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-121	N57W/78NE	(S72E)	(51)	53 SE

Comments: Minor fault through medium-grade franklinite-calcite ore. Accretionary fibers on fault surface appear to be mostly serpentine; step faces suggest probable reverse sense of slip.

Fault no. 122

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-122	N11W/55SW	(S18W)	(35)	44 SE

Comments: Minor fault through medium-grade franklinite-calcite ore. The fault surface bears mechanical scratches and also thin coatings of accretionary material, seemingly in part calcite, tiny step faces in which suggest a reverse sense of slip. The previous fault, no. 121, ends abruptly against this one.

Fault no. 123

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-123	N60W/52SW	(N60W)	00	(00)

Comments: Fault in medium-grade franklinite-calcite ore. Step faces in accretionary material suggest right-lateral movement with fair but not absolute certainty. The accretionary material is in part white and fibrous, but noncalcareous; its mineralogy was not determined.

Fault no. 124

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-124	N23W/46SW	S01E (S06E)	17 (21)	(30 SE) (24 SE)

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite. Tiny step faces in thin, fibrous accretionary material suggest right-lateral sense of slip.

Fault no. 125

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-125	N67E/89SE	(S64W)	(69)	69 SW

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite. Calcite accretionary fibers are well developed in patches in recesses of the irregular fault surface. The calcite is intergrown with a pale-colored, very finely fibrous mineral, not yet identified. Well-developed step faces in the accretionary material and attachment points of individual fibers show that the NW side of the fault is the upthrown block. This fault clearly predates, and is cut off by, fault no. 124 described above.

Fault no. 126

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-126	N58E/83NW	(S72W)	(63)	64 SW

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite. Slip sense unknown. Character of accretionary material on this fault surface is similar to that described for fault no. 125 above.

Fault no. 127

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-127	N61E/85NW	(S74W)	(69)	70 SW

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite. Slip sense unknown. Character of accretionary material on this fault surface is similar to that described for fault no. 125. This fault, too, seems to be cut off by fault no. 124.

Fault no. 128

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-128	N49W/47SW	(N52W)	03 NW	(04 NW)

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite. Abundant, tiny, well-formed step faces in finely fibrous accretionary material clearly indicate right-lateral sense of slip. Fibers on fault surface are in part calcite and probably in part serpentine.

Fault no. 129

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-129	N61E/63NW	N61W	(59)	(74 SW)

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite along footwall of East limb. Prominent, well-developed step faces in abundant, white to medium brown, finely fibrous accretionary material, in part calcite, indicate that the hanging wall moved up.

Fault no. 130

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-130	N55E/65NW	N67W	63 (61)	(75 SW)

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite along footwall of East limb. Prominent, well-developed steps in white to medium brown, finely fibrous accretionary material, in part calcite, indicate that the hanging wall moved up.

Fault no. 131

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-131	N85E/48NW	N43E	35 (36)	(53 NE)

Comments: Fault in medium-grained micaceous marble with scattered grains of franklinite. Abundant, well-formed step faces in fibrous accretionary calcite indicate that the hanging wall moved up and to the SW.

Fault no. 132

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-132	N33W/63SW	(N33W)	00	(00)

Comments: Fault in medium-grade franklinite-calcite ore. Weathered fault surface, but finely fibrous accretionary calcite is preserved in small patches. Tiny step faces in this material suggest right-lateral sense of slip.

Fault no. 133

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-133	N41W/59SW	(N44W)	04 NW	(05 NW)

Comments: Fault in medium-grade franklinite-calcite ore. The fault is coated with abundant white fibers of an unidentified mineral that shows no reaction to dilute HCl. Numerous tiny step faces in this accretionary material clearly indicate right-lateral sense of slip.

STATION 15 – Fill quarry, near and northeast of the entrance to the quarry from the Passaic pit. Center of station is at mine coordinates 1745N, 1375W.

Fault no. 134

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-134	N44W/65SW	(N47W)	07 NW	(08 NW)

Comments: Fault in medium-grained, low-grade franklinite-calcite ore near footwall of East limb. Abundant step faces in well-developed calcite accretionary fibers clearly indicate right-lateral sense of slip.

Fault no. 135

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-135	N65E/25NW	N67W	(19)	(51 SW)

Comments: Fault in very high-grade zincite-franklinite-calcite ore. A white, finely fibrous mineral (willemite?) and some secondary zincite are accreted on the fault surface. Fine step faces in this material show that the upper plate moved to the NW. This is a well-exposed fault near the entry to the old stope at the NW end of the NE face of the Fill quarry.

Fault no. 136

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-136	N81W/63SW	(N82W)	03 NW	(03 NW)

Comments: Fault in fine- to medium-grained, sparsely graphitic marble. Graphite-smeared fault surface. Sense of slip unknown, but apparent calcite accretionary fibers in an area of about 2 cm^2 on part of fault surface tenuously suggest a right-lateral sense of slip.

STATION 16 – Road to upper yard, low outcrops on WSW side. Station is centered on mine coordinates 1600N, 1380W.

Fault no. 137

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-137	N41W/50SW	S23E	(20)	(27 SE)

Comments: Fault in micaceous, coarse-grained tremolite marble. Numerous, prominent step faces in accretionary calcite, and fiber attachment points on individual calcite fibers, clearly indicate right-lateral sense of slip.

Fault no. 138

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-138	N58W/42SW	S04W	(38)	(68 SE)

Comments: Fault in micaceous, coarse-grained tremolite marble. The fault surface, though weathered, is well exposed and prominently grooved along the presumed direction of slip. No accretionary calcite was observed on its surface, and the slip sense on the fault was not determined.

Fault no. 139

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-139	N38W/67SW	S23E (S19E)	38 (31)	(34 SE) (42 SE)

Comments: Fault through medium-grained, micaceous graphitic marble. Sense of slip is probably right lateral, but calcite accretionary fibers on fault surface are much too weathered to be certain. *Note:* The bearing measurement given here is probably more accurate than the plunge.

Fault no. 140

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-140	N30W/31SW	S10E (S18E)	07 (12)	(23 SE) (14 SE)

Comments: Calcite accretionary fibers on fault surface are highly weathered, but preserved step faces and attachment points of individual fibers show clearly that the upper plate moved to the NNW (right-lateral sense of slip).

Fault no. 141

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-141	N02W/74SW	S54W (S55W)	(71)	80 SE

Comments: Fault in fine- to medium-grained, micaceous graphitic marble. Calcite accretionary material on fault surface is highly weathered, but preserved step faces and attachment points of individual fibers indicate, with fair certainty, a reverse sense of slip. *Note:* The pitch reading given above is probably more accurate than the bearing.

Fault no. 142

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-142	N51W/40SW	S82W	36 (approx.) (23)	(38 NW)

Comments: Fault in fine- to medium-grained graphitic marble. Calcite accretionary material on fault surface is highly weathered, but preserved step faces and attachment points of individual fibers in one small

(2 cm^2) area of the fault surface tentatively suggest a normal sense of slip. The evidence, however, is tenuous at best; the fibers are much too highly weathered for any comfortable statement on sense of slip.

Fault no. 143

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-143	N45E/80NW	(N62W)	(80)	87 SW

Comments: Fault in medium- to coarse-grained, tremolitic and sparsely graphitic marble. Calcite accretionary fibers and attachment points of individual fibers strongly suggest that the SE block is the downthrown side.

Fault no. 144

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-144	N48W/40SW	(S21E)	21 SE	(34 SE)

Comments: Fault in coarse-grained graphitic marble. Calcite accretionary fibers indicate that hanging wall moved to the north (right-lateral slip). The accretionary calcite is highly weathered, but step faces in it are abundant and fairly clear.

Fault no. 145

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-145	N46W/48SW	S44E (S41E)	06 (02)	(03 SE) (08 SE)

Comments: Graphite-streaked fault surface in coarse-grained, sparsely graphitic marble. Calcite accretionary fibers on this surface are poorly preserved and highly weathered, but presumed step faces in this material suggest right-lateral movement.

Fault no. 146

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-146	N60W/35SW	S47E	(09)	(16 SE)

Comments: Fault in coarse-grained marble with tremolite and graphite as accessory minerals. Accretionary fibers on fault surface are well exposed, with step faces clearly indicating the upper plate moved northwest.

STATION 17 – near southwest corner of the Hoist House, at mine coordinates 1130N, 2225W.

Fault no. 147

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-147	N28E/83SE	(S54E)	(83)	89 SW

Comments: Fault in medium-grained tremolitic marble. Calcite accretionary fibers are abundantly preserved on fault surface; numerous step faces in this material indicate southeast side moved down.

Fault no. 148

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-148	N31E/90	(S31W)	(87)	87 SW

Comments: Poorly exposed, graphite-smeared fault surface in medium-grained tremolitic marble with sparse graphite. Sense of slip unknown.

Fault no. 149

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-149	N27E/86SE	(S18E)	(84)	86 SW

Comments: Fault in fine- to medium-grained, sparsely graphitic marble with local tremolite. Poorly preserved, graphite-smeared fault surface; sense of slip unknown.

STATION 18 – A small quarry immediately across the dirt road southwest of the headframe. This is the feature locally referred to as the "Glory hole" and was once used to convey rock into the mine to be used as backfill. Power lines cross this area. The "Glory hole" has a diameter of less than 100 ft and is centered on mine coordinates 1070N, 2005W. *Note:* locality is no longer extant and has been buried by fill. The bums!

Fault no. 150

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-150	N49W/72SW	N56W (N57W)	23 (21)	(22 NW) (24 NW)

Comments: Weathered and partly moss-covered fault surface in medium- to coarse-grained marble on southeast side of quarry. Poorly preserved step faces in fibrous accretionary calcite suggest right-lateral sense of slip.

Note: A mineral field-identified as fluoborite is present in the marble here, in abundance, but in small grains, about 3 m south of fault no. 150. This occurrence remains unverified; observation of its fluorescence would be helpful. Could be diopside as well.

Fault no. 151

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-151	N40W/83NE	(S45E)	37 SE	(37 SE)

Comments: Fault in medium-grained, graphitic and tremolitic marble in the NE part of the quarry. Calcite accretionary fibers are well preserved in recesses in the fault surface. Step faces in the accretionary material and attachment points of fibers both indicate right-lateral sense of slip; that is, the SW side of the fault moved up and to the NW. *Note:* Our field notes are in error here, as they mention left-lateral slip, but the movement direction of the SW block as described necessitates right-lateral slip.

Fault no. 152

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-152	N52W/84NE	(S57E)	(38)	38 SE

Comments: Different part of the same fault as no. 151 above. Well-developed calcite accretionary fibers confirm sense of slip noted above.

Fault no. 153

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-153	N54W/87NE	(S58E)	(52)	52 SE

Comments: A different portion of the same fault in the same rock type as nos. 151 and 152 above, but note the more steeply pitching calcite fibers here. Locally on this fault, individual bundles of accretionary calcite fibers can be seen to curve to steeper plunges in the growth direction, indicating that the direction of slip gradually changed over time as slip proceeded. Well-developed step faces in this material show the same sense of slip as indicated above.

Fault no. 154

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-154	N54W/43SW	Due S	25 (approx.) (37)	(62 SE)

Comments: Fault in medium- to coarse-grained, graphitic and micaceous marble on NW side of quarry. Step faces in well-preserved fibrous accretionary calcite indicate hanging wall moved up and to the north.

Fault no. 155

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-155	N60E/86NW	(S74W)	(74)	74 SW

Comments: Fault in medium- to coarse-grained, graphitic and micaceous marble on NW side of quarry. Well-developed step faces in fibrous accretionary calcite clearly indicate that SE side of fault is downthrown.

Fault no. 156

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-156	N44W/60SW	S03E	41 (approx.) (49)	(60 SE)

Comments: Fault in medium-grained, tremolitic-graphitic-micaceous marble along NW side of quarry. Accretionary calcite is preserved in small patches; step faces and fiber attachment points indicate oblique reverse sense of slip with fair confidence. *Note:* Bearing reading is more accurate than plunge.

Fault no. 157

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-157	N54W/42SW	S19E	22 (approx.) (27)	(43 SE)

Comments: Fault in medium-grained, graphitic-tremolitic-micaceous marble along NW side of quarry. Marble contains well-developed pseudomorphs of mica after tremolite. Fibrous accretionary calcite is present on the fault surface but is too weathered to determine sense of slip.

Fault no. 158

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-158	N47W/65SW	(S05W)	(60)	72 SE

Comments: Fault in highly weathered, fine- to medium-grained marble (contains fluoborite) on SE side of quarry. Fibrous accretionary calcite is present on the fault surface but is poorly preserved; nevertheless step faces in this material suggest a reverse sense of slip.

Fault no. 159

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-159	N63W/56SW	N72W (N69W)	08	(10 NW)

Comments: Fault in medium-grained, graphitic and tremolitic marble on SE side of quarry. Weathered fault surface with poorly preserved fibrous accretionary calcite; sense of slip unknown. *Note:* Plunge reading probably more accurate than bearing.

Fault no. 160

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-160	N62W/47NE	S63E	00 (01)	(01 SE)

Comments: Fault in medium-grained graphitic and tremolitic marble on SE side of quarry. Fibrous accretionary calcite is present but too highly weathered to determine sense of slip.

Fault no. 161

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-161	N49W/49SW	(N55W)	(07)	09 NW

Comments: Fault in medium- to coarse-grained marble containing scattered tiny scales of graphite. Accretionary calcite is preserved in a few patches on the weathered fault surface; step faces indicate right-lateral sense of slip.

Fault no. 162

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-162	N39E/57NW	N45W (N40W)	55 (57)	83-85 NE

Comments: Fault in medium- to coarse-grained, graphitic and tremolitic marble. Step faces in prominent coatings of fibrous accretionary calcite clearly indicate reverse sense of slip. *Note:* Of the measurements given above for the slickenlines, the pitch is the most accurate, the bearing next, and the plunge probably least.

Fault no. 163

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-163	N22E/71NW	N75W	70 (71)	(88 SW)

Comments: Fault in medium- to coarse-grained, graphitic and tremolitic marble. Step faces on preserved patches of fibrous accretionary calcite on weathered fault surface clearly indicate reverse sense of slip.

Fault no. 164

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-164	N48E/65NW	N65W (N69W)	(62)	78 SW

Comments: Fault in medium- to coarse-grained, graphitic and tremolitic marble. Prominent step faces in fibrous accretionary calcite clearly indicate reverse sense of slip. All three faults here, nos. 162 to 164, are strands of the same small fault zone. *Note:* The pitch measurement of the slickenlines is by far the more accurate reading; the fault is inconveniently positioned for measurement of the bearing.

Fault no. 165

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-165	N49W/66SW	S31E	30 (35)	(39 SE)

Comments: Highly weathered fault surface through medium-grained graphitic marble. Calcite accretionary fibers are present on one part of the fault surface but are too poorly preserved for sense of slip to be determined. *Note:* The bearing measurement given above is good; the angle of plunge is probably less accurate.

Fault no. 166

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-166	N65E/65SE	S06E	(64)	(82 SW)

Comments: Graphite-streaked fault surface through medium- to coarse-grained graphitic and tremolitic marble. Sense of slip unknown.

STATION 19 – Behind storage sheds north of support tower for overhead conveyor, at parking level of the museum grounds, east of the East limb of ore, and on opposite face of the small outcrop nose of Station 16. Station is centered on mine coordinates 1555N, 1380W.

Fault no. 167

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-167	N54W/52SW	N81W	29 (30)	(40 NW)

Comments: Nearly planar, graphite-streaked fault surface through fine- to medium-grained, graphite-tremolite marble. Calcite accretionary fibers are poorly preserved but are present at numerous points on the fault surface and are all in parallel orientation. Attachment points of fibers and weathered step faces indicate right-lateral sense of slip.

Fault no. 168

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-168	N52W/51SW	N83W (N74W)	25 (33)	(44 NW) (33 NW)

Comments: Graphite-streaked fault surface through fine- to medium-grained, graphite-tremolite marble. Poorly preserved fibrous accretionary calcite forms wispy coatings in patches on fault surface. Fiber attachment points and weathered step faces suggest right-lateral slip, though evidence is not clear because too little of this material is preserved.

Fault no. 169

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-169	N52W/50SW	N63W (N66W)	16 (13)	(17 NW) (21 NW)

Comments: Fault in fine- to medium-grained, graphite-tremolite marble. Fibrous accretionary calcite is abundantly preserved in patches on the fault surface. Fiber attachment points and weathered step faces rather clearly indicate right-lateral sense of slip. On this fault, with white accretionary calcite on gray marble, it is quite easy to see the distribution of the accretionary material on the fault plane.

Fault no. 170

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-170	N52W/50SW	N52W	(00)	(00)

Comments: Graphite-streaked fault surface in fine- to medium-grained, graphite-tremolite marble. Fiber attachment points and weathered step faces in calcite accretionary material on fault indicate right-lateral sense of slip. Some bundles of calcite fibers show slight to moderate curvature along their length, which explains the different plunges and bearings in this area – the fault slip directions gradually changed over time. The best example seen to date is of fibers changing direction from 30^{o} westerly plunges at their attachment points to a 10^{o} southeasterly plunge for the latest stages of growth, over a lateral distance (fiber length) of about 2.5-3 cm.

Fault no. 171

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-171	N49W/46SW	(S46E)	03 SE	(04 SE)

Comments: Fault in medium- to coarse-grained, graphitic and tremolitic marble. Fiber attachment points and weathered step faces in accretionary calcite on fault surface indicate right-lateral sense of slip. Measurement of bearing not obtainable.

Fault no. 172

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-172	N49W/46SW	(N62W)	13 NW	(18 NW)

Comments: Same rock type and fault as above, but a different part of fault surface. Attachment points of calcite accretionary fibers suggest right-lateral sense of slip. Measurement of bearing not obtainable.

Fault no. 173

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-173	N35W/26SW	N62W	(13)	(30 NW)

Comments: Nonplanar, irregular fault surface in medium- to coarse-grained, tremolite-graphite marble. This fault is very different in character and orientation from the right-lateral faults documented above at this locality. Poorly preserved but definite calcite accretionary fibers on one part of the fault surface suggest upper plate moved to the NW. One of the faults listed above cuts across this one and appears younger, but the age relation is by no means certain here.

Fault no. 174

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-174	N59E/16SE	S48E	(15)	(74 NE)

Comments: Graphite-streaked fault surface in coarse-grained graphite-tremolite marble; sense of slip unknown. This fault is somewhat irregular and probably is related to no. 173 above. Both seem to be part of the same fault array that can be followed in continuity across the exposure face here, though so little of the fault surfaces are exposed that measurements are difficult to obtain.

Fault no. 175

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-175	N27W/31SW	S85W	(29)	(71 NW)

Comments: Fault in fine-grained graphite-tremolite marble. Well-developed fibrous accretionary calcite with readily visible step faces and fiber attachment points indicate hanging wall moved to the W.

Fault no. 176

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-176	N29W/39SW	S81W	(37)	(74 NW)

Comments: Same rock type and fault character as for no. 175 above, though fibrous accretionary calcite is not as thickly developed. Still, fiber attachment points and minute step faces show that hanging wall of this fault moved to the W.

Fault no. 177

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-177	N50E/87SE	(S41W)	(72)	72 SW

Comments: Graphite-streaked and calcite-coated fault surface through fine-grained graphite-tremolite marble showing fine pseudomorphs of scaly phlogopite after tremolite. The fibrous accretionary calcite on the fault surface is highly weathered, but fiber attachment points and preserved step faces suggest the SE side is the downthrown block. This fault must be very near the Nason fault.

STATION 20 – Northwest corner of Passaic pit, near entrance portal to mine (Rainbow Room area), extending toward old stope in West limb ore, at mine coordinates 835N, 1685W.

Note: The West limb ore in this area is magnetic, and care was taken to obtain accurate readings.

Fault no. 178

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-178	N50E/64NW	N27W	(63)	(84 NE)

Comments: Minor fault in moderate- to high-grade, medium-grained, franklinite-calcite-willemite ore. Splintery white fibrous accretionary calcite on fault surface indicates hanging wall is upthrown block; almost dip-slip movement on this fault.

Fault no. 179

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-179	N61E/60NW	N12E	(53)	(67 NE)

Comments: Minor fault in moderate- to high-grade, coarse- to medium-grained, franklinite-calcite ore. Fault surface is coated by a thin film of fibrous accretionary calcite. Sense of slip is probably reverse.

Fault no. 180

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-180	N60E/61NW	(N34W)	(61)	88 SW

Comments: Minor fault in medium-grained, high-grade willemite-franklinite-calcite ore. Splintery accretionary material on fault surface, in part composed of white calcite, indicates reverse sense of slip. This is part of a small, braided fault zone that is exposed over a distance of at least 10 m.

Fault no. 181

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-181	N54E/50NW	(N36W)	(50)	90

Comments: Minor fault in same rock type, and from same braided fault zone, as no. 180 above; these are curved, anastomosing faults. White fibrous accretionary calcite on fault surface suggests reverse sense of slip.

Fault no. 182

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-182	N37E/58NW	(N71W)	(57)	80 SW

Comments: Minor fault in medium-grained, high-grade willemite-franklinite-calcite ore. White, fibrous to splintery accretionary material lines fault, but its mineralogical composition is unknown. Well-developed step faces in this material indicate reverse sense of slip.

Fault no. 183

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-183	N76E/57NW	(N01W)	(56)	83 NE

Comments: Fault in medium- to coarse-grained, high-grade franklinite-calcite ore. Fault is coated with fibrous accretionary material, but it is weathered and of uncertain mineralogical composition. Step faces in accretionary material suggest reverse sense of slip.

Fault no. 184

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-184	N68E/58NW	Due N (Due N)	(56) (56)	78 NE (78 NE)

Comments: Fault in medium-grained, high-grade franklinite-calcite ore. Weathered fibrous accretionary minerals, species unknown, are preserved in patches on the fault surface. Step faces in accretionary material suggest reverse sense of slip.

Fault no. 185

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-185	N80W/57NE	(N72W)	(12)	14 NW

Comments: Fault in medium-grained, high-grade franklinite-willemite-calcite ore. Weathered fibrous accretionary minerals, species unknown, are preserved on the fault surface. Well-developed step faces in this material indicate left-lateral movement; that is, the hanging wall moved W. Minor fault with a trace length of only about 1 m.

Fault no. 186

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-215	N41E/80SE	(S32E)	(80)	87 SW

Comments: Minor fault through high-grade, granular franklinite-calcite-willemite ore at the hanging wall contact of the east branch of the West limb of ore. Mechanically scratched fault surface; sense of slip unknown. Weathered fibrous accretionary material, in part calcite, coats parts of fault surface.

Fault no. 187

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-216	N53E/89SE	(S26W)	(88)	88 SW

Comments: Minor fault through high-grade, granular franklinite-calcite-willemite ore at the hanging wall contact of the east branch of the West limb of ore. Mechanically scratched fault surface with local coatings of weathered, fibrous accretionary material, in part calcite. Step faces in accretionary material fairly clearly indicate that SE block is the downthrown side. This fault merges with the previous one, no. 186, along strike.

Fault no. 188

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-217	N77E/37NW	N46W	(32)	(63 NE)

Comments: A large fault, with an exposed trace length of about 6 m, along the north wall of the Passaic pit. The fault surface, though weathered, still preserves prominent grooves along the slip direction, and these were measurable from beneath on the underside of the hanging wall. The fault is gently sinuous and cuts the ore layers nearly at a right angle. This is one of numerous such faults here, many of them with irregular traces, and nearly all inaccessible.

Note: The south and east walls of the Passaic pit are too much affected by solution and in places so thoroughly moss- and lichen-covered that fault-surface structures are nowhere well preserved. Much of the steep east wall of the Passaic pit is inaccessible; thus the absence of fault readings in these areas.

STATION 21 – Footwall of West limb, extending from the "bat adit" southward toward the Noble pit, at mine coordinates 710N, 1730W.

Fault no. 189

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-186	N28E/74NW	(S88W)	(72)	81 SW

Comments: Moderately large fault, trace length at least 10 m, in coarse-grained marble with scattered grains of willemite and franklinite. Step faces in fibrous accretionary calcite on fault surface indicate reverse sense of slip.

Fault no. 190

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-187	N10W/13NE	S54E	(09)	(45 SE)

Comments: Minor fault, trace length 1 m or slightly more, in coarse-grained marble with scattered grains of willemite. A thin film of fibrous accretionary calcite lines fault, but slip sense is unknown.

STATION 22 – Northwest side of Passaic pit, above station 20, in mined-out cavity in West limb ore, at mine coordinates 790N, 1705W.

Fault no. 191

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-188	N76W/16NE	N51W	(07)	(26 NW)

Comments: Fault in granular, high-grade franklinite-willemite-calcite ore. White fibrous accretionary calcite lines fault surface; weakly developed step faces in this material suggest upper plate moved NW. This is one of at least seven such faults in a zone 1-2 m thick.

Fault no. 192

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-189	N51E/16NW	N47W	(16)	(82 SW)

Comments: Fault in granular, high-grade franklinite-willemite-calcite ore. White fibrous accretionary calcite lines fault surface; step faces in this material indicate upper plate moved NW. Part of same fault zone as fault no. 191 above.

Fault no. 193

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-190	N24E/14NW	N56W	(14)	(80 NE)

Comments: Fault in granular, high-grade franklinite-willemite-calcite ore. White fibrous accretionary calcite lines fault surface; sense of slip unknown.

STATION 23 – North wall of Passaic pit, starting at east side of entrance to Rainbow Room area in mine, and extending eastward, at mine coordinates 875N, 1645W.

Fault no. 194

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-191	N25E/60SE	(S81E)	(59)	82 NE

Comments: Graphite-streaked fault surface in medium-grained, sparsely graphitic marble with minor amounts of fibrous accretionary calcite preserved in tiny patches; sense of slip unknown.

Fault no. 195

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-192	N53E/59NW	N06W	49 (55)	(73 NE)

Comments: Fault in medium-grained tremolite-graphite marble. White fibrous accretionary calcite lines fault surface but is too weathered for sense of slip to be determined. *Note:* Bearing measurement is more accurate than that of plunge.

Fault no. 196

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-193	N67E/55NW	N02E	(52)	(75 NE)

Comments: Fault in fine- to medium-grained tremolite marble. Minor fibrous accretionary calcite is preserved on an area of several cm^2 on fault surface. Fiber attachment points and minute step faces in accretionary material suggest reverse sense of slip.

Fault no. 197

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-194	N69E/53NW	N16E (N24E)	43 (47)	(66 NE) (59 NE)

Comments: Fault in fine- to medium-grained marble containing layers rich in tremolite, norbergite, and diopside, with minor graphite. Fibrous accretionary calcite is common on fault surface. Fiber attachment points and well-developed step faces in accretionary material clearly indicate reverse sense of slip here.

Fault no. 198

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-195	N15E/70NW	(N58W)	(69)	84 NE

Comments: Fault in high-grade franklinite-calcite ore of the cross member. Minor accretionary material on fault surface consists of an unidentified white fibrous mineral and later splintery white calcite. Fiber attachment points tentatively suggest reverse sense of slip.

STATION 24 – Trotter tunnel, starting about 170 ft from west entrance, at collapsed area about halfway into tunnel (mine coordinates: 325N, 1510W), and working westward toward Noble pit (faults 199 to 206). Faults 207 to 210 were measured years later, when the collapsed debris had been cleared, and were measured from the area of collapse eastward to the east (Plant St.) entrance to the Trotter tunnel. Faults 211 to 214 were measured still later, in a small "room" adjacent to the west portal of the tunnel.

Note: Numerous faults are exposed in the Trotter tunnel, but few of them are measurable because their surfaces are either highly pitted by solution, or are covered by calcite flowstone, or both. Short stalactites,

draperies, and flowstone are evident in many places within the tunnel. The tunnel is so near the surface that descending rainwater, enriched in humic and fulvic acids from the soil horizon above, has dissolved some of the wallrock from many faults and thereby removed most evidence of slip indicators. Some fault surfaces, too, are covered in a thin film of mud brought in with the rainwater. Nevertheless, small areas of graphite-streaked fault surfaces are visible in places, and in a few places, patchy coatings of fibrous accretionary calcite are preserved as well. The Trotter tunnel, fairly short and open at both ends, differs from most areas in the mine in that it is host to numerous spiders. Crickets, of course, are present in abundance, as they are elsewhere.

Fault no. 199

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-196	N72W/80NE	(N69E)	(74)	78 SE

Comments: Mud-covered fault surface in medium-grained marble. Possible crude step faces in fibrous accretionary calcite suggest NE side of fault is upthrown block, but this is very uncertain.

Fault no. 200

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-197	N31W/65SW	S09E	51 (39)	(44 SE)

Comments: Fault in medium-grained marble. Well-developed step faces in fibrous accretionary calcite on fault surface indicate hanging wall moved up and northward. *Note:* Measured bearing is more accurate than the plunge.

Fault no. 201

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-198	N61E/64SE	(S34E)	(64)	88 NE

Comments: Very minor fault in medium-grained marble. This fault offsets fault no. 200 above (and also fault no. 202 below), but the total offset is only about 3 mm. Secondary calcite lines the fault surface, but the striations within it are so faintly developed that they are poor indicators of slip direction. The sense of slip as judged from offset of fault no. 200 is normal.

Fault no. 202

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-199	N03W/65NE	S40E (S35E)	49 (52)	(61 SE) (56 SE)

Comments: Fault in medium-grained, sparsely graphitic marble. Accretionary calcite is present on the fault surface, but the sense of slip is unknown. This fault is offset by fault no. 201 above.

Fault no. 203

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-200	N19W/76SW	S01W	48 (54)	(56 SE)

Comments: Fault in medium-grained, sparsely graphitic marble. Well-developed step faces in fibrous accretionary calcite on fault surface indicate W side of fault moved up and to the north. *Note:* Bearing measurement is more accurate than the plunge.

Fault no. 204

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-201	N59E/43SE	S33E	(43)	(89 NE)

Comments: Graphite-streaked minor fault surface in medium-grained graphitic marble. Total slip is only about 1 cm; sense of slip unknown.

Fault no. 205

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-202	N57E/85SE	(S30W)	(79)	80 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Fault surface is lightly filmed with fibrous accretionary calcite, but sense of slip is unknown.

Fault no. 206

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-203	N08W/54NE	S88E	(54)	(84 SE)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Fault surface is fairly smooth but highly undulatory. Sense of slip unknown.

Fault no. 207

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-372	N18W/84NE	(S39E)	(74)	75 SE

Comments: Minor fault in graphitic marble. Graphite-streaked and partially calcite-coated fault surface. Step faces in accretionary calcite on fault indicate E side is downthrown block.

Fault no. 208

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-373	N49E/48SE	(S03W)	(35)	51 SW

Comments: Graphite-streaked fault surface in graphitic marble. Amount of slip on fault, as judged by length of graphite streaks, is only about 1 cm. Sense of slip unknown.

Fault no. 209

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-374	N28E/39SE	S15W (S15E)*	29	(50 SW)

Comments: Graphite-streaked fault surface in graphitic marble. Sense of slip unknown.

* One of the readings above, either the plunge or bearing, is inaccurate. The plunge as calculated from the bearing is only 11º, an 18º difference from the measured value. It seems implausible to make an error that large, as it would have been visually obvious. The bearing as calculated from the measured plunge is S15E. Almost certainly the bearing was recorded as S15W when S15E was meant, but in any case, the data for this fault should not be used for fault-slip analysis.

Fault no. 210

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-375	N43E/59SE	(S47E)	(59)	90

Comments: A somewhat irregular fault that extends across the back and down both ribs. Graphite-streaked fault surface; sense of slip unknown.

Note: The four faults listed below were measured in a small room on the north side of the Trotter Tunnel, immediately inside the west portal, at approximate mine coordinates 375N, 1650W.

Fault no. 211

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-387	N78E/90	(N78E)	(80)	80 NE

Comments: A broad, irregular fault surface, prominently mineral-streaked in places, in graphitic marble. Thin, patchy coatings of accretionary calcite are preserved in places on the fault surface. Small step faces in this calcite suggest that the SE side of the fault is the downthrown block.

Fault no. 212

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-388	N67E/86SE	(S45W)	(79)	80 SW

Comments: Graphite-streaked fault surface in marble. Weakly developed step faces in thin films of accretionary calcite suggest the SE side of the fault is downthrown.

Fault no. 213

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-389	N74E/88NW	(N88W)	(84)	84 SW

Comments: Graphite-streaked fault surface in marble. Little of fault surface is exposed; sense of slip unknown.

Fault no. 214

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-390	N03W/87SW	(S17W)	(81)	82 SE

Comments: Mineral-streaked fault surface in graphitic marble. Small fault; sense of slip unknown.

STATION 25 – Stripped area east of Fill quarry, SW of core shed, at mine coordinates 590N, 1305W.

Fault no. 215

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-204	N32E/54SE	S70E	(53)	(83 NE)

Comments: Graphite-smeared fault surface in medium- to coarse-grained graphitic marble; sense of slip unknown.

Fault no. 216

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-205	N26E/70SE	(S81E)	(69)	84 NE

Comments: Minor graphite-streaked fault surface in medium- to coarse-grained graphitic marble. Fault has 8-10 mm total slip. Slip sense is normal as indicated by polarity of individual graphite streaks (streaks can be traced back to parent graphite grains by use of hand lens).

Fault no. 217

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-206	N16E/71SE	(N80E)	(69)	81 NE

Comments: Minor graphite-streaked fault surface in medium- to coarse-grained graphitic marble. Fault has 4-5 mm total slip. Slip sense is normal as indicated by polarity of individual graphite streaks (streaks can be traced back to parent graphite grains by use of hand lens).

Fault no. 218

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-207	N29E/85SE	(N80E)	(84)	86 NE

Comments: Minor graphite-streaked fault surface in medium- to coarse-grained graphitic marble. Fault has 6-7 mm total slip. Slip sense is clearly normal as indicated by polarity of individual graphite streaks (streaks can be traced back to parent graphite grains by use of hand lens).

Fault no. 219

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-208	N20W/80NE	(N81E)	(80)	88 SE

Comments: Minor graphite-streaked fault surface in medium- to coarse-grained graphitic marble. Slip sense is probably normal as suggested by the polarity of graphite steaks in a thin, streaked-out layer of graphitic marble cut by the fault.

Fault no. 220

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-209	N36E/50SE	(S60E)	(50)	86 NE

Comments: Minor fault in graphitic marble. Fault surface is graphite-smeared and broadly undulatory in dip. Sense of slip unknown. Fault no. 219 terminates against this one and probably moved in conjunction with it.

Fault no. 221

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-210	N25E/77SE	(S69E)	(77)	89 NE

Comments: Minor, graphite-streaked fault in graphitic marble; total slip about 1 cm. Sense of slip unknown.

Fault no. 222

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-211	N05E/53SE	S18E	21 (27)	(35 SW)

Comments: Minor, graphite-streaked and mechanically scratched fault in graphitic marble. Fault surface is moderately to highly weathered; sense of slip unknown. White, fine-grained, sugary, nonfibrous (post-faulting) calcite films parts of the fault surface. *Note:* Bearing reading given above is more accurate than angle of plunge.

Fault no. 223

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-212	N23W/60NE	S33E (S32E)	15	(17 SE)

Comments: Minor, graphite-streaked fault in graphitic marble. Sense of slip possibly left lateral, as suggested by polarity of graphite streaks on fault surface. Total slip about 1 cm. *Note:* Plunge reading given above is more accurate than the bearing.

Fault no. 224

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-213	N04W/50NE	S22E (S25E)	23	(31 SE)

Comments: Minor fault in graphitic marble. Fault surface is locally graphite-streaked and mechanically scratched, but too weathered for sense of slip to be determined. *Note:* Plunge reading given above is more accurate than the bearing.

Fault no. 225

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-214	N45E/77SE	(S02E)	(72)	78 SW

Comments: Fault in mica-scapolite-spinel lens within marble. Mechanically scratched fault surface; sense of slip unknown. Minor, post-slip calcite coats part of fault surface.

STATION 26 – Noble pit, at entrance to Trotter Tunnel, at mine coordinates 380N, 1655W.

Fault no. 226

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-218	N88W/52SW	N89W (N90W)	02 (02)	(03 NW)

Comments: Mechanically scratched and graphite-streaked fault surface in medium- to coarse-grained graphitic marble. Total slip 1.5-2 cm, judging from length of graphite streaks (smeared-out graphite plates) on fault surface. Sense of slip unknown.

Fault no. 227

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-219	N74W/55SW	S64E (S65E)	12 (14)	(17 SE) (15 SE)

Comments: Mechanically scratched and graphite-streaked fault surface in medium- to coarse-grained graphitic marble. Total slip about 1 cm, judging from length of graphite streaks (smeared-out graphite plates) on fault surface. Sense of slip unknown.

Fault no. 228

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-220	N68W/54SW	S58E (S62E)	08	(10 SE)

Comments: Minor fault in graphitic marble. Total slip 1-1.5 cm, judging from length of graphite streaks (smeared-out graphite plates) on fault surface. Minute step faces and attachment points of calcite fibers in probable accretionary calcite on fault surface suggest right-lateral sense of slip. The accretionary calcite is white, as opposed to the pale gray calcite of the adjacent wall rock. The white calcite appears fibrous under a hand lens and is developed only on those parts of the undulatory fault surface that would have opened into lenticular voids during right-lateral slip. *Note:* The plunge reading given above is probably more accurate than the bearing.

Fault no. 229

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-221	N75W/59SW	S56E	(29)	(34 SE)

Comments: Minor fault in graphitic marble. Total slip about 2 cm, judging from length of graphite streaks (smeared-out graphite plates) on fault surface. Minute step faces and attachment points of calcite fibers in probable accretionary calcite on fault surface suggest right-lateral sense of slip.

Note: Faults nos. 226 through 229 are all members of the same fault zone and were measured within a 1-m thickness of marble on the SW side of the portal to the Trotter tunnel.

Fault no. 230

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-222	N78W/57SW	S62E (S64E)	20 (23)	(28 SE) (24 SE)

Comments: Graphite-streaked fault surface in graphitic marble. Total slip about 1 cm or slightly less. Probable accretionary calcite on fault surface suggests right-lateral sense of slip. *Note:* Bearing reading given above is probably more accurate than angle of plunge.

Fault no. 231

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-223	N85W/55SW	S88E (S81E)	06 SE	(07 SE)

Comments: Graphite-streaked fault surface in graphitic marble. Total slip about 3-6 mm; sense of slip unknown (but see below). This fault and no. 230 are part of the same fault zone. All of the faults in this zone have accretionary calcite only on those portions of their surfaces that have slightly more northerly strikes than that of the mean fault plane; these are the portions that would have opened during right-lateral shear. The accretionary calcite appears to have grown in the only available space and provides independent evidence for the sense of slip.

Fault no. 232

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-224	N55E/63SE	(S05W)	(56)	69 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 233

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-225	N50E/61SE	(S16E)	(59)	78 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 234

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-226	N41E/88NW	(N49W)	(88)	90

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 235

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-227	N33E/87NW	(S78W)	(86)	87 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown. Total slip about 2 cm.

Fault no. 236

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-228	N68E/83NW	(N33E)	(78)	80 NE

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown. Total slip about 2 cm.

Fault no. 237

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-229	N77E/86NW	(N40W)	(86)	88 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown. Total slip about 2 cm.

Fault no. 238

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-230	N77E/81NW	(N32W)	(81)	87 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown. Total slip probably about 2-3 cm.

Fault no. 239

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-231	N74E/85SE	(S27E)	(85)	89 NE

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 240

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-232	N75E/88SE	(S60E)	(87)	88 NE

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 241

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-233	N73E/85SE	(S39E)	(85)	88 NE

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 242

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-234	N65E/86SE	(S47W)	(77)	78 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 243

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-235	N69E/80SE	(S14W)	(78)	83 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown. Total slip probably about 3-5 cm.

Note 1: The last eight faults listed above, nos. 236 through 243, are best exposed on the NE side of the Trotter Tunnel portal. Although the measured amounts of slip are quite small, some of the fault surfaces are fairly large, with exposed lengths of at least 5 m and exposed heights of 3-5 m. Others appear much larger but are inaccessible. These faults form part of the nearly vertical, NNW-facing wall of the Noble pit for a minimum distance of at least 30 m. Each of them consists of a series of *en echelon* segments at a very low angle to the median fault plane. If one looks at the SE wall of any such fault, the narrow faces between the *en echelon* segments consistently and conspicuously face up. This geometry, if interpreted in terms of

traditional Riedel shears, suggests the SE block is upthrown on these faults, though the actual slip sense is very probably the opposite. Unfortunately, no definite accretionary calcite was observed on any of these faults that might have provided unambiguous evidence of sense of slip.

Note 2: The rest of the notes for this station, plus those for stations 27-30, concern fractures other than faults. Inasmuch as the Noble and Passaic pits are similar in their overall geology (with, however, the Noble pit being much smaller), one might presume them to have similar genesis. The Passaic pit is underlain by the "mud zone," a pipelike body of fragmental rock that extends to a depth of more than 670 feet beneath the floor of that pit. Geometrically the "mud zone" conforms to a breccia pipe in the nongenetic sense of that term. One mechanism of forming such pipelike bodies, particularly in areas of carbonate rock, is by the collapse of rock into an underlying cavern as the rocks are progressively weakened by solution. Repeated collapse events, combined with (a) removal of some of the collapse debris by dissolution of the carbonate cement of the clasts, and (b) redistribution of the insoluble mineral grains so freed by streams flowing within the cave system, eventually lead to pipelike bodies of breccia rooted in the underlying cave: a *solution-collapse breccia pipe*. The Passaic pit, and thus possibly also the Noble pit, perhaps are the surface expressions of breccia bodies that were formed, at least in part, by a solution-collapse process. Breccia pipes so formed are in some places surrounded by a zone of "ring fractures" that dip at shallow to moderate angles outward from the pipe and everywhere strike tangentially to it, thus forming a zone of concentric fractures bordering the pipe (see Verbeek et al., 1988, for details of an example from the Grand Canyon region). We thus wished to determine if similar fractures were present along the walls of the Noble pit. The data below document the results. We state categorically, however, that the data are not convincing, even in aggregate, and we do not, at present, place much importance in them. Though we refer to these fractures as "ring fractures," we mean that only in the geometric and not necessarily the genetic sense of that term.

Reference for above-cited paper: Verbeek, E.R., Grout, M.A., and Van Gosen, B.S. (1988), *Structural evolution of a Grand Canyon breccia pipe--the Ridenour copper-vanadium-uranium mine, Hualapai Indian Reservation, Coconino County, Arizona*: U.S. Geological Survey Open-File Report 88-006, 75 p.

Possible ring fractures near west entrance to Trotter Tunnel:

N33E/62SE N45E/50SE N47E/58SE N46E/57SE N27E/54SE N44E/57SE
N20E/62SE N31E/63SE N31E/54SE N25E/53SE N30E/58SE N28E/60SE
N27E/56SE

Median: N31E/57SE (n = 13)

These fractures are typically subplanar, somewhat irregular in both strike and dip, and terminate against the measured faults in this area. They are interpreted as extension fractures because they show almost no evidence of having originated in shear. Their terminations against known faults in this area reveals them as the youngest fractures present. Their heights range from ¾-5 m, with many in the 2-4 m range; these are their full heights. Their exposed lengths are minimized by the orientation of the exposure and range from 0.5 to about 4 m. Most of these fractures show no sign of slip, despite the presence of abundant graphite in the wallrock, which renders even minor shear on fault surfaces readily visible through smeared-out graphite flakes on the fault planes. A couple of the fractures, however, show evidence of downdip slip of about 2-3 mm. No mineral coatings were visible on any of their surfaces, though such coatings are uncommon on the known faults of this area as well. Despite their NE strike in this area, the ring fractures are *not* parallel to compositional layering in the marble, which dips more steeply. Several ring fractures are limonite-stained,

and a few have somewhat rough, pitted surfaces as a result of dissolution. Though the orientations of these fractures, the general absence of shear along them, and their young age relative to the faults are consistent with a ring-fracture interpretation, the evidence is permissive only, and is certainly not diagnostic, even collectively.

STATION 27 – North wall of Noble pit, near northeast corner, at mine coordinates 420N, 1660W, and at an elevation about 5 m above that of Station 26.

Possible ring fractures:

N25W/62NE	N10E/57SE	N21W/47NE	N30W/60NE	N29W/58NE	N18W/47NE
N21W/46NE	N13W/52NE	N29W/47NE	N09W/57NE	N16W/50NE	N02E/59SE
N30W/45NE	N08W/43NE	N05W/44NE	N28W/43NE		

Median: N20W/49NE (n= 16)

Such fractures are common at this locality and are of similar character to those at station 26, but much more weathered. Many appear as open clefts in the rock face. Their surfaces are highly etched by solution, so no original surface features are preserved. The rock here is franklinite-rich ore on the southeast side of this station (= transition from keel area to hanging wall of West limb of ore) and marble toward the northwest side. The ore is quite magnetic, necessitating that strike measurements be taken by sighting from a distance. The feldspathic gneisses just to the west of this station are so highly weathered and show so few recognizable fractures that no readings were taken in that area; the rock weathers to locally thick accumulations of grus.

STATION 28 – West wall of Noble pit, centered on mine coordinates 385N, 1760W.

Possible ring fractures:

N32E/50NW	N22E/63NW	N10E/51NW	N14E/40NW	N18E/65NW	N22E/47NW
N32E/46NW	N36E/40NW	N08E/46NW	N01E/38NW	N24E/53NW	N17E/50NW
N20E/30NW	N14E/34NW	N13E/32NW	N11E/31NW	N27E/32NW	N20E/45NW
N24E/52NW	N25E/34NW	N12E/41NW	N19E/65NW	N22E/62NW	

Median: N20E/46NW (n = 23)

The marble in this area is cut by several fractures that appear to be minor faults of N65-85W strike and southwest dips of about 60º. The ring fractures recorded above terminate against these faults. In places along the wall here, four to five ring fractures are spaced only 15-25 cm apart. They are subplanar, commonly irregular fractures that curve gently to moderately along both strike and dip. Locally, where they are most closely spaced, they split and merge to form an anastomosing network, similar in overall geometry to the system of ring fractures at the Ridenour mine breccia pipe in the Grand Canyon.

The rock type here is a medium-grained to locally fine-grained graphitic marble, locally with abundant tremolite and minor diopside. In one place the tremolite prisms are partly to wholly replaced by a scaly, colorless mica. Much of the rock face in this area is moss-covered, and little if any of the original surface features on the various fractures is preserved.

STATION 29 – Noble pit, southwest corner of west wall, centered on mine coordinates 340N, 1725W.

Possible ring fractures:

N37W/65SW	N43W/63SW	N42W/42SW	N43W/26SW	N40W/65SW	N48W/63SW
N38W/62SW	N23W/58SW	N22W/73SW	N42W/62SW	N38W/62SW	N42W/59SW
N52W/61SW	N51W/63SW	N46W/60SW	N48W/64SW	N43W/63SW	

Median: N42W/62SW (n = 17)

The fractures recorded above are fairly common in this area, considering how few fractures are exposed. Much of the rock here is heavily moss-covered, and some is difficult of access. Few fractures can be followed for more than 2 m along their length, and abutting or crosscutting relations with other fractures are rarely exposed. Also, all of the fractures are so heavily weathered that their original surface features have long been obliterated. Thus, the sole evidence that these are ring fractures is that they have the "proper" orientation.

STATION 30 – Noble pit, north wall at northwest corner, centered on mine coordinates 425N, 1735W.

Possible ring fractures:

N70W/50NE N80E/53NW N76W/50NE

Median: N76W/50NE (n = 3)

In this area a resistant mass of franklinite ore, about 4-5 m high and 10 m long, lies along the northwestern wall of the Noble pit and dips into it. The three readings recorded above represent three of the largest fractures that cut across the lithologic layering of the ore here. The ore, though erosionally resistant, is nevertheless highly weathered, and individual franklinite grains in many places stand in bold relief on exposed surfaces. No original surface features were noted on any of the fractures at this locale. Obviously the data are too few to be of much value.

STATION 31 – Noble pit, south wall, west of Trotter Tunnel portal, at approximate mine coordinates 370N, 1685W.

Fault no. 244

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-236	N73W/49SW	N88W	13 (16)	(22 NW)

Comments: Fault juxtaposes fine-grained, graphitic and micaceous marble in the footwall against coarse-grained micaceous marble in the hanging wall. This fault has greater amounts of slip than comparable faults nearby at the entrance to the Trotter Tunnel. Attachment points of calcite fibers and step faces in accretionary calcite, which is abundant here, clearly indicate right-lateral slip. *Note:* The bearing reading given above is likely more accurate than the plunge.

Fault no. 245

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-237	N80W/28SW	S88E (N86W)	07 NW (03 NW)	(07 NW)

Comments: Fault in fine-grained, graphitic, micaceous marble with local mica pseudomorphs after tremolite. Fault is coated with white, well-developed, fibrous accretionary calcite. Fiber attachment points and step faces in accretionary calcite clearly indicate that the upper plate moved westward. *Note:* As with the fault below, in places where the fault striae are of very low plunge, it is easy to misinterpret which end of the compass needle should be read when measuring the bearing. A bearing of S88E is impossible for this fault (though not by much), but if N88W was meant, this is only 2º from the bearing (N86W) calculated from the measured NW plunge of 7º.

Fault no. 246

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-238	N85W/32SW	N78E (S78W)*	13 (10)	(20 NW)

Comments: Fault in fine- to medium-grained, graphitic and tremolitic marble. Graphite-streaked fault surface is abundantly coated with fibrous accretionary calcite. Fiber attachment points and step faces in accretionary calcite clearly indicate right-lateral slip. *Note:* Bearing reading given above is more accurate than angle of plunge. (However, clearly the wrong end of the compass needle was read when recording the bearing, as a bearing of N78E is impossible for a fault of this orientation, but a bearing of S78W results in a calculated plunge of 10º, in good accord with the measured value of 13º.)

Fault no. 247

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-239	N85W/48SW	S80W (S88W)	08 (16)	(22 NW) (11 NW)

Comments: Fault in fine- to medium-grained, graphitic and tremolitic marble. Graphite-streaked fault surface is abundantly coated with fibrous accretionary calcite. Fiber attachment points and step faces in accretionary calcite indicate right-lateral slip.

Fault no. 248

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-240	N56W/40SW	Due W (S88W)	26 (25)	(43 NW)

Comments: Fault in fine- to medium-grained, graphitic marble rich in tremolite. Fiber attachment points and step faces in minor accretionary calcite coating fault surface indicate right-lateral sense of slip. *Note:* Angle of plunge given above is more accurate than bearing direction.

Fault no. 249

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-241	N46E/70SE	(S13W)	(56)	62 SW

Comments: Fairly large, gently curved fault in medium- to coarse-grained graphitic marble with local mica and tremolite. Short bundles of calcite accretionary fibers, 2-4 mm long along the fiber length, abundantly dot the fault surface. Fiber attachment points and minute step faces in this accretionary material indicate normal sense of slip, but of quite small amount.

STATION 32 – "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, at mine coordinates 735N, 1750W. Readings extend from just outside the adit portal to 8 m inside it.

Fault no. 250

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-242	N18W/78NE	(N49E)	(77)	85 NW

Comments: Fault in medium-grained, micaceous and tremolitic marble about 1 m below footwall contact of ore. Fault has coating of white fibrous accretionary calcite. Apparent fiber attachment points and poorly preserved step faces in weathered accretionary calcite suggest normal sense of slip.

Fault no. 251

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-243	N72E/06NW	N57W	(05)	(51 SW)

Comments: Fault in medium-grained, micaceous and tremolitic marble. Fault surface is coated with fibrous white accretionary calcite and minor violet fluorite. Fiber attachment points and step faces in accretionary material indicate upper plate moved to the NW.

Fault no. 252

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-244	N42W/12NE	S57E*	(03)	(15 SE)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Step faces in fibrous accretionary calcite on fault surface show that upper plate moved to the NW. Violet fluorite is locally abundant on the fault as well. This is a large, prominent fault in the back, and it clearly cuts off another fault of orientation N25E/57SE. This older fault is too graphite-smeared for its slip sense to be evident. *Note:* The fault geometry here is interesting in that the fault surface consists of numerous *en echelon* segments with low rock steps between them. The rock steps face in the same direction as the step faces in the overlying accretionary calcite, but are of greater height, several millimeters to about 2 cm. The *en echelon* fault surfaces are striated but are not in the proper orientation for Reidel shears.

*Wrong end of compass needle was read; original reading of N57W is impossible and should have been S57E. This is common among fault with slickenlines of almost zero plunge, where it is not visually obvious in which direction the slickenlines are tilted; the next two faults are similar.

Fault no. 253

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-245	N23W/12NE	S56E*	(07)	(34 SE)

Comments: Fault in medium-grained graphitic marble with local sulfide-rich layers. Graphite-streaked fault surface coated with fibrous accretionary calcite. Little of this fault is exposed, but weakly developed step faces in accretionary material suggest upper plate moved to the NW.

*Wrong end of compass needle was read; original reading of N56W is impossible and should have been S56E.

Fault no. 254

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-246	N43W/15NE	S47E	(01)	(04 SE)

Comments: Fault in medium-grained, sparsely graphitic marble. Small step faces in fibrous accretionary calcite coating fault surface indicate upper plate moved to the NW.

*Wrong end of compass needle was read; original reading of N47W is impossible and should have been S47E.

Fault no. 255

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-247	N28E/36SE	S10E	(24)	(44 SW)

Comments: Fault in medium-grained, sparsely graphitic marble. Fault surface is lightly graphite-streaked and coated with fibrous accretionary calcite. Step faces in accretionary calcite indicate that upper plate moved to the NNW.

Fault no. 256

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-248	N20E/33SE	S40E	(29)	(64 SW)

Comments: Fault in medium-grained, sparsely graphitic marble. Fault surface is lightly graphite-streaked and coated with fibrous accretionary calcite. Little of its surface is exposed, and sense of slip is unknown.

Note: All of the faults measured above with NW- or SE-trending striations are part of the same set of faults exposed within 8 m of the adit portal. As is common for faults of this set throughout the mine, their surfaces are broadly and locally markedly curved, as reflected in the range of orientations.

STATION 33 -- "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, at mine coordinates 770N, 1770W. Readings extend from about 12 m to 18 m from the adit portal.

Fault no. 257

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-249	N21W/63NE	(N03W)	31 NW	(35 NW)

Comments: Graphite-streaked and lightly calcite-coated fault surface in medium-grained, sparsely graphitic marble. Fiber attachment points and step faces in fibrous accretionary calcite on fault surface fairly clearly indicate a left-lateral normal sense of slip.

Fault no. 258

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-250	N58E/54NW	N05E	(48)	(66 NE)

Comments: Graphite-streaked fault surface through medium-grained, graphitic, micaceous marble. Fibrous white accretionary calcite and minor violet fluorite coat fault surface. Step faces in accretionary material suggest reverse sense of slip.

Fault no. 259

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-251	N42E/62NW	(S89W)	(54)	66 SW

Comments: Fault in fine- to medium-grained graphitic marble with norbergite. Prominent, well-developed step faces in fibrous accretionary calcite on fault surface clearly indicate reverse sense of slip.

Fault no. 260

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-252	N38E/72NW	(N58W)	(72)	88 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Fault surface is coated with minor white fibrous accretionary calcite and violet fluorite. Minute step faces in accretionary calcite suggest reverse sense of slip, but this is uncertain because so little of the fault surface is exposed.

Fault no. 261

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-253	N88E/53NW	~N47E (N52E)	(38)	50 NE

Comments: Fault in medium-grained graphitic marble containing one layer rich in norbergite and sulfides. White fibrous accretionary calcite and minor violet fluorite coat fault surface. Prominent, well-formed step faces in the accretionary calcite clearly indicate reverse sense of slip. *Note:* Pitch reading given above is more accurate than the bearing.

Fault no. 262

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-254	N46E/63NW	(N80W)	(58)	72 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Fault surface is coated with minor white fibrous accretionary calcite and violet fluorite. Minute step faces in accretionary calcite suggest reverse sense of slip.

Fault no. 263

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-255	N52E/56NW	N08E (N12W)	(53) (46)	75 (60) NE

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Fault surface is coated with abundant white fibrous accretionary calcite and violet fluorite. Well-formed step faces in accretionary calcite clearly indicate reverse sense of slip.

Fault no. 264

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-256	N51E/63NW	(N28W)	(63)	85 NE

Comments: Fault in medium-grained graphitic marble with disseminated sulfides. Fault surface is graphite-streaked and coated with minor fibrous accretionary calcite. Minute, poorly preserved step faces in accretionary material suggest reverse sense of slip; this slip sense is confirmed by a 2-cm offset of another fault cut by this one.

Fault no. 265

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-257	N40E/62NW	(S87W)	(54)	66 SW

Comments: Fault in medium- to fine-grained graphitic marble. Step faces in fibrous white accretionary calcite on fault surface suggest reverse sense of slip. Minor violet fluorite also coats fault.

Fault no. 266

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-258	N67E/56NW	(N14E)	(50)	67 NE

Comments: Fault in medium- to fine-grained graphitic marble. Fibrous white accretionary calcite and minor violet fluorite coat the fault surface. Fiber attachment points and step faces in accretionary calcite fairly clearly suggest reverse sense of slip. Fault surface is also graphite-streaked. The slip direction on this fault is clearly different from that of fault no. 265 above, though the two are of similar orientation and only 0.5 m apart.

STATION 34 -- "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, at mine coordinates 795N, 1795W. Readings extend from about 23 m to 27 m from the adit portal.

Fault no. 267

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-259	N63E/75SE	(S31E)	(75)	89 NE

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Minor fibrous accretionary calcite coats fault surface, but sense of slip is unknown. Higher up the rib this fault steepens to vertical and then curves to dip about 65º NW.

Fault no. 268

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-260	N53E/62NW	(N68W)	(58)	74 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Well-developed step faces in fibrous accretionary calcite on fault surface indicate reverse sense of slip.

Fault no. 269

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-261	N36E/58SE	(S21E)	(53)	71 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Much of this fault surface is coated with post-mining flowstone. Graphite streaks are visible in some places through the translucent flowstone, as is minor fibrous accretionary calcite, but sense of slip on the fault could not be determined.

Fault no. 270

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-262	N48E/76NW	(N11E)	(67)	72 NE

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable step faces in minor, fibrous accretionary calcite on fault surface suggest reverse sense of slip.

Fault no. 271

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-263	N28E/69NW	(N81W)	(68)	83 SW

Comments: Fault in fine- to medium-grained graphitic marble that in some places resembles cemented pea gravel. Fault surface is mostly covered by flowstone, but graphite streaks and fibrous accretionary calcite are visible in places. Sense of slip seemingly is reverse, but not convincingly so because of poor exposure.

STATION 35 – "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, at mine coordinates 820N, 1805W. Readings extend from about 29 m to 35 m from the adit portal.

Fault no. 272

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-264	N53E/42SE	S30W (S29W)	20 (20)	(30 SW) (31 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Fault surface mostly obscured by flowstone; sense of slip unknown. *Note:* Plunge reading given above is more accurate than the bearing measurement.

Fault no. 273

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-265	N43E/29NW	N60W	(28)	(79 SW)

Comments: Graphite-streaked fault surface in medium- to locally fine-grained graphitic marble. Minor fibrous accretionary calcite coats fault, but little of fault surface is exposed. Sense of slip unknown.

Fault no. 274

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-266	N46E/23NW	N59W	(22)	(76 SW)

Comments: Graphite-streaked fault surface in medium- to locally fine-grained graphitic marble. Minor fibrous accretionary calcite coats fault, but little of fault surface is exposed. Sense of slip unknown.

Fault no. 275

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-267	N23E/32NW	N55W	(31)	(80 NE)

Comments: Graphite-streaked fault surface in medium- to locally fine-grained graphitic marble. Minor fibrous accretionary calcite coats fault. Little of fault surface is exposed, but local step faces in accretionary material suggest upper plate moved NW.

Fault no. 276

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-268	N39E/25NW	N45W	(25)	(85 NE)

Comments: Graphite-streaked fault surface in medium- to locally fine-grained graphitic marble. Minor fibrous accretionary calcite coats fault. Well-developed step faces in accretionary material rather convincingly suggest upper plate moved NW.

STATION 36 -- "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, at mine coordinates 845N, 1825W. Readings taken about 42 m from the adit portal.

Fault no. 277

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-269	N36E/50SE	(S42E)	(49)	82 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Little of fault surface is exposed; sense of slip unknown.

Fault no. 278

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-270	N53E/45SE	S41E	(45)	(87 NE)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble; sense of slip unknown.

STATION 37 -- "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, at mine coordinates 855N, 1830W. Readings taken about 47 m from the adit portal.

Fault no. 279

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-271	N26E/55SE	S02E (S19E)	45 (34)	(43 SW) (60 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble with sparse disseminated sulfides; sense of slip unknown. *Note:* Bearing reading given above is probably more accurate than angle of plunge.

Fault no. 280

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-272	N38E/40SE	S06E	30 (30)	(52 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble with sparse disseminated sulfides. Minor fibrous accretionary calcite coats fault surface, but sense of slip is unknown. *Note:* Bearing reading given above is probably more accurate than angle of plunge.

STATION 38 -- "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, at mine coordinates 900N, 1860W. Readings taken from about 58 m to 66 m from the adit portal.

Fault no. 281

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-273	N24E/43SE	S20E	(33)	(53 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface face SE on hanging wall.

Note: This and the next nine faults measured at this station have similar orientations and a probable reverse sense of slip. The mechanical significance of the rock-cut steps noted on all of these fault surfaces is not clear; mud and flowstone largely prohibit study of the fine detail of these minor fractures. It is not yet known if they are striated. See also note following fault no. 287.

Fault no. 282

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-274	N36E/33SE	S40E	(32)	(78 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Fault no. 283

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-275	N35E/38SE	S14E	(31)	(56 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Fault no. 284

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-276	N33E/44SE	S08E	(32)	(50 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Fault no. 285

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-277	N26E/56SE	S10E	(41)	(52 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Fault no. 286

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-278	N14E/50SE	S25E	(37)	(52 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Fault no. 287

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-279	N14E/55SE	S28E	(43)	(57 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Step faces in probable accretionary calcite on fault surface suggest reverse sense of slip. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Note: For faults nos. 281 through 286 above, the fault surfaces are either too mud-coated or encrusted with post-mining flowstone for the underlying accretionary calcite to be clearly discernible from the parent rock. This is the reason that the sense of slip has been so difficult to discern here. However, for this fault, no. 287, the fibrous accretionary calcite on the fault surface is much clearer, and step faces within it consistently face SE on the hanging wall, thereby indicating a reverse sense of slip. Note that the step faces in the accretionary material and the rock-cut steps in the wallrock both face in the same direction, so the rock-cut steps cannot be interpreted as classic Riedel shears.

Fault no. 288

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-280	N28E/50SE	S21E	(42)	(61 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Fault no. 289

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-281	N12E/46SE	S38E	(39)	(60 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall.

Fault no. 290

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-282	N07E/37SE	S42E	(30)	(55 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Probable accretionary calcite coats fault surface; sense of slip probably reverse. Rock-cut steps on fault surface (not in the accretionary material coating it) face SE on hanging wall. As in all the faults noted above at this station, the rock-cut steps on the hanging wall face SE, in the same sense as the supposed step faces in the accretionary calcite. The rock-cut steps thus apparently are not Riedel shears. Faults in other places on the property, too, have been observed with rock-cut steps and steps in accretionary minerals facing the same direction.

Fault no. 291

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-283	N48E/60SE	(S34W)	(23)	27 SW

Comments: Fault in norbergite-bearing marble. Surface of fault is coated with fibrous accretionary olive-green serpentine and minor violet fluorite. Sense of slip unknown. Here again one sees the close association of green serpentine on the fault surface with norbergite in the marble, the norbergite being the apparent source of the Mg to form the serpentine.

Fault no. 292

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-284	N27E/53SE	S28E	(47)	(67 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic and locally micaceous marble. Sense of slip unknown.

Fault no. 293

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-285	N26E/42SE	S41E	(40)	(72 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble with disseminated sulfides. Multiple step faces in what appears to be minor fibrous accretionary calcite on the fault surface suggest sense of slip is reverse.

STATION 39 -- "Glory Hole" adit in footwall of West limb, northwest side of Passaic pit, starting at mine coordinates 955N, 1900W. Readings taken from storage area adjacent to adit to the grizzly at its west end.

Fault no. 294

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-286	N79E/39SE	S46E	(33)	(61 NE)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Total slip on fault is 4-5 mm as judged from length of graphite streaks. Sense of slip unknown.

Fault no. 295

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-287	N80E/42SE	S66E	(27)	(42 NE)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble containing layers of disseminated sulfides. Total slip on fault is 3-5 mm as judged from length of graphite streaks; sense of slip unknown.

Fault no. 296

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-288	N85W/36SW	S40E	(27)	(51 SE)

Comments: Graphite-streaked fault surface in medium- to locally fine-grained, graphitic, micaceous marble with disseminated sulfides. A reverse sense of slip is suggested by minute step faces in calcite that coats the fault surface, but it is not certain that this is accretionary calcite.

Fault no. 297

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-289	N74E/36SE	S37E	(34)	(73 NE)

Comments: Graphite-streaked fault surface in medium- to locally fine-grained, graphitic, micaceous marble with disseminated sulfides. Sense of slip unknown.

Fault no. 298

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-290	N82W/44SW	(S68E)	13 E	(19 SE)

Comments: Graphite-streaked fault surface in medium- to locally fine-grained, graphitic, micaceous marble with disseminated sulfides. Rock-cut steps on hanging wall consistently face E. In comparison to other faults bearing both rock-cut steps and step surfaces in accretionary calcite, this is a possible indication of a right-lateral sense of slip. Total slip on fault is about 1-1.5 cm as judged from length of graphite streaks.

Fault no. 299

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-391	N81W/28SW	S40E	(19)	(45 SE)

Comments: Fault through coarse-grained calcite marble; exposed in back. Fault surface bears indistinct mineral streaks with orientation as recorded above. Sense of slip unknown.

Fault no. 300

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-392	N64W/46SW	S44E	(20)	(28 SE)

Comments: Prominently graphite-streaked fault surface in coarse-grained marble. This is a minor fault with only 1-2 cm of slip. Sense of slip unknown.

Fault no. 301

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-393	N52W/62SW	(S37E)	25 SE	(29 SE)

Comments: Graphite-streaked fault surface with patchy accretionary calcite. Sense of slip is possibly right-lateral, but the visible evidence is quite tenuous here and not to be relied on.

Fault no. 302

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-394	N54W/63SW	(S34E)	33 SE	(38 SE)

Comments: Another strand of fault no. 301 above. Graphite-streaked fault surface in marble; sense of slip unknown.

Fault no. 303

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-395	N87W/42SW	S42E	(32)	(53 SE)

Comments: Mineral-streaked fault surface in marble; sense of slip unknown.

Fault no. 304

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-396	N71W/36SW	(S69E)	02 SE	(03 SE)

Comments: Graphite-streaked fault surface in graphitic marble; sense of slip unknown.

Fault no. 305

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-397	N83W/54SW	(N87W)	05 NW	(06 NW)

Comments: Graphite-streaked fault surface in graphitic marble; sense of slip unknown.

Fault no. 306

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-398	N85W/55SW	Due W (Due W)	07 NW (07 NW)	(09 NW) (09 NW)

Comments: Different portion of fault no. 305 above. Graphite-streaked fault surface in graphitic marble. Possible accretionary calcite on fault surface suggests right-lateral slip, but this is quite tenuous.

Fault no. 307

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-399	N85W/43SW	S72E (S71E)	13 (12)	(19 SE) (18 SE)

Comments: A prominently graphite-streaked fault surface in coarse-grained marble; sense of slip unknown.

Fault no. 308

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-400	N57W/73SW	N83W (N68W)	32	(34 NW)

Comments: Mineral-streaked fault surface; striae are quite prominent. Even so, sense of slip was not determinable. *Note*: Plunge measurement is more accurate than that of the bearing.

STATION 40 -- Edison adit ("Edison tunnel"), adit level of mine. Starting at adit portal and working inward.

Fault no. 309

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-333	N20W/56SW	S47W (S24W)	46 (53)	(77 SE) (60 SE)

Comments: Minor, nearly planar fault in moderate-grade franklinite-willemite-calcite ore. Mechanically striated fault surface; sense of slip unknown.

Fault no. 310

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-334	N01E/51NW	S46W (S31W)	32 (41)	(58 SW) (43 SW)

Comments: Same character as fault no. 309 above.

Fault no. 311

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-335	N09E/68NW	S75W (S81W)	67 (66)	(81 SW) (83 SW)

Comments: Prominent fault on north rib. Fault is in medium-grade franklinite-willemite-calcite ore. Accretionary calcite on fault surface indicates reverse sense of slip.

Fault no. 312

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-336	N37E/78SE	S50E (S10E)	74 (78)	(89 SW) (73 SW)

Comments: Minor fault in medium-grade franklinite-calcite ore. Mechanically striated fault surface; sense of slip unknown. *Note:* Striae are nearly down dipline of steeply dipping fault, so a minor difference in plunge measurement will make a large difference in calculated bearing. The measured and calculated plunges agree within 4º, but the measured and calculated bearings differ by 40º. The actual slip vectors in 3D space are close to one another in any case.

Fault no. 313

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-337	N14E/71NW	S80W (S78W)	69 (69)	(82 SW) (81 SW)

Comments: Minor fault in lean franklinite-calcite ore. Mechanically scratched fault surface; sense of slip unknown.

Fault no. 314

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-338	N14E/73NW	N75W (N76W)	73	(90)

Comments: Minor fault in medium-grade franklinite-calcite ore. The fault is gently undulatory along dip. Step faces in accretionary calcite with minor green serpentine on fault surface indicate reverse sense of slip.

Fault no. 315

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-339	N78W/72SW	S41W	(69)	(80 NW)

Comments: Fault in medium-grade franklinite-calcite ore. Mechanically striated fault surface; sense of slip unknown.

Fault no. 316

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-340	N24E/67SE	S67E	64 (67)	(90)

Comments: Tiny fault in calcite marble bearing small, scattered grains of franklinite. Sense of slip unknown. *Note:* Bearing measurement is more accurate than the plunge.

Fault no. 317

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-341	N40E/51NW	(N27W)	(49)	75 NE

Comments: Minor, calcite-coated fault surface through ore; accretionary calcite indicates reverse sense of slip.

Fault no. 318

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-342	N42W/03NE	N42W	(00)	(00)

Comments: Minor fault through medium-grained franklinite ore. Fault is calcite-coated in part. Very little of fault surface is exposed; sense of slip unknown.

Fault no. 319

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-343	N04W/25NE	S61E	(21)	(60 SE)

Comments: Minor fault through medium-grained franklinite ore. Fault is calcite-coated in part, but sense of slip could not be determined with confidence.

Fault no. 320

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-344	N29E/61SE	S64E	(61)	(89 NE)

Comments: Minor fault in franklinite-bearing ore. Fault surface bears thin, patchy coatings of calcite, but sense of slip is unknown.

Fault no. 321

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-345	N55E/57SE	S55E	(55)	(79 NE)

Comments: This is one of a set of faults with very irregular, curving surfaces exposed for tens of meters along the south rib. The fault surface bears patchy coatings of calcite, but the sense of slip was not determinable.

Fault no. 322

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-346	N16E/69NW	N65W	(69)	(87 NE)

Comments: Minor fault in ore; poorly exposed. Indistinct step faces in accretionary material on fault surface suggest reverse sense of slip.

Fault no. 323

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-347	N11E/56NW	S54W (S50W)	43 (45)	(59 SW) (55 SW)

Comments: Fairly planar fault surface in franklinite-willemite-calcite ore. Sense of slip unknown.

Fault no. 324

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-348	N22E/67NW	N31W (N21W)	58 (62)	(74 NE) (67 NE)

Comments: Very small fault through black, fine-grained rock of uncertain mineralogy. Mechanically scratched fault surface. Little of fault surface is exposed; sense of slip unknown.

Fault no. 325

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-349	N13E/78NW	(S80W)	(77)	85 SW

Comments: Minor fault in medium-grained franklinite-calcite ore; sense of slip unknown.

Fault no. 326

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-350	N63E/44SE	S47E	(42)	(75 NE)

Comments: Mechanically scratched fault surface through coarse-grained calcite marble; sense of slip unknown.

STATION 41 – 920 crosscut, adit level of mine, between the Rainbow Room on the west and the drift round display on the east. Most of the faults in this area are near the west end of the crosscut.

Fault no. 327

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-351	N69W/53SW	S49E	17 (24)	(31 SE)

Comments: Fairly large, almost planar fault in medium-grained graphitic marble. Prominently graphite-streaked fault surface; sense of slip unknown. *Note*: Bearing measurement is more accurate than that of the plunge.

Fault no. 328

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-352	N75W/50SW	S48E	19 (30)	(38 SE)

Comments: Same comments as for fault no. 327 above.

Fault no. 329

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-353	N26E/55SE	S76E (N82E)	50 (54)	(83 NE) (69 NE)

Comments: Minor fault in medium-grained calcite marble; sense of slip unknown. A little higher on the north rib, this fault offsets a fault parallel to the two above and is thus of younger age.

Fault no. 330

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-354	N73W/54SW	S39E (S60E)	18 (38)	(49 SE) (22 SE)

Comments: A minor fault similar to nos. 327 and 328 measured at this station, and in the same rock type. Sense of slip unknown.

Fault no. 331

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-355	N69W/53SW	S62E (S60E)	11 (10)	(12 SE) (14 SE)

Comments: Minor fault in medium-grained graphitic marble. Graphite-streaked fault surface; sense of slip unknown. The striations recorded here are for the older of two sets on this fault; see next set of readings below for the younger set. *Note:* The bearing measurement is more accurate than the plunge.

Fault no. 332

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-356	N69W/53SW	(S39E)	34 SE	(44 SE)

Comments: Same fault as no. 331 above, but a more steeply plunging set of striations that apparently are younger than those of shallower plunge. This second set of striations is only patchily developed and appears to cut across and smear those of the other set.

Fault no. 333

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-357	N75W/58SW	(S72E)	05 SE	(06 SE)

Comments: A small fault in graphitic marble. Amount of slip about 1 cm; sense of slip unknown.

Fault no. 334

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-358	N77W/64SW	S65E (S68E)	17 (23)	(26 SE) (19 SE)

Comments: Minor fault in medium-grained graphitic marble. Graphite-streaked fault surface; about 2 cm of slip on fault; sense of slip unknown.

STATION 42 – Landmesser decline (Landmesser "tunnel"), = decline leading from area near Lamont-Doherty seismometer station to the lower stope.

Fault no. 335

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-359	N53E/52NW	N17E	(37)	(50 NE)

Comments: Minor fault through massive franklinite-calcite ore. Mechanically scratched fault surface; sense of slip unknown.

Fault no. 336

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-360	N60E/52SE	(S30E)	(52)	90

Comments: A fault in low-grade franklinite-calcite ore; exposed length of fault about 5 m. Mineral-streaked fault surface; sense of slip unknown. Fault is opposite slusher display.

Fault no. 337

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-361	N24W/55NE	(S89E)	(52)	75 SE

Comments: Minor fault nearly parallel to compositional layering in medium-grained calcite marble. Almost none of fault surface is exposed. Fault shows poorly developed striae on surface; sense of slip unknown.

Fault no. 338

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-362	N85E/53SE	(S81E)	(18)	23 NE

Comments: Very small fault in coarse-grained calcite marble. Weakly mineral-streaked fault surface; sense of slip unknown.

Fault no. 339

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-363	N12E/86SE	(N51E)	(84)	85 NE

Comments: Mineral-streaked fault surface in moderate-grade franklinite-willemite ore. Apparent but weakly developed drag features in wallrock along fault trace suggest west block is upthrown.

Fault no. 340

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-364	N11E/79NW	(S61W)	(76)	81 SW

Comments: Fault in moderate- to high-grade franklinite-willemite-calcite ore. Calcite-lined fault surface. Drag features in wallrock along trace of fault suggest west block is upthrown and show that the rock experienced some degree of ductile deformation during faulting. Fault continues across back and down opposite rib; this is one of fairly numerous such faults in this general area.

Fault no. 341

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-365	N05E/86NW	(S68W)	(86)	88 SW

Comments: All comments for previous fault (no. 340) apply here as well.

Fault no. 342

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-366	N40E/46SE	S43E	(46)	(85 SW)

Comments: Calcite-coated fault surface exposed in back; sinuous fault surface; sense of slip unknown. See also fault no. 343 below.

Fault no. 343

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-367	N43E/36SE	S42E	(36)	(86 SW)

Comments: Mineral-streaked fault surface; sense of slip unknown. This is the same fault as no. 342 above, but measured in a different place. One of a family of such faults in this area. The faults are fairly sinuous and split and merge along their traces.

Fault no. 344

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-368	N37E/52SE	S60E	(52)	(86 NE)

Comments: Another of the family of faults mentioned above; sense of slip unknown. This fault flattens to a more gentle dip of 38º SE toward the back.

Fault no. 345

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-369	N65E/72SE	(S20W)	(65)	73 SW

Comments: Minor fault in high-grade, franklinite-rich ore, high on the south rib. Mechanically scratched fault surface; sense of slip unknown.

Fault no. 346

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-370	N73E/31NW	N23W	(31)	(85 SW)

Comments: Minor fault in high-grade franklinite ore. Fault is calcite-coated in part; step faces in accretionary calcite indicate upper plate moved to NW.

Fault no. 347

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-371	N43E/90	(S43W)	(80)	80 SW

Comments: An irregular, locally highly curved fault cutting franklinite-willemite ore. The fault surface is coated with calcite, but the sense of slip could not be determined with confidence.

Fault no. 348

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-401	N66W/41NE	(N45E)	39 SE	(74 SE)

Comments: Very small, irregular, locally epidote-coated fault surface; sense of slip unknown. This fault terminates against fault no. 349 below.

Fault no. 349

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-402	N49E/87SE	(N60E)	(75)	75 NE

Comments: Prominent drag features adjacent to this fault indicate the southeast side is the downthrown block. The striae on the fault surface are indistinct but nevertheless visible, with orientation as recorded above.

Fault no. 350

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-403	N51E/77NW	(N74W)	(74)	81 SW

Comments: Inaccessible fault, exposed in back. Apparent step faces on accretionary calcite lining fault surface suggest that the southeastern side is the downthrown block (reverse fault). Two sets of striations are visible on this fault; see also fault no. 351 below.

Fault no. 351

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-404	N51E/77NW	(N13E)	(69)	74 NE

Comments: Same fault as no. 350 above, but a different set of striae. Apparent step faces on fibrous accretionary calcite suggest that southeastern side is the downthrown block, as was the case for the accretionary calcite associated with the other set of striae, but the fault is inaccessible, so the conclusion is uncertain. The age relation between the two is unknown.

Fault no. 352

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-405	N52E/53NW	(N74W)	47 SW	(66 SW)

Comments: Calcite- and epidote-coated fault surface cutting a block of pyroxene(?) gneiss. Very little of fault surface is exposed; sense of slip unknown.

Fault no. 353

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-406	N74E/31NW	N19W	(31)	(87 SW)

Comments: Calcite-coated fault surface. Small step faces in accretionary calcite indicate that hanging wall moved toward the NW. This fault is offset by one of orientation N39E/51SE, along which the southeast side is downthrown, but the slip vector is not measurable.

Fault no. 354

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-407	N33E/53NW	N62W	(53)	(87 SW)

Comments: Minor fault through franklinite-rich ore. Fault surface is calcite-coated in part. Sense of slip unknown.

Fault no. 355

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-408	N32E/87NW	(S77W)	(86)	87 SW

Comments: Mechanically scratched and mineral-streaked fault surface in franklinite-calcite ore. Sense of slip unknown.

Fault no. 356

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-409	N45E/89NW	(S51W)	(81)	81 SW

Comments: Fault in franklinite-willemite-calcite ore. Fault surface is mechanically scratched, at least in part, and bears two sets of striations. The most prominent set, recorded here, pitches 81º SW and is perhaps the older of the two, but the visual evidence of this age relation is unconvincing. Sense of slip unknown. See also fault no. 357 below.

Fault no. 357

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-410	N45E/89NW	(N39E)	(80)	80 NE

Comments: Same fault as no. 356 above, but a different and perhaps younger set of striae upon the fault surface. Striae of this set are subordinate to the NE-pitching set but appear to cut across them. The visual evidence, however, is weak.

STATION 43 – Main adit to mine, S rib, between adit portal and safety exit, at mine coordinates 1310N, 1380W.

Fault no. 358

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-291	N38E/42SE	S35E (S19E)	37 (41)	(77 SW) (64 SW)

Comments: Minor fault with irregular, curved surface in coarse-grained graphitic marble. Indistinct fibrous calcite on fault surface suggests hanging wall moved NW.

Fault no. 359

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-292	N79W/06NE	N42W	00 (04)	(37 NW)

Comments: Same fault character and rock type as fault no. 358 above. Step surfaces in well-developed accretionary calcite on fault surface show that upper plate moved to the NW.

Fault no. 360

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-293	N21E/25SE	S25E	12 (19)	(49 SW)

Comments: Exceedingly irregular fault surface in coarse-grained graphitic marble. Step faces in accretionary calcite on fault indicate hanging wall moved NW. *Note:* Bearing reading is more accurate than the plunge.

STATION 44 – Main adit in mine, between safety exit and air doors.

Fault no. 361

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-294	N58E/60NW	N35E	34 (34)	(40 NE)

Comments: Minor fault in coarse-grained calcite marble. Step faces on accretionary calcite on fault suggest hanging wall is upthrown block.

Fault no. 362

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-295	N56E/49NW	N11E (N10E)	40 (39)	(57 NE) (58 NE)

Comments: Minor fault in coarse-grained marble. Step faces in films of accretionary calcite on fault surface indicate reverse sense of slip (hanging wall is upthrown block).

Fault no. 363

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-296	N56E/65NW	N22E	46 (50)	(58 NE)

Comments: Same comments as for two faults above; reverse fault. *Note:* Bearing is more accurate reading than plunge.

Fault no. 364

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-297	N78W/81SW	(S76E)	13 SE	(13 SE)

Comments: Fault in medium- to coarse-grained marble. Fault surface is lined with accretionary calcite and serpentine; step faces in this material indicate right-lateral slip.

Fault no. 365

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-298	N57W/85SW	(S55E)	23 SE	(23 SE)

Comments: Same comments as for fault 364 above.

Fault no. 366

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-299	N65E/56NW	N16E	49 (48)	(64 NE)

Comments: Fault in calcite marble. Step faces in accretionary calcite suggest hanging wall is upthrown block. *Note:* Bearing is more accurate than plunge.

STATION 45 – Main adit in mine, between air doors and steel sets.

Fault no. 367

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-300	N70E/54NW	N05E	(51)	(75 NE)

Comments: Minor fault in marble; sense of slip unknown.

Fault no. 368

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-301	N80E/70NW	N20E	(67)	(79 NE)

Comments: Fault in graphitic marble. Graphite-streaked fault surface with local accretionary calcite; sense of slip unknown.

Fault no. 369

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-302	N78E/69NW	N06W	(69)	(88 NE)

Comments: Minor fault with about 1 cm slip in graphitic marble. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 370

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-303	N44E/73SE	S72E	(71)	(82 NE)

Comments: Minor fault, several cm of slip, in graphitic marble. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 371

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-304	N75E/89SE	(S15E)	89	(90)

Comments: Minor fault in graphitic marble; graphite-streaked surface; sense of slip unknown.

STATION 46 – Main adit in mine, between steel sets and lamp room.

Fault no. 372

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-305	N28E/66SE	N57E	(48)	(54 NE)

Comments: Minor fault in graphitic marble. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 373

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-306	N49E/73SE	(S61E)	72 NE	(84 NE)

Comments: Same comments as for fault above; sense of slip unknown.

Fault no. 374

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-307	N40E/88SE	S50E	88 (88)	(90)

Comments: Fault in graphitic marble. Prominently graphite-streaked and calcite-coated fault surface, with streaks oriented directly downdip. Step faces in accretionary calcite indicate southeast side of fault is downthrown.

Fault no. 375

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-308	N46E/85SE	S44E	85 (85)	(90)

Comments: Same information as for previous fault; striations directly downdip; southeast side is downthrown block.

Fault no. 376

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-309	N59E/89SE	(S31E)	89 (89)	(90)

Comments: Minor fault in coarse-grained graphitic marble. Graphite-streaked fault surface; sense of slip unknown. Striations directly downdip.

STATION 47 – Main adit in mine, south rib, between entrance and exit doors to lamp room.

Fault no. 377

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-310	N35E/41SE	S30E	(38)	(71 SW)

Comments: Minor fault in marble; graphite-streaked fault surface; sense of slip unknown.

Fault no. 378

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-311	N33E/83NW	(N57W)	83	(90)

Comments: Graphite-streaked fault surface with downdip striae, in marble; sense of slip unknown.

Fault no. 379

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-312	N35E/86NW	(N55W)	86	(90)

Comments: Fault in graphitic marble with downdip striae. Accretionary calcite on fault surface indicates that SE side of fault is the downthrown block.

Fault no. 380

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-313	N31E/52NW	N88W	(48)	(71 SW)

Comments: Minor fault in graphitic marble. Graphite-streaked fault surface with minor accretionary calcite and violet fluorite. Northwest side of fault is probably the upthrown block (reverse fault).

STATION 48 – Main adit in mine, between West limb footwall drift and shaft station.

Fault no. 381

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-314	N14E/52NW	N78W	(52)	(89 SW)

Comments: Fault in marble; weakly developed striations suggest reverse sense of slip.

Fault no. 382

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-315	N71E/82SE	(S26W) (S08W)	81 (79)	82 SW (86 SW)

Comments: Graphite-streaked fault surface also bearing a small patch of fibrous accretionary calcite. Sense of slip unknown.

Fault no. 383

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-316	N73E/72SE	(S71W)	(08)	08 SW

Comments: Graphite-streaked fault surface; sense of slip unknown.

Fault no. 384

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-317	N52E/76SE	(S08E)	(74)	82 SW

Comments: Large fault immediately west of large area of flowstone on north wall of shaft station. Graphite-streaked fault surface; sense of slip unknown.

STATION 49 – Adit level in mine, West limb footwall drift, between main adit and ore pass.

Fault no. 385

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
SUR-318	N22E/84SE	S55E	(84)	(89 SW)

Comments: Graphite-streaked fault surface in medium- to coarse-grained marble. Minor fault with only about 2 cm of slip. Sense of slip unknown.

Fault no. 386

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-319	N21E/47SE	S27E	(38)	(58 SW)

Comments: Graphite-smeared fault surface; individual streaks not visible. Fault is prominently grooved parallel to presumed slip direction as recorded above. Grooves have wavelength of 2-3 cm and amplitudes of about 0.5 cm. Sense of slip unknown.

Fault no. 387

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-320	N28E/44SE	S03E	(27)	(40 SW)

Comments: Different portion of same fault above, and a different set of striations. Age relative to other set unknown. Minor accretionary calcite lines fault surface, but sense of slip on fault could not be determined.

Fault no. 388

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-321	N02W/60SW	S38W	(48)	(59 SE)

Comments: Fault surface is coated with accretionary calcite intergrown with fluorite. Step faces in this material indicate hanging wall is upthrown block.

Fault no. 389

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-322	N17E/90	(S17W)	(78)	78 SW

Comments: Minor fault with 2-3 cm of slip. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 390

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-323	N22E/85NW	(S51W)	(80)	81 SW

Comments: Graphite-streaked fault surface in medium-grained graphitic marble. Sense of slip unknown.

Fault no. 391

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-324	N43E/80NW	(N86W)	(77)	82 SW

Comments: Graphite-streaked and calcite-filmed fault surface in medium-grained graphitic marble. Step faces in accretionary calcite indicate SE block is downthrown side. Minor violet fluorite is present within the accretionary calcite; also present are rare patchy films of pale green serpentine. As usual, where serpentine is present within accretionary material on a fault surface, the marble host rock contains chondrodite or norbergite.

Fault no. 392

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-325	N41E/69NW	(N57W)	(69)	87 SW

Comments: Minor fault in graphitic marble. Graphite-streaked fault surface partly coated with fibrous calcite and fluorite; sense of slip unknown.

Fault no. 393

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-326	N57E/86NW	(S79W)	(79)	80 SW

Comments: Graphite-streaked, calcite-filmed fault surface in graphitic marble. Sense of slip unknown. See also fault no. 394 below, which records a different episode of slip on this same fault.

Fault no. 394

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-327	N57E/86NW	(N43E)	(74)	74 NE

Comments: Same fault as above, but a different set of graphite streaks on fault surface. Step faces in accretionary calcite indicate that NW side of fault is upthrown block. Though the evidence is weak, this calcite appears to be plated over the graphite streaks of the other set and thus suggests that the calcite dates from the younger episode of slip.

Fault no. 395

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-328	N68E/71NW	N03E	(69)	(81 NE)

Comments: Graphite-smeared fault surface partly coated by accretionary calcite; sense of slip unknown.

Fault no. 396

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-329	N05W/80SW	(S40W)	(76)	80 SE

Comments: Graphite-streaked fault surface with minor violet fluorite. Sense of slip unknown.

Fault no. 397

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-330	N25E/51SE	(S67E) (S65E)	50 SE (51)	89 NE (90)

Comments: Fault is covered with a thin film of flowstone, but graphite streaks are visible beneath. Sense of slip unknown.

Fault no. 398

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-331	N51E/84SE	(S12E)	(83)	87 SW

Comments: Graphite-streaked and partly calcite-coated fault surface in graphitic marble. Faint step faces in accretionary calcite suggest SE side of fault is downthrown block.

Fault no. 399

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-332	N23E/87SE	(S06W)	(80)	80 SW

Comments: Graphite-streaked and partly calcite-coated fault surface in graphitic marble. Step faces in accretionary calcite indicate SE side of fault is downthrown block.

STATION 50 – Adit level of mine, West limb footwall drift, between 920 crosscut and the timber sets.

Fault no. 400

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-376	N52E/62SE	S37E	60 (62)	(90)

Comments: Graphite-streaked fault surface in graphitic marble; sense of slip unknown. *Note*: The bearing reading undoubtedly is fairly accurate for this fault and agrees with the two faults below. Using this value, the calculated plunge is within 2º of that measured. Proceeding in the opposite way – calculating the bearing from the measured plunge – is inherently risky for this fault, for even a small error in measured plunge results in a substantial difference in the calculated bearing. A plunge of 60º, for example, results in a calculated bearing of S16E, fully 21º different from that measured, and thus an unreasonable value. We thus accept the measured bearing of N37E and the calculated plunge of 62º.

Fault no. 401

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-377	N33E/48SE	S33E	(45)	(73 SW)

Comments: Graphite-streaked fault surface in graphitic marble; sense of slip unknown.

Fault no. 402

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-378	N31E/55SE	S30E	(51)	(72 SW)

Comments: Graphite-streaked fault surface in graphitic marble; sense of slip unknown.

Note: These three faults, nos. 400 through 402, developed within the mylonite zone of the ductile shear zone that is exposed at the timber sets here. The three faults represent much later, reactivated segments of the earlier shear zone and record brittle rather than ductile deformation. The development within the mylonite zone of numerous later faults is the reason the southern part of this zone, as currently exposed on the west rib, is covered with flowstone; it freely leaks water from above.

Fault no. 403

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-379	N66W/54SW	(N67W)	01 NW	(01 NW)

Comments: This fault is one of several within a zone 3-15 cm thick of sheared rock that contains multiple sinuous fault surfaces. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 404

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-380	N15W/40NE	S46E (S51E)	26 (23)	(43 SE) (38 SE)

Comments: Graphite-streaked fault surface coated with translucent flowstone, through which the graphite streaks can locally be seen. Sense of slip unknown.

Note: This fault, one of numerous such faults here, is highly irregular and curved. Faults of this set are exposed on both ribs and split and merge in complex fashion. Fault no. 403 above cuts across several members of this set and is thus the younger feature.

Fault no. 405

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-381	N06E/25NE	S67E (S60E)	23 (24)	(74 SW) (68 SW)

Comments: Very irregular, graphite-streaked fault surface with only about 1 cm of slip. A small area of apparent accretionary calcite suggests the upper plate moved to the NW.

Fault no. 406

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-382	N60W/32SW	(S47E)	08 SE	(15 SE)

Comments: Minor fault in graphitic marble. Graphite-streaked fault surface; sense of slip unknown. This is one member of a set of numerous such faults here, as documented in part by the next several examples.

Fault no. 407

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-383	N65W/46SW	(S58E)	07 SE	(10 SE)

Comments: Minor fault in graphitic marble. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 408

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-384	N70W/39SW	(S59E)	09 SE	(14 SE)

Comments: Very small fault surface in marble; graphite-streaked; sense of slip unknown.

Fault no. 409

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-385	N70W/42SW	S33E	(28)	(45 SE)

Comments: Graphite-streaked fault surface in graphitic marble; sense of slip unknown. The bearing given here is for a more steeply plunging set of striations (graphite streaks) on the fault surface than on the several faults listed above. Faults of this set have clearly been reactivated, as shown by two or more sets of graphite streaks on single surfaces.

Fault no. 410

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-386	N75E/37SE	S45E	(33)	(65 NE)

Comments: Minor fault showing only about 4 mm of slip, as indicated by the length of small graphite streaks on the fault surface. Sense of slip unknown.

Fault no. 411

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-420	N11E/46SE	S70E	(46)	(84 NE)

Comments: Graphite-smeared fault surface in coarse-grained graphitic marble. Sense of slip unknown.

Fault no. 412

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-421	N76W/53SW	(N78W)	03 NW	(04 NW)

Comments: Graphite-streaked fault surface that extends across the back and down both ribs. The wallrock marble is strongly sheared within a zone 1.5-2 cm thick along this fault. Sense of slip unknown. This is one

of multiple faults that split and merge within a zone about 15 cm wide. This fault offsets fault no. 411 above and thus appears to be younger. At least seven faults similar to fault no. 411 either terminate against or are offset by fault no. 412.

Fault no. 413

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-422	N06E/30SE	S70E	(29)	(78 SW)

Comments: Minor fault with a very irregular, curved surface in graphitic marble. Graphite streaks on fault surface indicate only 1-2 cm of slip. Accretionary calcite on fault surface indicates that hanging wall moved to the NW.

Fault no. 414

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-423	N36E/39SE	S74E	(37)	(74 NE)

Comments: Very irregular, curved fault, a member of the same set of faults as nos. 411 and 413. Graphite streaks on fault surface indicate only about 1 cm of slip. Sense of slip unknown. This fault terminates against fault no. 415 below, suggesting it has been offset by it and is thus older, but this has not been proven.

Fault no. 415

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-424	N58W/41SW	N60W	(02)	(03 NW)

Comments: Graphite-streaked fault surface in coarse-grained graphitic marble; sense of slip unknown. See fault 414 above for additional comments.

Fault no. 416

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-425	N70W/38SW	S49E	(16)	(26 SE)

Comments: Graphite-streaked fault surface in graphitic marble. As documented previously, at least two sets of striae are present on faults of this set, one of which shows moderate plunges to the southeast, while the other is nearly horizontal.

Fault no. 417

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-426	N23E/30SE	S23E	(23)	(50 SW)

Comments: Same character as fault no. 414; sense of slip unknown.

Fault no. 418

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-427	N40E/26SE	S23E	(23)	(65 SW)

Comments: Same character as fault no. 414; sense of slip unknown.

Fault no. 419

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-428	N23E/62SE	S42E (S50E)	61 (60)	(78 SW) (82 SW)

Comments: Prominently graphite-streaked fault surface in coarse-grained graphitic marble. The fault surface is not planar but consists of multiple low-angle *en echelon* segments. If these are Riedel shears a reverse sense of slip would be suggested, but numerous faults in the mine with *en echelon* segmented surfaces have been shown, through observation of fibrous accretionary material on the fault surfaces, to have the opposite sense of slip. Probably a normal fault (many other examples known of this general orientation).

Fault no. 420

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-429	N40E/50SE	S45E (S29E)	48 (50)	(87 SW) (76 SW)

Comments: Same comments as for previous fault. The fault surface is mostly covered in flowstone, but the flowstone is translucent and the striae can be viewed through it. As for previous fault, this fault surface consists of low-angle *en echelon* segments.

Fault no. 421

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-430	N14E/53SE	S69E	(53)	(86 SW)

Comments: Graphite-streaked fault surface in graphitic marble; sense of slip unknown.

Fault no. 422

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-431	N82E/40NW	N69E (N72E)	08 (11)	(13 NE) (17 NE)

Comments: Minor strike-slip fault, trace length less than 1 m, in graphitic marble. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 423

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-432	N79E/50NW	(N76E)	03 NE	(04 NE)

Comments: Same comments as for previous fault (no. 422).

Fault no. 424

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-433	N66E/46NW	(S78W)	12 SW	(17 SW)

Comments: Same comments as for fault no. 422 above.

Fault no. 425

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-434	N66E/52NW	(N43E)	(27)	35 NE

Comments: Minor fault in graphitic marble. Graphite streaks on fault surface indicate only 1 cm of slip. Sense of slip unknown.

Fault no. 426

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-435	N83W/30SW	S27E	(26)	(60 SE)

Comments: Graphite-streaked fault surface in graphitic marble. Sense of slip unknown.

Fault no. 427

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-436	N35E/60SE	S46E (S39E)	59 (60)	(86 SW) (82 SW)

Comments: Roughly planar but irregular fault surface in coarse-grained calcite marble. Mineral-streaked fault surface; sense of slip unknown.

Fault no. 428

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-437	N39E/82SE	(S78E)	(81)	86 NE

Comments: Poorly exposed, graphite-streaked fault surface in coarse-grained, graphitic calcite marble. Sense of slip unknown.

Fault no. 429

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-438	N44E/57SE	S60E	(56)	(82 NE)

Comments: Minor fault in coarse-grained marble. Fault surface is streaked with graphite. Possible accretionary calcite on fault surface suggests normal sense of slip, but this is far from certain; fault is poorly exposed.

Fault no. 430

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-439	N02W/88SW	(S20W)	(85)	85 SE

Comments: Minor fault in coarse-grained marble. Fault is exposed over only a few square inches in area. The surface of the fault is streaked with graphite; sense of slip unknown.

STATION 51 – Adit level of mine, lower stope adjoining the lowermost part of the Edison decline.

Fault no. 431

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-411	N44E/60NW	N15E (N11W)	55 (40)	(48 NE) (71 NE)

Comments: Minor fault in high-grade ore. Mechanically scratched fault surface; sense of slip undetermined. *Note:* Although no mention was made at the time of measurement, the plunge reading is likely more accurate than the bearing because the ore is probably magnetic to some degree, and an error of 15º in recording angle of plunge is unlikely. Trust the data calculated from the plunge measurement (bearing N11W, pitch 71 NE).

Fault no. 432

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-412	N22E/64SE	(S31E)	(59)	72 SW

Comments: Minor fault in marble on the hanging-wall side of the East limb. Sense of slip unknown.

Fault no. 433

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-413	N33E/78NW	(S86W)	(75)	81 SW

Comments: Mechanically striated fault surface in franklinite-rich ore. Calcite sparsely coats the fault surface but is insufficiently exposed to determine sense of slip.

Fault no. 434

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-414	N31E/70NW	(S70W) (S63W)	60 (55)	61 SW (67 SW)

Comments: Mineral-streaked and mechanically scratched fault surface in coarse-grained franklinite-calcite ore. Small patches of apparent accretionary calcite suggest reverse sense of slip. See next entry for a second set of striae on this same fault surface.

Fault no. 435

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-415	N31E/70NW	(N76W)	(69)	84 SW

Comments: Same fault as no. 434 above, but a different set of striae, similar to those on faults nos. 432 and 433. The sense of slip for these striae could not be determined, but they appear to cut across and thus postdate the SE-pitching striae recorded above.

Fault no. 436

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-416	N28E/75NW	(S65W)	(66)	71 SW

Comments: Grooved and mechanically scratched fault surface in coarse-grained, franklinite-bearing marble. Sense of slip unknown.

Fault no. 437

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-417	N35E/53SE	(S40E)	(52)	81 SW

Comments: Grooved and lightly striated fault surface in marble, part of a very long, broadly curved fault parallel to the ore-marble contact on the hanging-wall side. Sense of slip unknown. Such faults are common and apparently record slippage near the contact between the ore and the mechanically much weaker marble.

Fault no. 438

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-418	N15E/78NW	(S57W)	(72)	77 SW

Comments: Mechanically striated fault surface in marble bearing sparse grains of franklinite. Sense of slip unknown. Much of this fault is mud-covered, rendering its surface details, as well as the rock type, difficult to discern.

Fault no. 439

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
SUR-419	N45E/77NW	(N83W)	(74)	80 SW

Comments: Same comments as for fault no. 438 above.

180 level (includes Gravity Tram)

STATION 1 – West limb haulage drift about 40 ft south of raise to Gravity Tram, at approximate mine coordinates 1015N, 15850W.

Note: All sixteen faults measured at this station are from a single fault zone well exposed on the east rib of the drift. The zone is about 0.7 m wide and consists of multiple fault strands that are somewhat sinuous along both strike and dip. Mylonitic foliation is moderately to well developed within much of the zone, but not nearly to the same extent as along the Nason fault. Graphite streaks and smears nearly parallel to the dip line are visible on the foliation surfaces and probably record the earliest phase of movement on these faults. Intrafolial folds in the mylonite where this is best developed indicate a normal sense of shear; two beautiful examples on a centimeter scale are exposed here. Later phases of movement, from when the rock was cooler and more brittle, are responsible for the opening of vugs along the mylonitic foliation. The calcite that precipitated in these vugs mostly postdates faulting and appears as euhedral crystals, but some may, in part, be contemporaneous with the later stages of movement, as shown by observations of calcite bearing mechanical scratches due to slip. Such scratched calcite is uncommon here but was noted in a few places. At least two episodes of fault movement are indicated by the measurements taken here, the first dip-slip and responsible for the mylonitic foliation, and the second oblique-slip and responsible for the opening of the vugs along that foliation. This same fault zone is exposed in the Gravity Tram above, and there, water noisily percolates along it at a rate about that of a slow pee. The footwall ribs are heavily coated with flowstone. The fault in that place is obviously a highly permeable passageway for water flow.

Fault no. 440

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-1	N63E/60SE	S01E (S04W)	56 (57)	(76 SW) (73 SW)

Comments: Graphite-streaked fault surface through medium-grained, sparsely graphitic marble. Sense of slip unknown.

Fault no. 441

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-2	N62E/57SE	S43E (S70E)	48 (56)	(82 NE) (64 NE)

Comments: Prominently graphite-streaked fault surface in medium-grained, sparsely graphitic marble. Sense of slip unknown.

Fault no. 442

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-3	N61E/58SE	S04W (S18W)	47 (53)	(71 SW) (60 SW)

Comments: Graphite-streaked fault surface through medium-grained, sparsely graphitic marble. Sense of slip unknown.

Fault no. 443

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-4	N55E/60SE	S20E (S03W)	54 (59)	(82 SW) (69 SW)

Comments: Graphite-streaked fault surface through medium-grained, sparsely graphitic marble. Sense of slip unknown.

Fault no. 444

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-5	N55E/47SE	S37E (S36E)	47 (47)	(89 NE) (89 NE)

Comments: Graphite-streaked fault surface through medium-grained, sparsely graphitic marble. Sense of slip unknown. The slickenlines on this fault are nearly parallel to the dip line.

Fault no. 445

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-6	N55E/47SE	S16W (S16W)	34 (34)	(50 SW) (50SW)

Comments: This is the same fault as no. 444 above, but the readings here are for a later episode of slip. The fault surface is coated with a nearly colorless film of calcite plated over the graphite streaks that formed during the earlier episode of slip as recorded above. The striations recorded here reflect either true mechanical scratches on this calcite film or, less likely, a fibrous habit of the calcite. Small patches of calcite with visually discernible euhedral crystals about 1 mm across suggest the former. If, however, the calcite film is accretionary, broken step faces within it imply the hanging wall moved down and to the SSW; i.e., an oblique-slip, right-lateral normal fault.

Fault no. 446

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-7	N39E/65SE	S40E (S26E)	63 (65)	(85 SW) (79 SW)

Comments: Graphite-streaked fault surface through medium-grained, sparsely graphitic marble. Sense of slip unknown.

Fault no. 447

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-8	N47E/48SE	S13W (S19W)	28 (32)	(45 SW) (39 SW)

Comments: Graphite-streaked and locally calcite-coated fault surface in graphitic marble. Much of the calcite here is not fibrous accretionary material that precipitated during faulting but instead occurs as coatings locally 5-6 mm thick of nearly transparent, white to pale amber, euhedral crystals 3-7 mm long. Thus, this calcite is post-faulting and cannot serve as a kinematic indicator. Our field notes refer to broken surfaces in this calcite that resemble step faces, and if so the hanging wall would have moved down and to the SSW, but this evidence is not to be trusted if, as suggested above, the calcite postdates the faulting. Some of the calcite, however, might predate faulting, for in one small area, striae were visible that appeared to be mechanical scratches in the calcite; see also fault no 445 above for similar observations. The relations are clearer in areas devoid of calcite, for in those places the striae are beautifully developed physical grooves—true scratches—in the fault surface. Some of these scratches are nearly 1 mm deep and are parallel to the graphite streaks on the same fault surface; they are quite prominent and well-formed here.

Fault no. 448

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-9	N59E/63SE	S36E (S48E)	62 (63)	(88 NE) (82 NE)

Comments: Same fault as no. 447 above; graphite-streaked fault surface overlain by a translucent druse of tiny calcite crystals. The graphite striae here probably represent an earlier episode of movement than those of the previous reading.

Fault no. 449

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-10	N35E/65SE	S11W (S22W)	25	(28 SW)

Comments: The striae here are true scratches on the fault surface and are associated with minor graphite smears. Probably they represent a late stage of movement on this family of faults. *Note:* The plunge measurement given above is probably more accurate than the bearing.

Fault no. 450

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-11	N34E/63SE	S54E	62 (63)	(89 SW)

Comments: Graphite-streaked fault surface with streaks nearly down the dip line; sense of slip undetermined.

Fault no. 451

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-12	N34E/62SE	S15W (S21W)	23 (31)	(36 SW) (26 SW)

Comments: Same as fault no. 450 above, but a different set of striae. These are true scratches in the fault surface and also in the granular calcite coating it. These scratches appear to cut across the dip-slip graphite streaks documented above. This, plus the fact that they affect the calcite coating as well, suggest with near certainty that they date from a later stage of movement.

Fault no. 452

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-13	N31E/64SE	S26W (S18W)	25	(28 SW)

Comments: The readings reflect well-developed scratches 0.1-1 mm deep cut into the rock surface of the fault; probably these reflect a late stage of movement. Sense of slip unknown. *Note:* Plunge reading is probably more accurate than the bearing.

Fault no. 453

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-14	N36E/63SE	S61E	60 (63)	(87 NE)

Comments: Graphite-streaked fault surface showing nearly dip-slip movement; sense of slip unknown. *Note:* The bearing reading is here regarded as accurate because it gives a calculated pitch of 87º and our field notes indicate nearly dip-slip movement. The calculated pitch for a plunge of 60º (only 3º shallower than measured) deviates considerably from the dip line.

Fault no. 454

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-15	N57E/52SE	S32E	(52)	(89 SW)

Comments: Graphite-smeared fault surface showing nearly dip-slip movement; sense of slip unknown.

Fault no. 455

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-16	N32E/52SE	S40E	(51)	(79 SW)

Comments: Graphite-smeared fault surface in marble; sense of slip unknown.

STATION 2 – East end of Gravity Tram at mine coordinates 1030N, 1090W; hanging wall of East limb.

Fault no. 456

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-17	N05E/70SE	S15E (S11E)	37 (43)	(47 SW) (40 SW)

Comments: Mineral-streaked fault surface in medium-grained calcite marble containing tiny scales of graphite and small grains of a black, submetallic to metallic mineral resembling magnetite. The fault surface is prominently grooved parallel to the mineral streaks; the grooves are about 1 mm in amplitude (locally a little more) and 6-7 mm in wavelength. Sense of slip undetermined. The iron-stained surface of this fault is locally coated with post-mining flowstone.

Fault no. 457

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-18	N16E/50SE	S70E (S53E)	48 (50)	(87 SW) (76 SW)

Comments: Same rock type as fault no. 456 above. Minor fault with a trace length of about 2 m. Nearly dip-slip movement indicated by mineral-streaked fault surface, but sense of slip unknown. *Note:* The measured bearing of S70E is probably accurate because it corresponds to a pitch of 87º, and our field notes indicate nearly dip-slip movement on this fault. Calculating the bearing instead from the measured plunge of 48º, only 2º shallower than that calculated, results in a calculated pitch of 76º, rather far from the dip line.

Fault no. 458

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-19	Due N/87W	(S04W)	(56)	56 S

Comments: Mineral-streaked fault surface in medium-grained, sparsely graphitic marble. Sense of slip unknown.

Fault no. 459

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-20	N82W/53NE	N37W (N49W)	36 (43)	(47 NW) (59 NW)

Comments: Mineral-streaked fault surface in medium-grained, sparsely graphitic marble. Minor fracture surfaces at a slightly greater dip than the mean fault surface, if interpreted as Riedel shears, suggest the hanging wall moved down and to the west. Note, however, that we have seen numerous instances of faults with rock-cut steps facing in the same direction as the step faces in fibrous accretionary material; in those instances the fractures in the wallrock cannot be regarded as Riedel shears and the sense of slip would be the opposite.

STATION 3 – Gravity Tram, at mine coordinates 1050N, 1485W, north rib

Fault no. 460

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-21	N03W/01SW	N40W	(01)	(37 NW)

Comments: Minor fault with a dark gray, prominently mineral-streaked surface in medium-grained marble with disseminated graphite in tiny flakes; some of the marble layers are locally rich in norbergite and phlogopite. Orientation of compositional layering here: N33E/53SE. Offset layers in the marble show the

hanging wall of this fault moved NW about 20 cm. The fault is in multiple sinuous strands in a zone about 0.3-2 cm thick, locally a little more. This fault was traced along the north rib for about 22-23 feet and splays out as minor fractures toward each end. The rock layers toward the west end of the fault show the offset decreasing nearly to zero. The east end of the same fault, on the south rib of the Gravity Tram, dies out as a prominent drag fold, quite photogenic, and again showing that the upper plate of the fault moved NW. This fault, like many others, is readily visible in cross section, where it appears as thin dark seams (due to smeared-out graphite) cutting through the nearly white marble. This locality is at stations 191-196 of Steven Misiur.

Note: A prominent set of joints cuts through the marble at this locality, specifically at station 195 of Misiur. The joint surfaces are rough and totally unmineralized, and the adjacent wall rock is unaltered. The joints are about 20-80 cm high (these are true heights; both ends exposed) and have exposed (partial) lengths of 5-40 cm. No surface structures were seen on them except possible crude twist hackle. A few orientation readings: N60W/89NE N59W/88NE N58W/88NE N53W/88NE N66W/85NE
N65W/86NE N62W/86NE *Median:* N60W/88NE (n = 7)
The orientation of these joints closely matches the average strike (N61W) of 957 joints in Mesoproterozoic rocks in the Franklin quadrangle as documented by Rich Volkert (NJ Geological Survey).

STATION 4 – Gravity Tram at mine coordinates 1050N, 1525W

Fault no. 461

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-22	N36E/41SE	S45E	(39)	(75 SW)

Comments: Graphite-smeared fault surface through medium-grained graphitic marble. This fault cuts across the rock layering at a low angle and has the lesser dip. Minor fault; sense of slip unknown.

Fault no. 462

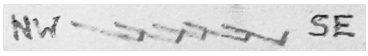
Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-23	N52E/52SE	S35E	(52)	(88 SW)

Comments: Minor fault with graphite-streaked fault surface in medium-grained graphitic marble; sense of slip unknown. This fault is traceable for barely a meter across the back, near the north rib. This fault cuts off fault no. 463 below and is thus the younger of the two.

Fault no. 463

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-24	N41E/23SE	S41E	(23)	(83 SW)

Comments: Graphite-streaked fault surface through medium-grained graphitic marble. Minor fault; sense of slip unknown. The fault surface is quite irregular and curves along strike. The ridges and crests defined by the curving fault trace appear to have their long axes about parallel to the slip direction of the fault as defined by the graphite streaks. This fault is cut off by, and thus older than, fault no. 462 above. *Note:* In detail this fault is composed of numerous *en echelon* striated fractures separated by narrow steps at steep angles (see sketch at left). These fractures have a slightly steeper dip than does the fault overall, so if they were interpreted as Riedel shears, the inferred sense of slip would be normal. However, it is well established that the upper plate of such faults moved NW, and the age of this fault, its low dip, and its highly irregular surface establish it as a member of



that family of thrust faults, so either the shear surfaces seen here reflect a later stage of movement (many of these faults were, in fact, reactivated) or they are not Riedel shears. Possibly this is a PT-type fault in the sense of Petit (1987), but this remains uncertain for now.

Fault no. 464

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-25	N44E/30SE	S43E	(30)	(87 SW)

Comments: Fault in medium-grained graphitic marble. This fault is much like no. 463 described above. The fault surface is compound and consists of numerous *en echelon* fractures that dip slightly more steeply than the mean dip of the fault overall. These surfaces are lightly graphite-streaked and also lightly, faintly scratched; the scratches are narrow and shallow, but present.

Note: The faults at station 4 form a well-developed set extending from station 202 of Misiur on the east to 1 m beyond station 213 on the west; i.e. 14 m or about 46 feet, approximately from 1489W to 1535W. Attempts to document the sense of slip on these faults from observation of offset layers failed; no good marker horizons are present, and most of the layers lens out laterally. Complicating things is the fact that the faults dip in the same direction as the layers and cut them at only low angles. These are minor faults and show little or no void space along them, nor any evidence of mineralization of their surfaces.

Fault no. 465

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-26	N43E/42SE	S38E	(42)	(83 SW)

Comments: Graphite-streaked fault surface in medium- to coarse-grained graphitic marble with diopside and scattered, irregular grains of norbergite. Minor fault; sense of slip unknown.

Note: There is, as noted above, little or no void space along these faults. All are minor. Cleavage planes of large calcite grains near these faults show no signs of distortion; there are many clear examples here. Much of the calcite immediately bordering these faults, however, is finer-grained and appears to have been recrystallized; it is darker than the coarser marble to either side due to included graphite (concentrated by pressure solution?). Some of the individual large calcite grains appear to span the fault plane, again suggesting the marble has been recrystallized along the faults; this, however, is neither clear nor common. The fine grain size of calcite along the fault and its recrystallized nature obscure the original wallrock-fault relations and hinder interpretation of the sense of slip.

Fault no. 466

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-27	N45E/56SE	S36E	(56)	(85 SW)

Comments: Minor fault in medium- to coarse-grained graphitic marble. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 467

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-28	N34E/52SE	S43E	(51)	(82 SW)

Comments: Minor fault in medium- to coarse-grained graphitic marble. Graphite-streaked fault surface; sense of slip unknown.

Fault no. 468

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-29	N40E/20SE	S45E	(20)	(85 SW)

Comments: This is one of the largest faults of this set. It is well exposed in the back, where about 4-5 square meters of its surface is visible, and cuts medium- to coarse-grained graphitic marble. The fault surface is conspicuously and clearly segmented, consisting of prominently graphite-streaked, *en echelon* surfaces that dip somewhat more steeply than the fault as a whole. The striated surfaces are dark gray to nearly black, due to the smeared-out graphite, and are 2-5 mm apart, locally increasing to about 1 cm. Interpreted as Riedel shears, these fractures would indicate a low-angle normal fault. On this same fault, however, fibrous, splintery accretionary calcite on the fault surface shows that the hanging wall moved to the NW, once again negating the interpretation of the graphite-streaked surfaces as Riedel shears. This calcite is white, pure (does not contain grains of graphite or other minerals of the Franklin Marble), and breaks into elongate fragments parallel to the transport direction of the fault, so is definitively accretionary calcite and is more to be trusted as a slip indicator than are the graphite-striated surfaces on this same fault.

Fault no. 469

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-30	N05W/19NE	S34E	(09)	(30 SE)

Comments: This fault is similar to no. 468 above in that it cuts graphitic marble and shows *en echelon*, graphite-streaked fault surfaces that dip somewhat more steeply than does the fault as a whole. Sense of slip unknown.

Fault no. 470

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-31	N45E/27SE	S34E	(27)	(80 SW)

Comments: Another fault similar to no. 468 above; it cuts graphitic marble and consists of *en echelon*, graphite-streaked fault surfaces that dip somewhat more steeply than does the fault as a whole. Sense of slip unknown. All three faults, nos. 468 through 470, are in the same area, at stations 208-210 of Misiur.

Fault no. 471

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-32	N54E/30SE	S36E	(30)	(90)

Comments: Same comments in all respects for the three faults above.

Note 1: The fault system at this station is still not fully understood despite concerted effort. The faults all appear to be part of the same set. Their surfaces are undulatory in dip, as reflected in the fairly broad range of dip angles, with most falling between 20^{o} and 50^{o}, but clustering toward the lower end of this range. Again, the general lack of void space along these faults is reflected in lack of discoloration (alteration) of the wallrock and lack of mineral coatings or fillings. Synfaulting accretionary minerals are uncommon here, but where present, as along fault no. 468, they indicate that the upper plate moved NW. This is in keeping with numerous other such faults elsewhere, where the sense of slip is well established. This leaves the structural significance of the striated *en echelon* fractures that compose these faults in considerable doubt. Though similar faults have been documented elsewhere, where striated *en echelon* fractures dip in the opposite direction from Riedel shears, it would nevertheless be desirable to revisit them to gather more detailed information on the minor structures associated with faulting here. Alas, they are all underwater now.

Note 2: Specimens rich in colorless granular fluorite in marble matrix were produced from this area. All came from the north rib and back between stations 130 and 136 of Misiur; most came from near 135. These were produced from the westmost of the two layers of fluorite in this area. The fluorite fluoresces white to bluish white SW and is sometimes referred to by collectors as "poor man's barite."

STATION 5 – 150 level, in subdrift leading NE from East limb footwall drift; station is centered on mine coordinates 970N, 1170W.

Fault no. 472

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-33	N74E/67NW	N48E (N46E)	47 (48)	54 NE (53 NE)

Comments: Minor fault in fine- to medium-grained, weakly layered graphitic marble. The fault surface is graphite-streaked and grooved parallel to the slip direction. The grooves are shallow rounded embayments in the fault surface, with wavelengths of 5-10 cm and amplitudes of 1 cm or less – not prominent, but obvious along parts of the fault. Sense of slip unknown. *Note 1*: The direct reading of 47/N48E for the slickenlines is probably more accurate than the measurement of pitch. *Note 2*: The measured bearing of N48E calculates to a plunge of 46º and a pitch of 51º. The measured plunge of 47º calculates to a bearing of N46E and a pitch of 53º. The measured pitch of 54 NE calculates to a bearing of N46E and a plunge of 48º. All of these readings are in close agreement. Probably the most accurate of all is the measurement of plunge angle, so that was used in the calculations shown above.

Fault no. 473

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-34	N84E/50NW	N42E (N35E)	42	(61 NE)

Comments: Minor, graphite-streaked fault in fine- to medium-grained graphitic marble with thin layers rich in norbergite and sulfides. Visible here are individual graphite scales embedded in the hanging wall of the fault and streaked out downward along the fault surface, indicating that the hanging wall is the upthrown fault block. The streaks become more narrow and diffuse downward, with increasing distance from the parent graphite grains, the whole resembling a series of tiny comets. Minor violet fluorite is also visible on the fault surface in places. Within the wallrock, a fine-grained brown mineral, possibly spinel, that is a major component of a layer that also contains norbergite and phlogopite, is prominently altered within 2-3 cm of the fault and is now pistachio green. This fault is near the steel vent door. *Note*: Angle of plunge is probably more accurate measurement than the bearing.

Fault no. 474

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-35	N70E/65NW	N18W	(65)	(89 NE)

Comments: This fault exhibits nearly dip-slip movement, quite distinct from the other two faults above. Minor fault in graphitic marble. Fault displays a prominently mineral-streaked surface; probable accretionary calcite deposited on that surface suggests that the hanging wall is the upthrown block (reverse fault). A few striations on one small portion of this fault have orientations similar to those of faults nos. 472 and 473 but are poorly formed; nevertheless they indicate more than one episode of slip on these surfaces. See also next fault below for measurement of these striations where they are better formed.

Fault no. 475

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-36	N72E/62NW	N48E (N44E)	45 (37)	(43 NE) (49 NE)

Comments: This is another strand of fault no. 474 above, along strike with it but 1.5 m farther northeast. The mineral-streaked fault surface here displays striations similar to those of faults nos. 472 and 473 and again shows that these faults experienced more than one episode of slip. Sense of slip unknown. The marble here is graphitic and contains a 4”-8” layer rich in norbergite, phlogopite, spinel(?), and sulfides.

Fault no. 476

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-37	N51E/58NW	S68W (S75W)	33	(40 SW)

Comments: Minor fault in fine- to medium-grained graphitic marble containing sparse norbergite and disseminated sulfides. This is another portion of fault no. 475 above but showing another clear set of striations. These striations appear to be true scratches on the fault surface, but little of it is exposed. Sense of slip unknown. Probable serpentine is present as a medium grayish-green film on the fault where it cuts a layer rich in norbergite, spinel(?), and sulfides below the graphitic marble. *Note:* Plunge measurement is probably more accurate than the bearing.

Fault no. 477

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-38	N61E/70NW	S87W (N81W)	59	(66 SW)

Comments: Minor fault in fine- to medium-grained graphitic marble containing sparse norbergite and disseminated sulfides. The fault surface is mineral-streaked where it cuts graphitic marble but is coated with accretionary calcite and serpentine where it cuts the norbergite-rich layer mentioned in fault no. 475. Step faces in probable accretionary calcite show that the hanging wall moved up. Again there is evidence of more than one episode of slip along this family of faults: the striations on the fault surface here bear to the SW, whereas those on fault no. 473 bear NE—a visually obvious difference. *Note*: Plunge reading recorded here is probably more accurate than that of the bearing; the latter is not readily measureable here.

Fault no. 478

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-39	N60E/65NW	N40E (N35E)	42 (36)	(41 NE) (48 NE)

Comments: Minor fault in fine- to medium-grained graphitic marble. Mineral-streaked fault surface. Probable accretionary calcite on part of fault surface suggests the hanging wall is the upthrown fault block, but only a few square centimeters of such calcite is exposed. In this small area the calcite is white rather than gray, lacks graphite streaks, and has a finely scored appearance that is a probable reflection of its fibrous nature. *Note*: Measurement of bearing is probably more accurate than that of the plunge.

Fault no. 479

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-40	N51E/59NW	N03E (N05W)	54 (51)	(65 NE) (71 NE)

Comments: Minor fault in fine- to medium-grained graphitic marble. The surface of this fault is lightly coated with accretionary calcite; step faces in this material show that the hanging wall of the fault is the upthrown block. *Note*: Measurement of bearing is much more accurate than that of plunge.

Fault no. 480

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-41	N57E/88NW	(N48E)	(77)	77 NE

Comments: This is one of the larger faults in this area, but still minor. The fault is prominently curved along dip, from 63º NW through vertical to 83º SE; the average of the exposed portion is about 80º NW. The fault cuts graphitic marble and the norbergite-rich layer referred to several times above. Step surfaces within prominent, white to apple-green accretionary calcite mixed with serpentine on the fault show clearly that the northwestern block is upthrown, the same sense of offset as determined for some of the faults previously measured here. With a hand lens one can clearly see the points of attachment of the calcite fibers on the fault surface, and, below them, the step faces where the fibers were broken across, again confirming the sense of slip documented here. Minor violet fluorite is present in the accretionary material as well. This calcite-serpentine-fluorite accretionary material coats the fault only where it cuts layers rich in norbergite (i.e., those rich in magnesium).

Fault no. 481

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-42	N58E/69NW	N27E (N40E)	43 (53)	(59 NE) (47 NE)

Comments: This is a different part of fault no. 480 above, where it cuts fine- to medium-grained graphitic and tremolitic marble above the norbergite layer. A different and more local set of slickenside striations is defined here by streaked-out graphite flakes. Farther down the fault, toward the area of the previous readings, the two sets of striations coexist. The N27E-bearing graphite streaks seem to be superimposed on, and thus younger than, those of steeper angle. Step faces in accretionary calcite on one part of the fault, a part showing the same set of striations as recorded here, suggest, as for the earlier set, that the hanging wall is the upthrown block.

Fault no. 482

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-43	N48E/87NW	(S71W)	(82)	83 SW

Comments: This is still another portion of the same fault as nos. 480 and 481 above, and a third clear set of striations. Fibrous accretionary calcite and serpentine coat the fault here. Attachment points of the fibers and step faces developed across them show clearly, as for the other two sets of striations, that the hanging wall is the upthrown block. Apparent streaks and smears of a dark mineral (graphite?) across this accretionary calcite are coincident with the striations recorded for fault no. 481 above, suggesting that they, the N27E-bearing striations, are younger than those recorded here. The evidence, however, is not as convincing as might be desired. Minor violet fluorite is also present here, as thin films on or within the calcite-serpentine accretionary material.

Fault no. 483

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-44	N47E/61NW	N59W	56 (60)	(82 SW)

Comments: Graphite-streaked minor fault surface in fine- to medium-grained graphitic marble; sense of slip unknown. *Note:* Measurement of bearing is probably more accurate than the plunge.

Fault no. 484

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-45	N05E/36SE	S52E	(31)	(62 SW)

Comments: Mineral-streaked fault surface through medium-grained graphitic marble; sense of slip unknown. This fault cuts off and is thus younger than no. 483 above; very clear here on NW rib. This fault, unlike those of N50-60E strike documented above, shows voids along its length and has water leaking from them. Post-mining flowstone has been deposited here and there on the marble below the fault.

Fault no. 485

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-46	N31W/24NE	S67E	(15)	(38 SE)

Comments: Same character as fault no. 484 above. This one seems to merge with the other, and probably both moved simultaneously. The fault is coated with post-faulting white calcite up to 1 mm thick. This calcite, however, has not sealed the fault completely, and it still leaks water; in places the fault is filmed with translucent, pale gray flowstone deposited by this water. Due to these mineral deposits, slickenside striations are obscure over much of the fault surface, but graphite streaks are visible here and there and gave the readings documented above. In addition to the graphite streaks the fault is also abundantly coated with accretionary calcite, visually distinguished from the calcite in the adjacent wallrock by its lack of graphite scales. If this material is indeed accretionary calcite—its fibrous nature could not be reliably determined visually—step faces developed within it indicate the upper plate of the fault moved to the WNW.

Fault no. 486

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-47	N77E/53NW	N41E	40 (38)	(50 NE)

Comments: Minor fault through fine- to medium-grained graphitic marble with norbergite. The fault surface is mineral-streaked in part and is also locally coated with white accretionary calcite with minor green serpentine and violet fluorite. Well-developed step faces within the accretionary material show that the hanging wall is the upthrown block. Serpentine is present in the accretionary material only where the fault cuts the norbergite-bearing layer. *Note*: Bearing measurement is more accurate than the plunge.

Fault no. 487

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-48	N11W/30NE	S72E	(27)	(64 SE)

Comments: Minor fault with graphite-streaked surface in fine- to medium-grained graphitic marble. One of several irregular and somewhat anastomosing minor faults here.

Fault no. 488

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-49	N36E/33NW	S55W (S50W)	09 (12)	(22 SW) (17 SW)

Comments: Very minor fault with graphite-streaked surface in fine- to medium-grained graphitic marble. Possible accretionary calcite on fault surface suggests hanging wall moved to the NW.

Fault no. 489

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-50	N48E/36NW	N29E (N44E)	03 (13)	(23 NE) (05 NE)

Comments: Small fault with graphite-streaked surface in medium-grained graphitic marble. Sense of slip unknown. *Note*: Bearing measurement is probably more accurate than angle of plunge.

STATION 6 – 150 level, in subdrift leading NE from drift along East limb; station is centered on mine coordinates 990N, 1140W.

Fault no. 490

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-51	N50E/78NW	(N74W)	(76)	82 SW

Comments: Minor fault in fine- to medium-grained graphitic marble. Mineral-streaked fault surface coated with a thin film of pale gray, translucent, post-mining calcite. Fault surface is fluted or grooved parallel to the slip direction as indicated by the mineral streaks; the grooves have wavelengths of 2-5 cm and amplitudes of 1-10 mm. Sense of slip unknown. This fault is cut off by no. 491 below.

Fault no. 491

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-52	N39E/55SE	S03W	(40)	(52 SW)

Comments: Mineral-streaked fault surface in fine- to medium-grained graphitic marble. Slip on this fault was apparently of greater magnitude than on others in this drift. The footwall marble is brecciated within a zone 2-5 cm thick along the fault; the breccia contains angular clasts of marble 0.2-1.5 cm long in a fine-grained, pale orange-tan matrix. Sense of slip nevertheless unknown. Post-faulting calcite 0.2-0.3 mm thick coats the fault surface in places. This fault abruptly cuts off no. 490 above and thus apparently is the younger of the two.

Fault no. 492

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-53	N54E/59SE	S19E	(58)	(81 SW)

Comments: This fault appears related to no. 491 above and is only 5-7 cm distant from it. Mineral-streaked fault surface in fine- to medium-grained graphitic marble. The streaks are best developed on those parts of the fault with shallowest dip; sense of slip is thus possibly normal with a slight left-lateral component.

Fault no. 493

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-54	N40E/75SE	S14W	58 (59)	(62 SW)

Comments: Minor fault with prominently graphite-streaked surface partly coated with flowstone, in graphitic marble. Sense of slip unknown. Our original notes state that normal slip is suspected, though on what basis was not recorded. *Note*: Bearing measurement is probably more accurate than angle of plunge.

STATION 7 – 150 level, in subdrift leading northeast from mined-out stope along East limb; station is near end of subdrift at mine coordinates 1020N, 1090W.

Fault no. 494

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-55	N30E/43SE	S71E	(42)	(82 NE)

Comments: Mineral-streaked fault surface in medium-grained graphitic marble; sense of slip unknown. Fault surface is prominently grooved parallel to the slip direction and is partially coated with flowstone. Where measured this fault dips 43º, as shown, but its average dip is 53º.

Note: There are many such faults between here and station 6, a dozen or more, but their surfaces are so weathered and covered by flowstone that slip indicators cannot be seen. Nevertheless these constitute a well-defined set of faults. Many have black surfaces overlain by flowstone. The largest of these faults, with orientation N34E/67SE, locally shows a series of solution channels 1-3 cm wide along its trace. The rock adjacent to the fault is altered and limonite-stained, and the solution channels are filled with mud. Also seen on this fault are some pre-mud calcite and post-mud flowstone. Water leaks freely into this end of the drift, much of it coming in along these faults. The faults are continuous from one rib diagonally across the back and down the opposing rib, and appear to be the youngest faults present; locally three or four of them are spaced only 20-40 cm apart. Slip along them appears to be modest, however; brecciation was minor and local, and no trace of mylonitic texture was seen.

STATION 8 – 150 level, drift along stoped-out portion of East limb ore at 975N, 1180W, east rib (hanging wall of East limb)

Fault no. 495

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-56	N56E/63NW	N41W	(63)	(87 SW)

Comments: Fault in coarse-grained marble with sparse willemite and franklinite, directly at the hanging wall contact with East limb ore. High-grade ore is still present here near the sill. Step faces within thick, well-developed accretionary calcite on the fault show clearly that the hanging wall is the upthrown block. No doubt about this one.

Fault no. 496

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-57	N52E/68NW	N28W	(68)	(86 NE)

Comments: Same fault as no. 495 above, but 0.3 m distant, where a clearly different set of slickenside striations is exposed. These too appear as streaked-out minerals on the fault surface. Small step faces in accretionary calcite here suggest a reverse sense of slip, but so little of this calcite is exposed it is difficult to be certain. Likewise it is difficult to determine the relative age of the slip events, but this mineral-streaked fault surface and associated minor calcite seem to reflect the earlier movement, and the thick (2-4 mm, locally > 1 cm) calcite of fault no. 495 appears to have grown atop this older calcite. All of this is very tenuous, however. The two slip directions are not much different, in any case.

STATION 9 – 150 level, at hanging-wall contact of East limb of ore, at mine coordinates 1005N, 1180W (east rib of drift, near sill)

Fault no. 497

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-58	N37E/63NW	N77W	(61)	(79 SW)

Comments: Mineral-streaked fault surface in high-grade, granular franklinite-willemite ore with subordinate zincite and calcite. Fault cuts hanging-wall contact with marble above, but exposure did not permit sense of slip to be determined. Fault surface is grooved parallel to the striations, so the

measurements given here probably record the earliest stage of movement on this fault. The grooves are quite prominent, as they often are in rich ore.

Fault no. 498

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-59	N45E/64NW	Due N (N08E)	51 (55)	(60 NE) (66 NE)

Comments: This is a different portion of fault no. 497 above. Exposed here is a pervasive set of striations—delicate scratches and a little fibrous accretionary calcite—that cover most of the fault surface. The accretionary calcite fibers grew in the troughs of the fault surface and are largely missing from the crests. Weakly developed step faces in this material suggest the hanging wall is the upthrown block—an oblique-slip left-lateral reverse fault. This phase of movement probably postdates that recorded above (fault no. 497), but the evidence for this was not recorded in our field notes. *Note:* The plunge reading recorded here is probably more accurate than the bearing.

Note: The mica-gahnite locality recently worked by John Kolic is along the footwall contact of the East limb, directly in line with the subdrift of stations 5 to 7, and opposite the mouth to this subdrift, along a 15-ft stretch centered on mine coordinates 960N, 1205W. This mica-gahnite zone extends to the surface; abundant mica is presently (August 1992) exposed along the footwall of the East limb at the northeast end of the Passaic pit. The same zone is again well exposed within 50-60 ft of the surface in stopes above the 150 level, south of the Log Cabin shaft, again along the footwall of the East limb.

STATION 10 – 180 level, West limb drift, west rib at mine coordinates 960N, 1600W

Note: See sketch map of this area on p. 94.

Fault no. 499

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-60	N19E/50SE	S68E (S56E)	49 (50)	(88 SW) (80 SW)

Comments: This fault is a member of the same fault zone as at Station 1, but here it places West limb ore (high-grade franklinite-brown willemite ore) on the hanging wall against medium-grained micaceous marble on the footwall. The fault surface is mineral-streaked, but the sense of slip is not obvious from the limited exposure here (though the geometry of the ore contact vs. the fault argues for a normal sense of slip). The fault shows a well-developed mylonitic foliation largely obscured by flowstone and mud on the mine ribs. A medium bluish-green mineral that appears as streaked films on the mylonitic foliation surfaces in the marble near the ore is possibly chlorite (an alteration product of mica?). The marble shows well-developed mylonitic foliation, but the ore hardly any. Also in this area, lensoidal masses of marble breccia occur locally in the footwall marble along the fault, a probable result of later movement under more brittle conditions. This fault leaks much water; its footwall exposed along the rib to the north is completely coated in flowstone.

Fault no. 500

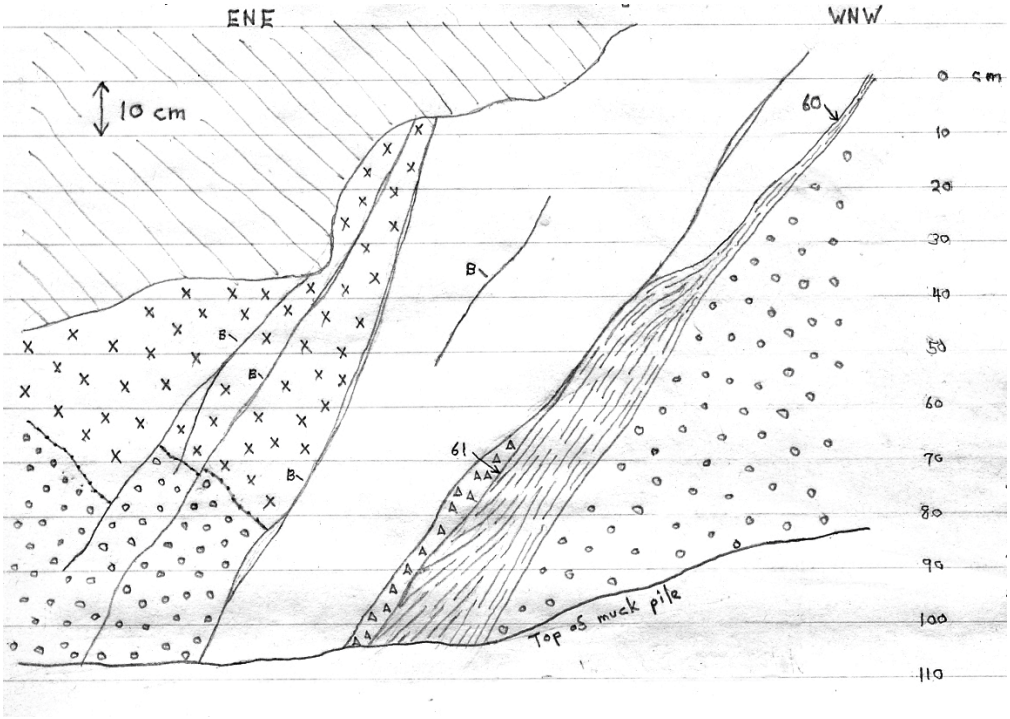
Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-61	N04E/51SE	~ S08E (S06E)	(12)	16 SW

Comments: This fault juxtaposes mylonitic marble on the footwall against marble breccia on the hanging wall. The striations on the fault surface are true scratches, well developed here, with low plunge as

recorded. This surface is in part discordant with the mylonitic foliation and cuts it off; it thus dates from a phase of brittle fault movement (thus the breccia and scored fault surface) much later than that responsible for the mylonite. A little higher this fault is completely in ore; see sketch on next page. On that sketch, the several faults labeled “B” contain a LW yellow-fluorescing mineral identified by Bob Jenkins as barite. These are minor braided faults along which the ore has been sheared out; they appear to be subsidiary shears that date from the main phase of movement. Streaked-out minerals are seen locally on their surfaces and indicate nearly dip-slip movement. The fault recorded here, however, with low-plunging striations, formed during a later phase of movement and contains no barite. It should also be noted that, nearer the surface, a LW yellow-fluorescing mineral collected in the adit level of the mine was for years regarded as barite, but X-ray diffraction analysis by Jim Van Fleet of Bucknell University proved conclusively it is calcite. Whether or not this is the same mineral seen by Bob Jenkins at this station is unknown.

[Sketch on next page]

The sketch map below is a projected vertical section, looking NNE along the strike of the fault zone at Station 10. The apparently anomalous offsets of the footwall ore contact are probably due to multiple episodes of movement in different directions, one of them with a strong lateral component (e.g., fault no. 500). These faults are known to have been repeatedly reactivated. In the sketch, the numbers 60 and 61 show the sites of measured slip indicators for faults nos. 499 and 500, respectively. Note that black ore on the west is here faulted against brown ore on the east. This is probably an up-plunge segment of black ore along the footwall of the East limb, here faulted northward against brown ore. Nearby, just to the south of this fault, along an unfaulted portion of the footwall of the East limb, the two grade laterally into each other.



Marble breccia

Chloritized marble mylonite

Micaceous marble, largely obscured by flowstone. Subsidiary shears near mylonite contact.

Ore: brown willemite and franklinite

Obscured area; flowstone on rib

Thin braided fault zones through ore and footwall marble

Footwall of East limb

"Black ore" (franklinite, dark gray to brownish gray and black willemite)

Note: The main strand of the fault described on the previous page, along the refaulted mylonite zone, crosses the back between stations 1 and 10 and is marked by a continuous line of calcite stalactites.

STATION 11 – Along footwall of East limb at mine coordinates 950N, 1595W, near station 10 but east of fault 500.

Fault no. 501

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-62	N03W/76SW	S80W	(76)	(88 SE)

Comments: A short, minor fault through high-grade franklinite-willemite ore. The willemite is purplish-brownish-gray and is transitional to black ore 2 feet to the north, and to more normal "brown ore" 2 feet to the south. The color change is quite obvious here, along the footwall contact of ore. This fault is only 30 cm long along strike and attenuates markedly at both ends, like a protofault that never fully developed. Its surface is coated with prominent fibrous accretionary calcite with fiber lengths of 1.5-2.0 cm that indicate the minimum amount of slip on this surface. Our field notes, unfortunately, are ambiguous as to the sense of slip, though mention that it is opposite to that of fault no. 499 suggests the west side is the upthrown block. Adjacent to the fault, the preferred orientation of elongated, flattened willemite grains parallel to the slip direction document that the ore was at least somewhat ductile during formation of this fault. The rapid attenuation of slip does likewise.

Fault no. 502

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-63	N14E/65NW	S86W	(64)	(82 SW)

Comments: Minor fault, wholly in "black ore," but otherwise similar to fault no. 501 above. Fibrous accretionary calcite on its surface shows the hanging wall (east side) is the upthrown block. Adjacent to this fault, the franklinite grains as well as the willemite grains show ductile elongation parallel to the slip direction.

Note: Today (August 26, 1992) is a day for animals—bats this morning (flew at cap lamp several times); centipede on ore this afternoon. Obvious we are near the surface.

Fault no. 503

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-64	N06E/67NW	S81W	(66)	(84 SW)

Comments: Fault in "black ore." Prominent fibrous accretionary calcite showing well-developed step faces indicate that hanging wall is the upthrown block (reverse fault). As with faults nos. 501 and 502, willemite and franklinite grains adjacent to this fault are elongated parallel to the slip direction and show ductile deformation of the wallrock during faulting.

Note: All three faults above, nos. 501 through 503, contain secondary willemite as well as calcite in the fibrous accretionary material on the fault surfaces; this is obvious by the fluorescence. Two of the faults, nos. 501 and 502, also show minor barite both in the wallrock and on the fault surfaces. The barite on the faults is not present as a discrete coating and could have been mechanically incorporated into the accretionary material during faulting.

STATION 12 – 150 level, footwall of East limb, centered on mine coordinates 930N, 1205W.

Fault no. 504

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-65	N87E/19SE	S28E	(17)	(66 NE)

Comments: Mineral-streaked, finely scored and polished fault surface in medium-grained, gahnite-biotite-pyroxene-calcite gneiss. Sense of slip unknown.

Fault no. 505

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-66	N10W/13SW	N27W	(04)	(17 NW)

Comments: Low-angle fault through biotite-gahnite-calcite gneiss. The fault surface is similar to that above (mineral-streaked, finely scored, and polished), but little of it is exposed. The sense of slip is uncertain, though it seems that the footwall contact of ore has been offset by the upper plate having moved NW.

Fault no. 506

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-67	N47E/50SE	S33E	46 (50)	(84 SW)

Comments: This is a small fault connecting faults nos. 504 and 505 above as part of a braided, anastomosing set of faults, the major members of which have very gentle dips. Like the others, the fault surface is mineral-streaked, finely scored, and polished. Minor accretionary calcite coating the fault shows fairly convincingly that the hanging wall moved to the NW. *Note:* The bearing measurement is probably more accurate than that of the plunge.

Fault no. 507

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-68	N42E/29SE	S28E	(27)	(72 SW)

Comments: Same character as the three faults above. Poorly developed step faces in sparse accretionary calcite coating the fault surface suggest the hanging wall moved to the NW, but not convincingly. This fault merges with nos. 504 through 506 as part of a braided fault zone.

Fault no. 508

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-69	N40E/33SE	S27E	(31)	(70 SW)

Comments: Same character as the four faults above. Step faces on accretionary calcite coating the fault suggest the upper plate moved to the NW.

Fault no. 509

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-70	N30E/24SE	S31E	(21)	(63 SW)

Comments: This fault places lean willemite-calcite ore in upper plate against mica-gahnite marble in lower plate, consistent with NW transport of the upper plate. Step faces in accretionary calcite are well developed here and confirm the sense of slip. This is one of the main strands of the fault zone here and is typical of the orientation of these faults as a whole, yet the observed offset is still minor—almost certainly less than 1 m. All fault surfaces in this set are curved, highly irregular, but smooth, much like the roche moutonées of a

glaciated surface. Amplitudes of the irregularities in the fault surface of 10-20 cm are common. The axes of the most pronounced bends or "waves" in the fault surface are about parallel to the slip direction.

Fault no. 510

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-71	N32W/17SW	S25E	(02)	(08 SE)

Comments: Fault places coarse-grained willemite-franklinite-calcite ore over mica-gahnite marble, consistent with NW transport of the upper plate. The fault surface, like those above, is mineral-streaked and locally finely scored and polished.

Fault no. 511

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-72	N29E/65NW	N35W (N25W)	60 (62)	(78 NE) (73 NE)

Comments: Fault places fine-grained garnet-pyroxene(?) rock over biotite marble. Very minor offset, probably on the order of 10 cm. The fault surface is mineral-streaked and locally semipolished. The fault is coated with abundant accretionary calcite and a little epidote (or possibly sheared-out gahnite); well-developed step faces in the accretionary calcite indicate a reverse sense of slip. This fault clearly is not a member of the same set of faults described above. Numerous others like it are present in this area, at least five of which were measurable (see below).

Fault no. 512

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-73	N42E/67NW	N36W	(66)	(85 NE)

Comments: Minor fault cutting biotite-bearing marble. Mineral-streaked fault surface with much accretionary calcite. Step faces in the calcite clearly indicate the hanging wall moved up (reverse fault).

Fault no. 513

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-74	N39E/64NW	N37W	60 (63)	(84 NE)

Comments: Minor fault cutting biotite-bearing marble. Mineral-streaked fault surface with much accretionary calcite. Step faces in the calcite clearly indicate the hanging wall moved up (reverse fault). *Note*: Measurement of bearing is likely more accurate than that of the plunge.

Fault no. 514

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-75	N19E/11NW	N35W	(09)	(54 NE)

Comments: Mineral-streaked and calcite-coated fault surface in biotitic marble. Prominent step faces in accretionary calcite indicate upper plate moved to the NW.

Fault no. 515

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-76	N23E/42NW	N36W	(38)	(66 NE)

Comments: Fault in coarse-grained willemite-franklinite-calcite ore. Mineral-streaked and locally polished fault surface. Calcite accretionary fibers on fault indicate hanging wall moved to the NW, in concert with the NW direction of transport of numerous other faults measured in this area. This fault is part of a set of

thrust faults, even though some of its members dip in the direction of transport (the faults have been tilted since their formation and are no longer in their original orientations).

Fault no. 516

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-77	N52E/56NW	N40W	(56)	(89 SW)

Comments: Fault through biotitic marble and overlying coarse-grained willemite-calcite ore with minor franklinite. Offset layers suggest reverse sense of slip on this fault. Mineral-streaked fault surface, mostly mud-covered here. This fault probably is cut off by one of the low-dipping thrusts, but although the two faults meet, it was not possible to observe offset of one by the other.

Fault no. 517

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-78	N46E/60NW	N44W	(60)	(90)

Comments: Fault places gahnite-rhodonite rock on hanging wall against biotitic marble on the footwall. Mineral-streaked, finely scored, and semipolished fault surface; sense of slip unknown. A slick of mud on the fault surface obscures the true color of the minerals beneath.

Fault no. 518

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-79	N21E/73NW	S67W	(67)	(74 SW)

Comments: Minor fault through gahnite-rhodonite-hematite rock with minor calcite. Scored, mud-covered fault surface. Minor accretionary calcite suggests reverse sense of slip, but little of this calcite is exposed.

Fault no. 519

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-80	N51E/64NW	N53W	(63)	(84 SW)

Comments: Mud-covered, prominently scored and fluted fault surface in red-brown willemite-franklinite-calcite ore. Some accretionary calcite is present on the fault surface, but step faces within it are too poorly developed to determine the sense of slip.

STATION 13 – 150 level, hanging wall of East limb at mine coordinates 900N, 1205W.

Fault no. 520

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-81	N89W/04SW	S56E	(02)	(33 SE)

Comments: Scored fault surface in coarse-grained marble; sense of slip unknown.

Fault no. 521

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-82	N17E/46NW	N57W	(45)	(79 NE)

Comments: Fault in coarse-grained marble in hanging wall of East limb. Possible step faces in accretionary calcite suggest that hanging wall of fault is the upthrown block, but the evidence is far from convincing, and the fault surface is covered in mud.

STATION 14 – 150 level, opposite and NE of raise to Gravity Tram, in hanging wall of East limb. Station is centered on mine coordinates 1070N, 1130W.

Fault no. 522

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-83	N33E/55SE	S86E	(51)	(72 NE)

Comments: Mineral-streaked foliation surface in a ductile shear zone through medium- to coarse-grained graphitic marble. The shear zone is about 8 cm wide, and the rock within it appears mylonitic. Sense of slip unknown.

Fault no. 523

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-84	N35E/60SE	S50E (S39E)	59 (60)	(87 SW) (82 SW)

Comments: Mineral-streaked fault surface in fine- to medium-grained graphitic marble; sense of slip unknown. Fault surface is smooth, sharply formed, and only gently curved (nearly planar).

Fault no. 524

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-85	N03E/26SE	S17E	(09)	(22 SW)

Comments: Mineral-streaked fault surface in graphitic marble. Probable accretionary calcite on fault suggests upper plate moved to the NW.

STATION 15 – 180 level, East limb near keel of orebody, between mine coordinates 550N and 620N.

The Nason fault forms the east rib of the stoped-out portion of the East limb here. Highly magnetic franklinite ore in the back and along the west rib prevented the measurement of fault-slip data in most of this area. To the north the stope has been filled, but one can crawl over the fill and continue northward. The Nason fault at this station is prominently grooved parallel to the slip direction, which is nearly down-dip; i.e. the fault is gently sinuous along strike. Wavelengths of 1.5-2 m and amplitudes of 10-30 cm are common along the curved fault surface, which is everywhere smooth and continuous. The fault surface is beautifully exposed for more than 20 m along strike and 3-7 m along dip. Multiple fault strands cut the rock on the footwall side of the main fault surface. The Nason fault here, near 550N, is fairly tight and leaks little water; this section of the mine is fairly dry. The fault places highly sheared and conspicuously brecciated marble on the hanging wall against ore on the footwall; the fault is either coincident with the hanging-wall contact of ore or cuts off a small portion of it. Farther north, near 620N, loose fill obstructs the ore, and one can proceed no further. In this area the subsidiary faults near the main strand of the Nason fault do leak a fair amount of water; one sees constant dripping in multiple places. The ore here, too, is too magnetic to warrant gathering of slip data.

STATION 16 – 180 level, East limb near keel of orebody, at mine coordinates 520N, 1370W.

Fault no. 525

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-86	N66E/86NW	(S80W)	(74)	74 SW

Comments: Minor fault in fine-grained pyroxene-feldspar gneiss. Prominently scored, discolored, mud-covered fault surface; sense of slip unknown.

Fault no. 526

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-87	N52E/74NW	(S68W)	(44)	46 SW

Comments: Minor fault in fine-grained pyroxene-feldspar gneiss. Prominently scored, discolored, mud-covered fault surface; sense of slip unknown. This area is still sufficiently close to magnetic ore that compass readings are affected; all orientation data were gathered as far from the rock as possible.

STATION 17 – 180 level, keel area at south end of West limb, at mine coordinates 480N, 1520W.

Fault no. 527

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-88	N15E/33NW	N71W	(33)	(87 NE)

Comments: Minor fault through weakly magnetic to nonmagnetic, moderate-grade franklinite-calcite ore. Well-developed fibrous accretionary calcite shows upper plate moved to the NW.

Fault no. 528

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-89	N17E/66NW	N77W	(66)	(88 SW)

Comments: Minor fault through weakly magnetic, moderate-grade franklinite-calcite ore. Step faces in very well-developed fibrous accretionary calcite indicate a reverse sense of slip. This fault appears to cut off no. 527 above. See also notes on next fault below, which confirms sense of slip recorded here.

Fault no. 529

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-90	N13E/28NW	S80W	(26)	(69 SW)

Comments: Minor fault with scored surface in weakly magnetic, moderate-grade franklinite-calcite ore; sense of slip unknown. This fault is offset about 3 cm in a reverse sense by fault no. 528.

STATION 18 – 180 level, footwall of West limb at mine coordinates 785N, 1585W.

Fault no. 530

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-91	N27E/71NW	S87W	63 (68)	(79 SW)

Comments: Minor fault with prominently striated surface through high-grade, granular (2-3 mm), brown willemite-franklinite-calcite ore. Step faces within accretionary calcite on fault surface suggest a reverse sense of slip; the evidence here is fairly clear but not quite definite. *Note:* Measurement of bearing is likely more accurate than that of the plunge.

Fault no. 531

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-92	N19E/70NW	S88W	(69)	(83 SW)

Comments: Same rock type and fault characteristics as fault no. 530 above. Accretionary calcite is better developed on this fault; numerous step faces in this material indicate a reverse sense of slip.

STATION 19 – 180 level, footwall of West limb, at mine coordinates 850N, 1570W.

Several calcite veins 1-4 mm thick cut the ore and the footwall marble at this locality between 845N and 870N. The veins contain calcite, sphalerite, and willemite, and are beautifully laminated; Bob Jenkins will describe these in detail at a later date [notes here made August 31, 1992]. The calcite fluoresces golden yellow LW, followed by an enduring phosphorescence, where the veins cut the zincite band near the footwall contact of ore. Calcite in these same veins instead fluoresces red, with typical fleeting phosphorescence, where these same veins pass into granular willemite-franklinite ore. The abrupt change in fluorescence correlates perfectly with the change in character of the wallrock, though visually there is no discernible difference in the vein contents. The ore here contains fairly abundant sphalerite in grains 1-2 mm across. Orientations of the veins:
N83W/88SW N79E/84NW N76W/85SW N87W/82SW N80W/86NE N85W/89NE N88W/87NE
(7 readings on 4 veins) Median: N83W/88SW
The veins are somewhat irregular along both strike and dip. Four principal veins are present, along with at least five shorter and thinner ones. Two of the veins can be traced from the W rib across the back to the E rib; the largest can be traced at least 5 m laterally and 4 m vertically.

STATION 20 – 180 level, W rib of drift along footwall of West limb, at mine coordinates 900N, 1590W.

Fault no. 532

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-93	N17E/43NW	S50W	(27)	(42 SW)

Comments: Minor fault through medium- to coarse-grained marble about 1 m below the footwall contact of ore. Well-developed step faces in accretionary calcite indicate hanging wall of the fault moved up and to the NE. Beneath the accretionary calcite one can observe the fault surface is mineral-streaked. Minor violet fluorite is present within the accretionary material.

Fault no. 533

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-94	N24E/62NW	S90W	(60)	(78 SW)

Comments: Minor fault through fine- to medium-grained graphitic marble with disseminated sulfides, below the footwall contact with West limb ore. Mineral-streaked fault surface. Well-developed step faces within accretionary calcite indicate reverse sense of slip. Abundant films of violet fluorite are included within the accretionary calcite.

Fault no. 534

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-95	N12E/63NW	S49W	(50)	(59 SW)

Comments: Same comments as for previous fault; hanging wall of fault moved up (reverse slip).

Fault no. 535

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-96	N19E/52SE	S49E (S45E)	49 (50)	(76 SW) (73 SW)

Comments: Mineral-streaked and finely scored fault surface through medium-grained graphitic marble. Sense of slip unknown.

STATION 21 – 180 level shaft station at mine coordinates 1200N, 1630W.

Fault no. 536

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-97	N10E/49NW	S18W	(09)	(12 SW)

Comments: Mineral-streaked and finely scored fault surface in medium-grained graphitic marble with minor tremolite. Sense of slip unknown.

STATION 22 – 180 level, near N end of 900W Stope at mine coordinates 990N, 1410W.

Fault no. 537

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-98	N40E/74NW	N74W (S86W)	(68)	75 SW

Comments: Minor fault in coarse-grained marble with local masses rich in dark green pyroxene (diopside?). Large (0.5-1.5 cm high) step faces in thick accretionary calcite on fault indicate reverse sense of slip with a slight left-lateral component. Calcite fibers on fault are locally curved, but orientation given here corresponds to that seen on 90% or more of the fault surface. Probably some serpentine is also present within the accretionary calcite (Mg content derived from wallrock diopside), but this is exposed only locally, and much of the fault is mud-covered. This fault is on the north edge of magnetic cross-member ore, but the strike of the fault was measured well away from the rock face, and there is little magnetic franklinite in the immediate vicinity of the fault. An identical strike was obtained by laying the compass directly on the fault surface. *Note:* Although the bearing as well as the pitch of the slickenlines were measured here, it is probably best to calculate the bearing from the pitch, as the latter is likely the more accurate measurement. If instead the bearing is regarded as more accurate, the calculated pitch would be 83 SW, and the plunge angle would be 73°.

Note 1: All other faults in this stope and associated drifts proved to be immeasurable; the ore is highly magnetic in the dozen or so places checked.

Note 2: Cracks in the hydraulic fill are a little wider now (August 31, 1992); plates are tilting toward the mud zone. Small rockfalls are common this morning; also (10:15 AM) a larger one. “The Swamp” is not much changed; mud zone material continues to come in the south end, and the sill is failing. The mine is restless.

STATION 23 – Gravity Tram in East limb, S rib and nearby (includes duftite locality), centered on mine coordinates 1040N, 1160W.

Fault no. 538

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-99	N11E/37SE	S60E	(36)	(75 SW)

Comments: Finely scored fault surface through medium-grained micaceous marble about 60 cm below the footwall of the East limb; sense of slip unknown. Abundant, white, fine-grained, post-slip calcite 0.5-1.5 mm thick lines the fault in places along the north rib and back. To the east this fault cuts through ore, and there has a lesser dip.

Fault no. 539

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-100	N01W/36NE	S41E	(25)	(46 SE)

Comments: Fault in high-grade franklinite-brown willemite-zincite-calcite ore. Minerals filling openings along this fault are 0.5-2 cm thick and include much white to tan and pale pink accretionary calcite, translucent brown serpentine, and secondary phosphorescent willemite. The primary calcite and willemite in the wallrock within 1.0-1.5 cm from the fault on either side are nonfluorescent, producing a prominent black "dead zone" under the SW lamp, identical to that seen on the 430 level near the safety exit. The secondary calcite lining the fault is nonfluorescent as well. Near the fault, the flesh-colored willemite of the wallrock become dark reddish-brown and nonfluorescent, almost certainly due to serpentinization. No secondary zincite is seen along this fault (but see fault no. 540 below). Tiny step faces within the accretionary calcite, plus the orientation of the calcite fibers and interlaminated serpentine as seen in cross section, suggest fairly convincingly that the upper plate of this fault moved NW.

Note: The absence of secondary zincite within this fault is probably because the fault cuts through the ore at a low angle and does not intersect the zincite-rich parts of it. Other, smaller faults related to this one and only 20 cm away, but within zincite-rich ore, *do* contain secondary orange zincite. Note also that the ore adjacent to this and related faults is nearly undeformed. The wallrock shows no sign of ductility in the form of flattened grains or drag of elongate grains into parallelism with the fault as the fault surface is approached. Instead, individual franklinite grains are neatly sliced off by this fault; numerous examples were seen here. This fault is offset by no. 540 below and thus is the older of the two.

Fault no. 540

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-101	N23E/59NW	N44W	(57)	(78 NE)

Comments: Fault though high-grade, franklinite-brown willemite-zincite-calcite ore. This fault offsets no. 539 above about 20 cm in a reverse sense. The ore clearly was ductile during this phase of reverse faulting; both of the severed sections of fault 539 are strongly dragged near this fault, and individual franklinite grains are strongly flattened and rotated toward parallelism with the fault as its surface is approached. Much "calcozincite" is present along this fault where it cuts ore containing primary zincite. The mineral fill along much of this fault is 0.5-2 mm thick, increasing in one spot to about 8 mm. Locally the fault breaks into multiple anastomosing strands to form a zone 1-2 cm wide. The rock slivers between these strands are highly sheared, with prominently flattened ore grains. No serpentine was seen along this fault, and secondary willemite, though present, is much less abundant than along fault no. 539. Calcite and willemite in the primary ore retain their bright fluorescence right up to the walls of the fault, and the willemite retains

its original color and shows no sign of serpentinization. Accretionary calcite within the fault shows, in different places, either a dull red fluorescence or none at all. The character of this fault is almost completely different from that of fault no. 539. *Note*: The bearing of the slickenlines was recorded in our notes as S44E, an impossible value. Almost certainly the wrong end of the compass needle was read, and the intended value was N44W. The orientations above were calculated in accordance with that assumption.

Fault no. 541

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-102	N07W/19NE	S58E	(15)	(53 SE)

Comments: Minor fault through (a) medium-grained marble containing biotite and a humite-group mineral, and (b) coarse-grained, blocky marble with sparse mica and diopside. The calcite in the marble is fluorescent; this locality is within the "manganese halo" near the footwall of the East limb. The mica in the upper, finer-grained layer is black but in the lower, coarser-grained layer is beer-bottle brown. The fault intersects these layers at a low angle and thus produces negligible offset. The manganoan calcite along this fault is strongly stained (altered) dark brown. The fault suface is crudely but definitely striated; multiple orientation measurements of these straie along the fault are consistent. The sense of slip is unknown, but given the low dip of the fault and the bearing of its striae, the upper plate probably moved to the NW.

Note: This fault as exposed on the north rib consists of *en echelon* surfaces, all of which are striated. Movement on this fault has been so minimal that these *en echelon* surfaces are, in some places, not yet linked to one another to form a continuous surface of rupture. These surfaces dip eastward at a slightly greater angle than that of the mean fault plane, so the subsidiary, striated surfaces that collectively define the fault dip away from the direction of transport of the upper plate. These surfaces thus do not have the geometry of Riedel shears.

Fault no. 542

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-103	N08E/10SE	S57E	(09)	(65 SW)

Comments: Minor fault through medium- to coarse-grained, blocky, sparsely micaceous marble with disseminated sulfide minerals (chalcocite?). Mineral-streaked fault surface, locally coated with secondary copper minerals (azurite, probable aurichalcite, etc.) This fault is exposed in the back and is only 10 cm below a related fault (no. 543) coated with a green mineral identified by Robert Jenkins as duftite. Calcite lining this fault is whiter than that of the wallrock and has a finely fibrous habit, so almost certainly is accretionary calcite. If so, step faces in three places in this material indicate the upper plate moved to the NW. The length of the mineral streaks on the fault surface suggest the total offset is only about 1 cm – thus very minor slip, as suggested also by dying-out of the fault laterally toward both ends.

Fault no. 543

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-104	N01W/32NE	S55E	(27)	(58 SE)

Comments: Minor fault through medium- to coarse-grained, blocky marble containing abundant, steely gray grains 1-5 mm across of a sulfide mineral (chalcocite?) and scales of phlogopite (same rock type as for fault no. 542 above). This is the fault that Robert Jenkins reported as coated with a green mineral at first thought to be conichalcite, but which was later identified as duftite, and from which about 50 specimens were recovered. Striations on this fault surface are barely recognizable; the total slip is probably a few millimeters at best. Sense of slip unknown.

Note 1: This and related faults here all have irregular, curved surfaces, as reflected in the spread of orientations documented above. In gross shape they much resemble the minor thrust faults seen in numerous places within the mine. Faults nos. 538, 539, and 541-543 are members of this set.

Note 2: In addition to the minerals listed, the marble at this locality also contains galena, yellow sphalerite, and chalcopyrite, all in grains generally less than 2 mm across, except for some blebs of chalcopyrite that approach 1 cm.

Fault no. 544

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-105	N50E/60NW	N31E (N23E)	38 (29)	(34 NE) (45 NE)

Comments: This fault places coarse-grained marble with scattered 0.5-1.5 cm grains of pinkish-tan-colored willemite and minor franklinite in the hanging wall against granular franklinite ore in the footwall. The franklinite ore is part of the footwall rocks of the East limb of ore. Mineral-streaked fault surface. Prominent step faces in probable accretionary calcite suggest the hanging-wall (NW) side of the fault moved up and to the SW; this is an oblique-slip left-lateral reverse fault. *Note:* Measurement of bearing is probably more accurate than that of the plunge.

Fault no. 545

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-106	N72E/27NW	N28W	(27)	(81 SW)

Comments: Minor fault in coarse-grained calcite marble with minor franklinite; this is near footwall contact of East limb of ore. Step faces in accretionary calcite suggest the upper plate moved to the NW, but not convincingly so. This fault appears (based on an incomplete but visually fairly convincing example in the back) to offset a minor fault of the low east-dipping set documented above (faults 99, 100, 102-104), but we place little importance in this because all are probably related to the same set of quite irregular, curved, low-dipping faults along which the upper plate moved to the NW. Such faults, where especially well exposed in a number of places in the mine, are clearly braided and show a wide spread in orientations.

Fault no. 546

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-107	N66E/63NW	N29E (N35E)	45 (50)	(59 NE) (53 NE)

Comments: Minor fault through the footwall of the East limb of ore; high-grade willemite-franklinite ore with minor calcite is underlain in fault contact by coarse-grained marble with scattered large grains of willemite and franklinite. Scored and lightly mineral-streaked fault surface; sense of slip unknown.

Fault no. 547

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-108	N46E/58NW	S88W (N80W)	(52) (47)	69 SW (60 SW)

Comments: Minor fault through high-grade, granular franklinite-calcite ore. Fault surface shows much accretionary calcite, step faces in which indicate a reverse sense of slip. *Note:* This fault is difficult of access, and measured bearing could be inaccurate; best to calculate bearing from the pitch angle.

Fault no. 548

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-109	N46E/58NW	N19E (N03W)	(50)	65 NE

Comments: Same fault as no. 547 above, but a different set of striations. Some accretionary calcite dating from this phase of faulting is present, but sense of slip could not be determined. This accretionary calcite appears to overlie that of fault no. 547 and thus possibly reflects a later phase of movement. Not much of this fault is exposed. *Note:* As for the previous fault, the bearing measurement possibly is not accurate, and the bearing is probably better calculated from the pitch angle.

Fault no. 549

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-110	N42E/75NW	N65W	(74)	(85 SW)

Comments: Minor fault in medium- to high-grade, granular franklinite ore of the East limb. Prominently mineral-streaked fault surface, but little of it is exposed. Minor accretionary calcite is present on part of the fault surface; poorly formed step faces weakly suggest a reverse sense of slip.

STATION 24 – Gravity Tram at mine coordinates 1040N, 1675W.

Fault no. 550

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-111	N15W/49NE	S36E	(22)	(30 SE)

Comments: Shear zone with minor fault breccia in medium-grained graphitic marble. The fault appears to show the beginning stages of a mylonitic shear zone, with mineral-streaked shear surfaces, local grain-size reduction, and foliation development. Minor accretionary calcite is present on some of the foliation surfaces. Slip sense unknown. The mix of ductile and brittle fault structures suggests more than one phase of movement on this fault.

Note: This fault cuts through and offsets no. 552 and is thus the younger of the two; it is continuous down both ribs and across the back. Fault no. 552, in turn, cuts across and is younger than fault no. 556. These relative-age assignments, however, must be interpreted with care, for some of the faults have experienced more than one episode of slip. Thus, if one fault offsets another, it does not necessarily mean that the offset fault *as originally formed* is the older of the two.

Fault no. 551

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-112	N40E/44SE	S04E	(34)	(53 SW)

Comments: Mineral-streaked fault surface in medium-grained graphitic marble; sense of slip unknown. Possible accretionary calcite on fault surface suggests hanging wall is the downthrown block.

Fault no. 552

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-113	N30E/49SE	S04W	(27)	(37 SW)

Comments: Mineral-streaked, mechanically scored, and corrugated fault surface in medium-grained graphitic marble. Probable accretionary calcite suggests hanging wall is the downthrown block. This fault is cut through and offset by fault no. 550; the offset segment of this fault is seen clearly in the back.

Fault no. 553

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-114	N09W/50NE	S34E	(27)	(36 SE)

Comments: Mineral-streaked fault surface in medium-grained graphitic marble. Fault shows minor brecciation and subsidiary shear surfaces in a zone 1-3 cm wide adjacent to the fault on the footwall side. Accretionary calcite shows that the hanging wall of this fault is the downthrown block; here the evidence is convincing. The accretionary calcite shows good fibrous structure, fairly well-developed step faces, and is pure white rather than the yellowish-white and pale gray of the adjacent marble. These are oblique right-lateral normal faults.

Fault no. 554

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-115	N03E/45SE	S27E	(26)	(39 SW)

Comments: Mineral-streaked fault surface through nearly pure, fine-grained marble with a few scattered scales of graphite. Lengths of the mineral streaks indicate 1-2 cm of slip; sense of slip unknown. Fault is nearly parallel to compositional layering in the marble as seen on the mine ribs but has a somewhat different strike.

Fault no. 555

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-116	N12W/51NE	N09W	(04)	(05 NW)

Comments: This is the same fault as no. 553 above, but here recording a different and apparently earlier set of striations (mineral streaks, some accretionary calcite) indicative of nearly strike-slip movement. Small troughs in the fault surface that are filled with these nearly horizontal accretionary calcite fibers are streaked and scratched in a direction parallel to the striae of fault no. 553, showing that the strike-slip movement documented here dates from an earlier episode of slip. Only remnant patches of the accretionary calcite and associated streaked-out minerals on fault surface remain; most of the fault surface instead shows striations of the later episode of slip. The age relations here are seemingly clear. Sense of slip unknown, though indistinct step faces in the accretionary calcite suggest left-lateral.

Fault no. 556

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-117	N40W/59NE	S44E	(07)	(08 SE)

Comments: Minor fault with prominently mineral-streaked surface through medium-grained graphitic marble. Sense of slip unknown. This fault is clearly cut off by no. 552, showing again that strike-slip movement on these faults (this one, plus no. 555) predated oblique slip on the others.

Fault no. 557

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-118	N08E/34SE	N14E	(04)	(07 NE)

Comments: Mineral-streaked fault surface in medium-grained graphitic marble. A thin coating of probable accretionary calcite lines this fault; small step faces within this material suggest left-lateral slip. See also fault no. 558 below.

STATION 25 – Gravity Tram at mine coordinates 1035N, 1700W (approximate location by pacing).

Fault no. 558

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-119	N07W/49NE	N07E	(16)	(21 NW)

Comments: Fault in fine- to medium-grained graphitic marble. Fibrous accretionary calcite on fault is well-developed, locally 1-3 mm thick, and is white, a noticeably different shade of white than that of the adjacent wallrock. The attachment points of calcite fibers on the fault surface are visible in several patches of calcite; also visible are north-facing step faces, both of which clearly indicate left-lateral slip on this fault. This is the best example seen thus far in this general area to establish sense of slip, and is a satisfying and clear one. Minor violet fluorite is present within the accretionary calcite.

Fault no. 559

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-120	N16W/48NE	S53E	(34)	(48 SE)

Comments: This is another portion of fault no. 558 above. Over much of the fault a second set of striations is visible as delicate but well-formed, conspicuous scratches across the accretionary calcite that had formed within minor depressions in the fault surface during the earlier phase of movement documented above (no. 558). Minor new accretionary calcite has formed on parts of the fault surface and shows fiber attachment points and step faces that indicate the hanging wall is the downthrown fault block; the evidence for this sense of slip seems abundantly clear.

Fault no. 560

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-121	N33E/18NW	N51W	(18)	(84 NE)

Comments: Fault through fine- to medium-grained graphitic marble with layers rich in norbergite. This fault offers a beautiful example of mineral streaks developed on those parts of the fault surface of shallowest dip (where the two walls of the fault were in contact), whereas accretionary calcite formed in the intervening areas of steeper dip (where the two walls moved apart during slip). Together these properties abundantly show the upper plate of the fault moved NW. Numerous other examples of low-angle faults dipping gently in the direction of transport have been seen throughout the mine.

Fault no. 561

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-122	N54E/16NW	N54W	(15)	(73 SW)

Comments: All information documented above for fault no. 560 applies to this fault also.

STATION 26 – Gravity Tram at approximate mine coordinates 1030N, 1740W.

Fault no. 562

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-123	N57W/64SW	(S55E)	(04)	05 SE

Comments: Graphite-streaked fault surface in fine- to medium-grained graphitic marble. Some of the thin marble layers are particularly rich in graphite, flakes of which are smeared out along the fault in a sense that clearly indicates about 1.5 cm of right-lateral slip.

Fault no. 563

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-124	N23W/63NE	N25E	(56)	(68 NW)

Comments: Minor fault through medium-grained graphitic marble. Mineral-streaked fault surface; sense of slip unknown. *Note:* Our original field notes had bearing as S25W, but a line in this direction cannot lie in the measured fault plane. Almost certainly the wrong end of the compass needle was read (common error!) and the intended value was N25E. The same is true of fault no. 565 below, and we have changed both readings to their presumed correct value.

Fault no. 564

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-125	N24W/63NE	N61E	(63)	(88 NW)

Comments: Very minor fault through medium-grained graphitic marble. Mineral-streaked fault surface. Streaks reflect nearly dip-slip offset of 1 cm or less, but sense of slip could not be determined.

Fault no. 565

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-126	N37W/72NE	N29E	(70)	(82 NW)

Comments: Minor fault with mineral-streaked surface in medium-grained graphitic marble. This is a different portion of fault no. 563 above, about 1.5 m distant, where a different set of striations (same direction as for fault no. 562) is visible. Sense of slip unknown.

STATION 27 – About 1.5 m east of the western, upper end of the Gravity Tram.

Fault no. 566

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-127	N25E/73SE	(S88E)	(72)	83 NE

Comments: Minor (1-2 cm wide) shear zone through graphitic marble. Sense of slip unknown.

STATION 28 – 180 level, 1290 crosscut at 1430W.

Fault no. 567

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-128	N61W/17SW	S27E	(10)	(35 SE)

Comments: Irregular, gently dipping fault with grooved, scored, and mineral-streaked surface through coarse-grained, nearly pure marble. Probable accretionary calcite on fault suggests upper plate moved to the NW.

Fault no. 568

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-129	N12W/37NE	N12W	00	(00)

Comments: Mineral-streaked fault surface in coarse-grained, nearly pure marble. Sense of slip unknown. This fault abruptly and clearly cuts off no. 567 above, but may have experienced two stages of slip. The second, however, if it exists, was minor; possible striations seen here are faint, not readily visible, and their character and origin not readily discerned.

Fault no. 569

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-130	N55E/54SE	S23E (S09E)	51 (53)	(83 SW) (74 SW)

Comments: Prominently mineral-streaked fault surface through medium- to coarse-grained graphitic marble; sense of slip unknown. The fault surface is mostly mud-covered and in part concealed by flowstone.

Fault no. 570

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-131	N54E/14NW	N51W	(14)	(75 SW)

Comments: Fault through medium-grained graphitic marble with calc-silicate pods bordered by phlogopite reaction rims. Prominently mineral-streaked fault surface coated with abundant accretionary calcite. Numerous step faces in accretionary material show that upper plate moved to the NW; very prominent here.

Fault no. 571

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-132	N58E/17NW	N60W	(15)	(63 SW)

Comments: Low-angle fault through medium-grained graphitic marble. Fault surface is prominently mineral-streaked and coated with abundant accretionary calcite. Numerous, well-developed step faces in the accretionary calcite show that upper plate of fault moved to the NW. This fault is cut off by fault no. 569 above.

Fault no. 572

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
180-133	N72E/63SE	S05E	(62)	(84 SW)

Comments: Mineral-streaked fault surface in coarse-grained graphitic marble. Possible accretionary calcite on fault surface weakly suggests a normal sense of slip.

340 level

STATION 1 – Keel of orebody, SW rib, near end, at mine coordinates 460N, 1405W (bats galore).

Fault no. 573

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-1	N16W/65SW	N90W (N81W)	63 (64)	(83 NW) (79 NW)

Comments: Fault in moderate-grade franklinite-calcite ore. Prominent step faces in splintery calcite 0.5-1 cm thick lining fault surface indicate hanging wall is upthrown block (reverse fault). *Note:* Plunge measurement is likely much more accurate than bearing; ore is highly magnetic in this area.

STATION 2 – East limb, about 30-35 ft north of safety exit, west rib, at mine coordinates 1260N, 1050W.

Fault no. 574

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-2	N29E/61NW	S64W (S64W)	46 (46)	(55 SW) (55 SW)

Comments: Fault in high-grade franklinite-zincite-calcite ore. Fibrous accretionary calcite several millimeters thick lines fault surface; step faces indicate hanging wall is upthrown block.

Fault no. 575

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-3	N28E/61NW	S76W (S73W)	52	(64 SW)

Comments: Polished and scratched fault surface in high-grade franklinite-calcite ore; sense of slip unknown. *Note:* Plunge measurement is probably more accurate than the bearing.

Fault no. 576

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-4	N06E/67NW	S55W (S45W)	56 (60)	(64 SW) (71 SW)

Comments: Fault in high-grade franklinite-calcite ore. Fibrous accretionary calcite thinly coats fault surface in patches here, but sense of slip on fault could not be determined. *Note:* Plunge measurement is probably more accurate than the bearing.

STATION 3 – East limb, at safety exit, at mine coordinates 1230N, 1050W.

Fault no. 577

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-5	N10E/58NW	S36W (S40W)	38 (35)	(43 SW) (47 SW)

Comments: Fault in coarse-grained micaceous marble. Fibrous accretionary calcite 3-10 mm thick lines fault surface. Step faces in this calcite indicate hanging wall is upthrown block.

Fault no. 578

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-6	N27E/61NW	S78W (S68W)	50 (59)	(80 SW) (61 SW)

Comments: Fault in coarse-grained micaceous marble. Step faces in fibrous accretionary calcite (1-3 mm thick) on fault surface indicate hanging wall is upthrown block.

Fault no. 579

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-7	N08E/47NW	S32W (S45W)	32 (23)	(33 SW) (48 SW)

Comments: Fault in coarse-grained micaceous marble. Step faces in fibrous accretionary calcite (2-5 mm thick) on fault surface indicate hanging wall is upthrown block. This fault is quite close to the two above, within 20 cm, but slip fibers along it have a distinctly shallower plunge.

STATION 4 – 935 Stope, in east limb of ore about 40-50 ft above 340 level, at mine coordinates 995N, 1070W.

Fault no. 580

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-8	N06E/49NW	(S09W)	03 S	(04 SW)

Comments: Fault in coarse-grained marble. Fibrous accretionary calcite, several millimeters to at least 1 cm thick, lines the fault surface; step faces in this material indicate that hanging wall moved northward (right-lateral fault).

Fault no. 581

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-9	N04E/65NW	(S09W)	11 S	(12 SW)

Comments: Fault in medium- to coarse-grained marble. Step faces in fibrous accretionary calcite on fault surface indicate hanging wall moved northward (right-lateral fault).

Fault no. 582

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-10	N08E/58NW	(S23W)	23 S	(27 SW)

Comments: Step faces in fibrous accretionary calcite on fault surface, 1-5 mm thick, indicate that hanging wall moved northward. Rock type not recorded, but probably same as for the two faults above.

Fault no. 583

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-11	N69E/63NW	(N18E)	(57)	70 NE

Comments: Fault in high-grade franklinite-willemite ore. Fault surface is mineral-streaked, polished, and bears fine scratches defining the slickenlines here. Contacts between ore and marble layers are offset across this fault by 10-15 cm and indicate that the hanging wall is the upthrown block.

Fault no. 584

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-12	N12E/65NW	S88W	(64)	(84 SW)

Comments: Irregularly curved fault surface coated with 1-4 mm of fibrous accretionary calcite. Step faces in accretionary material indicate hanging wall is upthrown block.

Fault no. 585

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-13	N65E/78NW	N40E (N32E)	(68)	72 NE

Comments: Polished, mineral-streaked, and finely scratched fault surface, locally filmed with calcite, in high-grade franklinite-willemite ore. Hanging wall is upthrown block, as indicated by 15-20 cm offset of ore-marble contacts. *Note:* Pitch angle as recorded above is more accurate than measurement of bearing.

Fault no. 586

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-14	N88E/70NW	N48E (N60E)	52 (61)	57 NE (68 NE)

Comments: Fault in high-grade franklinite-willemite ore, with scratched and polished surface locally filmed with calcite. Sense of slip unknown. *Note:* This is the rare fault in which bearing, plunge angle, and pitch were all measured. The slip direction as calculated from the plunge angle accords perfectly with that calculated from the pitch, so the accepted values here are plunge 52º, pitch 57º NE, and bearing N60E.

Fault no. 587

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-15	N47E/68SE	S68E	(66)	(80 NE)

Comments: Marble mylonite along main strand of Nason fault; graphite streaks along mylonite foliation surfaces define the slickenlines. Sense of slip unknown.

Fault no. 588

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-29	N54E/63SE	S40E	(63)	(88 NE)

Comments: Dark gray to nearly black foliation surfaces in marble mylonite of this fault are heavily streaked and coated by graphite, which is easily rubbed off by one's fingers. Sense of slip undetermined.

Note: Faults nos. 589 through 593 below were measured at the NE end of 935 Stope above 340 level.

Fault no. 589

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-113	N20E/41SE	S19E (S22E)	30 (29)	(47 SW) (50 SW)

Comments: Fault juxtaposing high-grade franklinite-willemite-minor calcite ore above against medium- to coarse-grained marble containing sparse willemite and franklinite grains below. Mineral-streaked and calcite-coated fault surface. Step faces in accretionary calcite suggest upper plate moved NW. In other places along this fault much breccia is seen. Some of this resembles a solution-collapse breccia, with rounded clasts in a fine-grained matrix.

Fault no. 590

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-114	N20E/41SE	S65E	(41)	(86 SW)

Comments: These measurements are for a second and later set of striations on the same fault as no. 589 above; the mechanical scratches that developed during this later phase of movement in places nearly obliterated the earlier striae recorded above. Probably these later striae were produced during a late phase of movement on the Nason fault nearby. This fault is along the footwall contact of the East limb, about 2-3 m below the mylonite zone of the Nason fault.

Fault no. 591

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-115	N16E/44SE	S32E	(36)	(57 SW)

Comments: This is a different part of the same fault as nos. 589 and 590 above, preserving the older set of striae. Sense of slip unknown. Here the fault is wholly within the footwall of the East limb and is in marble containing sparse grains of willemite and franklinite in red-fluorescent calcite. The fault surface is finely scored and locally coated with calcite.

Note: Photographs were taken of the breccia associated with faults 589-591 here, at the NE end of 935 Stope, beneath the ladder to 180 level. The matrix of this breccia apparently contains some carbonate but is nonfluorescent. The clasts are polylithologic: marble, franklinite-calcite ore, franklinite-willemite-calcite ore, etc. Some clasts are conspicuously rounded, so much that the rock locally forms a pseudoconglomerate. The fluorescence of most of the clasts, even those of ore, is weak to nil; ditto the matrix material, even though the calcite of the marble wallrock above and below is highly fluorescent. The photographed part of the fault is in the footwall of the East limb, 40-50 cm below the contact with ore; the rock on both sides is lean franklinite-willemite marble. The marble within 3-4 cm of the breccia on both the hanging wall and footwall sides, though not visibly deformed, is nonfluorescent, so here we have a "dead zone" similar to that along some of the faults near the safety exit on 430 level. Along parts of this fault, too, are lensoidal masses 0.2-1 cm thick and 5-15 cm long of honey-brown, fine-grained sphalerite in sheared, but not quite brecciated, calcite marble.

Fault no. 592

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-116	N05W/20SW	N53W	(15)	(50 NW)

Comments: Fault in high-grade franklinite-willemite-calcite ore. Large and very well-developed step faces in accretionary calcite show the hanging wall moved to the NW. This fault is well exposed but is nearly inaccessible in the back. The fault surface is neatly cut off by a more recent strand of the Nason fault at the base of the main mylonite zone, so the sequence of faulting here is (1) early slip on the Nason fault to generate the mylonitic foliation; (2) NW-directed thrusting on low-angle fault no. 592, followed by (3) normal faulting on a steeply dipping strand of the (reactivated) Nason fault.

Fault no. 593

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-117	N32E/27NW	N51W	(27)	(84 NE)

Comments: Fault in impure marble. Well-developed step faces in accretionary calcite indicate the hanging wall moved NW. This is the same fault as no. 592 and possibly no. 589 above.

STATION 5 – East limb near keel, at approximate mine coordinates 580N, 1255W.

Fault no. 594

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-16	N48W/67NE	N86E	(59)	~73 SE (69 SE)

Comments: Partially polished, locally calcite-coated, scratched fault surface in moderate-grade franklinite-calcite ore. Sense of slip unknown.

Fault no. 595

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-17	N42E/55SE	N65E (N51E)	12 (30)	(37 NE) (15 NE)

Comments: Fault in coarse-grained marble. Coarse splintery calcite, several millimeters to at least 1 cm thick, lines fault surface. Well-developed step faces in this material indicate left-lateral slip; hanging wall moved to NE.

Fault no. 596

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-18	N24E/47SE	N39E (N32E)	09 (15)	(21 NE) (12 NE)

Comments: Fault in lean franklinite-calcite ore. Step faces in splintery accretionary calcite on fault surface indicate hanging wall moved to NE (left-lateral fault).

Fault no. 597

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-19	N23E/48SE	N43E (N41E)	19 (21)	(29 NE) (26 NE)

Comments: Fault in coarse-grained marble bearing sparse grains of franklinite. Irregular, wavy fault surface coated with several millimeters of fibrous accretionary calcite, locally thickening to almost 2 cm in areas of fault curvature. Step faces in accretionary material show this is a left-lateral fault.

Fault no. 598

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-20	N32E/63SE	N32E (N32E)	00 (00)	(00) (00)

Comments: Fault in coarse-grained marble. Step faces in accretionary calcite, 1-3 mm thick on fault surface, indicate left-lateral sense of slip.

STATION 6 – Southwest end of 935 Stope, about 30 ft above 340 level. Locality not marked on our original maps, but probably in the vicinity of the raise leading to this stope at mine coordinates 930N, 1090W.

Fault no. 599

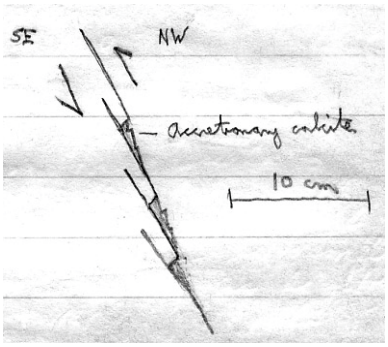
Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-21	N43E/88NW	(N20W)	(88)	89 NE

Comments: Nason fault, in franklinite-willemite-calcite ore. Ore is highly sheared along this fault. Step faces within a hematite-stained patch of accretionary calcite on the fault surface show that SE side of fault is the downthrown block; these record a late stage of slip within the mylonite zone.

Fault no. 600

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-22	N50E/77NW	(N27W)	(77)	87 NE

Comments: NW-dipping segment of Nason fault in high-grade franklinite-willemite ore. Fibrous accretionary calcite locally coats a polished fault surface developed within the mylonite zone. Step faces in this calcite indicate SE side of fault is the downthrown block.



Note: The sketch at left, a vertical SE-to-NW section, shows the geometry of the fault here. In detail the fault surface consists of multiple *en echelon* segments, each of them dipping at a slightly shallower angle than the mean fault surface. These rock-cut fractures, all of which can be traced into the footwall rock for several centimeters or more, are scored by delicate scratches parallel to the fibers in the accretionary calcite above. The accretionary calcite forms wedge-shaped masses along the steps from one *en echelon* fault segment to another. It thus forms ribbonlike masses on the fault surface, each ribbon being thickest (up to 1 cm) at its upper end and tapering to zero thickness at its lower end. The fibers within the accretionary calcite are inclined at slightly steeper angles than the mean fault surface, consistent with the NW-side-up, SE-side-down sense of slip. Thus, on the footwall block (left block as shown in sketch), the rock-cut steps on this fault surface face *downward*, while the step faces in the accretionary calcite face *upward*. Given that the Nason and related faults have overall steep SE to vertical dips, this NW-dipping portion of the fault was in an overall dilational field as fault slip occurred.

On a grosser scale, the entire fault surface curves along strike to form dip-parallel swells and troughs whose axes are exactly parallel to the calcite fibers and to the scratches on the fault surface. The swells and troughs are 10-40 cm in wavelength and several centimeters in amplitude.

Fault no. 601

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-23	N42E/53NW	N50W (N50W)	53 (53)	(89 SW) (89 SW)

Comments: Fault within highly sheared, mylonitic, high-grade franklinite-willemite ore containing only minor amounts of calcite. This is part of the Nason fault, but the fault documented here is a later feature that developed within the mylonite zone. The mylonitic foliation dips from 75º SE to about vertical; this fault cuts across the foliation and dips NW. A thick, 1-4 cm mass of splintery accretionary calcite intergrown with abundant secondary willemite lines the fault here. Step faces in the calcite indicate the SE side is the downthrown fault block (reverse fault), as it is on the other faults documented in this area. This NW-dipping fault strand, however, is oriented such that SE-side-down movement would open a wide cavity along the fault, thus accounting for the unusual thickness of the accretionary material. This is one of numerous faults that crosscut the mylonite of the Nason fault in this area, and along which accretionary calcite is well developed.

Fault no. 602

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-24	N48E/62SE	S35E	(62)	(87 SW)

Comments: Minor fault within fine-grained, nearly pure marble mylonite of the Nason fault. Striations on the fault surface are defined by a streaked-out platy mineral that resembles a mica partially altered to a chlorite or serpentine. Sense of slip undetermined.

Fault no. 603

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-25	N42E/85SE	(S07W)	(81)	83 SW

Comments: Fault in medium-grained marble containing grains of serpentinized(?) diopside. Fibrous accretionary calcite 1-5 mm thick lines fault surface; step faces in this material indicate SE side of fault is downthrown block. This fault is on the footwall side of the Nason fault.

Note: An oriented sample of the mylonite was taken here. The marked face is oriented N41E/78SE.

Fault no. 604

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-26	N65E/41SE	S37E	(40)	(81 NE)

Comments: Fault in marble on hanging-wall side of Nason fault. Fault surface is limonite-stained; slickenlines are defined by graphite streaked out on fault surface. Sense of slip unknown.

Fault no. 605

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-27	N20E/83NW	(N54W)	(83)	88 NE

Comments: Fault in highly micaceous marble. Scratches on fault surface define the slickenlines; sense of slip unknown. Fault surface is lightly stained reddish-brown, perhaps by hematite formed during breakdown of the mica.

Fault no. 606

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-28	N65E/54SE	S42E	50 (53)	(80 NE)

Comments: Hematite-stained, mineral-streaked fault surface in moderate- to high-grade franklinite-calcite ore on the hanging-wall side of the Nason fault. Sense of slip unknown. *Note:* Bearing measurement given above is probably more accurate than angle of plunge.

Fault no. 607

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-110	N46E/83SE	(S52E)	(83)	89 NE

Comments: Fault in medium-grained, sparsely micaceous marble. Calcite accretionary fibers on fault surface indicate SE side is downthrown block. This fault is near the footwall part of the Nason mylonitic fault zone but is a later brittle fault developed about parallel to the earlier mylonitic foliation.

Fault no. 608

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-111	N30E/80NW	(N33W)	(79)	85 NE

Comments: Fault in thinly foliated rock resembling a chloritized and/or serpentinized phyllonite, dark green to nearly black in color (= mylonite of Nason fault, within a slightly overturned segment of that fault, along the footwall). Calcite locally coats the finely scored fault surface, but the sense of slip along the fault could not be determined at this locality.

Fault no. 609

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-112	N30E/85NW	(N04E)	(79)	80 NE

Comments: Fault in high-grade franklinite-willemite-calcite ore. The fault surface is highly polished, smooth, hematite-stained, and mineral-streaked. Local accretionary calcite indicates the SE side is

downthrown block. The fault surface also bears a patchy coating 0.3-0.5 mm thick of later, post-faulting calcite.

STATION 7 – Southern portion of 1270 subdrift, west of East limb, between mine coordinates 620N, 1270W and 680N, 1265W.

Fault no. 610

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-30	N10W/23SW	N88W	(23)	(79 NW)

Comments: Epidote-coated fault surface through fine-grained feldspar-pyroxene gneiss; sense of slip unknown.

Fault no. 611

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-31	N44E/44NW	N18W	(40)	(69 NE)

Comments: Epidote-coated fault surface through fine-grained feldspar-pyroxene gneiss. Fault surface is locally coated with accretionary calcite, but sense of slip is indeterminate.

Fault no. 612

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-32	N38E/65NW	N28W (N16W)	60 (63)	(79 NE) (73 NE)

Comments: Prominent, moderately to highly polished, epidote- and calcite-coated fault surface through fine-grained feldspathic gneiss; sense of slip unknown. Fault is heavily striated and grooved parallel to the slip direction. *Note:* Meaurement of bearing is more accurate than that of plunge.

Fault no. 613

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-33	N31E/65NW	N12W (N17W)	57 (56)	(66 NE) (69 NE)

Comments: A different part of fault no. 612 above, showing a slightly different direction of slip. These striae, like those above, appear as scratches on an epidote- and calcite-coated surface, but the measurements here are within a different rock layer a little higher on the fault. Sense of slip unknown.

Fault no. 614

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-71	N57E/25SE	S66E	(21)	(60 NE)

Comments: This is one strand of a low-dipping fault zone near the sill, well exposed at 620-625N, at the end of the 1270 subdrift. The fault surface, mineral-streaked and finely scored, cuts impure, pyroxene-rich (dark green grains) marble. The marble between this fault and a larger fault strand 7-10 cm above is moderately sheared and thus well foliated. The upper plate probably moved to the NW, though this is difficult to determine with certainty.

Fault no. 615

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-72	N43E/23SE	S84E	(19)	(55 NE)

Comments: This is another strand of the same fault zone described above and cuts the same rock type. The fault surface is mineral-streaked and finely scored; sense of slip unknown.

Fault no. 616

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-73	N32E/27SE	S81E	(25)	(69 NE)

Comments: Different portion of same fault as no. 615 above, in the same rock type. Mineral-streaked and finely scored fault surface; sense of slip unknown.

Fault no. 617

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-74	N09E/34SE	S76E	(34)	(86 SW)

Comments: Another strand of the same fault zone as the three faults described above. The mineral-streaked fault surface is lightly filmed with apparent accretionary calcite and minor pale green serpentine. Step faces in this material suggest the hanging wall moved to the NW.

Fault no. 618

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-75	N28E/36SE	S68E	(36)	(85 NE)

Comments: Another strand of the same fault zone. Fault surface is filmed with accretionary calcite and minor pale green serpentine, step surfaces in which suggest the hanging wall moved to the NW.

Note: The five faults described above are all parts of the same fault zone. Individual fault strands are sinuous, anastomosing, and lie within a zone generally 10-20 cm thick. The main strand cuts garnet amphibolite that contains masses of gray to oil-green sphalerite; locally this rock is faulted against marble. The fault is definitely post-sphalerite; the sphalerite masses are neatly cut off at the contact. Where the fault cuts garnet amphibolite, along it are lensoidal masses 0.5-1.5 cm thick of white accretionary calcite streaked with epidote. No sphalerite was seen along the fault; again the fault appears younger than that mineral. Mineral grains within the fault zone are locally highly sheared, flattened, and reoriented. The fault zone is well exposed near the sill at the end of the subdrift and along its east rib; on the west rib it dies out in the wollastonite zone at about 628N. A second pod of green sphalerite cut off by the fault shows some of the sphalerite sheared-out within the fault, and again the conclusion is that the sphalerite predates the faulting. The sense of drag of mineral grains adjacent to the fault strands confirms the upper plates of these faults moved to the NW. Small fractures through garnets in the hanging wall within 25 cm of the fault zone have orientations compatible with extension fractures associated with the faulting; these fractures have gentle NW dips.

Fault no. 619

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-76	N26W/28SW	S23E (S24E)	01 (01)	(03 SE) (02 SE)

Comments: This is one strand of a sinuous, anastomosing fault zone through fine-grained feldspathic gneiss on the footwall and pyroxene-bearing marble on the hanging wall. The fault contains a lenticular mass 2 cm thick of white accretionary calcite with epidote; beautifully developed, coarse step faces in this material indicate the upper plate moved to the NW. Offset of the contact between the feldspathic gneiss and the marble across this fault is in accord with this sense of slip; the apparent offset of this contact on the east rib

is about 0.8 m. *Note:* The bearing in our field notes was given as N23W, but since the plunge is nearly zero, the actual bearing calculates to S23E.

Fault no. 620

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-77	N10W/38SW	N56W	(29)	(53 NW)

Comments: Another strand of the same fault zone above. The fault cuts through fine-grained feldspathic gneiss and is coated with accretionary calcite and epidote. Sense of slip unknown.

Fault no. 621

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-78	N36E/30NW	N40W	(29)	(78 NE)

Comments: Same fault zone as the two faults recorded above; similar comments apply here as well. The wide range of fault orientations reflects the strong sinuosity of the anastomosing fault surfaces in this zone.

Fault no. 622

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-79	N06E/45NW	N35W	(33)	(51 NE)

Comments: Same fault zone, rock type, and fault character as for the faults described above. The fault surface is coated with epidote and accretionary calcite, along with minor dark green to bluish-green chlorite(?). Step faces in the accretionary calcite indicate the hanging wall moved to the NW.

Fault no. 623

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-80	N87E/69NW	N09E (N32E)	65 (69)	(86 NE) (76 NE)

Comments: Fault in feldspathic gneiss. The fault surface is finely scored, polished almost mirror-smooth and bright, and covered with epidote 2-4 mm thick. The fault is furrowed along the dip direction; though only a small portion of its surface is exposed, one furrow has an amplitude of about 1.5 cm and a wavelength of 8-9 cm. The fault is highly curved along strike. The readings above were taken in the back near the east rib, but the same fault is well exposed on the west rib. Sense of slip unknown.

Fault no. 624

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-81	N62E/43NW	N59W	(39)	(66 SW)

Comments: This fault is either cut off by or merges with no. 623 above and is similar in all respects to it, except the fault surface is not as highly polished. Sense of slip unknown. Probably the two faults moved in concert.

Fault no. 625

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-82	N68E/40NW	N31W	(40)	(83 SW)

Comments: Epidote- and calcite-coated fault surface in feldspathic gneiss. Ill-developed step faces in accretionary calcite suggest hanging wall moved NW.

Fault no. 626

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-83	N34E/50NW	S42W	(09)	(12 SW)

Comments: Fault in fine-grained "black rock." Fault surface is coated with fibrous accretionary calcite and chlorite (or serpentine). Step faces in this accretionary material indicate the hanging wall moved to the NE. This fault abruptly steepens to about a 68º NW dip within 10 cm – it is a highly curved fault with a trace length of less than 1 m on the east rib. The bearing of the slickenlines is anomalous for this area.

Fault no. 627

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-84	N46E/50NW	N61W	(49)	(79 SW)

Comments: Chlorite- (deep blackish green) and calcite-coated fault surface in "black rock"; sense of slip unknown.

Fault no. 628

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-85	N49E/73NW	N65W	(72)	(83 SW)

Comments: Chlorite- and calcite-coated fault in "black rock"; sense of slip unknown.

Fault no. 629

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-86	N54E/52NW	N82W	(41)	(57 SW)

Comments: Prominently scored fault surface through "black rock," coated with minor white accretionary calcite and dark bluish-green chlorite; sense of slip unknown.

Fault no. 630

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-87	N43E/44NW	N02W	(34)	(54 NE)

Comments: Lightly scored and chlorite-filmed fault in "black rock." Sense of slip unknown, though crude step faces suggest hanging wall possibly moved up and to the S. Weird bearing on slickenlines here.

Fault no. 631

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-88	N69E/58NW	N40W	(57)	(80 SW)

Comments: Calcite- and chlorite-coated fault in "black rock." Well-developed step faces in accretionary calcite show that hanging wall moved up and to the SE; very clear relationship here (finally!).

Fault no. 632

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-89	N78E/56NW	N21E	(51)	(70 NE)

Comments: Calcite- and chlorite-coated fault surface in "black rock." Weakly developed step faces in accretionary calcite suggest that hanging wall moved up and to the SW.

Fault no. 633

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-90	N82E/60NW	N18E	(57)	(76 NE)

Comments: Finely scored, calcite- and chlorite-filmed fault surface in "black rock." Weakly developed step faces in accretionary calcite suggest hanging wall moved up and to the SSW.

Fault no. 634

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-91	N77E/58NW	N14E	(55)	(75 NE)

Comments: Finely scored, calcite- and chlorite-filmed fault surface in "black rock." Weakly developed step faces in accretionary calcite suggest hanging wall moved up and to the SSW.

Fault no. 635

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-92	N75E/55NW	N06E	(53)	(78 NE)

Comments: Finely scored and chlorite-filmed fault surface in "black rock"; sense of slip unknown.

Fault no. 636

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-93	N66W/41NE	Due E	(20)	(31 SE)

Comments: Finely scored and chlorite-filmed fault surface in "black rock"; sense of slip unknown. This fault is at 660N, in the back, adjacent to east rib.

Note 1: Within the "black rock" on the east rib, between 650 and 660N, are numerous calcite-filled tension gashes. Several readings of their orientations:

N58E/52NW N50E/69NW N46E/62NW (n = 3) Average: N51E/61NW

These provide the σ_3 vector and define the local σ_1- σ_2 plane for one of the episodes of deformation. Try to match to one of the faulting episodes.

Note 2: As indicated by measurements above, a zone of faults of low to moderate dip extends through several rock types in this area (coarse-grained garnet amphibolite, wollastonite marble, diopside marble, feldspathic gneiss) from 620N (south end of subdrift) to 650N. These faults are particularly well exposed on the east rib, where the zone can be traced in continuity. The faults are sinuous and anastomosing, so the orientation of any individual fault depends on where it is measured, and at any one place they collectively show a moderate range in orientation. Also their average orientation changes laterally because the entire fault zone shows broad curvature: The faults change from modest SE dips at 620N, to moderate SW dips at 635N, to gentle to moderate NW dips at 640N, to moderate NNW dips at 650N, all visible in complete continuity on the east rib. In addition, wallrock control on the nature of the minerals coating these faults is quite evident here. Epidote, for example, is found almost exclusively in the feldspathic gneisses, where many fault surfaces are bright yellowish-green. Dark bluish-green chlorite, in contrast, is confined almost wholly to faults cutting "black rock." A further difference is that the accretionary material on faults in feldspathic gneiss ranges widely in thickness, from a bare film to 2 cm, whereas in the "black rock" it is invariably thin, 0.5 cm or less.

Fault no. 637

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-94	N63W/46NE	N53W	(10)	(14 NW)

Comments: Chlorite-coated, finely scored fault surface in "black rock"; sense of slip unknown.

Fault no. 638

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-95	N32E/09NW	N50W	(09)	(82 NE)

Comments: Chlorite- and calcite-coated, finely scored fault surface in "black rock"; sense of slip unknown. This is the same fault as the one above; note the large difference in orientation. The fault surface curves markedly around an axis about parallel to the slickenlines.

Fault no. 639

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-96	N59W/45NE	N50W	(09)	(13 NW)

Comments: Another portion of the same fault as the two above. Chlorite- and calcite-coated fault in "black rock"; sense of slip unknown.

Note: For the three readings above, all on the same fault, the local orientations of the fault surface show wide variation, yet the slip vector on all three is quite consistent, proving that the axis of curvature of this (and many similar) faults is parallel to the direction of slip.

Fault no. 640

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-97	N25E/67NW	N83W	(66)	(82 SW)

Comments: Minor fault in "black rock"; chlorite- and calcite-coated fault surface. Sense of slip unknown.

Note 1: Exposed on the east rib here, at 650N, is a small ductile fault zone that defines the north end of the feldspathic gneiss unit. This is succeeded to the north by large masses of "black rock" in marble. Between these two units lies 5-30 cm of impure (diopsidic?) marble. The fault zone, of orientation N84E/76-80NW, developed within this marble. The marble is highly sheared within a zone 3-6 cm thick; streaked-out mineral grains give it the appearance of a protomylonite. Elongate stringers of fine-grained chalcopyrite(?) are quite common along this fault; the stringers are only 0.5-2 mm thick and are parallel to the shear foliation. The fault apparently acted as a fluid-flow conduit for sulfide mineralization. The sense of slip as interpreted from drag features suggests the south side of this fault is the downthrown block (reverse fault).

Note 2: This area was a prolific source of specimens, both of fluorescent wollastonite for the collector market and of scientific specimens gathered for the purposes of this study and that of Steven Misiur and Robert Jenkins. Steve Misiur made a detailed geologic map of the west rib at this locality and collected dozens of flats of reference specimens; these are housed at the Sterling Hill Mining Museum. The rock distribution in this area can be summarized as follows:

1. Specimens of coarse-grained garnet amphibolite +/- sphalerite came from a single mass 20-40 cm thick at about 621N, at the extreme southern end of the drift. This rock forms the outer margins of a large mass of fine-grained feldspathic gneiss along its contact with marble to the north.
2. Wollastonite in marble begins about 628N on the west rib and extends along the lower third of the drift to about 640N. The main concentration of wollastonite, the source of most of the specimens recovered by John Kolic from this area, is about 630N to 633N.
3. Fine-grained feldspathic gneiss on the east rib extends from about 638N to 649N.
4. "Black rock" on the east rib extends from about 650N to 677N, where large masses of this rock are embedded in marble. Similar but generally smaller masses embedded in marble are present on the west rib as well.

5. A large epidote-coated fault surface, source of specimens of mirror-polished slickensides, is on the west rib at 639-646N.

STATION 8 – Near entry to 1270 subdrift between mine coordinates 760N, 1180W to bend in subdrift at 730N, 1260W.

Fault no. 641

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-34	N01E/15SE	S33E	10 (09)	(35 SW)

Comments: Fault in medium-grained marble. Fault surface is lightly coated with a pale grayish-green, fibrous amphibole(?). Sense of slip unknown. *Note:* Bearing measurement is probably more accurate than angle of plunge.

Fault no. 642

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-35	N45W/29SW	S27E	(10)	(20 SE)

Comments: Fault in medium-grained marble. Fault surface is thinly coated with fibrous accretionary calcite. Weakly developed step faces in calcite suggest hanging wall of fault moved to the NW.

Fault no. 643

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-36	N37E/36SE	S88E	(31)	(60 NE)

Comments: Fault in marble; abundant fibrous amphibole(?) and minor accretionary calcite coat fault surface. Sense of slip unknown.

Fault no. 644

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-37	N44E/37SE	S47E	(37)	(89 NE)

Comments: Fault in medium-grained marble. Local fibrous accretionary calcite on fault surface suggests that hanging wall moved to NW, but this is uncertain.

Fault no. 645

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-38	N15E/40SE	S85E	(40)	(82 NE)

Comments: Fault in medium-grained marble. Indistinctly scratched, hematite-stained fault surface; sense of slip unknown. See also fault no. 646 below.

Fault no. 646

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-39	N15E/40SE	S48E	(37)	(69 SW)

Comments: Same fault as no. 645 above, but a different set of slickenlines on the fault surface. These too are indistinct but conform to the dominant slip direction on other members of this set of faults here. Sense of slip and age relative to the S85E set of slickenlines unknown.

Fault no. 647

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-40	N39E/37SE	S46E	(37)	(86 SW)

Comments: Fault in medium-grained marble. Pale green fibrous amphibole(?) and local accretionary calcite coat fault surface; sense of slip unknown.

Fault no. 648

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-41	N09W/29NE	S52E	(21)	(47 SE)

Comments: Fault in medium-grained marble. Streaked-out minerals and mechanical scratches on hematite-stained fault surface define the slickenlines; sense of slip unknown.

Note: Coatings of accretionary minerals on all the faults documented above at this station are thin, and step faces within them are difficult to recognize with certainty. Moreover, because the wallrock is fairly pure calcite marble, visual distinction between sheared calcite immediately adjacent to the fault surfaces and accretionary calcite deposited on them is difficult. Nevertheless, the preponderance of evidence suggests the hanging walls were transported to the NW, as confirmed on the basis of much stronger evidence elsewhere (see also fault no. 649 below). Faults of this set are quite abundant here and are spaced only 15-50 cm apart. As elsewhere, their surfaces are irregular and locally strongly curved, as reflected in the orientations recorded above.

An interesting property of these faults, noted elsewhere in the mine as well, is that their surfaces appear to be composed of a series of small, closely spaced, overlapping surfaces, all of them striated, that dip slightly more steeply to the SE and E than the mean fault planes.

Fault no. 649

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-42	N82E/14SE	S41E	(12)	(58 NE)

Comments: Fault in marble. This fault, plus one 30 cm above, are much larger than the others measured at this station. They have trace lengths of 5-7 m and are lined with much thicker masses of accretionary calcite than all of the other faults measured here. On these faults the accretionary calcite is 0.5-2.5 cm thick in some areas, is splintery, pale cream in color, and lacks included mineral grains. The calcite in the adjacent wallrock, in contrast, is pale gray and contains scattered grains of mica and pyrrhotite. Abundant and well-formed step faces in the accretionary calcite show clearly that the hanging wall of this fault moved to the NW.

Note 1: Collectively the faults at this station define a set of braided, low-angle faults whose upper plates were transported northwestward. These faults bear no relation to the nearby Nason fault. Our field notes for this area include a somewhat cryptic comment that the footwall surfaces of the Nason fault neatly truncate these low-angle faults. We interpret this to mean that the faults that developed within and adjacent to the mylonite along the Nason fault, upon reactivation of that structure, are younger than the braided fault zone documented here, an interpretation in full accord with observations elsewhere.

Note 2: This locality, centered around approximate mine coordinates 745N, 1225W, is notable mineralogically for a probable occurrence of zinkenite, previously known only from the 800 and 900 levels at Sterling Hill. Disseminated sulfide minerals, particularly chalcopyrite, are abundant within coarse-

grained marble in this general area, but here, within a zone about 3.5 m thick, appear dark gray lensoidal masses that much resemble those of zinkenite and fine-grained quartz from the lower levels. The lenses, best visible along a newly exposed portion of the north rib, are commonly 3-20 cm long, 1-6 cm thick, and have their long dimensions parallel to compositional layering in the marble. The two largest masses in cross section measure 34 x 11 cm and 38 x 11 cm; these are on the south rib. Both appear to be boudins, part of the same, once-continuous layer. Visually there is not the slightest evidence for structural control of the sulfides here; they appear to represent original compositional layers in the marble. Specimens were taken of these dark lenses for later optical and X-ray study. It should be noted that these lenses are in a much different position relative to the orebody than the 800- and 900-level occurrences, but as noted above, they are of visually identical character and should be studied to determine their mineralogical makeup.

This same part of the subdrift has long been known as a locality for post-mining guérinite, a hydrous calcium arsenate. If these lenses also contain arsenopyrite, like those on 800 and 900 level, that mineral may have been the source of arsenic for the guérinite.

Fault no. 650

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-54	N44E/11NW	N42W	(11)	(86 NE)

Comments: Fault in medium-grained marble with minor pale green amphibole or pyroxene and disseminated sulfides. Apparent accretionary material on hanging wall of fault shows prominent SE-facing steps, suggesting NW transport of upper plate. At this locality, however, the nature of the material interpreted as fibrous accretionary growth is unclear; this is not an unambiguous interpretation.

Fault no. 651

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-55	N71E/22NW	N56W	(18)	(55 SW)

Comments: Minor fault in medium-grained graphitic marble; one of several such faults here. Fault shows nearly horizontal trace on north rib. Step faces visible on the hanging wall face SE, as in fault no. 650 above; the same comments apply.

Fault no. 652

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-56	N30E/24NW	N54W	(24)	(86 NE)

Comments: Minor fault in medium-grained graphitic marble. Fault surface is dark gray due to smeared-out graphite. Step faces in accretionary calcite on hanging wall suggest upper place moved NW. In this area the accretionary calcite is too thin to be confidently established as such, but the grain size and color difference between this calcite and that of the wallrock lend strength to the interpretation.

Fault no. 653

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-57	N49E/24NW	N42W	(24)	(89 SW)

Comments: Fault in medium-grained marble bearing small, sparse grains of graphite and amphibole or pyroxene. Mineral-streaked fault surface; step faces in apparent accretionary calcite on footwall face NW and thus suggest upper plate moved in that direction. Minor pale green serpentine in recesses in the footwall likewise suggest northwestward transport of the upper plate.

Fault no. 654

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-58	N21E/28NW	N40W	(25)	(64 NE)

Comments: Fault in medium-grained graphitic marble with disseminated sulfides. The mineral-streaked fault surface bears thin, patchy coatings of fibrous accretionary calcite that suggest upper plate of fault moved to the NW. The accretionary calcite here is more confidently interpreted as such than along most of the faults in this area; it is distinctly white, as opposed to the pale gray calcite marble of the wallrock.

Fault no. 655

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-59	N53E/37NW	N51W (N58W)	35 (36)	(79 SW) (72 SW)

Comments: Fault in medium-grained marble bearing sparse grains of graphite and sulfides. The fault surface is lightly filmed with pale- to medium-green serpentine attached to the more steeply NW-dipping portions of the footwall, a distribution suggesting NW transport of the upper plate.

Fault no. 656

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-60	N19E/43NW	N53W	(42)	(77 NE)

Comments: Fault in medium-grained marble bearing sparse grains of graphite and sulfides. The fault surface is graphite-smeared and thinly coated with distinct fibrous accretionary calcite; here the character of that material is undoubted. Medium- to dark-green serpentine or chlorite is also present as thin films on the fault surface. As for fault no. 655 above, the distribution of these minerals on the fault surface suggests NW transport of the hanging wall.

Fault no. 657

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-61	N50E/44NW	N55W (N62W)	42 (43)	(79 SW) (74 SW)

Comments: Fault in medium-grained marble with graphite and disseminated sulfides, both sparse overall but locally moderately abundant. Fault surface is prominently streaked due to large (2-3 mm), sheared-out graphite flakes. Small but common patches of fibrous accretionary calcite on fault surface suggest hanging wall moved to NW. Also present along the fault is a late-stage mineral, ivory to pale tan, in thin crusts with a microbotryoidal surface.

Fault no. 658

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-62	N63E/26NW	N34W	(26)	(84 SW)

Comments: Fault in medium-grained graphitic marble containing dark quartz-rich pods with abundant sulfides, probably including zinkenite. Prominent fibrous accretionary calcite in overlapping patches on the graphite-smeared fault surface firmly indicate hanging wall of fault moved NW.

Note: Faults with gentle to moderate SE dips at the entrance to the 1270 subdrift are members of the same fault zone as those with gentle to moderate NW dips farther into the drift. The curvature of the fault zone can be traced in continuity here, especially along the southeast rib. The upper plates of these faults moved to the NW. Below are readings on additional faults, revealed by recent washing, near the entrance to the subdrift.

Fault no. 659

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-98	N55E/45SE	S42E (S56E)	43 (45)	(85 NE) (75 NE)

Comments: Fault in impure, medium-grained marble with scattered grains of dark green diopside. Hematite-stained accretionary calcite lines fault surface; sense of slip unknown. This fault cuts through the mylonite along the footwall of the Nason fault but is itself cut off by a later strand of that fault (see no. 661), thus once again demonstrating renewed movement along the Nason fault. The marble here also contains sparse grains of franklinite; this is close to the East limb of ore (thus the hematite-stained fault surface).

Fault no. 660

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-99	N25E/39SE	Due E (N89E)	36 (36)	(70 NE) (69 NE)

Comments: Same rock type and character of fault surface as no. 659 above. Step faces in accretionary calcite lining the fault surface indicate westward transport of the upper plate. This fault, too, cuts sheared rock of the Nason fault and is in turn cut off by a later strand of that fault.

Fault no. 661

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-100	N27E/36SE	S50E	(35)	(79 SW)

Comments: Same fault as no. 660 above, but a different set of slickenlines on a calcite-coated, hematite-stained surface. The striae are diffuse and visible only on small portions of the fault surface, and even then with difficulty, but nevertheless are reasonably convincing to the eye. Probably, then, they are an indication of at least two episodes of movement on this and similar faults, or a complex phase with changing stress directions over time, as reflected in the range of slickenline orientations in previous data. Sense of slip unknown, as is the age of this set of slickenlines relative to the other set. In addition to calcite on the fault surface, there is also some secondary willemite and hydrozincite.

Fault no. 662

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-101	N30E/85NW	(N08E)	(77)	78 NE

Comments: This is a sinuous, irregular fault within the footwall part of the Nason fault zone; it postdates the mylonitic foliation and represents a later episode of faulting. The Nason fault here is slightly overturned, though the main strand is not, and juxtaposes impure marble (containing scattered grains of pyroxene) in the NW block against very lean franklinite-calcite ore on the SE. Step faces within hematite-stained accretionary calcite coating the later fault surface are quite well developed; they indicate that the SE side of the fault is the downthrown block.

Fault no. 663

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
340-102	N60W/58NE	N53E (N70E)	51 (56)	(77 SE) (66 SE)

Comments: Fault cutting lean franklinite ore, in part showing mylonitic texture, in the footwall of the Nason fault. This fault postdates the main phase of movement on the Nason fault and cuts across the mylonitic foliation. The fault surface is coated with hematite-stained, fibrous accretionary calcite; very well-developed step faces in this material indicate that the hanging wall moved up (reverse fault). This fault

is cut by no. 662 above and appears also to have been cut by fault no. 659, though the latter relation is uncertain. *Note:* The bearing as given above is more accurate than the plunge.

Fault no. 664

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-103	N27E/25SE	S64E (S64E)	25 (25)	(89 NE) (89 NE)

Comments: Calcite-coated and hematite-stained fault surface in lean franklinite ore. Beautifully developed step faces in accretionary calcite indicate upper plate moved NW. The fault is exposed here in vertical section, where the geometry of a gently NW-dipping segment is clearly visible and shows well-developed, lenticular masses of splintery calcite proving the NW transport direction of the upper plate (see sketch at left). The fault-zone calcite is locally more than 1 cm thick and is white to ivory in color, as opposed to the pale gray of the parent rock. Several fine examples were seen here.

Fault no. 665

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-104	N40E/37SE	S48E	(37)	(88 SW)

Comments: Calcite and serpentine (or chlorite)-coated fault in impure marble bearing sparse grains of a dark green pyroxene. Step faces in accretionary calcite on fault surface indicate NW transport of upper plate.

Fault no. 666

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-105	N08W/26NE	S43E	(16)	(38 SE)

Comments: Same rock type as for fault no. 665 above; calcite-coated and serpentine(?)-filmed fault surface. Crude step faces in accretionary calcite suggest NW transport of upper plate.

Fault no. 667

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-106	N06W/26NE	S42E	(16)	(39 SE)

Comments: Same rock type and fault character as for faults nos. 665 and 666 above. Crude step faces in thin coating of accretionary calcite on fault suggest NW transport of upper plate.

Note: These faults, where viewed along the transport direction, are seen to be sinuous, curved surfaces, some of which split and merge to form a braided or anastomosing network. Viewed perpendicular to the transport direction, the faults are still sinuous but more nearly parallel; the braided pattern is not nearly as pronounced. Most of the faults in this area have an eastward component of dip, but farther into the subdrift they curve to northwest dips; see previous notes.

Fault no. 668

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-107	N14W/13SW	N34W	09 (04)	(20 NW)

Comments: Graphite-streaked and calcite-coated fault surface in medium-grained graphitic marble; step faces in accretionary calcite on fault indicate NW transport of upper plate. *Note:* Even a small error in measured amount of plunge for such a low-dipping fault would result in a large error in the calculated

bearing. The converse, however, is not true. For this reason we accept the bearing as measured; this results in only a 5º difference in measured vs. calculated values of plunge.

Note: This fault, plus the next two faults below, were measured near the entry to the 1270W subdrift.

Fault no. 669

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-108	N50W/11NE	N40W	(02)	(10 NW)

Comments: Calcite and chlorite-coated fault surface through medium-grained impure marble containing (in different horizons) graphite, chalcopyrite, pyroxenes, etc. This is one of the largest low-angle faults here and is well exposed in the back; parts of it contain up to 2 cm of accretionary calcite. Large and well-developed step faces in this calcite indicate NW transport of the upper plate. Also on the fault surface are spots of secondary copper minerals as alteration products of probable chalcopyrite.

Note: Fault surfaces in this area are hematite-stained in low-grade franklinite ore, but the hematite stain disappears abruptly as the faults pass into marble along the footwall of the East limb. The change is dramatic as seen here at the entry to 1270 subdrift. In this area, lean franklinite ore has been thrust northwestward in slices over marble; the whole package was then later cut by faults that developed upon reactivation of the Nason fault.

Fault no. 670

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-109	N40E/26NW	N56W	(26)	(85 SW)

Comments: Graphite-streaked and calcite-coated fault surface through medium-grained graphitic marble. Small step faces in the accretionary calcite indicate the upper plate moved NW.

Note 1: Hydrozincite lines fault surfaces here and is quite abundant (and beautifully fluorescent) at the entrance to the 1270 subdrift, in and within about 0.5 m of the lean ore. Hydrozincite on the faults then disappears abruptly as the faults pass into marble.
Note 2: At this locality the footwall of the Nason fault, as exposed on the west rib of the East limb haulage drift, is a huge, smooth surface that dips 76º. The hanging wall of this same fault as exposed on the east rib of the drift is a similarly large, smooth surface, but of shallower dip, 50º-53º. This is a quite conspicuous and consistent difference.
Note 3: Secondary copper minerals are conspicuous on fault surfaces within the marble, where disseminated sulfide minerals are common. The secondary copper minerals disappear abruptly where these faults instead cut lean franklinite ore near the footwall of the East limb.

STATION 9 – Near and at end of small drift about 200 ft south of the shaft station, at mine coordinates 1015N, 1470W.

Fault no. 671

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-43	N09W/31SW	N52W	(22)	(47 NW)

Comments: Large, irregular fault cutting coarse-grained marble. Step faces in local accretionary calcite on fault surface indicate hanging wall moved NW.

Fault no. 672

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-44	Due N/13W	N62W	(12)	(63 N)

Comments: Large, irregular fault cutting coarse-grained marble. Step faces in local accretionary calcite on fault surface indicate hanging wall moved NW.

Fault no. 673

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-45	N53W/48SW	N52W (N54W)	01	(01 NW)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown. The fault surface here is cut by numerous small, *en echelon* fractures striking a few degrees counterclockwise from that of the mean fault plane, as seen elsewhere along faults of this set. All of the small fractures are striated, and their traces, where they crop out on the main fault plane, are uniformly convex to the SE. These are not Riedel shears. Wherever such faults have been observed in association with fibrous accretionary calcite, the calcite fibers are indicative of right-lateral slip. *Note:* The measured bearing of N52W on this fault is impossible, but only by a single degree; N53W corresponds to a plunge of 0. The measured plunge of 1º in the NW direction corresponds to a bearing of N54W, a scant 2º off from that measured.

Fault no. 674

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-46	N51E/56SE	S50E	(56)	(84 NE)

Comments: Graphite-smeared fault surface in marble; sense of slip unknown. As in fault no. 673 above, the fault surface is bordered by numerous small *en echelon* fractures at low angles to the mean fault plane. Here they are on a fault of different age and orientation, but if interpreted similarly, then a normal sense of slip is suggested.

Fault no. 675

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-47	N62E/62SE	S42E	(61)	(83 NE)

Comments: Graphite-smeared fault surface in strongly sheared marble showing marked grain-size reduction. Sense of slip unknown.

Fault no. 676

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-48	N46E/62SE	S48E	(62)	(88 NE)

Comments: Graphite-smeared fault surface in strongly sheared marble showing marked grain-size reduction. Sense of slip unknown.

STATION 10 – East limb haulage drift between mine coordinates 700N, 1200W and 735N, 1170W.

Fault no. 677

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-49	N29E/55SE	S37E (S24E)	49 (53)	(76 SW) (67 SW)

Comments: This is one strand of the Nason fault, which here is exposed as a broad, smooth surface that defines the SE rib of the drift. The fault surface is furrowed along dip, parallel to the slip direction recorded

above. The furrows are gentle, with amplitudes of 5-20 cm and wavelengths of 0.7-1.5 m, so the fault is gently undulatory along strike. The rock here is coarse-grained marble containing grains of pyroxene and scales of mica, and along the fault it is highly sheared and locally finely foliated. Multiple foliation surfaces along this fault bear scratches that define the slickenlines, but from these it is difficult to tell the sense of slip. Patchy grayish-blue chlorite(?) films these surfaces; also present locally on these surfaces are greenish-blue secondary copper minerals. Within 30 cm of the highly sheared rock on the footwall side (hanging wall is not exposed) are multiple subsidiary faults; these and the striated foliation surfaces mentioned above reflect reactivation of the Nason fault under more brittle conditions than those responsible for formation of the original mylonite. Pyroxene grains in the marble are neatly cut off by these minor subsidiary faults and appear *not* to be distorted by plastic flow; there is little evidence of ductile shear in the rock here away from the (older) mylonite zone. The spacing of these minor faults is 2-10 cm near the main strand of the Nason fault, increasing to 50 cm and more away from it. *Note:* Bearing measurement above is probably more accurate than angle of plunge.

Fault no. 678

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-50	N19E/56SE	S25E (S19E)	42 (46)	(60 SW) (54 SW)

Comments: Same fault as above, but 0.5 m higher. Prominently striated and mineral-streaked (sheared pyroxenes) foliation surfaces are visible here, with patchy coatings of serpentine or chlorite. Sense of slip unknown.

Fault no. 679

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-51	N32W/38SW	S64W	(38)	(85 NW)

Comments: Fault in granular franklinite-brown willemite-calcite ore in back of drift, 5 m SW of readings above on the Nason fault. White fibrous accretionary calcite on the fault surface indicates that hanging wall is downthrown block.

Fault no. 680

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-52	N67W/52SW	S10E	44 (47)	(68 SE)

Comments: Fault in granular, medium- to high-grade franklinite-calcite ore with minor brown willemite. Finely scratched, reddish-brown surface; sense of slip unknown. On the southeast rib this fault appears as a zone 2-3 cm wide of moderately sheared rock. Reddish-brown serpentine(?) containing small (2-10 mm) breccia clasts of calcite forms lenticular masses within the fault zone. Also present in these lenses is an unidentified fine-grained, pale gray, sugary carbonate mineral. On the opposite rib this fault curves markedly and within a distance of about 70 cm seems to merge with the Nason fault. See also fault no. 681 below. *Note:* Measurement of bearing is more accurate than that of plunge.

Fault no. 681

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-53	N84E/48SE	S20E	(47)	(81 NE)

Comments: Same fault as no. 680 above, but measured in the back, 1 m from the northwest rib. Sense of slip unknown. Note the fairly consistent slip direction but marked change in fault orientation.

Fault no. 682

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-139	N27E/48SE	S49E	(47)	(81 SW)

Comments: Mineral-streaked fault surface in impure marble; sense of slip not readily determined here. This is hanging wall of Nason fault.

Fault no. 683

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-140	N12E/59SE	S53E	(56)	(76 SW)

Comments: Mineral-streaked fault surface in micaceous marble near hanging wall of Nason fault. Local fibrous accretionary calcite on fault surface indicates hanging wall moved down.

STATION 11 – East end of 1130 crosscut, extending into small subdrift leading northward to the safety exit. Station is centered on mine coordinates 1130N, 1105W.

Fault no. 684

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-63	N28E/73NW	N47W (N34W)	71 (72)	(85 NE) (81 NE)

Comments: Lightly mineral-streaked fault surface through coarse-grained marble containing sparse pale-green grains of diopside and medium-brown mica, presumably phlogopite. Local fibrous accretionary calcite and serpentine(?) suggest hanging wall is upthrown block (reverse fault).

Fault no. 685

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-64	N41E/68NW	N35W (N31W)	67 (67)	(85 NE) (83 NE)

Comments: Lightly mineral-streaked fault surface through coarse-grained marble containing sparse, pale-green grains of diopside and medium-brown mica, presumably phlogopite. Hanging wall is the probable upthrown block (reverse fault), as indicated by upward-facing step faces on the footwall, but whether the steps are developed in accretionary calcite (to support this interpretation) has not been established with certainty. This fault is offset by no. 686 below.

Fault no. 686

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-65	N24E/49SE	~N47E (N45E)	22	(30 NE)

Comments: Mineral-streaked fault surface in medium-grained marble with sparse phlogopite and green bladed amphibole. Slip sense unknown. This fault offsets no. 685 above. *Note*: The plunge measurement is probably more accurate than the bearing.

Fault no. 687

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-66	N25E/49NW	N73W (N86W)	47 (49)	(85 SW) (76 SW)

Comments: Minor fault in medium-grained marble with sparse phlogopite and green bladed amphibole. The finely scratched fault surface is lightly and patchily coated with fibrous serpentine. Small step faces in this material suggest the hanging wall is the upthrown block (reverse fault).

Fault no. 688

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-67	N12E/67NW	S85W (S78W)	65 (66)	(83 SW) (80 SW)

Comments: Fault through impure marble; some layers are rich in norbergite, others in pale green, fine-grained pyroxene or amphibole, etc. Fault is coated with fibrous accretionary calcite and serpentine. Well-developed step faces in the accretionary material clearly indicate hanging wall is upthrown block; very clear relationship here. The serpentine accretionary fibers appear only on those parts of the fault that cut layers of norbergite-bearing marble; elsewhere the fault is coated with accretionary calcite. The change from serpentine to calcite on the fault surface occurs within 1 cm; this is the same effect as seen on 900 level. This fault is exposed on the south rib of 1130 crosscut.

Fault no. 689

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-68	N35E/72NW	N60W	(72)	~85 SW (88 SW)

Comments: Fault in impure marble containing emerald-green diopside(?), magnetite(?), and in a layer below, a pale green pyroxene or amphibole and dark brown chondrodite or norbergite. Step surfaces within fibrous accretionary calcite and serpentine on fault surface suggest hanging wall is the upthrown block (reverse fault).

Fault no. 690

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-69	N20E/68NW	N76W	(68)	~84 SW (88 SW)

Comments: Fault in medium- to coarse-grained marble containing small grains of a pale green pyroxene or amphibole and phlogopite. Well-developed step faces in accretionary calcite on fault surface clearly indicate that hanging wall is upthrown block (reverse fault).

Fault no. 691

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-70	N23E/61NW	N77W	(61)	(85 SW)

Comments: Fault in coarse-grained marble containing variable amounts of a pale green to grayish green pyroxene or amphibole. Step faces in fibrous accretionary calcite on fault surface indicate hanging wall is upthrown block (reverse fault).

STATION 12 – "Black rock" zone centered on mine coordinates 1010N, 1090W.

Fault no. 692

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-118	N13W/40SW	S16E (N16W)	(03)	(04 NW)

Comments: Fault in fine-grained "black rock." Fault surface is heavily coated with white accretionary calcite, layers of which are separated by thin films of dark green to nearly black chlorite. Prominent step faces in the accretionary calcite indicate hanging wall moved to the NNW (right-lateral slip). *Note:* The plunge of the slickenlines is near-zero, leading to visual uncertainty, in the field, as to whether the slickenlines were gently inclined SE or NW. The calculated value is N16W.

Fault no. 693

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-119	N20E/43NW	N06W	(22)	(34 NE)

Comments: Fault in impure marble containing norbergite; an abundant, pale olive-green unknown (diopside?); and disseminated chalcopyrite in different layers, about 20-30 cm from the south contact with the "black rock" zone. The fault surface is encrusted with white accretionary calcite and apple-green serpentine(?); prominent step faces in this material indicate that the hanging wall moved to the NNW – very clear here. See fault no. 694 below for additional information.

Fault no. 694

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-120	N15E/05NW	N33W	(04)	(48 NE)

Comments: Fault in impure, medium-grained marble 25 cm from the south contact with the "black rock" zone. This is a different part of the preceding fault; prominent step faces in accretionary material on the fault surface confirm the hanging wall moved to the NW. Note the large difference in dip of fault surface between these two readings, a common characteristic of these NW-directed faults.

Fault no. 695

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-121	N20W/28SW	N37W	(09)	(19 NW)

Comments: Fault in norbergite-bearing marble. Fault surface is coated with calcite and pale apple-green serpentine. Prominent step faces in accretionary material indicate hanging wall of fault moved NW.

Fault no. 696

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-122	N23W/40SW	N41W	(15)	(23 NW)

Comments: Fault in norbergite-bearing marble, heavily encrusted with accretionary calcite and pale apple-green serpentine. Superbly formed accretion steps show that hanging wall of fault moved NW. The accretionary calcite on the fault here is 3-10 mm thick.

Fault no. 697

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-123	N12E/46NW	N15W (N05W)	17	(24 NE)

Comments: Fault in nearly pure, medium-grained marble. Coarse and well-developed step faces in accretionary calcite indicate hanging wall of fault moved NNW. *Note:* Angle of plunge is a much more accurate measurement than the bearing, which was awkward to sight here.

Fault no. 698

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-124	N49E/50NW	N14W	43 (47)	(72 NE)

Comments: Minor fault through norbergite-bearing marble. Step faces in accretionary calcite and serpentine on fault surface strongly suggest hanging wall of fault moved up and to the SSE. *Note:* Bearing measurement is more accurate than that of plunge angle.

Fault no. 699

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-125	N54E/29NW	N48W	(28)	(79 SW)

Comments: Very minor slip surface in coarse-grained, garnet-feldspar-quartz-minor calcite rock, at S edge of the "black rock" zone. Step faces in masses of accretionary calcite and chlorite on fault surface indicate hanging wall of fault moved NW.

Fault no. 700

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-126	Horizontal	N27W	(00)	(00)

Comments: A large fault here is exposed over several square meters of the back, above the ore chute. The back is about 12 ft high and the fault is inaccessible, but it is visibly nearly horizontal. Well-developed step faces in accretionary calcite indicate upper plate of fault moved NW.

Fault no. 701

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-127	N29E/70NW	N57W	(70)	~86 SW (89 NE)

Comments: Lengthy fault in "black rock," traceable for perhaps 10 m across the back and down both ribs. Crude step faces in accretionary calcite and chlorite on fault surface somewhat doubtfully suggest hanging wall is upthrown block. This fault cuts across and offsets no. 700 above. The striae on this fault are approximately coincident with the dip line; they pitch about 86º SW.

Fault no. 702

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-128	N32E/78NW	S35W (S37W)	23 (14)	(14 SW) (24 SW)

Comments: Same fault as above, but a different portion, showing local development of a second set of striations as fine scratches on the chlorite- and calcite-coated fault surface. The age of these striations relative to the first set is uncertain, but probably they are younger because they appear as scratches not only on the fault surface but on the accretionary material that was deposited during the dip-slip phase of movement documented above. In this locality there are also numerous thin stringers of a fine-grained sulfide mineral along the fault.

Fault no. 703

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-129	N05W/77NE	(N60E)	(76)	84 NW

Comments: Chlorite and patchy calcite coat fault surface through "black rock" here; sense of slip unknown.

Fault no. 704

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-130	N81W/51NE	N46E	(45)	(65 SE)

Comments: Chlorite-filmed, finely scored fault surface in "black rock." Sense of slip unknown.

Fault no. 705

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-131	N20E/57NW	S80W	(53)	(73 SW)

Comments: Chlorite- and calcite-coated, finely scored fault surface in "black rock." Sense of slip unknown.

Note: The next seven faults all have NE strikes, moderate NW dips, and appear to be related. Though evidence of the sense of slip along these faults is only suggestive at best, in all three places seen it suggests reverse movement, with the hanging wall having moved up and south to southeast. These are all minor faults and resemble a set of joints reactivated in shear. Their surfaces are nearly planar, and all appear as single rather than multiple surfaces—that is, none define a shear zone but are individual "clean" breaks. They are abundant (spacings are 8-90 cm), mutually parallel, and do not split, merge, or otherwise connect to one another. Amounts of slip on most are trivial, a centimeter or so. Tellingly, some of these surfaces display what appears to be twist hackle, a feature that forms only on extension fractures. Thus, these surfaces are here provisionally interpreted as reactivated joints.

Fault no. 706

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-132	N66E/42NW	N02W	(40)	(73 NE)

Comments: Finely scored, chlorite-filmed fault surface in "black rock" with later(?) patchy calcite. Sense of slip unknown.

Fault no. 707

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-133	N34E/58NW	N24W	(54)	(72 NE)

Comments: Indistinct striae on chlorite-filmed fault surface in "black rock." Very minor slip on this fault; sense of slip unknown.

Fault no. 708

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-134	N52E/47NW	N49W (N63W)	44 (46)	(82 SW) (72 SW)

Comments: Chlorite-filmed fault surface in "black rock." Apparent but very small step faces in patchy accretionary calcite coating fault suggest hanging wall moved up, but the evidence for this is doubtful and unconvincing here.

Fault no. 709

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-135	N56E/47NW	N54W	(45)	(76 SW)

Comments: Chlorite-filmed fault surface in "black rock." Calcite accretionary fibers on fault surface suggest that hanging wall of fault moved up and to the SE (reverse fault).

Fault no. 710

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-136	N47E/51NW	N16W	(48)	(72 NE)

Comments: Chlorite-filmed and lightly scored fault surface in "black rock." Sense of slip unknown.

Fault no. 711

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-137	N34E/63NW	N05W	(51)	(61 NE)

Comments: Minor chlorite- and calcite-filmed fault surface in "black rock." Small steps in accretionary calcite on fault suggest hanging wall moved up and southward.

Fault no. 712

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-138	N28E/62NW	N35W	(59)	(77 NE)

Comments: Small, finely scored, chlorite-filmed fault surface in "black rock." Sense of slip unknown.

STATION 13 – Near main shaft at mine coordinates 1130N, 1460W.

Fault no. 713

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-141	N51E/67SE	S72E	(63)	(76 NE)

Comments: Mineral-streaked and crudely scratched minor fault surface in impure marble containing graphite and norbergite. Some accretionary calcite and violet fluorite coat the fault surface. What appears to be accretionary calcite suggests the hanging wall is the upthrown fault block.

Fault no. 714

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-142	N14E/67SE	N70E	(63)	(75 NE)

Comments: Graphite-streaked fault surface in medium-grained marble. Apparent accretionary calcite on fault indicates hanging wall is downthrown block.

Fault no. 715

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-143	N34E/42SE	S04W	(24)	(38 SW)

Comments: Mineral-streaked fault surface in sparsely graphitic marble; sense of slip unknown. This fault appears to cut off no. 714 above and thus is possibly younger.

Fault no. 716

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
340-144	N10E/64SE	Due E	(64)	(86 NE)

Comments: Graphite-streaked fault surface in medium-grained marble; sense of slip unknown.

430 Level

Note: The field notes for the first four stations on this level were gathered during the earliest stages of this study and are not nearly as detailed as our later notes for stations 5 through 10.

STATION 1 – East limb haulage drift at safety exit, at mine coordinates 1255N, 980W.

The Nason fault is well exposed here. Some measurements of its orientation:
N38E/60SE N43E/62SE N28E/60SE N29E/62SE N23E/61SE
N08E/64SE N14E/58SE N17E/62SE
Median: N25E/61SE (n = 8)

As is evident from the readings, the Nason fault is sinuous along strike but (at this locality) of nearly constant dip. The readings were taken within the main fault zone, which here is about 0.5 m thick. Within this zone are numerous small, irregular surfaces about parallel to the main fault. Although not recorded in our notes at the time, almost certainly these are minor faults that developed within the mylonite of the Nason fault during much later episodes of reactivation.

Fault no. 717

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-60	N10W/57NE	S14E (S12E)	03 (06)	(07 SE) (04 SE)

Comments: Fibrous accretionary calcite on this fault shows that the hanging wall moved S (right-lateral fault).

Fault no. 718

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-61	N20E/60SE	S21E (S26E)	51 (49)	(60 SW) (64 SW)

Comments: Fault surface bears mechanical scratches that define the slickenlines here; sense of slip undetermined.

Fault no. 719

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-62	N21E/60SE	S49E (S53E)	59 (59)	(80 SW) (82 SW)

Comments: Dark, mineral-streaked fault surface within highly sheared rock of Nason fault. Our field notes indicate that the hanging wall is the downthrown block, but on what basis was not recorded; the slip sense is best regarded as unknown.

Fault no. 720

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-63	N02E/22SE	S75E	20 (21)	(78 SW)

Comments: Chlorite-coated, mechanically scratched fault surface in lean franklinite-calcite ore. Sense of slip unknown.

Fault no. 721

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-72	N14W/25NE	S70E (S49E)	15 (21)	(59 SE) (38 SE)

Comments: This fault and no. 720 above are part of a braided fault zone 0.5 m thick in lean ore. Individual fault strands are irregular and locally split and merge. The rock within this zone is highly sheared, and the fault surfaces are coated with a soft mineral resembling chlorite. Probable fibrous accretionary calcite on one of the faults suggests the upper plate moved to the northwest.

STATION 2 – East limb haulage drift south of safety exit, at mine coordinates 1120N, 960W.

Fault no. 722

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-64	N17E/46SE	S46E (S48E)	43 (43)	(71 SW) (72 SW)

Comments: Sense of slip indeterminate. Our field notes indicate this is the Nason fault. The measurements probably refer to a late break along this structure, but no details were recorded during this early (Nov. 1989) phase of our work. Observation that fault no. 723 below is older than this one supports the late break interpretation.

Fault no. 723

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-65	N02W/17SW	N50W (N51W)	13 (13)	(49 NW) (50 NW)

Comments: Streaked-out minerals on fault surface define the slickenlines here. This fault is older than no. 722 above.

STATION 3 – Immediately west of East limb haulage drift, along short passage leading S70W to 1080 pillar, at mine coordinates 1135N, 995W.

Fault no. 724

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-66	N58W/41NE	S70E (S65E)	06 (10)	(16 SE) (09 SE)

Comments: Scratched and chlorite-coated fault surface in franklinite-calcite ore; sense of slip on fault unknown.

Fault no. 725

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-67	N17W/40NE	S63E (S56E)	28 (31)	(54 SE) (47 SE)

Comments: Fault in franklinite-calcite ore. Slickenlines are defined by scratches on fault surface; sense of slip unknown.

Fault no. 726

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-68	N47E/80NW	N42W (N82W)	77 (80)	(90) (82 SW)

Comments: Fault in franklinite-sphalerite-calcite ore. Streaked-out minerals and mechanical scratches on fault surface define the slickenlines; sense of slip indeterminate. *Note:* For such a steeply dipping fault, even a minor error in measuring the plunge results in a significant error in the calculated bearing. The *measured* bearing of N42W is probably an accurate number, resulting in a calculated plunge of 80º, only 3º different from the measured angle.

Fault no. 727

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-69	N50E/70NW	N42W (N65W)	68 (70)	(89 SW) (81 SW)

Comments: Slightly mineral-streaked and scratched fault surface in marble; sense of slip unknown. *Note:* For such a steeply dipping fault, even a minor error in measuring the plunge results in a significant error in the calculated bearing. The *measured* bearing of N42W is probably an accurate number, resulting in a calculated plunge of 70º, only 2º different from the measured angle.

Fault no. 728

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-70	N20E/82NW	N41W (N41W)	81 (81)	(86 NE) (86 NE)

Comments: Fault in lean franklinite-calcite ore. Scratches on fault surface define the slickenlines; sense of slip unknown.

Fault no. 729

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-71	N27E/62NW	N56W (N41W)	60 (62)	(87 NE) (79 NE)

Comments: Minor fault in lean franklinite-calcite ore. Our field notes mention that probable accretionary material on the fault surface suggests that the hanging wall is the downthrown block, but we now (2012) believe this observation to be dubious at best. Clear evidence in multiple other areas of the mine (e.g., 900 level, 700 level, 180 level, Passaic pit) shows these are reverse faults.

STATION 4 – Along East limb of ore just north of 1000 crosscut, at mine coordinates 1015N, 980W.

Fault no. 730

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-73	N18E/58SE	S09E (S12E)	39 (36)	(44 SW) (48 SW)

Comments: Fault in high-grade franklinite-zincite-calcite ore. Parts of the fault surface are beautifully polished; light scratches define the slickenlines here. Sense of slip unknown.

Fault no. 731

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-74	N26E/57NW	S48W (S40W)	20 (30)	(37 SW) (24 SW)

Comments: Fault in high-grade franklinite-zincite-calcite ore. Fault surface bears mechanical scratches, but slip sense is unknown.

Fault no. 732

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-75	N40E/39SE	S53E (S76E)	36 (39)	(88 NE) (69 NE)

Comments: Well-polished and scratched fault surface in franklinite-calcite ore; sense of slip unknown. *Note:* The measured and calculated plunges are only 3º apart, yet they result in a 23º difference in measured vs. calculated bearing. The measured rather than the calculated bearing undoubtedly is the number more to be trusted.

Fault no. 733

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-76	N53E/77NW	N12E (N24E)	67 (70)	(75 NE) (68 NE)

Comments: Scratched and partially polished fault surface in franklinite-willemite-calcite ore; sense of slip unknown.

Fault no. 734

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-77	N71E/55NW	N47W (N53W)	50 (52)	(73 SW) (69 SW)

Comments: Fault in ore; possible accretionary calcite on fault surface provides dubious suggestion of normal sense of slip. [Later note: incorrect; these are reverse faults. Glad we equivocated in original field notes!]

Fault no. 735

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-78	N48E/88NW	N13E (N41E)	75 (86)	(87 NE) (75 NE)

Comments: Fault in ore; sense of slip unknown. *Note:* For nearly vertical faults it is quite difficult to directly measure an accurate bearing, but the measured pitch or plunge angles present no such problem. In this case the measured plunge of 75º results in a calculated bearing of N41E, which we take as the accepted values. The two directions in space are close in any event (as shown on a stereonet).

Fault no. 736

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-79	N43E/62SE	S36E (S30E)	61 (62)	(85 SW) (82 SW)

Comments: Nason fault. Chlorite-coated fault surface within large fault zone; sense of slip unknown.

Fault no. 737

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-80	N50E/63SE	S53E (S57E)	62 (62)	(84 NE) (82 NE)

Comments: Nason fault. Mechanical scratches on mylonitic foliation surfaces and probable fibrous accretionary calcite on fault surface developed within the mylonite strongly suggest hanging wall is downthrown block (normal fault). Reactivated fault; see notes below.

Note: The Nason fault here occupies a zone of highly sheared rock about 0.5 m wide. The fault places franklinite-willemite-calcite ore on the hanging wall against marble on the footwall. Within the fault zone the marble is highly sheared. The mylonite itself dates from the earliest episode of slip on this fault. Individual slip surfaces are wavy in vertical section; some are nearly vertical and others have SE dips as low as 45º. The average dip of the mylonite zone is about 65º SE. Later episodes of movement reactivated the Nason fault and resulted in the formation of discrete minor faults within and adjacent to the mylonite zone. These faults commonly show a normal sense of slip, as indicated by fibrous accretionary minerals that formed within them, and by the sense of drag of sheared minerals adjacent to them.

Fault no. 738

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-81	N68E/86SE	S09W (S15W)	85 (86)	(88 SW) (87 SW)

Comments: Mineral-streaked fault surface in willemite-bearing marble. Sense of slip unknown.

Note: Following is a descriptive cross section of the Nason fault as it intersects the north rib here. The wall of the rib trends N80W in this local area. The Nason fault strikes N45-60E; N50E seems to be about average. All apparent thicknesses given here must be converted to true thicknesses to take into account the angle between the fault and the rib wall.

Starting at an arbitrary point west of the fault and proceeding eastward along the north rib:

From 0 to 1.5 m is fine-grained black amphibolite(?) and coarse-grained marble west of the fault zone.

At 1.5 m, end of amphibolite.

At 1.7 m, in marble, is first visible evidence of the influence of the Nason fault. Small shear surfaces, only 2-5 cm in vertical extent, cut through the marble and show minor smearing-out of graphite flakes on their surfaces.

At 2.1 m, beginning of rock displaying distinctly sheared appearance. In this area is a rather abrupt transition from medium- and coarse-grained marble containing relatively few visible shear surfaces to more strongly sheared marble showing distinct grain-size reduction and longer streaks of graphite on shear surfaces.

At 2.33 m is transition to pale- to medium-gray, very fine-grained, streaky, moderately sheared marble that extends for another 0.25 m.

At 3.07 m, beginning of main mylonite zone of Nason fault. The rock here is highly sheared, pale- to dark-gray, prominently streaked marble showing extreme grain-size reduction. Numerous elongate lenses of less-deformed rock form flattened lenticular masses parallel to the mylonitic foliation. The mylonite here displays shows numerous cm-scale intrafolial folds.

At 3.50 m, moderately sheared, fine-grained mylonite; beginning to exit main strand of mylonite zone. From here to 4.41 m, over a distance of 0.91 m, the rock shows gradual eastward reduction in visible signs of shearing of rock. Graphite streaks much shorter than in main mylonite zone. Marble still is fine-grained, however.

At 4.41 m, fault contact with a large mass of fine-grained (0.5-1 mm), pale gray rock resembling dolomite. This rock contains numerous tension gashes filled with white calcite and oriented compatible with normal sense of slip on Nason fault.

At 5.71 m, fairly abrupt transition into moderately sheared calcite marble of finer grain size than the dolomite.

At 7.27 m, moderately sheared, very fine-grained white marble with abundant graphite streaks.

At 7.39 m, moderately to strongly sheared marble. The most strongly sheared part of this zone is 3-5 cm thick and has a pronounced streaky appearance similar to that of the main mylonite zone; mineral streaks on foliation surfaces are long and continuous. This abruptly passes into moderately sheared marble that persists for 0.8 m eastward. Grain-size reduction in this area is generally not as severe as along the main mylonite zone.

At 8.19, fault contact with high-grade franklinite-willemite-calcite ore. Ore along this contact is strongly sheared and brecciated within a zone 3-10 cm thick. East of this zone, however, it retains its original texture. The ore is cut by minor subsidiary faults parallel to the main strand of the Nason fault, but grain distortions similar to those observed in the adjacent calcite marble are not evident. On the opposite rib, however, where the ore is more coarse-grained and calcite-rich, strong drag effects are visible adjacent to these fault strands.

STATION 5 – 1080 pillar along north side of cross member, at mine coordinates 1095N, 1160W.

Fault no. 739

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-82	N41E/68SE	S06E (S01W)	58 (61)	(71 SW) (66 SW)

Comments: The data given here are the average of three closely agreeing sets of measurements on the same fault, with fault orientations of N33E/67SE, N49E/68SE, and N42E/69SE; and slickenlines of 58/S05E, 61/S06E, and 54/S08E, respectively. The fault cuts high-grade franklinite-willemite ore with only minor calcite ("brown ore") and shows a delicately scratched, slightly polished, and seemingly serpentinized surface. Much fine-grained chalcocite and secondary green to blue copper alteration minerals line the fault surface. In addition are local films of a greenish-yellow mineral, as yet unidentified (greenockite?). The chalcocite and its alteration products not only coat the measured fault but also line subsidiary fractures parallel to it for distances of 1-1.5 cm away from the main strand. The chalcocite itself probably postdates the faulting and does not itself appear to be deformed. Farther east this same fault contains fibrous accretionary calcite and cuts across a compositional layer in the marble that also contains chalcocite, apparently older, as described below. Sense of slip was not determined.

Note 1: An oriented sample was obtained of this mineralized fault. The marked surface, corresponding to the main fault plane, is N51E/62SE.

Note 2: This area is of mineralogic interest due to the presence of a layer 3-4 cm thick of marble rich in blebby chalcocite. The chalcocite-rich layer is conformable to compositional layering in the ore-marble sequence here, and there is nothing to indicate a secondary origin. It is described in context as follows:

Within the raise leading downward to 1080 pillar, the wallrock consists of massive, gneissic franklinite-willemite ore with only minor calcite; this is the so-called "brown ore" and has a grain size of 3-7 mm. To the east, toward the top of the ore, the ore becomes more calcitic, especially in its upper 25 cm. A fairly abrupt contact marks the top of the massive ore. Above this is 10-12 cm of calcite marble containing stringers of disseminated franklinite and willemite, succeeded by 18-23 cm of coarse-grained marble containing sparse, disseminated grains of brown willemite and franklinite. Above this is the layer, 3-4 cm thick, that contains much blebby chalcocite in blocky calcite marble. The calcite in this layer appears indistinguishable from that above and below, and from all visual indications it is a primary compositional layer in the marble, conformable with the layering both in the marble and the ore. Above the chalcocite layer is 34-36 cm of coarse-grained blocky calcite marble that contains some disseminated willemite and franklinite, but more sparsely than the layers below. This is succeeded by another layer of ore, 24-29 cm thick, of brown willemite and franklinite with variable but generally minor amounts of calcite, and much sphalerite (var. cleiophane), especially toward the base. And finally, above this ore layer, is blockier calcite marble containing stringers of franklinite-rich ore.

The position of the chalcocite-rich layer in the ore sequence appears unremarkable. There is no major lithologic change above or below, and the calcite throughout appears visually similar and is brightly fluorescent. The chalcocite layer simply appears to be part of a thicker layer that consists mostly of coarse-grained, fluorescent calcite within which the percentage of disseminated willemite gradually decreases upward. The chalcocite appears to be fresh and unaltered, unlike the apparently younger chalcocite along fault no. 739 described above.

The orientation of the compositional layering in the ore and marble was measured in several places:
N02W/37NE, on the base of the upper ore layer, and on a compositional layer within it;
N03W/38NE, chalcocite layer in marble;
N13W/38NE, from a calcite layer in the main ore sequence; and
N20W/42 NE, at top of massive ore sequence.
Median: N08W/38NE (n = 4)

STATION 6 – East limb haulage drift, west rib, about 55 ft north of the safety exit, at mine coordinates 1305N, 990W.

Note: All faults measured at this station are between 40 ft and 70 ft north of the safety exit. The north end of station 6 defines the south end of station 7.

Fault no. 740

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-1	N04E/48NW	S34W	(29)	(41 SW)

Comments: Minor fault cutting moderate-grade, medium-grained franklinite-calcite ore. Fibrous accretionary calcite up to 0.5 cm thick lines the fault surface; also present is minor secondary willemite. Step faces on accretionary calcite indicate hanging wall of fault moved up and to the NE.

Fault no. 741

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-2	N02W/77SW	S11W (S03W)	22 (44)	(46 SE) (23 SE)

Comments: This fault is seemingly part of, and continuous with, no. 740 above; the change in orientation is rather abrupt. Fibrous accretionary calcite 1-3 mm thick with minor secondary willemite lines the fault surface. Prominent step faces in the accretionary material indicate that the hanging wall moved up and to the N. *Note:* Bearing as given above is probably more accurate than angle of plunge, but it seems highly unlikely that a 22^{o} error would have been made in the latter measurement. We here adopt values intermediate between the two.

Fault no. 742

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-3a	N02W/67SW	S20W (S12W)	29 (41)	(46 SE) (32 SE)

Comments: Different portion of same fault as nos. 740 and 741 above, in moderate-grade franklinite-willemite-zincite-calcite ore. As with those, the fibrous accretionary calcite that lines the fault shows that the hanging wall moved up and to the N. A second set of slickenlines at this locality is documented below. See also notes on fault no. 755; this fault offsets it.

Fault no. 743

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-3b	N02W/67SW	S70W	62 (66)	(83 SE)

Comments: This is the same fault as no. 742, but a second set of slickenlines, defined here by a clear set of mechanical scratches upon the semipolished fault surface, and also by short calcite accretionary fibers within recesses on the fault surface. These slickenlines are definite, but not nearly as pronounced as those

of the more shallow-dipping set; their sense of slip and age relative to the other set are uncertain. The fault at this location cuts moderate-grade franklinite-willemite-zincite-calcite ore. Minor secondary willemite is present with calcite in the accretionary material lining the fault. See also notes on fault no. 755; this fault offsets it. *Note:* The bearing given above is probably more accurate than the angle of plunge.

Fault no. 744

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-4	N10E/52NW	S21W (S24W)	17 (14)	(18 SW) (22 SW)

Comments: Same fault as nos. 740 through 743 above, but this reading is probably most representative of its average orientation. Fibrous accretionary calcite with stringers of serpentine and secondary willemite, the whole up to 2 cm thick, line the fault surface and indicate that the hanging wall moved up and to the N.

Fault no. 745

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-5	N86E/38NW	N75E (N77E)	07 (09)	(14 NE) (11 NE)

Comments: Fault in moderate-grade franklinite-calcite ore with minor willemite. Fibrous accretionary calcite with only minor secondary willemite lines the fault surface; locally this material is 5-10 mm thick. The accretionary material indicates that the hanging wall moved to the W.

Fault no. 746

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-6	N56E/44NW	N43E (N50E)	06 (12)	(18 NE) (09 NE)

Comments: Fibrous accretionary calcite 2-10 mm thick, with only a trace of secondary willemite, line the fault surface here. Our field notes state that step faces in the accretionary calcite indicate the hanging wall moved to the W, which is obviously incorrect; with such low-plunging striae it had to move either SW or NE. Should probably regard slip sense on this feature as unknown.

Fault no. 747

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-7	N22E/59NW	N78W (S85W)	56 (59)	(85 SW) (75 SW)

Comments: Polished fault surface in moderate-grade franklinite-calcite ore. Fibrous accretionary calcite and much secondary willemite, commonly 3-10 mm thick but locally as much as 2 cm, line the fault surface. Sense of slip uncertain.

Fault no. 748

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-8	N08E/58NW	S58W (S36W)	37 (51)	(66 SW) (45 SW)

Comments: Fibrous accretionary calcite 1-4 mm thick with a trace of secondary willemite line the fault surface. Prominent step faces in the accretionary material indicate the hanging wall moved up and to the N. *Note:* Although our field notes indicate that the bearing measurement is probably more accurate than the angle of plunge, an error of 14º in the plunge measurement appears highly unlikely. An average reading (plunge of 44º) is here adopted as a reasonable value.

Fault no. 749

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-9a	N08E/56NW	S63W (S34W)	33 (51)	(41 SW) (69 SW)

Comments: Fault in moderate- to high-grade franklinite-willemite-calcite ore. Prominent step faces in fibrous accretionary calcite (up to 3 mm thick) on fault surface indicate hanging wall moved up and to the N. Minor secondary willemite is also present within the accretionary material. *Note:* Plunge reading given above is undoubtedly more accurate than the bearing. The measured bearing, possibly affected by magnetism of the ore, results in a calculated plunge of 51º, and an 18º error in measuring this angle is highly unlikely. Accepting the measured plunge angle as correct, the calculated bearing is S34W.

Fault no. 750

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-9b	N08E/56NW	S78W (S78W)	54 (54)	(78 SW) (78 SW)

Comments: Same fault as above, but a second set of slickenlines defined by a different generation of fibrous accretionary calcite. Sense of slip and age relative to the accretionary calcite of fault no. 749 unknown.

Fault no. 751

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-10	N33W/47NE	S39E (S35E)	02 (07)	(09 SE) (03 SE)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. Translucent brown serpentine and fibrous accretionary calcite on fault surface indicate hanging wall of this fault moved to the NW (left-lateral slip).

Note: This fault, as well as nos. 745 and 746, are members of a prominent set of large and closely spaced (0.5-1 m) faults that cut through the ore at this location. This is a braided fault set of highly irregular, curved faults that split and merge in complex fashion. The orientations of these faults are thus quite diverse, depending on where they are measured, but their average dip appears to be about 40º to the NE and N. On average they strike about parallel to the drift here, and dip into the west rib. The thickness of the secondary minerals that line these faults is likewise quite variable because of the mismatch between the hanging wall and footwall fault surfaces after slip.

Fault no. 752

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-11	N56W/66SW	N76W (N70W)	28 (38)	(42 NW) (31 NW)

Comments: Minor fault in moderate-grade franklinite-willemite-calcite ore. Fibrous accretionary calcite, serpentine, and secondary willemite line the fault surface in seams 2-5 mm thick and indicate that the hanging wall of this fault moved to the NW (oblique right-lateral slip). This fault transects and offsets no. 753 below by 0.5 cm, again in a right-lateral sense.

Fault no. 753

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-12	N24E/51NW	N74W (N82W)	50 (51)	(85 SW) (80 SW)

Comments: Fibrous accretionary calcite, seams of brown serpentine, and stringers of secondary willemite line the fault surface. Sense of slip undetermined. This fault is offset 0.5 cm by fault no. 752 above, in a sense compatible with the slip direction documented on that fault. Nearby, another fault with orientation similar to this one (no. 753) is also offset by a SW-dipping fault similar to no. 752.

Fault no. 754

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-13	N07E/45NW	S09W (S15W)	08 (02)	(03 SW) (11 SW)

Comments: Minor fault in moderate-grade franklinite-willemite-calcite ore. Fibrous accretionary calcite and serpentine line the fault. Little of the fault surface is exposed, but weakly developed step faces in the accretionary calcite suggest that the hanging wall of this fault moved N (right-lateral slip). This fault is offset by another fault of orientation N74W/73SW, but slip indicators are not apparent on this later fault, even though it is lined with 0.5-1.5 cm of calcite interlayered with long stringers of willemite and serpentine. *Note:* Measurement of bearing is more accurate than that of plunge.

Fault no. 755

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-14	N12W/49NE	N02E (N02E)	16 (16)	(21 NW) (21 NW)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. Calcite and translucent, greenish brown to brown serpentine 1-6 mm thick line the fault surface. Accretionary fibers suggest with fair confidence that the hanging wall of this fault moved S (right-lateral). This fault is offset 1-3 cm by the repeatedly active fault documented here as nos. 740 through 744 by 1-3 cm; the east side is down, consistent with the sense of slip documented on that earlier fault.

Fault no. 756

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-15	N09W/67NE	S71E (N81E)	67 (64)	(78 SE) (90)

Comments: Same fault as no. 755 above, but 1 m to the N, and a different, more steeply plunging set of slickenlines as defined by fibrous accretionary calcite and minor, finely fibrous secondary willemite on fault. Sense of slip unknown.

Fault no. 757

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-16	N07E/52NW	S26W (S21W)	17 (22)	(29 SW) (22 SW)

Comments: Fairly large fault in moderate-grade franklinite-willemite-calcite ore. Abundant fibrous accretionary calcite with stringers of serpentine and some secondary willemite line the fault surface. The accretionary material indicates the hanging wall moved up and to the N (right-lateral slip). This fault appears to cut off, and thus postdate, one member of the NW-striking, moderately NE-dipping faults documented above (e.g., faults nos. 745, 746, 751).

Fault no. 758

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-17	N41E/60NW	N88W (S78W)	46 (53)	(68 SW) (56 SW)

Comments: Semipolished fault surface in moderate-grade franklinite-calcite ore. Franklinite grains are slightly streaked out on fault surface to produce the observed slickenlines, but sense of slip on fault is unknown.

Fault no. 759

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-18	N42E/55NW	N32E (N27E)	20 (14)	(17 NE) (25 NE)

Comments: Fault in moderate- to high-grade franklinite-willemite-calcite ore. Fibrous accretionary calcite 0.1-1.5 cm thick with minor secondary willemite on fault surface indicate hanging wall moved up and to the SW (oblique left-lateral slip). This fault clearly offsets another fault of orientation N08E/69SE; an observed offset of 2 cm with a reverse sense of throw is consistent with the slip sense documented here. However, only 1 m above, this fault (no. 759) is neatly cut off by another E-dipping fault, a probable indication of more than one episode of slip on many of the faults here.

Fault no. 760

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-19	N65E/26NW	N55E (N52E)	06 (05)	(11 NE) (14 NE)

Comments: A fairly large, low-angle fault, exposed here over a distance of at least 5 m. Abundant fibrous accretionary calcite and brown serpentine line the fault, along with a trace of secondary willemite. The accretionary fibers indicate that the hanging wall of this fault moved SW (left-lateral slip).

STATION 7 – East limb haulage drift, west rib, between 70 and 120 ft north of safety exit, centered on mine coordinates 1030N, 980W.

Note: This is the area from which the specimens of "dead-zone" willemite were collected. These are characterized by cm-thick veins of solid willemite in granular, brightly fluorescent calcite-willemite ore. Adjacent to each vein, for a distance of 2-4 cm, the calcite and willemite grains in the ore are "dead" – that is, they show no fluorescence, so under shortwave ultraviolet light one sees a prominent slash of green (the willemite vein) bordered by two strips of black, these in turn bordered by red-and-green-fluorescent ore. Such specimens are visually dramatic and highly prized by collectors. They came from a set of faults that strike nearly parallel to the drift here (approximately N-S) and dip westward. The most prominent members of this set are beautifully exposed on the west rib from about 60 ft to 100 ft north of the safety exit. As indicated by the faults documented here and at station 6, members of this fault set are quite abundant in this part of the mine.

Fault no. 761

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-20	N07E/58SE	N37E (N33E)	35 (38)	(47 NE) (43 NE)

Comments: Fault is lined with dark brown serpentine, abundant willemite, and dolomite (probable identity; pinkish tan grains 0.5-1 mm across) which in places aggregate 1 to nearly 2 cm thick. The dolomite was the first mineral to be deposited on the fault walls. The hanging wall of this fault appears to have moved down and to the NE (oblique-slip left-lateral normal fault), but this is indefinite due to the poor definition of step faces in the accretionary material.

Fault no. 762

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-21	N20E/88NW	(N14E)	(72)	72 NE

Comments: Fault in moderate-grade franklinite-willemite ore. The fault is lined with fibrous, cream-colored accretionary calcite; translucent to transparent, toffee-brown serpentine; and secondary willemite, the whole having a prominently layered appearance. Prominent step faces in the accretionary calcite indicate the W block of this fault is the upthrown block.

Fault no. 763

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-22	N30E/59NW	N36W (N23W)	53 (57)	(77 NE) (69 NE)

Comments: Fault in high-grade franklinite-willemite ore containing almost no calcite. Fibrous accretionary calcite on the fault surface is only 1-2 mm thick, but step faces in this material indicate hanging wall is upthrown block (reverse fault).

Fault no. 764

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-23	N12E/46NW	N22W	33 (30)	(44 NE)

Comments: Minor fault in medium-grained marble with local pod of diopside. Fibrous accretionary calcite thinly lines the fault surface. Low step faces in this calcite indicate hanging wall moved up (reverse fault). *Note:* Bearing measurement is probably more accurate than angle of plunge.

Fault no. 765

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-24	N27E/54NW	N14W (N25W)	47 (42)	(56 NE) (65 NE)

Comments: Minor fault lined with fibrous accretionary calcite 1-5 mm thick. No secondary willemite was noted along this fault. Step faces within the accretionary calcite indicate hanging wall is the upthrown block (reverse fault). This fault, as well as no. 764 above, appear to terminate against a member of the braided faults that, on average, dip moderately to the NE and N in this area (e.g., fault no. 751). If these terminations reflect true offsets, faults 764 and 765 predate at least one episode of slip along the braided fault zone.

Fault no. 766

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-25	N13E/54NW	N40W	(48)	(66 NE)

Comments: Minor fault in high-grade franklinite-willemite ore locally containing abundant zincite. "Calcozincite" fibers coat fault surface; pyrochroite is possibly also present. Sense of slip unknown.

Fault no. 767

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-26	N74W/60SW	(N76W)	(03)	03 NW

Comments: Small fault showing multiple strands within a zone 2-6 cm wide. The fault cuts medium- to coarse-grained, high-grade franklinite-willemite ore with local lenses rich in zincite. The fault surface is lined with serpentine, calcite, abundant willemite, and probable secondary zincite as well, but the sense of slip along it was not determinable. Grains of primary willemite within slivers of ore caught up in the fault zone are, in places, completely serpentinized and nonfluorescent.

Note: Here again we see seemingly conflicting evidence of the relative ages of different sets of faults, a natural consequence of more than one episode of movement along some of them. Fault no. 767 at this locality is cut through and offset by one member of the braided faults that, on average, dip moderately to the NE and N in this area (e.g., fault no. 751), suggesting fault no. 767 is the older of the two. However, only 20 cm distant, another member of the set of braided faults is clearly offset about 1.5 cm *by* no. 767, suggesting the opposite age relation. This is expected in areas with a complex fault history and multiple episodes of fault reactivation, and it necessitates great care in interpreting relative-age data.

Fault no. 768

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-27	N85W/74SW	(N86W)	(03)	03 NW

Comments: Minor fault (trace length only 20 cm) through high-grade franklinite-calcite ore. Secondary calcite, serpentine, and willemite line the fault surface in seams 2-4 mm thick. What appear to be several tiny and weakly developed step faces in an area less than 1 cm^2 on the fault surface suggest right-lateral slip, but this is tenuous at best, and the sense of slip is best regarded as unknown. The upper part of this fault, too, is neatly truncated by another member of the NE-dipping braided faults that are common to this area.

Fault no. 769

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-28	N10E/47NW	N52W (N29W)	34 (43)	(70 NE) (50 NE)

Comments: Minor fault in high-grade franklinite-willemite-calcite ore. Patchy fibrous accretionary calcite locally lines fault to a thickness of about 1 mm. Sense of slip unknown. *Note:* Bearing measurement is probably more accurate than angle of plunge.

Fault no. 770

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-29	N03E/52NW	N67W	(50)	(77 NE)

Comments: Minor fault in high-grade franklinite-willemite-calcite ore locally containing zincite. The fault surface bears well-developed scratches, especially prominent across individual franklinite grains. Sense of slip unknown. This fault, as for faults nos. 764, 765, 767, 768, etc., appears to end against (and thus is offset by?) a member of the NE-dipping set of braided faults that are so common here.

Fault no. 771

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-30	N34E/55NW	N31W	44 (52)	(75 NE)

Comments: Fault in high-grade willemite-franklinite ore. Fibrous accretionary calcite 1-2 mm thick with minor secondary willemite lines fault surface. Step faces in accretionary material show that hanging wall is upthrown block (reverse fault). *Note:* Bearing measurement is probably more accurate than angle of plunge.

Fault no. 772

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-31	N27E/59NW	N30W	49 (55)	(72 NE)

Comments: Fibrous accretionary calcite 1-2 mm thick and minor secondary willemite line fault surface. Rock type not recorded, but undoubtedly high-grade ore. Well-developed step faces in the accretionary material indicate hanging wall is upthrown (reverse fault). *Note:* Bearing measurement is probably more accurate than angle of plunge.

Fault no. 773

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-32	N23E/53NW	N54W	(52)	(82 NE)

Comments: Fairly large fault through high-grade franklinite-willemite ore locally rich in zincite. Fibrous accretionary calcite and secondary willemite line the fault surface, locally to at least 6 mm thick. Step faces in the accretionary calcite indicate the hanging wall is upthrown block (reverse fault).

Note: Faults of this set, reverse faults with NE strikes and moderate to steep NW dips, have irregular and locally strongly curved surfaces that in many places split and merge to enclose lensoidal masses of ore. This is a property they share with the other common set of faults here, those that dip NE to N. As in other areas of the mine, faults in ore seem commonly to possess quite irregular surfaces, as opposed to faults in marble, which in general are more nearly planar.

Fault no. 774

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-33	N08E/68SE	N45E (N29E)	41 (56)	(64 NE) (45 NE)

Comments: Fault in high-grade franklinite-calcite ore with minor willemite. A steeply dipping portion of this fault bears grooves within an area of 10 x 3 cm, with orientation recorded above. Elsewhere no such striations are recognizable with certainty, in part because the fault is heavily coated with translucent brown serpentine and calcite, along with local seams of secondary willemite. The calcite, however, is not fibrous, so does not independently confirm the slip direction indicated by the grooves. Slip sense unknown.

Note: The characteristics noted above are common to many such faults at this locality, those with strikes about N-S and moderately steep E to SE dips. Mineral fillings along such faults are commonly thicker than those along faults of different orientation; thicknesses of 1-3 cm are common, and some are locally as thick as 6 cm. Broad, serpentine-coated surfaces of these faults are well exposed in many places, but reliable slip indicators are few.

Fault no. 775

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-34	N73W/43NE	N32E	40 (42)	(79 SE)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. Fibrous accretionary calcite 3-15 mm thick lines fault surface; step faces within this material indicate hanging wall is upthrown block. *Note:* Bearing measurement given above is probably more accurate than angle of plunge.

Fault no. 776

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-35	N08E/63SE	N15E (N23E)	27 (13)	(15 NE) (31 NE)

Comments: This fault is coated with 1-2.5 cm of serpentine, pale tan willemite in stringers as much as 1 cm thick, and minor calcite. Slickenlines are visible on the serpentine-coated part of the fault and appear to have been molded against the (fibrous) calcite. The serpentine is nearly transparent through a thickness of several millimeters, appearing much like amber. Only 15 cm distant, slickenlines defined by fibrous to splintery calcite are oriented 33/N12E, in close agreement with the original reading. Here the calcite fibers are visible through a thin film of transparent serpentine. The sense of slip is not known with certainty, but poorly developed step faces in the accretionary calcite suggest the hanging wall of this fault moved northward (left-lateral slip).

Fault no. 777

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-36	N82E/29NW	N77E (N75E)	04 (03)	(06 NE) (08 NE)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. Extremely well-developed step faces in fibrous accretionary calcite on fault surface show that the upper plate moved westward (left-lateral fault). The calcite filling this fault is locally as much as 3 cm thick, but along most of the fault trace is 1 cm or less.

Fault no. 778

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-37a	N07W/83NE	S37E (S48E)	79 (76)	(78 SE) (82 SE)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. Well-developed fibrous accretionary calcite with minor serpentine indicate E side of fault is downthrown block. See also fault no. 779 below for a second set of slickenlines on this same fault. *Note:* The angle of plunge given here is probably more accurate than the bearing. In our original field notes the opposite end of the compass needle was read and the bearing given at N37W, when S37E was meant. A bearing of N37W is impossible for this fault. A S37E bearing gives a calculated plunge of 76º, in close agreement with that measured.

Fault no. 779

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-37b	N07W/83NE	S12E (S15E)	48 (36)	(36 SE) (48 SE)

Comments: Same fault as above. The slickenlines recorded here are also defined by accretionary calcite fibers with serpentine. This accretionary calcite appears to have been plated over by that of fault no. 778 and thus appears to have formed during an earlier episode of slip, but the sense of slip is unknown. Total thickness of the mineral fill along this fault is 0.5-1 cm. Our field notes indicate that this fault postdates fault no. 777, but on what basis this conclusion was drawn is not stated.

Fault no. 780

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-38	N58E/30NW	N53W	(28)	(72 SW)

Comments: Fault in high-grade franklinite-calcite ore with local willemite. Slickenlines are defined by minerals streaked out on the fault surface and by fibrous accretionary calcite precipitated within voids along the fault. Well-developed step faces in the accretionary calcite indicate that the hanging wall moved down and to the NW. This fault is exposed at the extreme north end of station 7.

STATION 8 – East limb haulage drift, east rib, about 35-40 ft north of the safety exit, at mine coordinates 1290N, 970W.

Fault no. 781

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-39	N11E/63SE	- -	- -	- -

Comments: This is the Nason fault, a description of which is given below. Slip vectors were unobtainable at this locality because the entire fault surface is either coated with flowstone or is heavily altered.

The Nason fault is well exposed here on the east rib. The rock adjacent to the fault is highly altered and structurally weak; parts of the back have stoped out upward for distances of 10-15 ft. This alteration zone is about 0.5-1 m wide and at least 8 m long along the footwall side of the main fault surface here. It contains much limonitic clay, plus the original rock has been so thoroughly altered in places that, when wet, it can be indented by hand. The altered rock is of identical texture to that of moderate-grade ore containing 25-40% franklinite in calcite in the footwall and probably was originally the same lithology. There appears to be a complete gradation here between unaltered ore on the east side of the fault, to altered ore with still-recognizable texture, to limonitic clay adjacent to the fault on the west. The alteration zone is highly irregular and pinches out both above and laterally to areas where solid rock is present on both sides of the fault.

Two bags of samples were collected in the altered area. The bag of ochre-colored clay was taken about 20-25 cm away from the main fault surface. The bag of darker brown material is highly altered rock about 50 cm away from the fault surface.

Exposed in the back where the Nason fault extends upward are several irregular solution pockets, seemingly part of an interconnected network of solution channels on the footwall side of the fault, and within 2 m of it. Water drips abundantly from these openings onto the sill, where is coats rock fragments with an orange to red iron stain. One bag of these fragments was collected from a point about 40 ft north of the safety exit. Similar iron-stained material heavily coats the main fault surface in places; other parts of the fault are coated with calcite flowstone. The impression gained here is that the clay and altered rock fragments described two paragraphs above formed along similar solution channels, and that these are of local development. The largest solution channels are seen in marble, along the hanging-wall contact between massive ore on the west and marble with thin ore layers on the east. The hanging-wall contact here strikes about N15-20W and dips steeply east, estimated at 65°. Local faults at a low angle to this contact, and thus oblique to the Nason fault, may have been where solution began. It is well known that late episodes of movement along the Nason and similar faults produced discrete fault surfaces within and adjacent to the earlier mylonitic zones, and that these acted as permeability conduits for water descending from above.

STATION 9 – 935 stope, about 50 ft above 430 level, at approximate mine coordinates 1150N, 960W. The long axis of the stope is about N45E.

Fault no. 782

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-40	N40E/50SE	S06W (S08W)	32 (33)	(46 SW) (44 SW)

Comments: Fault in coarse-grained marble. The fault surface is fairly smooth, devoid of minerals precipitated upon it except for local iron (hematite) stains, and bears striae defined by mechanical scratches. Sense of slip unknown. This fault defines the hanging wall (SE wall) of the stope and is parallel to the hanging-wall contact of ore, as shown by local patches of ore preserved along it. Shear along this contact is to be expected, given the strong mechanical contrast between the massive ore and adjacent marble.

Fault no. 783

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-41	N41E/56SE	Due S (S10W)	37 (44)	(57 SW) (47 SW)

Comments: Scratched and grooved fault surface in marble; sense of slip unknown. No minerals on fault except for light iron (hematite?) stain.

Fault no. 784

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-42	N40E/55SE	S03W (Due S)	43 (41)	(53 SW) (56 SW)

Comments: Striated and grooved fault surface in marble; sense of slip unknown.

Fault no. 785

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-43	N31E/50SE	S70E	(49)	(83 NE)

Comments: Fault in coarse-grained marble containing sparse grains of willemite. Striated and grooved fault surface; sense of slip unknown. Fault surface is locally stained brown to red by hematite.

Note: The north half of the northwest (footwall) side of this stope is bordered by mylonite of the Nason fault. The readings below are all from the Nason and related faults in this area and are followed by a description of the character of this important structure.

Fault no. 786

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-44	N32E/63SE	S64E (S75E)	62 (63)	(87 NE) (82 NE)

Comments: Prominently lineated mylonite consisting mostly of calcite with abundant scales of a greenish-black mica, the scales oriented with their broad faces parallel to the mylonitic foliation. Sense of slip undetermined.

Fault no. 787

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-45	N17E/44SE	S65E (S69E)	43 (44)	(84 SW) (87 SW)

Comments: Mylonitic marble containing abundant dark greenish-blue scales of chlorite(?) oriented parallel to the mylonitic foliation. Sense of slip on fault undetermined.

Fault no. 788

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-46	N29E/54SE	S61E (S76E)	53 (54)	(90) (81 NE)

Comments: Same character as fault no. 787 above.

Fault no. 789

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-47	N53E/81SE	~S85E (N87E)	74	(77 NE)

Comments: Same character as fault no. 787 above. *Note:* The bearing given here is approximate; the angle of plunge is the more accurate measurement.

Fault no. 790

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-48	N51E/62SE	S64E (S70E)	58 (60)	(78 NE) (74 NE)

Comments: Mylonitic marble; sense of slip on fault undetermined. The foliation surfaces are heavily stained medium reddish-brown by hematite and/or limonite.

Fault no. 791

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-49	N51E/73SE	S66E (S67E)	71 (71)	(82 NE) (81 NE)

Comments: These readings are from a fault strand in coarse-grained marble above the mylonite zone proper. The fault surface is coated with 1-5 mm of fibrous accretionary calcite. Prominent step faces in this material indicate the hanging wall is the downthrown block (normal sense of slip).

Fault no. 792

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-50	N48E/76NW	N15E (N24E)	58 (66)	(70 NE) (61 NE)

Comments: Same comments as for fault no. 791 above. This is a locally overturned part of the fault. Prominent fibrous accretionary calcite coating the fault indicates the hanging wall moved up, which is still consistent with the southeast side of the fault being the downthrown block.

Fault no. 793

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-51	N51E/66SE	S76E (N75E)	43 (61)	(73 NE) (48 NE)

Comments: Striated fault surface in calcite marble; sense of slip indeterminate. *Note:* The bearing given here is probably more accurate than the angle of plunge.

Fault no. 794

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-52	N45E/85SE	(N56E)	(65)	65 NE

Comments: Fault in fine-grained amphibolite(?). Prominent fibrous accretionary calcite coating the fault surface indicates that the southeast side of this fault is the downthrown block.

Fault no. 795

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-53	N34E/70SE	N64E (N62E)	52 (54)	(59 NE) (57 NE)

Comments: Fault in micaceous amphibolite (= probable rock type; almost all of rock here is concealed by calcite coating the fault). Step faces in fibrous accretionary calcite 3-10 mm thick on the fault surface indicate that hanging wall is the downthrown block (normal fault).

Fault no. 796

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-54	N40E/67SE	S85E (N73E)	52 (63)	(75 NE) (59 NE)

Comments: Fault in medium-grained marble. Step faces in fibrous accretionary calcite on fault surface indicate normal sense of offset. Calcite coating the fault ranges in thickness from several millimeters to 1.5 cm.

Fault no. 797

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-55	N47E/87SE	(N52E)	(58)	58 NE

Comments: Fault in marble. Step faces in fibrous accretionary calcite coating fault surface indicate SE side of fault is downthrown block.

Fault no. 798

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-56	N45E/90	N45E (N45E)	61	(61 NE)

Comments: Fault in marble. Fibrous accretionary calcite on fault surface is 2-5 mm thick. Step faces in accretionary calcite indicate SE side is downthrown block.

Fault no. 799

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-57	N42E/60SE	S50E (S64E)	59 (60)	(89 NE) (82 NE)

Comments: Fault in medium-grained marble. Fibrous accretionary calcite coats fault in layer 1-4 mm thick. Poorly developed step faces in accretionary calcite suggest hanging wall is downthrown block (normal sense of slip).

Fault no. 800

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-58	N54E/76SE	(S66E)	(74)	82 NE

Comments: Mineral-streaked fault surface in marble mylonite; sense of slip indeterminate.

The observed character of the Nason fault is related to the amount of shear at any given point and to rock type. In places one sees a true mylonite, a very fine-grained rock derived from much coarser-grained marble. Where the marble was graphitic (not in this stope) the mylonite is streaked white and gray. In some places it is streaked greenish blue and gray, possibly due to sheared-out chlorite, small scales of which are seen locally on foliation surfaces within the sheared rock. Mylonite in other places probably was derived from biotite gneisses and appears as a highly schistose rock containing lensoidal streaks of calcite and locally stained brownish red by thin films of hematite, a probable decomposition product of the biotite. Most of the calcite lenses in this rock are accretionary calcite deposited along shear surfaces during episodes of faulting much later than that responsible for the mylonitic foliation.

Above the mylonite zone but parallel to it in this stope are discrete fault surfaces lined with fibrous accretionary calcite, prominent step faces in which consistently indicate that the SE sides of the faults are the downthrown blocks; these are thus normal faults. These, too, date from a later episode of slip than that which formed the mylonite. Slickenlines on these faults suggest at least two episodes of post-mylonite movement, one nearly pure dip-slip and the other involving a substantial component of left-lateral movement, but both with the SE blocks downthrown. Which of these is the earlier has yet to be determined.

Individual strands of the Nason fault in this stope curve significantly along strike and especially along dip. Dips range over roughly 50º, from 45º SE through vertical to slightly overturned to the NW. The Nason fault defines the footwall contact of ore in the northeastern part of the stope and then continues into the rock bordering the NW wall of the stope. On average the Nason fault has a slightly steeper dip than the hanging wall contact of ore on the opposite side; the hanging wall contact dips about 40º-55º SE.

Fault no. 801

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-59a	N50E/85SE	(N59E)	(60)	60 NE

Comments: A fault that developed within the mylonite of the Nason fault. This fault is lined with fibrous accretionary calcite. Slip sense undetermined, but presumably SE side down with a left-lateral component, as described in paragraphs above. A second set of slickenlines on this fault is recorded below.

Fault no. 802

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
430-59b	N50E/85SE	(S41W)	(61)	61 SW

Comments: Same fault as no. 801 above, but a later set of slickenlines. These appear as delicate scratches, both on foliation surfaces within the mylonite and on the accretionary calcite noted above. The sense of slip is indeterminate. These delicate striae are compatible with those observed along other faults near the hanging wall contact of ore along the SE wall of the stope; they define a clear set of striae exposed over a large area. Taken together there is evidence here for at least three episodes of movement on the Nason fault, the earliest one responsible for formation of the mylonite in a deep-seated shear zone, followed by the episodes of more brittle deformation that produced the slickenlines pitching 60º NE and 61º SW, respectively.

STATION 10 – About 60 ft SW of 1080 pillar and north of 1000 crosscut, at mine coordinates 1045N, 1230W.

The northernmost portion of the mud zone is well exposed here. The “mud” consists of highly weathered, polylithologic clasts of rock in a loose matrix ranging in grain size from fine gravel to clay. Rock fragments in the mud range in size from a few centimeters across to large blocks at least 6 x 6 x 3 ft. In color these rock fragments are variously ochre, reddish brown, brown, to almost coal black. In density they range from extremely heavy masses derived from high-grade franklinite ore to others nearly as light as pith, and whose original lithology is uncertain, though in many cases the textural detail of the original rock is preserved. Some of the rock fragments are still sufficiently indurated that some of the calcite within them is preserved; such rock fragments are brittle and can be broken by sharp blows of a hammer. Most of the fragments, however, are so thoroughly altered that they are weak and plastic, and absorb repeated blows of a hammer without breaking. Many of these fragments can be torn apart by hand, and some contain so much clay that they can be molded into any desired shape. Graphite is an obvious residual component of the matrix material – when it is handled it leaves a slick black graphite film upon one’s hands.

Note: Multiple specimens were collected of the highly altered rock fragments in the mud zone here. Of these, only one was able to be preserved intact by repeatedly allowing a dilute solution of Elmer’s glue to soak into it as it dried. The others fell into fragments as they shrunk upon drying, a probable indication of a significant percentage of expansive clays as alteration products. Their mineralogy should prove fascinating.

500 Level

Note: Only part of one day was spent on 500 level, during one of the earliest days of this study. Our field notes during this early phase of our work are not nearly as detailed as those taken later, but the orientation data are nonetheless useful and are recorded here.

STATION 1 – 1300 crosscut, near safety exit at approximate mine coordinates 1300N, 975W.

Fault no. 803

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-1	N48W/50NE	S85E (S77E)	30 (36)	(50 SE) (41 SE)

Comments: Sense of slip undetermined.

Fault no. 804

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-2	N36E/58NW	N39W (N39W)	57 (57)	(82 NE) (82 NE)

Comments: Sense of slip undetermined.

Fault no. 805

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-3	N14E/47SE	S04W (S09W)	06 (10)	(14 SW) (08 SW)

Comments: Fault cutting rich franklinite-calcite ore; mechanically scratched fault surface; sense of slip unknown.

Fault no. 806

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-4	N80E/38NW	N06E (N05E)	37 (37)	(77 NE) (78 NE)

Comments: Fault in rich franklinite-calcite ore. Fibrous accretionary calcite lining fault is 1-2 cm thick, locally up to 7 cm thick, and indicate hanging wall is upthrown block.

Fault no. 807

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-5	N70W/08SW	N67W (S67E)	02 (00)	(00) (03 SE)

Comments: Fault in franklinite-calcite ore; fault exposed in back. Well-developed step faces in accretionary calcite show upper plate of fault moved to NW. *Note:* A bearing of N67W is technically impossible for this fault, though a bearing of N70W (parallel to the strike line) is perfectly legitimate. A bearing of N70W results in a calculated pitch and plunge of zero. If instead one assumes the wrong end of the compass needle was measured (common error), so the bearing should instead have been recorded as S67E, the calculated plunge is again nearly zero and the pitch would be 03º SE. In either case the two sets of measurements are in close agreement. For a low-dipping fault exposed in the back, the measured bearing is probably fairly accurate, and the plunge likely less so. We thus accept a bearing of S76E, a plunge of <1º, and a pitch of 03º SE.

STATION 2 – 1250 Stope, at approximate mine coordinates 1220N, 920W.

Fault no. 808

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-6	N38E/53SE	S15E (S01W)	38 (47)	(66 SW) (51 SW)

Comments: Polished fault surface in franklinite-calcite ore; sense of slip undetermined.

Fault no. 809

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-7	N06W/85NE	S09E (S14E)	58	(58 SE)

Comments: Fault in franklinite-calcite ore. Fibrous accretionary calcite on fault surface shows west side of fault is upthrown block. This fault terminates against fault no. 808 above and also appears to either merge with or terminate against fault no. 810 below. *Note:* For such a steeply dipping fault the plunge is readily measured, but the bearing is difficult. We thus accept the measured plunge of 58º, a calculated pitch of 58º SE, and a calculated bearing of S14E, which compares favorably to the measured bearing of S09E.

Fault no. 810

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-8	N32E/50SE	S24E (S28E)	46 (45)	(67 SW) (70 SW)

Comments: Fault in franklinite-calcite ore. Fibrous accretionary calcite on fault indicates hanging wall is upthrown block. *Later note:* Sense of slip probably incorrect; was footwall meant instead? No telling now…

Fault no. 811

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-9	N22W/75NE	S89E (S78E)	72 (74)	(84 SE) (80 SE)

Comments: Fault in franklinite-willemite-calcite ore. Scratched and partly polished surface; sense of slip unknown.

Fault no. 812

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-10	N14W/87NE	S77E (S37E)	82 (86)	(88 SE) (83 SE)

Comments: Fault in franklinite-willemite-calcite ore. Scratched and partly polished surface; sense of slip unknown. *Note:* For near-vertical faults the plunge is readily measured, but an accurate measure of bearing is difficult to achieve. Regardless if the plunge is calculated from the bearing or the bearing is calculated from the plunge, the two sets of measurements indicate nearly the same vector in space, as can be shown by plotting them on a stereonet. Don't let the disparate values for the bearing mislead you!

Fault no. 813

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-11	N08E/84SE	N75E (N45E)	80 (83)	(87 NE) (82 NE)

Comments: Fault in franklinite-willemite-calcite ore, filmed with accretionary calcite. Sense of slip undetermined. *Note:* Ditto for previous fault.

Fault no. 814

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-12	N14E/32SE	S49E (S44E)	28 (29)	(67 SW) (62 SW)

Comments: Scratched and polished fault surface in franklinite-willemite-calcite ore; sense of slip unknown.

Fault no. 815

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-13	N10W/43NE	S55E (S50E)	31 (33)	(54 SE) (49 SE)

Comments: Scratched and polished fault surface in franklinite-willemite-calcite ore; sense of slip unknown.

Fault no. 816

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
500-14	N13W/73NE	- -	- -	Steep

Comments: Major fault zone about 1 foot wide here, parallel to some of the above-documented faults. The fault appears to be quite young and throughgoing, and cuts off other faults of more shallow dip (see below. The ore within the zone is intensely sheared and discolored. The orientation of the sheared layers within the fault zone, if interpreted as an S-C mylonite, suggests the hanging wall moved down. *Later note*: Probably this is one of the early faults that formed at great depth; initial movement on these was east side down, as inferred from intrafolial folds on similar faults on other levels of the mine. Later, during the last episode of fault movement in the region, these were reactivated as normal faults. This probably explains the observation as recorded here that this fault cuts off those of lower dip and appears to be young. These faults have been repeatedly active.
Note: A 90º pitch calculates to a bearing of N77E and a plunge of 73º for the slickenside striations, but because no quantitative measurement was made of the slip vector, no data should be entered for computer calculations.

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600 Level

No data are available for this level. The authors were too involved with their assigned duties with the U.S. Geological Survey to travel to New Jersey for work on this level.

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700 Level

STATION 1 – Footwall of West limb at mine coordinates 770N, 1225W, about 4-5 m from ore contact.

Fault no. 817

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-1	N88E/72SE	S30W (S51W)	62 (69)	(79 SW) (68 SW)

Comments: Graphite-streaked fault surface in coarse-grained marble containing minor graphite and tremolite. Sense of slip unknown. Minor fault; total slip probably a few centimeters at most.

Fault no. 818

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-2	N83E/62NW	N29E (N48E)	48 (57)	(71 NE) (56 NE)

Comments: Graphite-streaked fault surface in marble. Minor fault; sense of slip unknown. Hanging wall for 10-15 cm adjacent to the fault is cut by fractures of similar strike to the fault but of steeper (73º) dip. No evidence of slip was noted on these, but see comments on next fault for probably similar fractures.

Fault no. 819

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-3	N83E/60NW	N02E (N20E)	57 (60)	(85 NE) (76 NE)

Comments: Graphite-streaked, minor fault surface in fine- to medium-grained marble. Along this fault, in contrast to the one mentioned above, striated surfaces that dip a few degrees steeper than the main fault surface are present in areas where the rock is devoid of graphite. If these fractures are interpreted as Riedel shears, the sense of slip along this fault is normal. These are not fractures developed within accretionary minerals deposited on the fault surface but are developed within solid wallrock. *Later note:* In many areas of the mine, *en echelon* fractures along faults similar to those described here, but where the sense of slip is unequivocally known, have been shown not to be Riedel shears, and if interpreted as such would have resulted in an incorrect sense of slip. Faults 818 and 819 are probably reverse faults.

Note: For all three faults above, the host marble contains variable proportions of diopside, lesser and more localized amounts of norbergite, and a little tremolite. The diopside is not visually distinctive except where in large (4-7 cm) masses; these are of grayish-brown color.

STATION 2 – In small drift centered on mine coordinates 720N, 1190W. Entrance to drift is in ore; the drift crosses the footwall contact of the West limb ore into marble.

Fault no. 820

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-4	N72E/75NW	N13W (N16E)	72 (75)	(88 NE) (80 NE)

Comments: Graphite-streaked fault surface in prominently layered, medium-grained diopsidic marble. Minor fault; dies out low on the rib and across the back. The fault has an undulatory surface, but no lensoidal vugs are visible along its trace. Mineral-streaked (thus sheared) minor fractures that dip a few degrees steeper than the main fault are visible here; if these are Riedel shears the sense of slip is normal. Note, however, the contradictory and more trustworthy evidence for fault no. 826, which indicates the opposite sense of slip and implies the minor *en echelon* fractures associated with this fault are not Riedel

shears. Numerous cases of this situation have been noted in the mine, and in every case where the slip sense is undoubted, it proves that the low-angle subsidiary fractures along the fault are not Riedel shears and dip in the opposite direction.

Fault no. 821

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-5	N07W/86SW	(N46W)	(84)	85 NW

Comments: Very minor fault; graphite-streaked fault surface in medium-grained marble with minor diopside. Sense of slip unknown. This fault seems to be cut off by, and thus is probably older than, fault no. 820 above.

Fault no. 822

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-6	N03W/83SW	(N26W)	(73)	74 NW

Comments: All comments made for fault 821 apply here as well; this fault, too, seems to be older than no. 820.

Fault no. 823

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-7	N69W/52NE	N60W (N62W)	09 (11)	(14 NW) (11 NW)

Comments: Minor, dark emerald-green serpentine and violet fluorite coat a striated fault surface in medium- to coarse-grained marble at this locality. The marble is near the ore contact and shows a weak red fluorescence SW. This fault is composed of multiple strands in a zone 0.5-1.0 cm thick. The sense of slip is unknown, but possible Riedel shears along it are suggestive of left-lateral movement. The evidence, however, is weak. *Later note:* Where the slip sense on these faults can unequivocally be determined from accretionary minerals, the *en echelon* surfaces point in the opposite sense of Riedel shears! This would suggest a right-lateral fault.

Fault no. 824

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-8	N11W/87SW	(N19W)	(69)	69 NW

Comments: Minor fault; graphite-streaked fault surface in coarse-grained, nearly pure marble; sense of slip unknown. If, however, the graphite-streaked surfaces are interpreted as Riedel shears, their slightly steeper dip than that of the main fault surface is suggestive of the west side being the downthrown block. The geometry of these surfaces is consistent from fault to fault in this area, but its proper interpretation is not yet certain. [See fault no. 823 above for cautionary note.] In any event, this fault is cut off by (and thus older than) no. 820 above, and also by another fault parallel to no. 820, only 15 cm distant. Slip vectors on this fault, no. 824, are incompatible with slip on fault no. 820, so it appears that the latter is the younger of the two.

Fault no. 825

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-9	N85E/65NW	Due N (N11E)	64 (65)	(88 NE) (83 NE)

Comments: Graphite-streaked fault surface in medium-grained marble containing minor graphite and norbergite. Length of the streaks on the fault surface suggests maximum displacement of 1 cm. Sense of slip undetermined. Minor violet fluorite coats fault surface.

Fault no. 826

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-10	N75E/84NW	(N25E)	(82)	85 NE

Comments: Fault in impure marble. Splintery, ivory-colored accretionary calcite forms lensoidal masses 1-3 cm thick along this fault. Offset layers in the marble, an offset pyroxene-rich lens embedded in the marble, and the sense of drag along this lens show that the south side of this fault is the downthrown block. The apparent offset is about 10 cm. *Note:* See fault no. 829 below, and especially no. 830, for additional information.

Fault no. 827

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-11	N90E/68N	N30E (N37E)	63 (65)	(78 E) (74 E)

Comments: Graphite-smeared fault surface in medium-grained marble. Sense of slip unknown but is possibly reverse, based on doubtful correlation of diffuse compositional layers from one side of the fault to the other.

Fault no. 828

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-12	N79E/62NW	N34E (N48E)	44 (53)	(65 NE) (52 NE)

Comments: Graphite-streaked fault surface in medium-grained marble; sense of slip unknown.

Fault no. 829

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-13	N79E/62NW	N07W (N17E)	59 (62)	(88 NE) (76 NE)

Comments: This is the same fault as no. 828 above, in medium-grained marble, but the readings here are for a second set of diffuse graphite streaks that seem with fair certainty to cut across and streak-out the older and broader ones measured above. The sense of slip is unknown, but here is good evidence for reactivation of these faults. This might explain the diversity of observed slip directions; e.g. faults nos. 820, 825, 826, 827, and 828.

Fault no. 830

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-14	N79E/80NW	N35E (N44E)	(69) (73)	72 NE (80 NE)

Comments: This is the same fault as no. 826, but measured 40 cm distant and on a different patch of splintery calcite accretionary fibers. Sense of slip undetermined. Probably, like faults nos. 828 and 829, this fault has experienced more than one episode of slip. *Note:* The bearing as given above is probably more accurate than the pitch measurement.

Fault no. 831

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-15	N26E/35SE	S31E	(30)	(62 SW)

Comments: Low-dipping fault exposed in the back. Graphite-streaked fault surface; sense of slip unknown. This fault is in multiple strands within a zone 1-4 cm thick and is possibly a NW-directed thrust fault. Concentrations of graphite both on the fault and in dark gray bands 1-2 mm thick adjacent to it are suggestive of solution concentration along these surfaces. *Note*: At this locality it was observed that none of

the ENE-striking faults described above continue through this fault, and a couple appeared to have been cut off by it, leading to a suggestion that this fault is the younger feature. The evidence was noted at the time as "not incontrovertible" and apparently led to an incorrect inference, for almost certainly this thrust fault is the older feature. See notes on fault no. 832 below.

Fault no. 832

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-16	N61E/88NW	(N54E)	(75)	75 NE

Comments: This fault neatly and definitely cuts off no. 831 above and is clearly younger; the evidence is much clearer here than for the other faults mentioned above. This fault appears as a narrow zone of strongly sheared rock, in some places almost mylonitic but in most showing elongate, lensoidal masses of little-deformed marble outlined by dark gray, anastomosing shears 1 mm or less thick. The dark gray color of these shears presumably indicates loss of carbonate by pressure solution and consequent concentration of the graphite. Striations on the graphitic surfaces of these shears are diffuse and not very convincing, in large part because the fault is mud-covered, but yielded the measurement given above. The striations appeared much clearer when cleaned with a handerchief and viewed through a hand lens.

Fault no. 833

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-17	N79E/72NW	(N43E)	(61)	67 NE

Comments: Fault in medium-grained, sparsely graphitic marble. The character of this fault is the same as no. 832 above, and it too neatly cuts off fault no. 831. Slight curvature of the latter fault adjacent to this one is weakly suggestive of a normal sense of offset, if the curvature is due to drag; this, however, is tenuous evidence at best, especially for faults that have irregular surfaces to begin with.

Fault no. 834

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-18	N90E/86S	(S60E)	(82)	83 E

Comments: Prominently graphite-streaked, braided fault; sense of slip unknown. In overall character this fault is much like nos. 832 and 833 above, but the rock is not as highly sheared. This fault, like some of the others here, is sinuous in dip, ranging from 82° S through vertical to 72° N; all are part of the same fault set.

Fault no. 835

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-19	N81W/76NE	(N65E)	(66)	70 SE

Comments: Graphite-streaked fault surface in medium-grained marble; sense of slip undetermined.

Fault no. 836

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-20	N80E/73NW	N18E (N10E)	72 (71)	(81 NE) (84 NE)

Comments: Graphite-streaked fault surface in medium-grained marble; sense of slip undetermined.

STATION 3 – In raise between 800 and 700 levels at approximate mine coordinates 735N, 1140W, at approximate depth 725. Axis of raise is about 45/S40E as measured downward. This is a mcgovernite locality.

Fault no. 837

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-21	N55E/87SE	N35W (N35W)	87 (87)	90 (90)

Comments: Fault in moderate-grade, franklinite-willemite-zincite-calcite ore. The franklinite appears to be nonmagnetic here. The fault surface is undulatory along dip, as are the other associated faults here. It is slip along these nonplanar faults, plus associated brecciation, that created the voids within which various secondary minerals would form. This fault is coated with lenticular masses 1-4 mm thick of brilliant red-orange zincite interlayered with a white to pale lavender carbonate, some of which fluoresces red, but most of which fluoresces green due to included secondary willemite. Sense of slip along fault unknown.

Fault no. 838

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-22	N48E/81NW	N42W (N42W)	81 (81)	90 (90)

Comments: Lithology and fault character same as for fault no. 837 above.

Fault no. 839

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-23	N60W/53NE	N12W (N03W)	48 (45)	(62 NW) (69 NW)

Comments: Gently curved fault surface coated with white calcite and scaly mcgovernite. Fault is in moderate-grade, franklinite-willemite-calcite ore. In contrast to the two faults above, there is no zincite in the wallrock, and no secondary zincite lining the fault—remarkable. Zincite along the faults is abundant only 0.5 m away, where the ore contains primary zincite, but is totally absent from all fractures where it does not. The slickenline direction given above is based on slightly splintery calcite in one small area of the hanging wall and does not constitute a convincing indicator of slip direction, but was measured anyway because of the importance of the mcgovernite. The closely similar readings for fault no. 840 below provide confidence in these values. *Note:* Measurement of bearing is more accurate than that of the plunge.

Fault no. 840

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-24	N61W/56NE	N20W	(44)	(57 NW)

Comments: Calcite-coated fault surface in franklinite-calcite ore of moderate grade. The splintery to fibrous calcite on the fault here is more obvious than that on the preceding fault and furnishes a reliable slip direction. The sense of slip was probably left-lateral normal (hanging wall down), but it is difficult to tell with any sense of certainty because the calcite fibers are exposed over only a few square inches of the fault surface.

Fault no. 841

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-25	N78W/58NE	N35W (N44W)	42 (47)	(60 NW) (52 NW)

Comments: This is another portion of the same fault measured above, but here the striations are readily visible as black streaks (sheared franklinite) within the white accretionary calcite coating the footwall of the fault. Sense of slip unknown.

Fault no. 842

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-26	N40E/75NW	N19E (N21E)	48 (50)	53 NE

Comments: Minor fault in franklinite-willemite-zincite-calcite ore; sense of slip unknown. The fault is lined with calcite (lavender, gray, and white), zincite, and minor mcgovernite. The splintery "calcozincite" mixture furnished the striation measurements recorded above. The carbonate filling is locally 7-8 mm thick, but most is fine-grained and apparently massive, so furnished no information on slip directions. The splintery calcozincite is exposed over only a few square centimeters of the fault surface but is visually prominent. *Note:* Measurement of bearing above is more accurate than that of the plunge, but both are likely less accurate than the pitch measurement.

Fault no. 843

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-27	N53E/69NW	(N09W)	(66)	79 NE

Comments: A black, "tarnished," poorly exposed fault surface in franklinite-willemite-calcite ore of moderate grade. Striations on this fault surface are visually prominent, but their nature is difficult to discern because of the poor exposure. The pitch angle as recorded above is only approximate due to difficulty of measurement. Sense of slip on fault unknown.

Fault no. 844

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-28	N79E/81NW	(N08E)	(81)	87 NE

Comments: Fault in moderate-grade, franklinite-calcite ore; sense of slip unknown. Striations on the fault are visually prominent and are true scratches on its unmineralized surface. A representative strike reading on this fault is difficult to obtain; the fault is poorly exposed and highly irregular, and curves to about a N65E strike within 0.5 m of the measurement given above.

Fault no. 845

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-29	N66E/68NW	N52W	(66)	(79 SW)

Comments: Mud-covered, poorly exposed fault in franklinite-willemite-calcite ore of moderate grade; sense of slip unknown. Slip direction along this fault is indicated by true scratches on the fault surface, but other parts of the same fault, where zincite is present in the wallrock, are coated with "calcozincite." This fault and the two above are part of the same anastomosing network of curved and interconnected faults.

Note: Mcgovernite at this station occurs as scaly masses in irregular, discontinuous veinlets within the faults noted above, and in others related to them. Most of the mcgovernite scales are only 1-2 mm across, but some measure fully 1 cm, these occurring in one wide vein where the mcgovernite grew as coarse plates nearly perpendicular to the vein walls. Slip along multiple, interconnected minor faults, along with brecciation along some of them, created the void space within which the mcgovernite grew. Some hand specimens, then, show an interesting network of mcgovernite-cemented, broken rock. Mcgovernite is most prevalent in faults cutting ore that lacks zincite but is not restricted to such places; its lesser abundance in faults cutting zincite-rich ore possibly is attributable to closure of most available void space by secondary zincite and calcite. Mcgovernite appears to have been the last phase to form. Grains of it are commonly implanted directly on the fault surfaces or on the calcite that coats them.

STATION 4 – 735 crosscut at 735N, 1030W (zeolite locality).

Fault no. 846

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-30	N01W/82SW	(S26W)	(73)	75 SE

Comments: Epidote-coated, polished fault surface in granular pyroxene-calcite gneiss. Sense of slip unknown, but a fibrous, dark green amphibole(?) coating part of the fault suggests the west side is the upthrown block.

Fault no. 847

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-31	N03E/81NW	(S21W)	(63)	64 SW

Comments: Same fault character and rock type as fault no. 846 above; here, however, a thin film of white calcite is present on the fault. Offset of a coarse-grained, calcite-rich pod of rock, along with flattening of pyroxene grains near the fault, both tenuously suggest the west side of this fault is the upthrown block. The lithologies to either side of the fault, however, are irregular and lack well-defined layering, so matching one rock type to another to document apparent offsets along this fault is an uncertain procedure at best.

Fault no. 848

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-32	N07E/87NW	(N03E)	(50)	50 NE

Comments: The character of this fault and the nature of the wallrock are the same as for the two faults above. Apparently undeformed, post-faulting calcite adheres in patches 1 mm or less thick to the polished, epidote-coated surface of the fault. This fault is exposed in a nearly inaccessible area; no more details are visible.

Fault no. 849

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-33	N23E/64NW	N05W (N07W)	47 (45)	(52 NE) (54 NE)

Comments: Epidote-coated, polished fault surface in pyroxene-garnet-calcite rock of highly variable grain size. Post-faulting white calcite coats part of fault surface. Sense of slip unknown.

Fault no. 850

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-34	N16E/68NW	N81W (S72W)	64 (68)	(87 SW) (76 SW)

Comments: A nearby portion of the same fault above. This fault shows two clear sets of slickenside striations, both having an appearance of actual scratches, but on an epidote-coated, polished fault surface. The striations oriented 45/N05W (fault no. 849) are by far the dominant set; probably also they are younger. The fault surface is prominently grooved or furrowed parallel to the west-plunging (N81W) set; the grooves have amplitudes of 1-3 cm and appear as pronounced, linear undulations of the fault surface. These, part of the original morphology of the fault, most likely parallel the original direction of slip and are oriented almost parallel to the dipline of the fault. Also, the N05W striations appear to overprint the N81W set and to be more deeply cut into them on the crests of the undulations and more shallowly in the intervening areas. Recessed areas of the fault surface tend to lack the N05W set, but asperities on the fault show them strongly. More specifically, the north side of each crest on the fault is heavily striated by the N05W set, but the south sides are only lightly striated and in large areas not at all. This suggests that the

hanging wall of the fault moved up and to the south during the younger episode of movement; that is, an oblique-slip, left-lateral reverse fault.

Fault no. 851

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-35	N34E/69NW	N60W (N75W)	68 (69)	(89 SW) (83 SW)

Comments: A broad, epidote-coated fault surface in pyroxene-garnet-calcite rock of widely variable grain size. The fault shows linear undulations whose axes are parallel to the set of striations recorded here, and thus nearly parallel to the dip line. These corrugations and striations are similar to those described for fault 850, and, like those, probably date from the earliest stage of slip on this fault.

Fault no. 852

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-36	N34E/69NW	N12W (N02E)	54 (62)	(71 NE) (60 NE)

Comments: Same fault as no. 851 above, but a different and apparently younger set of striations. The fault surface, as before, is epidote-coated, appears as if polished, and shows a corrugated surface of ridges and troughs nearly parallel to the dip line. A white mineral, probably calcite, fills the troughs. The striations of the N60W, downdip set (fault no. 851) thus appear as broad (2-12 mm) stripes of varying pale to deep green color, the paler color corresponding to the calcite-filled depressions and the darker color to the pyroxene-rich wallrock of the ridges. Here and there the ridges, too, are coated with calcite, but only as a bare film. Striations of the N12W set recorded here appear as fine scratches cut into the fault surface along the dark ridge crests. The thin coatings of calcite on these ridge crests appear streaked, but because the calcite has been filmed over with epidote so thin as to be transparent, it could not be determined with certainty if these streaks represent true scratches in the calcite, or if the calcite postdates faulting altogether. The streaks on the calcite, which appear in varying shades of green, possibly are due to varying thicknesses of the epidote filling the scratches and healing them over. The exposed surface of the fault is now perfectly smooth.

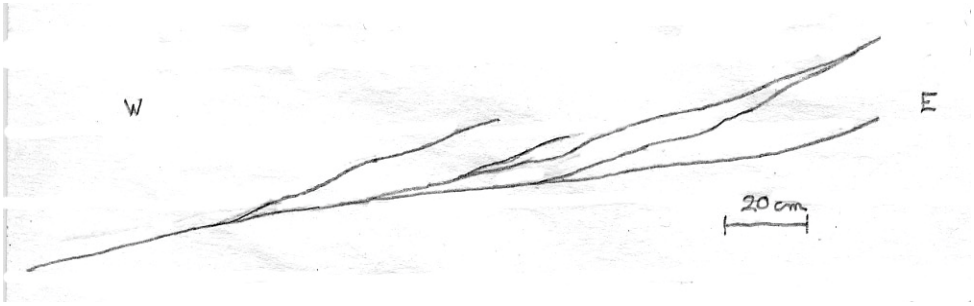
Fault no. 853

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-37	N23E/76NW	N23E (N20E)	14 (00)	(00) (14 NE)

Comments: Same fault as nos. 851 and 852 above, but with yet another set of striations. These are scratches that clearly cut across the calcite described above and are not filmed over with epidote; thus they appear to date from the latest stage of movement on this fault. Their distribution on the fault surface is suggestive of right-lateral movement, though corroborating evidence would be welcome.

Fault no. 854

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-38	N50E/36NW	N85W	(27)	(51 SW)



Comments: Epidote-coated fault surface bearing mechanical scratches due to fault slip. This is the fault that produced most of the zeolite specimens collected recently (late 1990) by John Kolic. The fault cuts pyroxene-calcite-feldspar(?) gneisses of highly variable grain size (0.1-3 cm). Above is a field sketch of this fault, which splays into multiple strands. Epidote lines the fault surfaces. Sphalerite, minor galena, calcite, and zeolites occupy open spaces in the areas between the fault strands, where minor brecciation occurred. The zeolites encrust the calcite and are probably the latest minerals to be deposited there.

Fault no. 855

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
700-39	N73E/41NW	N76W	(24)	(39 SW)

Comments: No additional information was gathered for this fault; ran out of time.

Notes on the 700 level wollastonite occurrence:
About 30 feet east of station 4 was a significant locality for wollastonite, numerous specimens of which were recovered; mine coordinates for this area are 735N, 1000W. This part of the 735 crosscut is dominated by gneissic rock and was drilled and blasted in a search for zeolites. Wollastonite was not at first exposed. After the first blast no zeolites were found (though they did eventually turn up nearby, only 30 feet farther west, at station 4), but a UV lamp was on hand, and out of curiosity the blasted rib and muck pile were searched. A tiny area of wollastonite was visible on the rib. This area was drilled and blasted about five times, during which the exposed size of the wollastonite mass successively increased through the first few blasts but then decreased again. An estimated 80% of the wollastonite thought to be in place was recovered. Around the wollastonite mass, close to it and locally within one-half inch from it, was abundant granular galena. During blasting the rock always broke through the galena, so no specimen showing the transition from the galena-bearing rock into the wollastonite could be preserved.

The amount of material recovered, mostly as hand-sized or larger pieces, filled about 50 powder boxes. The largest specimens, blocks 20-50 cm across, were placed on the floor to form a pile about 12 feet long, 2 feet wide, and 1.5 feet high, numbering (as a pure guess) perhaps 60-80 pieces. Assuming each powder box held about 15 specimens, these, in addition to those on the floor, totaled about 830 specimens – an impressive amount. Most are of granular wollastonite thickly dispersed in calcite, attractive but not otherwise notable. Some, particularly the larger specimens, are more interesting in that they show, through variation in the abundance of wollastonite, the prominent layering of the rock. Among these are some that show, as well, a good color change in the fluorescence of the wollastonite, either gradually across the face of the specimen or (rarely) rather abruptly from one layer to another. The associated calcite ranges from nonfluorescent to weakly red-fluorescent SW; the intensity of the calcite fluorescence generally increases with increasing richness of color of the associated wollastonite. That is, wollastonite fluorescing pale yellow is generally in a matrix of nonfluorescent calcite (low-Mn rock), and wollastonite fluorescing orange is generally in a matrix of red-fluorescing calcite (higher Mn content).

In the Hauck collection is a singular piece from this occurrence, measuring 22 x 18 x 8 cm, and containing a mass of wollastonite as densely packed grains within an area of 17 x 10 cm, consisting of 90-95% wollastonite. The wollastonite shows a dramatic variation in color of fluorescence within single grains. The bulk of this material fluoresces bright, rich orange, much like Franklin "first find" wollastonite, but the cores of some grains fluoresce moderately bright pale lime green to yellowish green. The color of fluorescence in wollastonite depends on its content of manganese, an impurity element that substitutes for calcium. The fluorescence ranges from pale green or greenish gray at low levels of Mn through yellow to orange and deep orange at higher levels. The green response is rarely seen in natural material, but here it is well developed. The change from green to bright orange fluorescence in most grains is fairly abrupt, rather than going through the green → yellow → orange transition. Here there is only green and orange with, minimally, only a little yellowish-orange to deep yellow-fluorescing material. In daylight the wollastonite is ivory to pale tan in color and is in a matrix of pale gray calcite containing grains of a greenish-black pyroxene. The calcite is so fine-grained as to resemble chert and shows a weak to moderate red fluorescence SW. The coarsest wollastonite grains are 1.0-2.5 cm in length; it is these that show the zoned fluorescence. Most of the grains, however, are so tightly packed that their size is difficult to determine. Another notable aspect of this specimen is that it was recovered from the muck pile after the first blast into the wollastonite zone. Little wollastonite was produced during that first blast; in addition to the Hauck specimen was one other about 1/3 the size (which entered the Kozykowski collection) and a few small fragments. The bulk of the wollastonite was recovered during later blasts.

The specimen described above is one of the few from this occurrence to show a mass of densely packed wollastonite grains. Also notable is the mass known as the "Aztec sun," one-half of which is in the Bostwick collection and the other half in the Verbeek collection. Both show a large, roughly circular area of densely packed wollastonite grains that fluoresce pale yellow, in a matrix of nonfluorescent calcite. The vast majority of specimens from this occurrence are attractive and richly fluorescent pieces, but of small wollastonite grains densely scattered in calcite matrix, most with considerably less than 50% wollastonite.

Four of the wollastonite specimens contain thin, discontinuous veinlets of a mineral that fluoresces and phosphoresces bright green. These resemble, and may be, tiny willemite-filled tension gashes; they are 2-10 mm long and range in thickness from a hairline crack to 0.5 mm, rarely as much as 0.8 mm. Their planar surfaces are nearly parallel to the compositional layering in the rock or cut it at a low angle.

The notes above were made on January 7, 1991, after about 5-10% of the wollastonite specimens, mostly the larger pieces, had been sold. Since then the Hauck specimen became, upon incorporation of the Sterling Hill Mining Museum as a nonprofit institution, part of the collection of that museum. It was later sold to Mark Leger, thereby removing the prime specimen from this occurrence from a public museum to a private collection, and still later was sold to Dick Bostwick, in whose collection it remains (as of October 2015). Though still belonging to Mr. Bostwick, it has long been on display in the fluorescent room in Zobel Hall of the Sterling Hill Mining Museum, so once more is viewable by the public.

Notes on the 700 level barite occurrence:

The best and most prolific find of barite from the mine was on 700 level, in late 1990, in the hanging wall of the East limb, in the southern part of the mine. This area was reached through a raise from 800 level, which took one to the west end of 740 crosscut. One then walked E-ward along the crosscut to its end, turned left, and proceeded NE-ward along the stoped-out portions of the East limb to the barite locality.

The barite from this occurrence was in two finds. The earlier of the two was at mine coordinates 850N, 840W, and comprised about 20% of the total number of specimens recovered. Nearly all of this material had been sold by the time these notes were made (January 8, 1991). The second find was far more prolific and produced the best and largest specimens. This find was about 40 feet northeast of the earlier one, at mine coordinates 870N, 820W. Specimens from the second find filled about 15 powder boxes and three five-gallon buckets; in addition to these were 10 additional and generally larger specimens 15-30 cm across. As a wild guess this material totaled about 200 large (15 cm or larger) specimens and numerous smaller ones down to miniature size.
The rock from this locality tended to split along the barite seams, which in general were 1-2 cm thick, so the display faces on many specimens are flat and rich in barite. In a few pieces the barite layer is as much as 4 cm thick. Most of the barite grains are fairly coarse, 0.5-1.5 cm across, with some as much as 2.5 cm across. The fluorescence of the barite ranges from bright to very bright creamy white, and the calcite matrix from moderate deep red to bright orange-red. The fluorescence of one seems not to correlate with fluorescence in the other in terms of brightness; there are duller barites in bright calcite and vice versa, and also bright barites in bright calcite. The barite fluoresces as brightly as the best Franklin material, and more brightly than most of it, and in the best specimens is in pleasing balance with the fluorescence of the calcite matrix. Unlike much of the Franklin material, barite from the 700-level Sterling mine occurrence is quite inconspicuous in daylight, occurring as off-white grains in a pale gray, medium-grained calcite matrix. Accessory minerals include a dark green pyroxene in scattered grains 2-5 mm across and a black metallic mineral, not yet examined but possibly franklinite.

The largest and best specimen recovered from this find is a huge slab measuring 96 x 60 cm across the display face; of this, an area of about 73 x 55 cm is about 35% covered with brightly fluorescent barite. It was mined by John Kolic and Steve Misiur on Friday, December 21, 1990. After a blast, a large area of barite was observed high on the east rib of the haulage drift parallel to the East limb of ore. Steve had wanted a large barite specimen to display in the Rainbow room along with the large calcite-willemite and wollastonite specimens already there, so he and John attempted to extract this one intact. John drilled a hole 1.5-2.0 feet deep behind the barite and hammered in a wedge, but strenuous hammering yielded no result. A second hole was drilled, a second wedge inserted, and some small fractures in the calcite were produced. A third wedge produced much more cracking, but still no separation of the specimen. John then inserted a small chisel into the most prominent crack, and after 15-20 blows the piece separated completely and fell off the wall, coming to rest, unbroken, on edge, on the sill of the drift. John and Steve then roped the specimen to a 9-foot length of drill steel and attempted to carry it to the raise down to 800 level, but got only about 30 ft before deciding it was more than a two-man job. They descended to 800 level, recruited Bob Hauck and Charlie Puzio to help, and then returned to 700 level to the barite locality. With two men on each end of the pole they then carried the barite specimen—in Steve Misiur's words, "like a stuck pig"—to the top of the raise. There it remained until the next day (12-22-90), when John Onder announced he would get the thing out. He, Steve, and Bob returned to the top of the raise, wrapped the specimen in several gunny sacks, attached it to a rope, and lowered it down the raise—a half-hour process. From there it was loaded on an Eimco, driven to the shaft station, placed on the cage, and brought to the surface. For years it was on display, as intended, in the Rainbow Room in the mine, but it was slowly weathering in place, the calcite turning brown and the fluorescence of both minerals gradually dimming. Around 2010 it was removed from the mine by Pete Gillis, successfully cleaned to its former appearance, and moved to a display case in the Thomas S. Warren Museum of Fluorescence, where it remains. The smaller, opposing face of this same mass was purchased by Earl R. Verbeek and is currently (2015) on display in the Franklin Mineral Museum.

The barite on 700 level was exposed in both places where the rock was blasted for specimen recovery; its presence had already been known from previous lamping of the area. This contrasts with the earlier occurrence on 900 level, where the discovery of barite was a stroke of luck. That area had been drilled and blasted to recover orange calcite for the tourist trade, but no barite was visible until the muck pile was lamped.

800 Level

Note 1: The first 26 faults measured on this level were documented during an early phase of this study, when slip vectors were measured but descriptive information on fault geometry, wallrock lithology, etc. was not recorded in detail. Interpretations of slip sense are particularly vulnerable to question here, so should be used with caution. Where reference is made to "mineral-streaked fault surfaces" this almost always means a fault in the Franklin Marble where flakes of graphite have been streaked out or smeared onto the fault surface.

Note 2: This level of the mine started to flood on November 11, 1990, when at 9:00 AM the water stood two inches deep at the shaft station. By the next day it was more than a foot deep, two feet in places (as near the old shaft at 1100N, 740W). November 12 was the last day this level of the mine was accessible; the data on faults nos. 904 through 911 were gathered that day.

STATION 1 – North of shaft station at about 1350N, 1030W.

Note: All of the faults measured in this area show minor slip and have smooth surfaces that are sinuous along strike but basically subplanar overall, and that show little or no void space along them. There is a near-complete lack of fault gouge and no obvious evidence of deformation of the wallrock adjacent to the faults. Where individual large calcite grains are in contact with the faults, the cleavage surfaces of those grains show no apparent deformation.

Fault no. 856

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-1	N20W/28SW	S03E (S03W)	12 (09)	(19 SE) (26 SE)

Comments: Mineral-smeared fault surface in coarse-grained marble. Our field notes state that the hanging wall possibly is the downthrown block, but on what basis is unknown, and the inference was regarded as "definitely not clear." *Later note:* The inference is also probably wrong, since dozens of low-dipping faults in the mine have been proven to have their upper plates transported northwestward (with fair variation in the actual slip vector).

Fault no. 857

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-2	N42E/38NW	N16E (N16E)	19 (19)	(32 NE) (32 NE)

Comments: Fault in coarse-grained marble; fibrous accretionary calcite on fault surface suggests that hanging wall moved down and to the northeast.

Fault no. 858

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-3	N46E/41NW	S86W (N86W)	33 (29)	(48 SW) (56 SW)

Comments: Fault in coarse-grained marble; fibrous accretionary calcite on fault surface questionably suggests that the hanging wall is the upthrown block (reverse fault).

Fault no. 859

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-4	N67E/45NW	N81W (N82W)	27 (28)	(41 SW) (40 SW)

Comments: Fault in coarse-grained marble; fibrous accretionary calcite on fault surface shows that the hanging wall is the downthrown block.

Fault no. 860

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-5	N74E/37NW	N71W (N50W)	32 (23)	(41 SW) (62 SW)

Comments: Fault in coarse-grained marble; fibrous accretionary calcite on fault surface shows that the hanging wall is the downthrown block.

Fault no. 861

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-6	N50E/30NW	N56W (N76W)	25 (29)	(76 SW) (58 SW)

Comments: Mineral-streaked fault surface in coarse-grained marble. Fibrous accretionary calcite locally coats the fault surface, but the sense of slip is unknown.

Fault no. 862

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-7	N88W/85NE	N06W (N02E)	85 (85)	(89 NW) (90)

Comments: Mineral-streaked fault surface in coarse-grained marble. Fibrous accretionary calcite on fault surface shows that north block of fault is the upthrown block.

STATION 2 – North of cross member at about 1350N, 940W.

Fault no. 863

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-8	N63E/61NW	N39W (N54W)	58 (60)	(84 SW) (76 SW)

Comments: Mineral-streaked fault surface in marble; sense of slip unknown.

Fault no. 864

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-9	N68E/54NW	N03E (N01W)	52 (51)	(75 NE) (77 NE)

Comments: Locally anastomosing fault segments with very narrow voids along them, and no visible gouge. Sense of slip unknown.

STATION 3 – Haulage drift west of cross member at 1270N, 950W.

Fault no. 865

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-10	N42E/61SE	S50E (S64E)	60 (61)	(89 NE) (82 NE)

Comments: Anastomosing fault zone about 0.5-1.5 cm in width; faults are tight and sinuous along both strike and dip. Dark, prominently mineral-streaked fault surface, but sense of slip is unknown. This fault offsets multiple fractures oriented N80W/65SW.

STATION 4 – Haulage drift west of cross member at 1225N, 990W, about 60 ft southwest of station 3.

Fault no. 866

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-11	N83E/51NW	N41W (N80W)	20 (46)	(67 SW) (26 SW)

Comments: Olive-green, chlorite(?)-coated fault surface locally encrusted with fibrous accretionary calcite. Hanging wall of fault is downthrown block. *Note:* Poor agreement betwee measured bearing and plunge here (i.e., 46/N41W vs. 20/N80W); best not to use this fault in computer calculations.

STATION 5 – Haulage drift west of cross member at 1200N, 1000W, about 30 ft southwest of station 4.

Fault no. 867

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-12	N57E/61NW	N02E (N02E)	56 (56)	(71 NE) (71 NE)

Comments: Tight fault coated with fibrous accretionary calcite; one of several such faults here. Reverse fault; hanging wall is upthrown block.

STATION 6 – Just north of west end of 1040 crosscut at 1055N, 1045W.

Fault no. 868

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-13	N39W/23SW	S02W (Due S)	16 (15)	(43 SE) (41 SE)

Comments: Fibrous accretionary calcite is present along fault. Hanging wall probably moved northward along this fault, but sense of slip was not reliably determined here; see, however, fault no. 869 below.

Fault no. 869

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-14	N41W/23SW	S05W (S08E)	13 (17)	(48 SE) (35 SE)

Comments: One of several tight, gently undulating fault surfaces here. Fibrous accretionary calcite on fault surface show clearly that hanging wall moved to the north and is upthrown block.

STATION 7 – West limb haulage drift near keel of orebody, at 750N, 1170W.

Fault no. 870

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-15	N30W/68SW	S31E (S25E)	11 (00)	(00) (12 SE)

Comments: Nearly planar, tight fault exposed from sill to back. Mineral-streaked fault surface. Fibrous accretionary calcite on fault shows that hanging wall moved NW; this is a right-lateral fault.

Fault no. 871

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-16	N29E/69NW	S34W (S35W)	16 (13)	(14 SW) (17 SW)

Comments: Dark, mineral-streaked fault surface. Local fibrous accretionary calcite suggests that hanging wall of fault moved up and to the northeast.

Fault no. 872

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-17	N38E/73NW	S59W (S50W)	35 (50)	(53 SW) (37 SW)

Comments: Fibrous accretionary calcite on fault shows that hanging wall moved up and to the northeast. Also coating the fault here is an unidentified soft, platy, nearly white mineral with pearly luster (talc?).

Fault no. 873

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-18	N33E/69NW	S61W (S46W)	30 (51)	(56 SW) (32 SW)

Comments: Fibrous accretionary calcite on fault surface shows clear indication that hanging wall moved up and to the northeast along this fault.

Fault no. 874

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-19	N50E/71NW	N54W (N58W)	70 (70)	(85 SW) (84 SW)

Comments: One member of multiple fault surfaces in a zone 2-6 cm wide cutting across the back and down both ribs here. Fault strands enclose narrow lenses of brecciated calcite marble. No open voids were visible along the fault. Offset of compositional layering in the marble shows that the hanging wall is the upthrown block.

Fault no. 875

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-20	N56E/90	n.a.	90	(90)

Comments: A second fault strand within the narrow fault zone mentioned above. Dark, mineral-streaked fault surface in marble; sense of slip undetermined (but see fault no. 874 above).

Note: Fluorescent norbergite, diopside, and tremolite were all found at this locality.
Norbergite: Orange-colored grains up to 1 cm across in a 5-cm-thick layer; pale yellow fl. SW.
Diopside: Grains up to 1.5 cm across; widely distributed; bright pale blue fl. SW.
Tremolite: Crystals 1-3 cm long in layer 1 m thick; dull bluish-gray fl. SW.

STATION 8 – West limb haulage drift near keel of orebody, at 780N, 1180W.

Fault no. 876

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-21	N30E/77NW	N55W (N39W)	76 (77)	(89 NE) (85 NE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown.

Fault no. 877

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-22	N23E/87NW	N44W (N33W)	86 (87)	(89 NE) (87 NE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown.

STATION 9 – West entrance to backfilled stope along West limb, at 830N, 1160W.

Fault no. 878

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-23	N76W/58SW	S51E (S40E)	43 (35)	(42 SE) (54 SE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown.

Fault no. 879

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-24	N22W/49SW	S03W (S11E)	13 (26)	(35 SE) (17 SE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown.

Fault no. 880

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-25	N42W/28SW	Due S (S19W)	25 (20)	(46 SE) (64 SE)

Comments: Mineral-streaked fault surface; possibly chlorite. Sense of slip undetermined. *Later note:* the "chlorite," given the marble lithology, is probably serpentine.

Fault no. 881

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-26	N83W/38SW	S18E (S19E)	35 (35)	(70 SE) (69 SE)

Comments: Graphite-streaked fault surface in marble. Hanging wall is possibly upthrown block, but not known with certainty.

STATION 10 – Western part of 1040 crosscut at 1040N, 975W.

Note: This western part of this crosscut is an area of great mineralogic interest. Prominent layers rich in zinkenite and realgar occur within the marble here, particularly on the north rib. Both above and below the zinkenite-realgar zone are occurrences of wollastonite. Following is a very slightly edited version of our field notes at this locality, plus data on one fault measured here.

The zinkenite-realgar zone measures 2.4 m thick and is prominently banded in black and white. Most of the zinkenite-rich layers are < 5 cm thick; many are 1-3 cm. All are enclosed in coarse-grained (about 1 cm), white to pale gray marble. The zinkenite layers are discontinuous and of uneven thickness due to boudinage (marble more ductile); individual layers pinch and swell, and commonly pinch out entirely. Few are traceable in continuity for more than 1 m on the rib face. Within the zinkenite zone are irregular, lenticular (flattened parallel to compositional layering) masses of nearly pure, coarse-grained quartz, 1-3 cm thick and 5-10 cm long, and of pale grayish-brown color. These appear to be part of the same layer, perhaps once continuous and now boudinaged. The quartz is immediately underlain by, or rather forms the topmost part of, another prominently boudinaged layer containing much fine-grained, medium-green pyroxene(?) and local scales of a beautiful, rich mahogany-brown mica, as well as coarse grains (4-7 mm) of a bright tin-white mineral, probably arsenopyrite.

The base of the zinkenite-rich zone is marked by a 7-10 cm thick layer of coarse-grained, pale brownish yellow calcite nearly devoid of other minerals. Below this, sulfides still occur, but only in minor amounts,

distributed in thin, wispy stringers throughout the marble. Zinkenite, if present at all in this zone, is inconspicuous; this is "typical" Franklin Marble with scales of graphite, green pyroxene(?), etc. distributed in layers. At 1.5 m stratigraphically below (west of) the base of the zinkenite zone, a layer rich in fine-grained, pale orange-fluorescent wollastonite occurs. This layer is 6-7 cm thick at its thickest part but is discontinuous and local; it is the only such layer here. The same layer in the same position was better developed on 900 level; the wollastonite there had identical appearance and fluorescence. Fluorescent calcite first appears 65 cm lower. From here on down (west) is marble, locally very pyroxene-rich, to the stoped-out portions of the West limb. Most of the marble is nonfluorescent or only very weakly fluorescent until 2-3 m from the ore.

The top of the zinkenite zone is gradational as zinkenite becomes less abundant and then disappears. Above this is marble and calc-silicate rock defined by variable proportions of calcite, dark green pyroxene, orange-grown garnet, and wollastonite, the latter quite rich in some layers and in coarse (4-7 cm) bladed grains. Wollastonite first occurs 60 cm above the top of the zinkenite-realgar zone, the top of which is here regarded as the highest occurrence of realgar (in the absence of zinkenite).

Wollastonite samples were collected from a zone about 2.4 m above the top of the zinkenite-realgar zone. The compositional layering in the marble at this locality is oriented N55E/65SE, N33E/77SE (in zinkenite zone), N54E/73SE (best reading for this area; average strike sighted along the back).

A thin, green-fluorescing vein cuts the wollastonite here. The vein is nearly parallel to the compositional layering. Samples of this green-fluorescent vein mineral were taken by Dick Bostwick. He later sent one to Bob Jenkins, who identified it as monohydrocalcite.

Fault no. 882

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-27	N74E/37NW	N48E (N56E)	13 (18)	(31 NE) (22 NE)

Comments: Dark green, fibrous serpentine (or perhaps amphibole) lines fault surface in medium-grained marble 1-2 m below the zinkenite zone at this station. If these are accretionary fibers as they appear, they indicate that the hanging wall of this fault is the upthrown block. The slip vector on this fault is nearly parallel to the strike of compositional layering in the marble, so stratigraphic offsets cannot readily be used to determine slip sense.

STATION 11 – East limb footwall haulage drift at 1230N, 705W.

Fault no. 883

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-28	N20E/61SE	S67E (S54E)	60 (61)	(89 SW) (82 SW)

Comments: Graphite-streaked fault surface in medium-grained graphitic marble; sense of slip unknown. Minor fault; graphite streaks are only a few centimeters long.

Fault no. 884

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-29	N11E/60SE	S80E (S80E)	60 (60)	(89 NE) (89 NE)

Comments: Graphite-smeared fault in fine- to medium-grained, sparsely graphitic marble. Minor fault; sense of slip unknown.

Fault no. 885

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-30	N01W/63NE	S47E (S55E)	58 (55)	(66 SE) (72 SE)

Comments: Graphite-smeared fault in fine- to medium-grained, sparsely graphitic marble. Minor fault; sense of slip unknown.

Fault no. 886

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-31	N04W/59NE	S48E (S49E)	50 (49)	(62 SE) (63 SE)

Comments: Graphite-streaked fault in fine- to medium-grained, sparsely graphitic marble. Minor fault; sense of slip unknown.

Fault no. 887

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-32	N01W/58NE	S46E (S50E)	50 (48)	(62 SE) (65 SE)

Comments: Graphite-streaked fault in fine- to medium-grained, sparsely graphitic marble. Minor fault; sense of slip unknown.

Fault no. 888

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-33	N42E/69NW	N38W (N48W)	68 (69)	(86 NE) (90)

Comments: Minor fault in coarse-grained, medium-orange calcite marble; sense of slip unknown. Fault surface is pale green due to thin coating of presumed serpentine. *Note:* Bearing of slickenlines in original field notes was given as S38E, an impossibility; probably wrong end of compass needle was read. The opposite bearing of N38W gives a calculated plunge in excellent agreement with that measured. Slickenlines are nearly downdip on this fault.

Note: Aso present at this locality are numerous joints that cut across the N- to NNE-striking faults but do not offset them, even slightly. The joints are subplanar, gently sinuous along both strike and dip, have exposed lengths from a few centimeters to 2 m, exposed heights from 0.5 to 2 m, and are spaced 1-2 m apart generally, but 10-25 cm locally. No evidence of slip along these surfaces was seen; they are simple joints and are unmineralized. A few readings of their orientations:

N88W/76NE N78W/78NE N79W/69NE N83W/74NE N73W/75NE
N84E/73NW N85E/78NW N78W/77NE N90E/75N

Median: N83W/75NE (n = 9)

Compare to joint sets documented at station 12 on 800 level and station 4 on 900 level; probably is correlative set.

STATION 12 – 1220 crosscut east of cross member, at 1220N, 770W.

Fault no. 889

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-34	N32E/60SE	S77E (N87E)	55 (59)	(80 NE) (87 NE)

Comments: This is the Nason fault, which here cuts through medium-grained marble and forms a well-expressed mylonite zone 20-25 cm thick. Rock within the mylonite zone is prominently streaked dark gray and white and is quite fine-grained, reflecting pinpoints of light from the beam of a cap lamp. This is a compact, tough rock with an appearance similar to that of chert or novaculite. The fault here is nearly parallel to the compositional layering in the nearby ore. Foliation surfaces within the mylonite are conspicuously lineated; the orientation of the lineations is recorded above. The rock tends to break along the foliation and only with difficulty across it, so obtaining samples with faces perpendicular to the foliation to show the structure to advantage is scarcely achievable. This fault has been repeatedly active. Our notes indicate a normal sense of slip at this locality, but to which episode of slip this pertains is unknown at present. *Note:* The bearing given above is more accurate than the angle of plunge.

Fault no. 890

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-35	N03W/60NE	S21E (S24E)	32 (28)	(33 SE) (38 SE)

Comments: Small fault in fine-grained “black rock” east of the Nason fault. Step faces on the fault surface here face up and to the NE, but the fault is too poorly exposed to know if these are steps in accretionary material deposited on the fault surface or are rock-cut steps; thus sense of slip is unknown.

Fault no. 891

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-36	N03W/53NE	S34E (S31E)	32 (34)	(45 SE) (42 SE)

Comments: This fault is of identical character to no. 890 above.

Note 1: A set of joints at this station cuts through the mylonite of the Nason fault and is obviously the younger feature. Calcite films the joint surfaces; the calcite shows a dim red fluorescence (thus is manganoan) and weathers brown to nearly black where exposed. The fluorescence of the calcite probably is due to proximity to the orebody here; this station is quite close to the East limb of ore. Also on these joints are films of a dark grayish-blue clay(?), but the joints are otherwise unmineralized. Readings:

N82W/76NE N75W/72NE N77W/70NE N83W/77NE

Median: N80W/74NE (n = 4)

Note 2: The fine-grained “black rock” is common rock type at this station and is present in huge masses; it is also present in large quantities near the old shaft about 120 ft to the south. The contact between the “black rock” and the marble seems to be everywhere characterized by rounded convex protrusions of the “black rock" into the marble, versus pointed cusps of marble into the “black rock”, as in sketch at left. The meaning of this geometry is unclear. One possible view is that it represents load casts of original silicate mud deposited over carbonate mud, the whole later lithified and metamorphosed. If so (though this interpretation is tenuous at best) the “black rock” is younger and once lay stratigraphically above the marble.

STATION 13 – Along 740 crosscut in West limb of ore just north of the keel, at 740N, 1080W.

Note: January 11, 1990: Water has reached 800 level, 2" deep at shaft station, 9:00 AM.

Fault no. 892

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-37	N34E/69NW	N50W (N37W)	68 (69)	(88 NE) (83 NE)

Comments: Polished and scratched fault surface in high-grade franklinite-willemite-zincite-calcite ore. The fault is coated with white to lavender calcite and secondary zincite. This fault offsets the footwall contact of ore about 25 cm in a reverse sense – for once, a clear and direct indication of both the sense and magnitude of fault slip.

Fault no. 893

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-38	N31E/71NW	N67W (N77W)	70 (71)	(87 SW) (84 SW)

Comments: Fault in high-grade franklinite-willemite-zincite-calcite ore. Fault is coated with secondary zincite and white to lavender calcite. The fault offsets the footwall contact of ore 4 cm in a reverse sense.

Fault no. 894

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-39	N52E/60NW	S86W	45 (44)	(53 SW)

Comments: Minor fault in moderate-grade franklinite-willemite-calcite ore. White fibrous secondary willemite coats the irregular fault surface. These fibers seem to be attached to the [footwall?] rock surface on their upper ends, thereby suggesting that the hanging wall of this fault moved down and to the west (oblique-slip normal fault). *Note:* The bearing given above is probably more accurate than the angle of plunge.

Fault no. 895

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-40	N53E/59NW	S82W	38 (39)	(47 SW)

Comments: Rock type and fault character similar to that of fault no. 894 above; sense of slip unknown. Little of this fault surface is exposed. *Note:* The bearing of the slickenlines is an accurate reading, perhaps more so than the angle of plunge.

Fault no. 896

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-41	N25E/80NW	(N03W)	(69)	72 NE

Comments: Minor fault cutting high-grade franklinite-willemite-zincite-calcite ore. The slickenlines recorded here appear to be the earliest set on the fault surface; the fault is slightly grooved parallel to them, minerals appear smeared out on the fault surface in this direction, and splintery accretionary calcite grew in this direction. Sense of slip unknown.

Fault no. 897

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-42	N25E/80NW	(S56W)	(71)	74 SW

Comments: This is the same fault as no. 896 above, but a different and apparently later set of slickenlines as defined by well-developed "calcozincite" encrusting the fault surface. Much secondary zincite is present on this fault, along with calcite (fluorescent red), fine-granular fault gouge (locally fluorescent green due to secondary willemite), and mcgovernite (coating those portions of the fault lacking zincite). The net slip on this fault appears to be in a reverse sense. This movement, probably the second episode of slip, opened lenticular voids that are now filled with zincite, locally 0.5-1 cm thick. Secondary zincite on the fault, as usual, occurs only where the ore is zincite-bearing; the same fault upon entering franklinite-willemite-calcite ore abruptly loses the secondary zincite and is filled instead with much red-fluorescent secondary calcite and local mcgovernite, the whole locally as much as 3" thick.

Fault no. 898

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-43	N42E/77NW	(N10E)	(66)	70 NE

Comments: Fault in high-grade franklinite-willemite-zincite-calcite ore. Lenticular voids along the fault are filled with secondary calcite where zincite is absent in the wallrock; "calcozincite," zincite, and calcite where zincite is present in the wallrock; and locally with a fine-grained, lavender to pale brown material that is in part fault gouge and probably in large part a carbonate mineral, as yet unstudied. Fragments of wall rock several millimeters across are abundantly embedded in this material. The fault surface itself appears to bear mechanical scratches, but the sense of slip along it was not determinable.

Fault no. 899

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-44	N25E/30NW	N56W (N42W)	28 (30)	(82 NE) (70 NE)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. The striations are defined by streaked-out minerals and splintery secondary accretionary calcite on the fault surface, but the sense of slip is unknown.

Fault no. 900

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-45	N25E/30NW	N21W (N29W)	25 (23)	(50 NE) (58 NE)

Comments: Same fault as no. 899 above, but a second, well-defined, and apparently later set of slickenlines, here too defined in part by splintery accretionary calcite. The accretionary calcite suggests the upper plate of this fault moved to the NW, but the relations are not especially clear. The apparently earlier calcite of fault no. 899 appears locally to be finely scratched parallel to the N21W direction, consistent with the relative age inferred here.

Fault no. 901

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-46	N07W/54SW	N56W	(46)	(63 NW)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. Beautifully defined step faces in thick (0.5 cm in places) fibrous accretionary calcite over a broad area of the fault surface clearly show that the slip sense on this fault was normal.

Fault no. 902

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-47	N16W/50SW	(S85W)	(49)	83 NW

Comments: This is a different part of the same fault (no. 901) documented above. Step faces in fibrous accretionary calcite indicate normal sense of slip. This fault thus shows somewhat inconsistent directions of slip, but for both sets of striae in a normal sense. The steeply pitching calcite fibers recorded here appear in places to be scratched parallel to the N56W direction documented above, and also are overplated by newer calcite with N56W-oriented fibers, suggesting that the steeply pitching fibers record an earlier phase of movement on this fault.

STATION 14 – 740 crosscut north of keel, at mine coordinates 740N, 960W.

Fault no. 903

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-48	N40E/67SE	S60E (S74E)	65 (67)	(86 NE) (80 NE)

Comments: This is the Nason fault, which cuts through medium-grained marble on the N rib here, and through franklinite-rich ore on the S rib. The fault shows a well-developed mylonite zone 35 cm thick, with prominently streaked foliation surfaces. Sense of slip undetermined.

STATION 15 – Stope along East limb of ore about 20 ft above 800 level. Axis of raise leading up to stope from 800 level is about 58/S80E as measured downward. Approximate mine coordinates at south end of stope, at raise entry, are 1220N, 690W.

Note 1: January 12, 1990: last day on 800 level. Fred Kirk lowered the cage to 2 feet above the shaft station so I could step off. Water now more than 1 foot deep at shaft station; deeper at old shaft. Water almost to top of work boots by end of day.

Note 2: This is a mineralogically noteworthy stope from which numerous specimens of sphalerite and associated sulfides were recovered. The stope is elongated in a N-S direction and is about 120 ft long by 20-25 ft wide, with a fill fence on the north and a raise on the south.

Fault no. 904

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-49	N02E/54NW	S07W (S06W)	06 (06)	(08 SW) (07 SW)

Comments: Fault in moderate-grade franklinite-zincite-willemite-tephroite(?)-calcite ore. The fault is coated by a well-developed layer of coarse-fibrous to splintery accretionary calcite. Step faces in this material indicate a right-lateral sense of slip. *Note:* Bearing was given in our field notes as N07E, but this should have been S07W (i.e., other end of compass needle).

Fault no. 905

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-50	N09E/55NW	S67W (S57W)	47 (50)	(70 SW) (63 SW)

Comments: Same fault as no. 904 above, but a different set of calcite accretionary fibers indicating a different phase of movement. This phase of movement, too, is indicated by a well-defined set of calcite

accretionary fibers – splintery white calcite – but subordinate in area to those mentioned above, and with an unknown sense of slip. These more steeply plunging fibers appear to be the older set; the calcite of the younger set is plastered atop them. In one place, the northern side of a bundle of these fibers served as the points of attachment for fibers of the younger, gently plunging set, which filmed the older set over and grew northward during right-lateral movement. The older fibers are still visible beneath the younger ones where the latter are thin.

Note: This fault, where measured, is at the hanging-wall contact of ore against marble in the stope. Where the fault cuts ore it is plastered with abundant calcite and secondary willemite (as indicated by fluorescent green streaks parallel to the calcite fibers), local "calcozincite" where the wallrock contains zincite, and sparse secondary copper minerals of turquoise color. The copper minerals are generally at or near the ore-marble contact, with the sole exception of a single small patch 25 cm from the contact. The same fault where it cuts the medium- to coarse-grained marble above the ore, however, contains abundant sphalerite, other associated sulfides, abundant rather than sparse secondary copper minerals, and no zincite. In addition, secondary willemite intergrown with the accretionary calcite of both sets of fibers, so common where the fault is in ore, is nowhere to be seen where the fault cuts marble. This, as in 970 Stope on 1000 level, is a dramatic example of how the character of the wall rock influenced the mineralogy of secondary minerals precipitated along a fault. The change in mineralogy occurs precisely at the hanging wall contact of the ore and is quite abrupt. The change in mineralogy is reflected in minerals developed later, upon weathering, as well: Hydrozincite, an alteration product of sphalerite, is common here in the marble but was not seen in ore. The combination of the bright blue-fluorescent hydrozincite against a matrix of bright red-fluorescing calcite is quite a beautiful one.

Fault no. 906

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-51	N76E/56NW	N14E (N33E)	45 (52)	(73 NE) (59 NE)

Comments: Fault in high-grade franklinite-willemite-zincite-calcite ore. The fault surface is coated with 1-5 mm of fibrous to splintery accretionary calcite, secondary willemite, and "calcozincite." Though the accretionary material is quite well developed, the sense of slip on this fault is nevertheless unknown.

Fault no. 907

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-52	N24E/67NW	N24E	00 (00)	(00) (00)

Comments: Fault in medium-grained marble 1-2 ft above hanging-wall contact of ore. Fibrous accretionary calcite lines parts of fault, but sense of slip is unknown. Multiple interconnected fault strands are present here, this being one of them, with abundant sulfides forming irregular veins along them. Visible here along the fault is a mass of chalcopyrite, lenticular in shape, and measuring 18 x 4 cm in cross-sectional area. Also present is much black material, probably chalcocite and sphalerite, with blue to green alteration products. This fault is about 30 ft north of the raise and is probably where most of the black sulfide specimens were recovered shortly before (early January 1990).

Fault no. 908

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-53	N76E/50NW	N65E (N66E)	12 (13)	(17 NE) (16 NE)

Comments: Same fault and rock type as no. 906 above. The slickenlines recorded here are a "ghost" set of striae that appear here-and-there as streaked-out minerals on the smooth, semipolished surface of the fault

where this surface is not covered by accretionary calcite of later age. These striae are accepted as a valid set because they are consistently oriented from place to place along the fault and are visually rather convincing. Presumably they record the earliest stages of slip along it. Slip sense undetermined.

Fault no. 909

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-54	N71E/48NW	S82W (S84W)	14 (12)	(16 SW) (19 SW)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. Splintery white accretionary calcite lines the fault; also present is a translucent, caramel-colored mineral with waxy luster (probably serpentine). Step faces in the accretionary calcite consistently indicate left-lateral slip on this fault.

Fault no. 910

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-55	N21W/64SW	S48W	(62)	(80 SE)

Comments: Irregular, branching, multiple-stranded fault in medium- to coarse-grained marble with accessory phlogopite, 0.5-1 m above hanging wall contact of ore. The slickenlines on this fault are diffuse and perhaps not trustworthy, but the fault is important. It occurs at approximate mine coordinates 1280N, 690W, and is one of the principal faults controlling the sphalerite mineralization here. The fault strands are quite irregular and form anastomosing surfaces; fault breccia cemented by sphalerite is locally developed where the strands are closely spaced. Also present are an iridescent blue mineral (tarnished bornite or chalcopyrite?), probable hematite (rock stained red in areas of alteration), and hydrozincite (alteration product of sphalerite). The fault strands occupy a zone 0.5-0.7 m thick. As noted above, the fault strands are quite irregular; another one measured here has orientation N10E/58NW. This is the area from which Robert Hauck recovered numerous specimens of sulfide minerals during the second week of January 1990.

Fault no. 911

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
800-56	N01W/48SW	N55W (N50W)	40 (42)	(64 NW) (60 NW)

Comments: Small, poorly exposed, hematite-stained fault in medium-grained, willemite-bearing marble close to the hanging-wall contact of ore. Minerals streaked out on the fault surface define the slickenlines here; sense of slip unknown. This is probably one of the family of sphalerite-bearing faults in this stope, but the portion exposed here lacks that mineral.

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900 Level

STATION 1 – Recharging station near main shaft at mine coordinates 1230N, 1060W.

Fault no. 912

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-1	N53E/59SE	S15E (S22E)	58 (57)	(79 SW) (82 SW)

Comments: Minor, graphite-streaked fault surface in marble. Sense of slip unknown.

Fault no. 913

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-2	N47E/60SE	S20E (S27E)	59 (58)	(78 SW) (82 SW)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown. Minor fault with exposed height of 2 m.

Fault no. 914

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-3	N52E/65SE	S24E (S22E)	64 (64)	(84 SW) (83 SW)

Comments: Minor, graphite-streaked fault surface in marble. Sense of slip unknown.

Fault no. 915

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-4	N62E/72SE	(S11W)	(67)	76 SW

Comments: Minor, graphite-streaked fault surface in marble. Sense of slip unknown.

Fault no. 916

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-5	N81E/47SE	S16E (S34E)	44 (47)	(85 NE) (72 NE)

Comments: Minor, graphite-streaked fault surface in marble. Sense of slip unknown. This fault, and several others like it, appear to have moved in concert with the four faults listed above. The slip vector on this fault appears to be parallel to the line of intersection of this fault with the others, and two of the above faults terminate against this one. Moreover, the west end of this fault curves markedly into parallelism with the other faults, and in that area has striations in the same direction. In addition, another small fault parallel to the four listed above cuts through and offsets this fault, so all appear to have moved together. If this is a true offset the slip sense on these faults must be reverse, but the relations here are not clear.

Fault no. 917

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-6	N73E/43SE	S26E	41 (43)	(84 NE)

Comments: Minor, graphite-streaked fault surface in marble. Sense of slip unknown. This fault and no. 914 meet at a sharp angle and appear to have moved in concert. *Note:* Bearing measurement given above is probably more accurate than angle of plunge.

Fault no. 918

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-7	N64E/70SE	S15E (S06W)	67 (70)	(86 SW) (78 SW)

Comments: Minor, graphite-streaked fault surface in marble. Sense of slip unknown. This fault terminates against fault no. 917.

Fault no. 919

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-8	N56E/69SE	S21E (S03E)	66 (68)	(85 SW) (78 SW)

Comments: Minor, graphite-streaked fault surface in marble. Sense of slip unknown. This fault terminates against fault no. 916.

STATION 2 – Main haulage drift along West limb, from mine coordinates 870N, 1095W to 900N, 1080W.

Note: This is an updip extension of the locality where fluoborite as a primary metamorphic mineral of the Franklin Marble was first found underground at Sterling Hill, as opposed to area quarries. Fluoborite from Sterling Hill had previously been known only as a fibrous secondary mineral on slip surfaces in ore. The marble at this location is pale gray and shows prominent compositional layering, defined mostly by layers of orange-brown norbergite and phlogopite 5-20 cm thick. The layers thicken and thin laterally but are mostly continuous along their exposed extent. One layer of mixed phlogopite with an unidentified black mineral (probably spinel) and subordinate calcite is prominently boudinaged, with boudins 30-70 cm long, 15-25 cm thick at their midpoints, and 1-10 cm thick at the necks. Norbergite appears in the outermost 1-1.5 cm of these boudins at the expense of phlogopite; this is succeeded inward by a 1-2 cm zone of white calcite (depleted reaction rim?) and then by normal norbergite marble.

Fault no. 920

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-9	N57E/62NW	N17E	54 (51)	(61 NE)

Comments: Graphite-streaked fault in marble. The fault surface is composed of numerous *en echelon* striated surfaces dipping at a slightly steeper angle than the mean fault plane. These are not Riedel shears, for that would imply normal slip, but in many places these are proven to be reverse faults (see paragraph below). *Note:* The bearing measurement given above is more accurate than the angle of plunge.

Note: When this and numerous other faults listed below were first examined, their sense of slip was quite uncertain, as was the character of the calcite coating parts of their surfaces. This prompted careful reexamination. The marble here is impure and in different layers contains graphite, norbergite, fluoborite, etc., but the calcite seen upon some of the fault surfaces, though in some places not conspicuously fibrous, nevertheless is everywhere fine-grained, white, and lacks these minerals, as opposed to the generally coarser-grained, pale gray, and impure calcite of the host rock. This white calcite is thus accretionary material precipitated within openings along the fault, and from prominent step faces within it we interpret these faults as reverse faults. Faults nos. 935 through 937 offer particularly clear examples.

Fault no. 921

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-10	N69E/50NW	N17E (N20E)	42 (43)	(63 NE) (61 NE)

Comments: Minor, graphite-streaked fault surface in marble. Little of fault surface is exposed; sense of slip unknown.

Note: Compositional layering in the marble here has orientation N25E/48SE and is especially prominent in norbergite-graphite-fluoborite marble with disseminated sulfides. Ductile shear has taken place parallel to the layering as shown by streaked-out mineral textures, but the exposure proved insufficient to determine the slip vector or sense of slip.

Fault no. 922

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-11	N27E/88NW	(N18E)	(78)	78 NE

Comments: Minor, graphite-streaked fault surface in marble. Little of fault surface is exposed; sense of slip unknown.

Fault no. 923

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-12	N70W/51SW	S38E (S29E)	39 (33)	(45 SE) (54 SE)

Comments: Graphite-coated fault surface in marble; sense of slip unknown. This is the steep portion of a smooth, undulating fault against which terminate several smaller, near-horizontal fractures.

Fault no. 924

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-13	N32W/52SW	S09E (S20E)	15 (27)	(35 SE) (19 SE)

Comments: Graphite-streaked fault surface in marble. The fault is prominently striated, but also mud-covered, and its sense of slip could not be determined. The surface of this fault is undulatory, like that of fault no. 923 less than 1 m distant; both are exposed for about 2-3 m on the west rib.

Fault no. 925

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-14	N79E/57NW	N33E (N40E)	44 (48)	57 NE (62 NE)

Comments: Minor, curved, graphite-streaked fault surface in marble; exposed in back; sense of slip unknown. *Note:* The bearing and plunge measurements given above are probably more accurate than the angle of pitch. Not shown above, but the pitch as calculated from the measured plunge of 44º is 56º, almost exactly the measured value. All three measured values are in good agreement with one another.

Fault no. 926

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-15	N75E/77NW	N17E	74 (75)	(82 NE)

Comments: A poorly exposed, minor fault in the back. *Note:* The bearing reading is accurate, much more so than the angle of plunge.

Fault no. 927

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-16	N26W/26SW	S10E (S07E)	09 (08)	(18 SE) (21 SE)

Comments: Broadly undulatory, graphite-streaked fault surface in marble; sense of slip unknown.

Fault no. 928

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-17	N31E/35NW	N03E (N04W)	22 (18)	(33 NE) (41 NE)

Comments: Irregular, broadly undulatory, graphite-streaked fault surface in marble; sense of slip unknown.

Fault no. 929

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-18	N53E/63NW	N16W (N01W)	58 (61)	(80 NE) (72 NE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown. Local violet fluorite lines fault.

Fault no. 930

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-19	N58E/67NW	N21W (N15W)	66 (67)	(86 NE) (83 NE)

Comments: Prominently graphite-streaked fault surface; sense of slip unknown. Graphite-streaked surfaces are arranged *en echelon* to form the fault here, and if interpreted as Riedel shears would suggest normal sense of slip. However, in many places in the mine, as in fault 935 below, fibrous accretionary minerals on the fault surface clearly demonstrate the opposite. Calcite on this particular fault does not appear to be fibrous and may even be part of the wallrock, which here is a nearly pure marble.

Fault no. 931

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-20	N28E/77NW	(N16W)	(72)	77 NE

Comments: The fault surface here appears to be patchily coated with fibrous accretionary calcite, lime green serpentine, and violet fluorite. If this interpretation is correct (fault is inaccessible overhead), then the hanging wall moved up, and this is a reverse fault. This fault curves to merge with fault no. 920 above and may be the same fault. See notes on fault no. 935, a related fault of almost certain reverse slip.

Fault no. 932

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-21	N42E/60NW	S85W	(50)	(62 SW)

Comments: A beautifully striated, bright green, serpentine-coated fault cutting norbergite-graphite-phlogopite marble. Although the host rock is well-layered on the centimeter scale, the fault shows minimal offset in the plane of section, and its slip sense could not be determined.

Fault no. 933

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-26	N58E/64NW	N17E (N06E)	58 (53)	(63 NE) (71 NE)

Comments: Graphite-coated fault surface, also locally coated with apparent accretionary calcite. Sense of slip unknown. This is same fault as no. 920 above, but measured in a different place and showing a much different slip vector. Minor violet fluorite films the fault surface.

Fault no. 934

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-27	N39E/30NW	N05W (Due N)	20 (22)	(48 NE) (43 NE)

Comments: Graphite-streaked fault surface in marble. Minor violet fluorite forms bare films on parts of fault surface. Somewhat doubtful accretionary calcite on fault surface suggests upper plate moved to NW. Numerous faults of this general orientation are present in this area, but most are poorly exposed.

Fault no. 935

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-28a	N38E/64NW	N06W (N19W)	(55) (60)	74 NE (66 NE)

Comments: Fault in norbergite-bearing marble. Fibrous accretionary calcite and bright green serpentine encrust fault, locally as much as 1.5 cm thick; prominent step faces in this material show slip sense to have been reverse. See additional comments below for later slip event on same fault.

Fault no. 936

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-28b	N38E/64NW	N89W (S81W)	(58) (54)	64 SW (71 SW)

Comments: Same fault as no. 935 above, but a later slip event. Step faces in fibrous accretionary calcite and serpentine show the slip sense to have been reverse for this event also. *Note 1:* Many individual fibers show an abrupt change in orientation from NE (earlier) to SW (later) pitches on the fault surface; very clear relations here. *Note 2:* The green serpentine fibers have formed only on those parts of the fault surface that cut norbergite-bearing marble; they stop abruptly at the top of the norbergite layer. Above that, in a zone two inches thick where the wallrock is graphitic marble, the fault surface is graphite-streaked. Above the graphitic marble the wallrock is pure saccharoidal marble, and there the fault surface is coated only with a bit of powdery gouge. Very clear, tight relation between composition of wallrock and the character of the material coating the fault surface here. No Mg (norbergite) in the wallrock, no serpentine on the fault.

Fault no. 937

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-29	N56E/68NW	N24W (N09W)	66 (68)	(86 NE) (80 NE)

Comments: Fault in marble. Fibrous accretionary calcite thickly coats fault surface; fault is also prominently graphite-streaked. Step faces in accretionary material indicate reverse sense of slip. Violet fluorite also coats this fault surface.

STATION 3 – 820 Pillar, West limb near keel of orebody, near footwall contact of ore, at approximate mine coordinates 790N, 995W.

Note: In this area a prominent zincite layer, generally 6-8 inches thick but locally tapering to 1.5-2 inches, lies embedded in the granular willemite-franklinite-calcite ore at a mean distance of about 1.5 ft from the footwall contact of ore. The footwall contact (orientation N48E/64SE) is abrupt, planar, and undeformed, and the compositional layers in the coarse-grained marble beneath are parallel to it. The zincite layer, however, is prominently folded and thus occurs at a variable distance, 8 inches to 2 feet, from the footwall contact. The fold forms are rounded and range from open to fairly tight, the tightest with an interlimb angle of about 50°. Almost certainly these are nontectonic, soft-sediment folds due to loading of the heavy zincite-rich layer on the less-dense layers below. The folds thus date from about 1.3 Ma, when the metalliferous sediments that later became the Sterling mine orebody were first deposited. This is the feature locally and informally referred to as “The Squiggle.”

Fault no. 938

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-22	N41W/84SW	(S49W) (S49W)	84 (84)	90 (90)

Comments: Fault in ore. A pale tan, leathery, fibrous mineral that coats brecciated sphalerite and calcite defines the striations on this fault. The fibrous mineral resembles "mountain leather," lies along the SW wall of the 2-cm-thick layer of fault gouge, and may indicate a late episode of slip; it forms a continuous thin coating over an exposed surface of about 10" x 1". Sense of slip unknown.

Fault no. 939

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-23	N16W/77SW	(N17W)	(04)	04 NW

Comments: Fault in ore. This is the same fault as no. 938 above, but measured eight inches distant and on opposite (NE) wall. Here again a medium-brown fibrous mineral resembling "mountain leather" defines the striation direction – a completely different direction from the similar material on the opposite wall. Multiple episodes of slip are indicated (hardly an unusual occurrence in this mine). Sense of slip unknown.

Fault no. 940

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-24	N35W/80SW	S33W (S28W)	79 (79)	(86 SE) (85 SE)

Comments: Fault in ore. The striae here are defined by calcite(?) mixed with sphalerite along the NE wall of the fault. This is the same fault as nos. 938 and 939 above, measured about eight inches distant from the fault 939 reading. The minerals filling the fault define a vein 2-3 cm thick, bordered on both sides by a discontinuous layer 0-3 mm thick of orange to reddish-tan, sheared calcite and sphalerite. The interior of this vein is apparently undeformed, olive-brown cryptocrystalline sphalerite lacking any visible internal structure. Sense of slip unknown.

Fault no. 941

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-25	N50W/75SW	(S51W)	(75)	87 NW

Comments: Same fault as nos. 938 through 940 above, but measured where the fault cuts the footwall contact of ore; faults 938-940 were measured 1-2 m above this contact. Mechanically scratched fault surface coated with chlorite(?); sense of slip unknown. *Note:* The pitch angle is approximate only, but the striae are visibly nearly down the dip line.

Fault no. 942

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-30	N26W/74SW	N30W (N29W)	12 (13)	(14 NW) (12 NW)

Comments: Graphite-streaked fault surface; sense of slip unknown. Low rock steps on the footwall surface face NW and appear to be at a low angle, 5° or less, to the mean fault surface. If these were interpreted as Riedel shears the inferred sense of slip would be left lateral, but we have noted numerous instances in the mine where fibrous accretionary material proves the opposite sense of slip. These features do not seem to be developed in accretionary material but are present in the coarse-grained, sparsely graphitic marble of the footwall. This fault terminates against no. 943 below. *Note:* Original reading of bearing was S30E, an impossibility (though only by 4°). Obviously wrong end of compass needle was read, and bearing was meant to be recorded as N30W, a value that agrees perfectly with the measured plunge of 12°.

Fault no. 943

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-31	N35E/70SE	S34E (S30E)	68 (69)	(83 SW) (81 SW)

Comments: This fault appears as a highly sheared/mylonitized zone 2-2.5 cm thick in graphitic marble; streaks of graphite on shear surfaces define the striae. Sense of slip unknown. Measured about 0.8 m from footwall contact of ore. *Note:* Our original field notes do not indicate whether the graphite streaks are original to the mylonite or formed on a later fault surface developed within it, as is common in the Sterling mine.

Fault no. 944

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-32	N33W/71SW	S03W (S06W)	(60) (61)	68 SE (66 SE)

Comments: Fault in marble; surface of fault is lightly coated with an unidentified, greenish-brown fibrous mineral. Sense of slip unknown. This fault terminates abruptly against fault no. 943 above and probably predates the latest episode of slip along it.

Fault no. 945

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-33	N39W/68SW	N61W (N62W)	44 (43)	(47 NW) (49 NW)

Comments: Fault in marble; surface of fault is lightly coated with an unidentified, greenish-brown to brownish-green fibrous mineral. Sense of slip unknown.

Fault no. 946

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-34	N30W/71SW	N74W (N60W)	56 (63)	(71 NW) (61 NW)

Comments: Fault in marble; surface of fault is lightly coated with an unidentified, greenish-brown fibrous mineral that scratches easily and has a talcose feel. Sense of slip unknown.

Fault no. 947

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-35	N29W/71SW	N86W (N74W)	64 (68)	(78 NW) (72 NW)

Comments: Fault in marble, near footwall contact of ore; surface of fault is lightly coated with an unidentified, greenish-brown fibrous mineral that scratches easily and has a talcose feel. Sense of slip unknown.

Fault no. 948

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-36	N56W/77SW	(S80W)	(72)	77 NW

Comments: Graphite-streaked fault surface in footwall marble; sense of slip unknown.

Fault no. 949

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-37	N62E/75SE	S29E (S28E)	75 (75)	(90) (90)

Comments: Graphite-coated fault surface within a zone of strongly sheared marble 0.5-1 inch thick; sense of slip unknown.

General note on faults in this pillar: Many faults in this pillar strike about N30W and dip steeply SW. These show several episodes of movement, and some can be followed from the ore into the calcite marble of the footwall. In marble the faults are generally single surfaces coated with a talcose mineral; most of these faults show little evidence of wallrock deformation adjacent to the fault. In ore, however, the faults become more irregular and curving, and many split and merge to enclose elongate lenses of rock. Several fault surfaces in a narrow zone are often present, as opposed to the single surfaces characteristic of the marble. Faults in ore are commonly lined with streaked veins of sphalerite, orange to reddish tan to brownish red, in irregular stringers 1-2 cm thick, locally as much as 3 cm, in some places accompanied by later, gray, apparently undeformed sphalerite. Embedded in these masses of gray sphalerite are small grains, 1-2 mm across, of chalcopyrite. Nearby, about 25 ft farther SE along one of these same faults, additional sulfides sight-identified as fine-grained bornite and chalcocite are also present. The wallrock within 1-2 cm of the fault surfaces is depleted in zincite wherever these faults cut zincite-rich ore (e.g., "The Squiggle," which is about 80% zincite and the rest franklinite with a little calcite). All of this changes where these same faults enter the marble -- sphalerite that lines faults in the ore ends abruptly within one inch of the footwall contact, and no sphalerite lines faults within the marble. Within the ore there is strong visual evidence of hydrothermal effects along and near the faults, but within the marble, along these same faults, such evidence is lacking.

Fault no. 950

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-38	N13W/77SW	(N29W)	(50)	52 NW

Comments: Fault in high-grade willemite-franklinite-calcite ore. The slickenside striations are defined by a thin stringer of white, fibrous, nonfluorescent accretionary calcite associated with red sphalerite, chalcocite, etc. within the fault. Small step faces within the calcite suggest a normal sense of slip, which agrees with the normal offsets (2"-3" each) of the hanging-wall contact of ore across two of these faults. This is the same fault as nos. 938-941 farther southeast.

Fault no. 951

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-39	N66E/75NW	N46E (N44E)	55 (51)	(54 NE) (58 NE)

Comments: Semipolished, smooth, sinuous, streaked fault surface in ore, bordered in places by strongly deformed wallrock. The ore is locally brecciated and shows grain-size reduction due to cataclasis in zones 1-2 cm wide along and within anastomosing strands of this fault. Willemite and franklinite grains are strained to elongate shapes and are bent almost into parallelism with the fault strands in places; the sense of shear shows a left-lateral component of slip. The sphalerite vein of fault no. 950 is offset 1.5 ft in a left-lateral sense across this fault and continues on the other side; very clear age relationship of the two faults here, with fault no. 951 being the younger. The sphalerite vein also shows strong curvature due to drag within 10 cm of fault no. 951; here too the sense of shear shows a left-lateral component. Within fault no. 951 there is no sphalerite, just secondary powdery willemite that renders the fault trace strongly phosphorescent. Between the two offset segments of fault no. 950, however, small brecciated clasts of sphalerite are caught up in the fault zone of no. 951. The evidence is strong here that this is an oblique-slip left-lateral reverse fault; i.e. the NW block moved up and to the SW. *Note:* Bearing reading given above is more accurate than angle of plunge.

Fault no. 952

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-40	N62E/72NW	N37E (N49E)	50 (60)	(66 NE) (54 NE)

Comments: Fault in ore; hanging wall is upthrown block. Same fault as 900-39 above, but measured in a different place.

STATION 4 – Stope along West limb near keel (780 pillar just south of 800 crosscut) ("Mcgovernite stope"), at mine coordinates 785N, 990W.

Note: Two repeat measurements of the total thickness of the orebody in this area came out to 5.9 and 6.4 m. Of this, the lower 4-4.5 m is good ore, zincite-rich near the base and willemite higher, both mixed with abundant franklinite. The top 2-2.5 m of ore, however, contains only franklinite in a calcite matrix.

Fault no. 953

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-41	N45E/70NW	N14E (N19E)	50 (55)	(60 NE) (55 NE)

Comments: Fault in franklinite-willemite-calcite disseminated ore. The fault is apparently one of moderate slip with much evidence of wallrock deformation. Along the main strand of the fault the rock is, in places, strongly sheared in zones 1-2.5 cm wide, bordered by broader zones of ductilely deformed willemite and sheared franklinite grains in a calcite matrix. Within 10-15 cm of the main fault strand the wallrock is cut by numerous, finely anastomosing subsidiary fractures about parallel to the main fault, in places so much so that the rock is brecciated and elongate slabs of ore are offset from one another, but with only negligible rotation of the clasts. The subsidiary fractures are lined with highly fluorescent and phosphorescent secondary willemite. In the most-sheared parts of this zone, all fragments are less than 1 cm across and are shot through with secondary willemite in a complex spiderweb vein network whose main and thickest branches are about parallel to the main fault. Such strong cataclasis is confined almost exclusively to the hanging wall. The main fault strand itself is lined with beautiful cream-colored accretionary calcite, which is quite splintery, mostly 0.5-1 cm thick but locally up to 2 cm thick, and fluoresces bright red. Secondary willemite is also present along the main strand, as is much post-faulting mcgovernite. Judging from local step faces in the accretionary calcite, the slip sense along this fault is interpreted as oblique left-lateral reverse. Further and stronger evidence for this sense of slip is the S-shaped configuration of flattened and rotated franklinite grains between two of the fault strands here, as shown in the field sketch at left; some of the franklinite grains are quite flattened, with rounded edges. *Note:* As happens occasionally, and all too readily, the wrong end of the compass needle was read when measuring the bearing. The original reading of S14W (an impossibility for this fault) was meant to be N14E, which agrees well with the measured plunge (50º vs. 55º) and with the bearing direction as calculated from that plunge (N14E vs. N19E).

Fault no. 954

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-42	N70E/27NW	N64W (N61W)	21 (20)	(49 SW) (52 SW)

Comments: Fault in moderate-grade franklinite-willemite-calcite ore. This is a fairly extensive fault, traceable across the entire width of the stope, and is the fault from which numerous mcgovernite specimens were recovered in 1990. Much accretionary calcite (1-3 cm thick) and secondary willemite line the fault surface, the calcite in coarse splintery masses and the willemite as local druses of pale green acicular

crystals in narrow open vugs. The fault surface is locally "corrugated" with wavelengths of 1-2 ft and amplitudes of 2-3 inches; the axes of the corrugations are parallel to the calcite accretionary fibers. The sense of drag along ductilely deformed franklinite and willemite grains adjacent to the fault indicate that the upper plate moved to the NW; step faces in the accretionary calcite lining the fault indicate likewise.

Fault no. 955

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-43	N90E/06N	N44W (N47W)	04 (04)	(46 W) (43 W)

Comments: Fault in willemite-franklinite-calcite ore locally containing zincite as well. The sense of drag along elongate, ductilely deformed grains within 1-2 cm of the fault shows that the upper plate moved to the NW. The fault surface is lined with splintery accretionary calcite, secondary willemite, secondary zincite ("calcozincite"), and a leathery, fibrous white amphibole(?). The accretionary calcite within the fault is, as usual, whiter than that of the wallrock. Typically the "calcozincite" is present on the fault surface only where there is zincite in the adjacent ore; along most of the fault it is absent. In this area we have observed repeated instances of this effect, where alternating layers of ore contain zincite, and the fault cutting them is lined with "calcozincite" only in those areas.

Fault no. 956

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-44a	N75E/82NW	(N52E)	(70)	72 NE

Comments: Fault in willemite-franklinite-zincite-calcite ore. Much accretionary calcite and "calcozincite" line the fault here. As in fault 955 above, again one sees the restriction of the secondary "calcozincite" to those parts of the fault that cut zincite-rich ore. The accretionary calcite lining this fault indicates two episodes of slip. Step faces in the fibers pitching 72^{o} to the ENE suggest that the hanging wall moved up; that is, this is an oblique-slip, left-lateral reverse fault. This also is the clear sense of slip indicated by drag of ductilely deformed, elongate franklinite and willemite grains, which are sheared and flattened within 1-3 cm of the fault surface.

Fault no. 957

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-44b	N75E/82NW	(N81W)	(71)	73 SW

Comments: Same fault as no. 900-44a above, but with a different and apparently younger set of accretionary calcite fibers. Step faces in this second set of fibers suggest that the hanging wall moved up, though not as clearly as evidenced by the first set. In several places it appears, though nowhere convincingly, that the calcite with WSW-pitching fibers is the younger of the two. This is judged from areas of WSW-pitching fibers filling depressions in surfaces underlain by accretionary calcite with ENE-pitching fibers, and from rare instances where the ENE-pitching fibers appear to have been mechanically scratched during the later movements when the calcite of the WSW-pitching set was deposited. None of this evidence, however, is satisfying.

Note: Two additional faults that were measured at this locality – faults nos. 967 and 968 – are misplaced in our notes and appear on p. 198. The several notes that follow them, on p. 198-199, also pertain to this locality rather than Station 5.

STATION 5 – 800 crosscut, in gneissic core near the keel of the orebody at approximate mine coordinates 804N, 975-1000W.

Note: The gneissic core of the orebody is exposed in this area, just north of the keel of ore. The apparent dip of the rock layers in this area is about 50º W. At approximate mine coordinates 804N, 935W, the sequence of rocks on the north rib is as follows, from east to west:

1. Fine-grained feldspar-pyroxene gneiss, grain size 1-3 mm, about 8 ft thick.
2. Coarse-grained, orange-brown garnet with interstitial pyroxene grains, 6-12 inches thick, showing a gradational contact to next layer.
3. Very coarse-grained pyroxene with rounded inclusions of calcite and minor sphalerite, about 3 ft thick. This layer shows a sharp contact with layer (4); along this contact is much pale greenish-amber sphalerite.
4. Calcite marble containing scattered euhedral crystals of pyroxene (one 7 inches across), minor irregular pods of sphalerite, and a few grains of greenish-blue apatite, in a layer about 2.5 ft thick.
5. Mixed coarse-grained garnet and pyroxene with subordinate calcite, 8-12 inches thick.
6. Fine-grained feldspar-mica gneiss; grain size 2-3 mm, thick mass. Mica is abundant, dark-colored to nearly black.

Fault no. 958

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-45	N62W/81SW	(S61E)	(10)	10 SE

Comments: Fault juxtaposing franklinite-calcite ore on the SW against dark, gneissic, pyroxene-rich rock on the NE. This fault is well exposed across the back and along the north rib of the crosscut, and is the fault that provided the permeability conduit for the deposition of zeolites (stilbite, chabazite) in pockets here. The zeolites were heavily collected, but the top part of the main pocket remains in the back and is located directly on, and elongated parallel to, the fault. The lean ore on the SW side of the fault is very near the upper (hanging wall) part of the orebody and is here pyroxene-rich and franklinite-poor; a little higher and to the east this rock grades rather abruptly into the gneisses. At the location of the zeolite pocket the fault thus juxtaposes gneiss against gneiss. Where the lean ore is exposed, a black mineral is seen concentrated within 1 inch of the fault; probably this is hematite. A sample was taken of this mineral; the green surface on the sample is the fault surface. The fault in this locality is locally coated with pale green accretionary fibers, probably serpentine and/or calcite. The slip sense is probably left-lateral but is not known with certainty.

Fault no. 959

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-46	N31E/72NW	(N05W)	(61)	67 NE

Comments: Fault in pyroxene gneiss and marble. The gneissic foliation shows strong drag on both sides of the fault and indicates that the NW (hanging wall) side of the fault moved up. This fault cuts off no. 958 above and is thus younger. It also cuts off and thus postdates several low-dipping faults whose upper plates moved to the NW, similar to those measured in the adjacent mcgovernite stope of Station 4. Much of the fault along the N rib, across the back, and halfway down the S rib consists of one to two discrete fault surfaces of steep (avg. 75º NW) dip. These fault surfaces are smooth, appearing almost as if polished, and are coated with epidote and locally with a greenish-blue amphibole(?) and calcite; the adjacent wallrock is also partially altered to epidote. In the lower part of the S rib, however, the fault enters carbonate rocks and juxtaposes lean, highly calcitic zinc ore on the W side against diopsidic marble stratigraphically below the

gneisses on the E side. This change in wallrock type corresponds to a remarkable change in character of the fault. The fault steepens to vertical, and the discrete fault surfaces in the gneiss are here replaced by a zone of ductilely deformed and elongated grains 8 to locally 12 inches thick, within which is a well-formed mylonite zone 2-4 inches thick of intensely sheared rock. In this area, in the carbonate rocks, discrete fault surfaces do not exist.

Note 1: The dominant rock types here are massive, coarse-grained (1-3 cm) amphibolites interlayered with (a) fine-grained (1-2 mm), highly feldspathic garnet amphibole(?) gneisses in which the feldspar is locally highly altered to epidote, and (b) local, highly irregular masses of very coarse-grained, gray to pale brown to cream-colored calcite. Embedded in the calcite are irregular masses and stringers as much as 1 cm across of molybdenite, and also some specular hematite. Small solution vugs in the calcite contain druses of bright green epidote crytals and small, medium-brown, perfectly formed rhomboidal crystals of chabazite that fluoresce weak to moderate emerald-green SW. In addition, in the feldspathic gneisses and the amphibolite within 0.5 m of the molybdenite occurrences, are numerous tiny grains of powellite (or molybdian scheelite) showing pale yellow fluorescence SW. Sphalerite of pale amber color also occurs in the same general area.

Note 2: Nearly identical feldspathic gneisses are exposed on both ribs east of this fault, and on the north rib west of it, suggesting that displacement on this fault is probably not more than a few meters.

Note 3: This fault neatly cuts off and thus postdates other faults in this area, those with low dips and whose upper plates moved to the NW, similar to those measured in the adjacent 780 pillar (mcgovernite area). See also faults nos. 960 and 961 below.

Fault no. 960

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-47	N74E/26NW	N78W (N80W)	12 (13)	(31 SW) (28 SW)

Comments: Fault in lean franklinite-calcite ore; fault surface bears local mechanical scratches (from franklinite grains?) indicating slip direction. Local calcite accretionary fibers suggest upper plate moved to the NW. This is confirmed by strong drag features of sheared-out franklinite grains within 1 cm of the fault.

Fault no. 961

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-48	N44E/28NW	N70W (S72W)	14 (26)	(69 SW) (31 SW)

Comments: Scratched and semipolished fault surface in moderate-grade franklinite-calcite ore. Strong drag features of deformed franklinite grains adjacent to the fault show that upper plate moved to the NW, as do drag features on at least four other such faults in this immediate area. Slip on this fault appears to be only about 7 cm. The fault dies out completely where it enters a calcite marble layer nearly devoid of franklinite.

Fault no. 962

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-49	N45E/55NW	N42W (Due N)	45 (55)	(88 NE) (60 NE)

Comments: Small fault in fine-grained, epidotized pyroxene(?)-feldspar gneiss. Serpentine accretionary fibers line the fault surface. This fault has an exposed height of only 2/3 m and has a maximum offset of only 1.5 cm, dying out to zero at both ends. This is a dip-slip reverse fault, as shown both by the accretionary fibers and offset of gneissic foliation, and is one of at least three such minor faults here.

Fault no. 963

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-50	N41E/72NW	N49W (N49W)	72 (72)	(90) (90)

Comments: Fault in epidotized pyroxene(?)-feldspar gneiss. The fault surface is lined with fibrous accretionary calcite and epidote; the fiber orientations suggest that this is a reverse fault, but not with certainty. Some hematite (identified by its dark red streak) also lines the fault here in places. Local vugs (probably residual voids along the fault, though our field notes do not specify that) contain druses of epidote crystals and tiny euhedral calcite crystals.

Fault no. 964

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-51	N24E/36NW	N43W (N44W)	34 (34)	(71 NE) (72 NE)

Comments: Fibrous accretionary calcite and epidote on the fault surface show the upper plate of this fault moved to the NW, as confirmed also by offset lithologic contacts. This fault meets no. 963 in a "V" where both terminate; neither appears to cross the other. Toward the back this fault appears to either merge with or perhaps is cut off by fault no. 959 above. [Later note: probably the latter; see fault no. 959 for details.]

Fault no. 965

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-52	N32W/50SW	N51W (N51W)	21 (21)	(28 NW) (28 NW)

Comments: Epidote-coated fault surface in fine-grained pryoxene-feldspar gneiss. Local dark green fibrous accretionary amphibole along part of the fault surface suggests right-lateral sense of slip, but this is not known with certainty.

Fault no. 966

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-53	N20E/28NW	N52W (N47W)	26 (27)	(74 NE) (69 NE)

Comments: Fault in garnet amphibolite(?). Fibrous accretionary calcite and epidote line the fault surface, adjacent to which the garnets in the wall rock are strongly sheared. The hanging wall of this fault apparently moved to the NW.

Note: The next two faults, plus the appended notes after them, are misplaced. They pertain to Station 4 rather than Station 5.

Fault no. 967

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-54a	N73E/87NW	(N67E)	(63)	63 NE

Comments: Fault cutting marble and ore, near footwall contact of orebody. The fault contains two sets of fibrous accretionary calcite where the fault cuts through marble, as indicated here and in no. 968 below. Little of this fault is exposed, and the relative ages of the two episodes of slip are unknown. For both, however, the accretionary calcite suggests that the north side of the fault moved up. As elsewhere, the fault consists of multiple anastomosing segments where it cuts ore, but is a nearly planar single surface where it cuts through marble. Secondary zincite is present along the fault surface in ore, but is lacking in the marble.

Fault no. 968

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-54b	N73E/87NW	(N84W)	(82)	83 SW

Comments: See description of fault no. 967 above; this is a second set of calcite accretionary fibers on the same fault. Two readings were taken of the fiber pitch here: 81 SW and 85 SW. Accretionary calcite on the fault surface suggests the north block of the fault is upthrown.

Note 1: Several faults of similar orientation are well exposed, though inaccessible, in the back at this locality. Accretionary calcite along them firmly indicates the north side moved up for the most steeply inclined set of fibers. One of these faults contains a 1-cm-thick lensoidal mass of accretionary calcite, but the fault when traced about 1 m laterally in either direction into the ore loses its identity as a discrete fracture and becomes a shear zone 1.5-2 cm thick, locally widening to 3 cm. This shear zone is readily traced because the calcite within it is whiter than that in the adjacent rock, and because grains of willemite and franklinite show pronounced flattening and rotation within it. The sense of grain rotation confirms the N-side-up sense of slip here. As the fault is traced another meter farther, however, both the amount of flattening and grain rotation decrease, as does the color contrast of the calcite, and ultimately no trace of the fault is seen as it dies out.

Note 2: Attitude of gneissic foliation here at footwall contact of ore: N09W/41NE.

Note 3: A well-developed set of joints is present at this locality. A few readings:
N85W/81SW N80W/84SW N76W/86SW N86W/84SW N80W/89SW
Median: N80W/84SW (n = 5)
These joints are spaced 0.5-1 m apart and have rough, discolored surfaces, but other than bare films of calcite they are unmineralized: they contain no secondary zincite, no willemite, no mcgovernite. Many of them terminate against the low-dipping faults present here, those whose upper plates moved to the NW; the joints clearly are younger. A few joints cut through these faults without offset and again are obviously younger than those faults. The joints also appear to be younger than the near-vertical set of faults here, though that relation is not as clearly expressed as for the low-dipping set of faults.

STATION 6 – Crosscut through gneissic core of orebody at mine coordinates 1040N, 830W.

Fault no. 969

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-55	N40E/79SE	n.d.	n.d.	n.d.

Comments: This is the major fault in this area, a shear zone about 1-1.3 m thick. Within this zone is an intensely sheared, strongly laminated mylonite averaging 25-30 cm wide, locally nearly 50 cm. The fault juxtaposes coarse-grained marble and calc-silicate rocks on the SE (hanging wall) side against fine-grained, nearly black feldspathic amphibolites on the NW (footwall) side. Beautifully developed folds within the mylonite indicate a normal sense of slip; the folds are of almost ideal similar style. However, no accurate measurements of slickenside striations or fold axes were attainable at this exposure.

Fault no. 970

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-56	N37E/75SE	(N68E)	(63)	67 NE

Comments: Mechanically scratched and graphite-smeared fault surface in coarse-grained marble; sense of slip unknown. This fault is very near the hanging-wall edge of the sheared rock of fault no. 969 above but dates from a later episode of movement.

Fault no. 971

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-57	N67E/21SE	S60E	(17)	(55 NE)

Comments: Undulatory fault exposed in the back; thus no measurement of plunge was obtained. The fault is lined with fibrous accretionary calcite as much as 2 cm thick, as well as minor violet fluorite in streaks parallel to the calcite fibers. Step faces in the accretionary calcite indicate the upper plate moved to the NW. This fault is exposed on the SE side of fault no. 970, and there is no trace of it in the rock to its NW, in the mylonitic rock of fault no. 969. Also, one small fault parallel to fault no. 970 clearly offsets the accretionary calcite of this (no. 971) fault in a normal sense. Collectively these observations show that *some* slip on the steeply dipping faults at this locality postdates formation of the low-dipping faults. This is consistent with evidence at other localities, though it should be noted that the steeply dipping, NE-striking mylonitic faults at Sterling Hill have been repeatedly reactivated, with new fault surfaces forming within and adjacent to the older mylonitic zones.

STATION 7 – East limb haulage drift at mine coordinates 860N, 680W.

Fault no. 972

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-58	N27E/56SE	S39E	(54)	(76 SW)

Comments: Fault in amphibole-garnet gneiss interlayed with finer-grained feldspathic gneiss on both the hanging wall and footwall. The fault surface bears slickenside striations (mechanical scratches) but is poorly exposed over an area of less than 2 square inches; sense of slip unknown.

Fault no. 973

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-59	N29E/88NW	(N61W)	(88)	90

Comments: Fault in garnet amphibolite containing pods of calcite. The fault surface is polished and locally coated with epidote; elsewhere it is filled with lenticular seams of calcite. Offset of the contact between the garnet amphibolite and calc-silicate marble here indicates SE side of fault is the downthrown block. This fault cuts off (is younger than) no. 972 above.

Fault no. 974

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-60	N23E/58SE	S37E (S30E)	52 (54)	(73 SW) (68 SW)

Comments: Minor fault in fine-grained, feldspathic amphibole(?)-garnet gneiss. The fault surface is semipolished and coated with epidote. Sense of slip unknown.

Fault no. 975

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-61	N17E/72SE	S41E (S18E)	60 (69)	(79 SW) (66 SW)

Comments: Same rock type as fault no. 974 above. Striated fault surface, but sense of slip unknown.

Fault no. 976

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-62	N09E/75NW	(S49W)	(67)	73 SW

Comments: Epidote-smeared fault surface locally coated with fibrous accretionary calcite. Character of host rock not recorded, but probably feldspathic gneiss. West wall of fault is the upthrown block (reverse slip). Minor fault with an offset of less than 1 cm.

Fault no. 977

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-63	N45E/59NW	S69W	(34)	(41 SW)

Comments: Minor fault in coarse-grained garnet amphibolite. Fault surface is locally coated with epidote and fibrous accretionary calcite. The calcite fibers indicate that the hanging wall of the fault moved down and to the southwest.

Fault no. 978

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-64	N42E/60NW	S67W (S69W)	38 (36)	(43 SW) (45 SW)

Comments: Minor fault with epidote-smeared surface in garnet amphibolite. The sense of slip on the fault is unknown, but offsets of individual clots of garnet suggest the hanging wall moved down and to the SW by a distance of less than 0.5 cm. *Note:* The bearing reading given above is more accurate than the plunge.

Fault no. 979

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-65	N32E/60NW	N77W (S82W)	53 (59)	(80 SW) (67 SW)

Comments: Minor fault with epidote-smeared surface in garnet amphibolite. Fibrous accretionary calcite on the fault surface shows that the hanging wall is the downthrown block.

STATION 8 – East limb haulage drift at mine coordinates 910N, 670W.

Fault no. 980

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-66	N68E/81SE	(S41E)	(81)	87 NE

Comments: A well-exposed fault in fine-grained calcite marble. Prominent steps in apparent accretionary calcite on the fault surface suggest the SE side of the fault is the downthrown block, but the fault surface is mud-covered, and some of the step faces appear to be developed in the wallrock rather than in material known for certain to be accretionary calcite. Obviously this lends considerable uncertainty to an interpretation of a normal sense of slip. Moreover, in one area of the fault, tiny step faces in undoubted accretionary calcite indicate the opposite sense of slip, SE side up. Both could be true, as many faults in the mine experienced multiple episodes of slip.

STATION 9 – South end of 1110 stope, east of East limb haulage drift, at mine coordinates 990N, 500W.

Note: All faults at this station were measured in franklinite-zincite-calcite ore from 1 to 3 meters below the hanging-wall contact of the orebody. Compositional layers in the orebody are oriented N50E/60SE. The

width of the orebody as measured along a horizontal line perpendicular to strike is 9.4 m; thus its true thickness is 8.14 m (26.7 ft). The ore near the hanging wall is rich in zincite; the footwall ore is disseminated franklinite in calcite.

Fault no. 981

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-67	N89W/47NE	N13W (N03W)	47 (46)	(80 NW) (87 NW)

Comments: Fault surface is lined with accretionary "calcozincite." Step faces in accretionary material indicate reverse sense of slip.

Fault no. 982

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-68	N87W/45NE	N03W (N12W)	44 (45)	(86 NW) (79 NW)

Comments: Fault surface is lined with accretionary "calcozincite." Step faces in accretionary material indicate reverse sense of slip.

Fault no. 983

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-69	N46W/42NE	S57E (S60E)	13 (10)	(15 SE) (19 SE)

Comments: Fault is lined with fibrous accretionary calcite in a zincite-poor part of the ore. Little of this fault is exposed; sense of slip unknown.

Fault no. 984

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-70	N43W/36NE	S49E (S47E)	03 (04)	(07 SE) (05 SE)

Comments: Polished fault surface in franklinite-willemite ore. Local step faces in fibrous accretionary calcite on fault surface indicate hanging wall moved NW. *Note:* The bearing of the slickenside striations was originally given in our notes as N49W (impossible), but undoubtedly the opposite end of the compass needle was meant (S49E). Although it makes little difference for striae of such low plunge, a bearing of S49E results in a calculated plunge of 4º, in almost perfect agreement with that measured (3º).

Fault no. 985

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-71a	N44W/37NE	(N12W)	22 (to NNW)	(38 NW)

Comments: Fault in franklinite-calcite ore. The ore here is highly magnetic; thus the strike of the fault was taken from a distant sighting, and the bearings of the various sets of slickenlines on the fault must be determined from their angles of pitch or plunge, as indicated. The fault surface is both mechanically scratched and coated with fibrous accretionary calcite showing at least three different fiber orientations. For the fibers plunging 22º (= pitch of 38º), as recorded here, the upper plate appears to have moved to the NNW (N12W), but this is uncertain. For the fibers pitching 30º NW (fault 986 below) the sense of slip appears to be reverse, with the upper plate moving N19W. For the fibers pitching 9º NW (fault 987 below) the sense of slip also appears to be reverse, but in a different direction, N37W. The relative ages of these three episodes of movement are similarly clouded. Our notes suggest the fibers pitching 9º may postdate the fibers pitching 30º, but this is very uncertain. Slightly more convincing, though still quite uncertain, the fibers pitching 9º may postdate the ones pitching 38º because in one place the latter fibers appear to have

transverse scratches parallel to the fibers of 9º pitch. We stress that these relations are quite tenuous, and the relative age of the various episodes of slip will hopefully be revealed by better evidence elsewhere.

Note: It's been a long day, and it shows. Our field notes for the next two faults, nos. 986 and 987, are ambiguous in terms of recorded pitch directions, possibly because of the strong magnetism of the ore here. For fault 986, for example, the measured pitch angle is 30º, but did this mean 30º from the strike line of N44W, or was a pitch of 30º from S44E meant instead? For each of these faults, one of the two possible answers is broadly consistent with our observations on sense of slip, and the other is not. Although we have reconciled the data with our field notes, and the data are probably correct, the values for these two faults probably should not be used in computer analysis of stress orientations.

Fault no. 986

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-71b	N44W/37NE	N19W	(18)	30 NW

Comments: See comments for fault 985 above; readings here are for another episode of slip (one of three) on the same fault.

Fault no. 987

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-71c	N44W/37NE	N37W	(05)	09 NW

Comments: See comments for fault 985 above; readings here are for another episode of slip (one of three) on the same fault.

STATION 10 – Shaft station, west of West limb haulage drift, at mine coordinates 1280N, 1090W.

No faults were measured at this locality, but it was noted that the solution-collapse breccia exposed here postdates at least one episode of faulting. The breccia is restricted to the northeast one-third of the shaft station. As on 1000 level, it is a poorly sorted breccia with clasts ranging in size from small fragments barely a centimeter across to large blocks 2 m in maximum dimension. The latter, however, are rare, and most of the clasts seem to be 5-30 cm across. Most of the clasts are subangular, but some have been conspicuously rounded by solution. Nearly all of the clasts are of Franklin Marble, but clearly from different compositional layers within that unit, as shown by differences in clast color, grain size, and texture. Two clasts appear to be fine-grained pyroxene or amphibole gneiss partially altered to epidote (a common lithology on this level). One of the marble clasts contains a graphite-smeared, calcite-coated fault that ends at the clast margins and does not continue into the surrounding matrix; clearly the faulting predated the brecciation. The breccia is firmly cemented and probably was metamorphosed to some extent, as judged from the evident crystallinity of the matrix material. In addition, fractures within the breccia break through clasts and matrix alike. Wherever individual clasts show compositional layering, the layers show no evidence of preferred orientation within the breccia. The breccia for the most part appears to be clast-supported.

STATION 11 – Northeast rib of short passage leading from shaft station to West limb haulage drift, opposite entrance to recharging station, at around 1240N, 1030W.

Fault no. 988

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-72	N87W/52SW	S11W (S25W)	50 (52)	(85 NW) (76 NW)

Comments: Graphite-smeared fault surface in coarse-grained marble. Sense of slip unknown.

Fault no. 989

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-73	N29W/30SW	N29W (N29W)	00 (00)	(00) (00)

Comments: Graphite-streaked fault surface in coarse-grained marble. Sense of slip unknown.

Fault no. 990

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-74	N78W/58SW	S31W (S27W)	57 (57)	(80 NW) (82 NW)

Comments: Graphite-streaked fault surface in coarse-grained marble. Sense of slip unknown.

Fault no. 991

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-75	N19E/74SE	S38E (S33E)	69 (71)	(80 SW) (78 SW)

Comments: Graphite-streaked fault surface in coarse-grained marble. Sense of slip is normal, as shown by offsets of older, low-dipping faults across this one.

Fault no. 992

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-76	N53W/63SW	S68W (S66W)	60 (59)	(75 NW) (76 NW)

Comments: Graphite-streaked fault surface in coarse-grained marble. Sense of slip unknown.

Fault no. 993

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-77	N81E/67SE	Due S (S15W)	65 (67)	(86 SW) (80 SW)

Comments: Graphite-streaked fault surface in coarse-grained marble. Sense of slip unknown.

Fault no. 994

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-78	N18E/78SE	(S20E)	(71)	75 SW

Comments: Graphite-streaked fault surface in coarse-grained marble. Sense of slip unknown.

STATION 12 – West rib of passage near west entry to 1250 stope (backfilled) in cross member, at mine coordinates 1250N, 880W.

Fault no. 995

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-79	N73E/38NW	Due W	(13)	(21 SW)

Comments: Graphite-smeared fault surface in coarse-grained marble. Fibrous accretionary calcite on fault surface indicates upper plate moved to the west.

Fault no. 996

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-80	N30E/70SE	(S38E)	(69)	82 SW

Comments: Graphite-smeared fault surface in coarse-grained marble; sense of slip unknown.

Fault no. 997

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
900-81	N62W/42SW	S07E (S16E)	33 (36)	(63 SE) (54 SE)

Comments: Fault in coarse-grained marble. Weakly developed slickenside striations are visible on this fault, but fault surface is muddy, and sense of slip is unknown. This fault is cut off by fault no. 996 above and is thus the older of the two.

1000 Level

STATION 1 – West limb haulage drift at ore chute, a few meters from the bulkhead door, at mine coordinates 1180N, 920W.

Fault no. 998

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-1	N30E/38SE	S77E (S81E)	36 (37)	(77 NE) (73 NE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown. Minor fault, undulatory along dip, but with only 0.5 m of its trace height exposed. Wallrock adjacent to fault shows no visible deformation. This fault is subsidiary to a much larger fault slightly lower down, but no slip data were obtainable on that larger fault.

Fault no. 999

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-2	N04W/62NE	N04W (N04W)	00 (00)	(00) (00)

Comments: Graphite-streaked minor fault surface in marble; sense of slip unknown. Individual calcite grains meet the fault surface with no visible sign of deformation.

Fault no. 1000

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-3	N33E/60SE	S75E (S80E)	58 (59)	(81 NE) (78 NE)

Comments: Graphite-streaked minor fault surface in marble; sense of slip probably normal. Length of individual graphite streaks is 5-6 mm and indicates amount of slip.

Fault no. 1001

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-4	N48E/66SE	S50E (S59E)	65 (66)	(87 NE) (83 NE)

Comments: This is the main strand of a relatively large fault, with exposed length of 6 m and exposed height of 1 m. The fault surface is completely black and graphite-coated; sense of slip unknown. Calcite marble adjacent to the fault shows no visible sign of deformation. Subsidiary faults of much smaller size and lesser amounts of slip are common adjacent to this fault.

Fault no. 1002

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-5	N38E/57SE	S47E (S48E)	57 (57)	(87 SW) (88 SW)

Comments: Graphite-streaked minor fault surface in marble. The length of individual graphite streaks is 5-7 mm and indicates amount of slip. This fault is subsidiary to fault no. 1001 above.

Fault no. 1003

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-6	N10E/43SE	S79E	(43)	(89 SW)

Comments: Black, graphite-coated fault surface. The major strand of this fault is nearly parallel to the drift and is exposed from 1200 N to about 1120 N. The marble wallrock is brecciated adjacent to the fault, but only locally, and particularly between small, curving, subsidiary fractures where these are present parallel to the main fault strand.

General comment on faults at this station: Numerous faults at this locality, as partially reflected in the data above, have about N30E-N40E strikes, moderate to steep SE dips, and slickenside striations nearly parallel to the dip line. These faults are undulatory along both strike and dip. Slip along the largest among them opened abundant lenticular voids, some of them as much as 1.5 cm across. All of these faults have smooth surfaces, with no evidence of ductile deformation of the wallrock to either side.

STATION 2 – West limb haulage drift at approximate mine coordinates 955N, 980W.

Fault no. 1004

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-7	N30W/53SW	S15E (S10E)	24 (19)	(24 SE) (31 SE)

Comments: Graphite-streaked fault surface in marble; sense of slip uncertain but probably right-lateral. This fault extends across the back and down both ribs; several smaller faults lie parallel to it within a zone 15-20 cm wide. These faults show no obvious evidence of ductile deformation or brecciation of the adjacent wallrock. This fault offsets fault no. 1005 below and is thus younger.

Fault no. 1005

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-8	N89W/77SW	S53E (S62E)	63 (69)	(73 SE) (66 SE)

Comments: Graphite-streaked fault surface in marble; sense of slip undetermined. This is one of several minor faults of similar orientation here. Two such faults are offset by fault no. 1004 above; very clear age relation here. *Note:* The angle of plunge given above is uncertain; the bearing measurement is accurate.

Fault no. 1006

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-9	N16E/75NW	S81W (S67W)	71 (73)	(83 SW) (78 SW)

Comments: Minor, graphite-streaked fault surface in marble; sense of slip unknown. Trace height of this fault is only about 1 m.

Fault no. 1007

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-10	N07W/68SW	S24W (S13W)	40 (52)	(58 SE) (44 SE)

Comments: Small, graphite-coated and mechanically scratched fault surface in marble; sense of slip unknown. Trace height on rib is only about 1 m.

Fault no. 1008

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-11	N65E/79NW	N42E (N54E)	44 (64)	(66 NE) (45 NE)

Comments: Minor, graphite-streaked fault surface in marble; sense of slip unknown. Length of individual graphite streaks is 3-6 cm and indicates amount of slip.

Fault no. 1009

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-12	N24E/77NW	S71W (S52W)	64 (72)	(78 SW) (67 SW)

Comments: Minor, graphite-smeared fault surface in marble; sense of slip unknown.

STATION 3 – West limb haulage drift, between mine coordinates 875N, 995W and 894N, 1000W, mostly on west rib.

Note: This is where fluoborite in the Franklin Marble underground at Sterling Hill was first discovered by Earl R. Verbeek and Marilyn A. Grout on May 22, 1990. Fluoborite was previously known as a secondary, fibrous to splintery mineral coating fault surfaces in ore, but here it was found as a primary metamorphic mineral in equant to squat prismatic grains in the marble host rock, identical to its appearance in some of the marble quarries of the area. Similar fluoborite was later found in modest abundance in the updip extension of this occurrence on 900 level.

Fault no. 1010

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-13	N39E/90	S54E	88 to SW	(88 SW)

Comments: Minor fault in norbergite-pyroxene-phlogopite marble; sense of slip unknown. The fault surface is streaked dark green, possibly from sheared pyroxene grains. *Note:* If the dip of the fault were exactly 90º, the bearing of the slickenside striations would have to be either N39E or S39W. The measured bearing of S54E implies a steep SE dip, close, but not quite equal to, 90º. If, for example, the fault were oriented N39E/89SE, striations plunging directly downdip (pitch = 90º) would result in a bearing of S51E, only 3º different from that measured. The actual slip vector is very nearly vertical in any case.

Fault no. 1011

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-14	N57E/85NW	N06E (N28E)	80 (84)	(86 NE) (81 NE)

Comments: Minor fault in marble with accessory norbergite, fluoborite, and arsenopyrite. The fault surface is prominently streaked emerald-green and white from fibrous accretionary calcite intergrown with (probable) serpentine. Prominent step faces in the accretionary material indicate SE side is the downthrown block.

Fault no. 1012

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-15	N43E/82SE	S11W (S20E)	81 (75)	(77 SW) (86 SW)

Comments: Fault in marble. Surface of fault is coated with white to grass-green fibrous accretionary material, dominantly calcite but probably with intergrown serpentine, the whole measuring 1-10 mm thick. Step faces in the accretionary material indicate that the SE block is downthrown; offset of compositional layering in the marble indicates the same. Note: The striations on this fault were difficult to measure, and the bearing is thus somewhat in question, but the striations are very nearly downdip. Given that the measured plunge is the more trustworthy measure, this results in a calculated pitch of 86 SW (in agreement with the observation of "very nearly downdip" striations) and a bearing of S20E.

Fault no. 1013

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-16	N30E/72SE	S55E (S41E)	71 (72)	(88 SW) (84 SW)

Comments: Minor, graphite-streaked fault surface in norbergite-graphite marble. Sense of slip unknown, though tiny rock-cut steps on fault surface suggest normal sense of slip.

Fault no. 1014

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-17	N02W/50NE	S54E (S54E)	43 (43)	(63 SE) (63 SE)

Comments: Black, graphite-smeared fault surface in sparsely graphitic marble; sense of slip unknown.

Fault no. 1015

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-18	N10E/69NW	S28W (S19W)	21 (38)	(41 SW) (23 SW)

Comments: Minor fault in norbergite-graphite marble; fault has trace length of only 1 m. The fault surface is coated with accretionary calcite, but not sufficiently exposed that the sense of slip could be determined.

Fault no. 1016

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-19	N17E/78NW	S30W (S21W)	20 (47)	(48 SW) (20 SW)

Comments: Fault in norbergite-graphite marble. Step faces in fibrous accretionary calcite suggest slip sense was dominantly right-lateral.

Fault no. 1017

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-20	N20E/31NW	N05W (N01W)	12 (14)	(29 NE) (24 NE)

Comments: Minor fault, trace height only about 1 m, in norbergite-graphite marble. Fault surface appears to be coated with fibrous accretionary calcite but was insufficiently exposed for determination of slip sense. *Note:* The bearing should have been recorded as N05W rather than S05E (an impossible value; wrong end of compass needle was read). As shown above, the readings are in close agreement.

Fault no. 1018

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-21	N08E/60NW	S19W (S18W)	17 (18)	(21 SW) (20 SW)

Comments: Minor fault in norbergite-graphite marble. Very little of this fault is exposed. Fibrous accretionary calcite is visible on the fault surface, but the sense of slip could not be determined. Faults 1016 and 1018 are two of at least 10 such faults here, and all are of minor size.

Fault no. 1019

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-22	N05E/30NW	S09W (S12W)	04 (02)	(05 SW) (08 SW)

Comments: Graphite-smeared fault surface in graphitic marble. Fibrous accretionary calcite coats part of fault surface, but sense of slip could not be determined. Trace amounts of violet fluorite coat the fault as well.

Fault no. 1020

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-23	N12E/60NW	S22W (S17W)	09 (16)	(19 SW) (10 SW)

Comments: Graphite-smeared and mechanically scratched fault surface in norbergite-graphite marble; sense of slip unknown. This is one of four similar minor fault strands in a zone 5-10 cm wide.

Fault no. 1021

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-24	N35E/57NW	(N28E)	10 to N	(12 NE)

Comments: Minor, graphite-smeared fault surface in graphitic marble. What appears to be fibrous accretionary calcite on the fault surface suggests a right-lateral sense of slip. Violet fluorite also is present on the fault surface, but it is granular and thus probably postdates the fibrous, slip-related calcite.

Fault no. 1022

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-25	N05W/54SW	S19W (S08W)	17 (29)	(37 SE) (21 SE)

Comments: Minor, graphite-streaked fault surface in graphitic marble. Fibrous accretionary calcite on fault surface shows that slip sense is probably right-lateral.

STATION 4 – 780 Pillar, extending southward to 740 Pillar, in keel of the orebody, between mine coordinates 740N, 860W and 780N, 880W.

Fault no. 1023

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-26	N58E/90	Due E (see note)	80	(80 NE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown. Individual graphite streaks on fault surface are 4-7 cm long and indicate amount of slip. *Note:* Our field notes originally gave the bearing of the slickenlines as due E, an impossibility; for a fault of N58E strike and vertical dip the bearing must be either N58E or S58W. That we measured a bearing at all indicates the fault dip is not exactly vertical but must be quite steep, and to the SE to allow an E-directed bearing. (Note that a bearing of due E would calculate to a fault dip of 84º SE, not much different from vertical.) Since the projection of the slickenlines in the horizontal plane would be exceedingly short for any fault of near-vertical dip, any direct measurement of bearing is subject to considerable error, whereas the plunge angle of 80º almost certainly is accurate. Accepting a plunge of 80º, then, and taking the average between the measured dip of 90º and the calculated dip of 84º SE (thus 87º SE), we arrive at a fault plane of N58E/87SE and a slip vector of 80/N74E. Regardless of the combination of fault dip and slickenline bearing selected, the resultant slip vector would not be much different in any case; all scenarios lead to a slip vector not far from vertical.

Fault no. 1024

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-27	N59E/73SE	S51E (S65E)	70 (72)	(84 NE) (79 NE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown.

Fault no. 1025

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-28a	N39E/77SE	(S80E)	(75)	83 NE

Comments: Graphite-streaked fault surface in marble. Probable step faces in fibrous accretionary calcite indicate SE side of fault is downthrown. Graphite streaks on fault are 3-5 cm long and show amount of slip. These readings indicate the first episode of slip along this fault; see fault no. 1026 below for second episode.

Fault no. 1026

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-28b	N39E/77SE	(N56E)	(51)	53 NE

Comments: Same fault as no. 1025 above, but a later generation of slickenside striations. These striae appear as tiny, very closely spaced scratches cutting obliquely across the graphite streaks of the earlier episode of slip. Sense of slip unknown.

Fault no. 1027

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-29	N41E/70SE	S58E (S74E)	68 (70)	(87 NE) (81 NE)

Comments: Prominently graphite-streaked fault surface in marble exposed over an area of several square meters. Fault is undulatory in both strike and dip. Step faces in fibrous accretionary calcite indicate that slip sense is probably normal.

Fault no. 1028

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-30	N18E/69SE	S80E (N82E)	67 (69)	(87 NE) (80 NE)

Comments: Graphite-streaked fault surface in marble; sense of slip unknown. Minor fault with exposed length and height of only one meter or so. The fault splays out in the back as three or four curving "horsetail" fractures.

Fault no. 1029

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-31	N41W/43NE	S47E (S51E)	09 (05)	(08 SE) (13 SE)

Comments: Black, graphite-smeared fault surface in marble; sense of slip unknown. The fault is smooth but also quite irregular, changing orientation from shallow to moderate dips rather abruptly. This is a fairly large fault, with an exposed length of 5-6 m and exposed height of 3 m. The fault flattens as it approaches the back to a gentle dip estimated at about 20º SE. Locally within the upper plate the marble wallrock has a streaked appearance due to sheared graphite, with lensoidal masses of sheared marble enclosed in more marble.

Fault no. 1030

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-32	N52W/39NE	N52W (N52W)	00 (00)	(00) (00)

Comments: This is a splay fault related to no. 1029 above. The fault surface is graphite-smeared. Our field notes mention that step faces on the fault suggest upper plate moved to the NW, but did not specify whether these step faces were developed within accretionary material or the wallrock; thus slip sense is uncertain here. This fault appears to be cut off by a steeply dipping minor fault of N50W strike, but that later fault had no slip indicators exposed. *Note:* Faults nos. 1029 and 1030 together enclose a lensoidal fault block in 740 Pillar.

Fault no. 1031

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-33	N76W/12SW	S30E (S35E)	08 (09)	(47 SE) (42 SE)

Comments: Small, graphite-smeared fault surface exposed in the back. Small step faces in probable accretionary calcite suggest upper plate moved to the NW. The fibrous accretionary calcite coats the fault

surface only within recesses; this calcite is pale ivory in color and completely lacking in graphite (thus upholding its interpretation as fault-related accretionary material). Beneath this patchy coating the fault surface is smeared with dark gray graphite.

Fault no. 1032

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-34	N31W/53NE	S53E (S57E)	30 (27)	(34 SE) (39 SE)

Comments: Irregular, curving, but smooth fault surface locally coated with post-faulting drusy calcite. Slickenside striations are readily visible within several small areas on the fault surface, but their nature is not evident because the fault surface is so heavily caked with mine mud. Sense of slip unknown.

Fault no. 1033

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-35	N13W/52NE	S53E (S44E)	33 (40)	(54 SE) (44 SE)

Comments: Graphite-smeared fault surface in marble. Fibrous accretionary calcite is present on fault surface. Our field notes state that sense of slip is uncertain but suggest that hanging wall moved to NW; the basis for this inference was not recorded. The marble wallrock is strongly sheared within a zone several mm to 1 cm thick adjacent to the fault on either side.

Fault no. 1034

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-36	N09W/27NE	S47E (S38E)	14 (17)	(41 SE) (32 SE)

Comments: Dark gray to black, graphite-smeared fault surface in marble, coated with white, fibrous accretionary calcite in irregular lensoidal masses as much as 2 cm thick. Step faces in accretionary calcite indicate that hanging wall moved NW. This fault is offset by nearly vertical minor faults of about N60W strike.

Fault no. 1035

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-37	N54E/42SE	S20E (S06E)	38 (41)	(78 SW) (67 SW)

Comments: Graphite-smeared fault surface coated with fibrous accretionary calcite; sense of slip unknown.

Fault no. 1036

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-38	N29W/77SW	S54W (S40W)	76 (77)	(88 SE) (85 SE)

Comments: Graphite-streaked fault surface coated with fibrous accretionary calcite. Numerous tiny step faces in accretionary calcite indicate reverse sense of slip.

Fault no. 1037

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-39	N28W/77SW	S58W (S62W)	77 (77)	(89 SE) (90)

Comments: Graphite-streaked fault surface coated with fibrous accretionary calcite. Step faces in accretionary calcite indicate hanging wall is upthrown block (reverse fault).

Fault no. 1038

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-40	N27W/73SW	S55W (S35W)	71 (73)	(88 SE) (81 SE)

Comments: Minor, graphite-streaked fault surface; sense of slip unknown. Individual streaks are 5-7 mm long and indicate amount of slip.

Note: Faults nos. 1036 through 1038 are members of a common set of faults here, of which at least a dozen are visible. The marble wallrock immediately adjacent to these faults is locally sheared along subsidiary fault surfaces but is otherwise little deformed, with the local exception of minor brecciation where these subsidiary faults are most closely spaced. See also note below fault no. 1040 for information on younger faults that offset members of this set.

Fault no. 1039

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-41	N24E/54SE	S33E (S23E)	45 (49)	(69 SW) (61 SW)

Comments: Graphite-smeared fault surface. Striations on the fault appear to be due to fibrous accretionary calcite, but this is subtle and somewhat uncertain. Probable step faces in this calcite suggest normal sense of slip. *Note:* Bearing measurement is probably more accurate than the plunge.

Fault no. 1040

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-42	N26E/73SE	S54E (S20E)	67 (73)	(87 SW) (74 SW)

Comments: Graphite-streaked fault surface; sense of slip unknown.

Note: Faults nos. 1039 and 1040 are two strands of a fairly substantial zone of faults here, one shown on the mine maps, and within which the graphitic marble is strongly sheared in a zone 10-15 cm thick. Individual slip surfaces within this zone appear in the back and on both ribs as dark gray to black "lines" due to sheared-out graphite. Fault no. 1040 cuts off and is thus younger than a fault of N28W/71SW orientation, a member of the nos. 1036 through 1038 group of faults described above. Additional measurements of other members of these young faults: N20E/68SE, N21E/72SE, N24E/66SE, N30E/67SE, N29E/68SE, N26E/69SE.

STATION 5 – 970 Stope, East limb, along east wall of stope. The station is centered on approximate mine coordinates 1080N, 420W.

Fault no. 1041

Field no.	Fault Orientation	Bearing (slickenlines)	Plunge (slickenlines)	Pitch (slickenlines)
1000-43a	N81E/75NW	N43W (N57W)	68 (72)	(80 SW) (74 SW)

Comments: Fault through high-grade franklinite-willemite-zincite-calcite ore. Fault is lined with 1-10 mm of fibrous accretionary calcite with sheared-out franklinite and zincite ("calcozincite"). The orientation of the fibers relative to the fault surface, as well as step faces within the accretionary calcite, show that the hanging wall moved up (reverse fault).

Fault no. 1042

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-43b	N81E/75NW	N08E (N46E)	65 (74)	(85 NE) (70 NE)

Comments: Same fault as above, but a second and apparently younger set of slickenside striations that appear as mechanical scratches on the accretionary material described above. Nearby on this same fault surface is additional fibrous "calcozincite," the fibers of which are parallel to the scratches described here. Sense of slip undetermined for this second set. See also the two readings on faults 1043 and 1044 below, for two similar sets of striae.

Fault no. 1043

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-44a	N66E/76NW	N52W (N70W)	70 (74)	(83 SW) (76 SW)

Comments: Fault in ore, lined with fibrous accretionary calcite and zincite ("calcozincite"). Step faces in the accretionary calcozincite indicate that the hanging wall moved up (reverse fault).

Fault no. 1044

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-44b	N66E/76NW	N10E (N36E)	63 (73)	(81 NE) (67 NE)

Comments: Same fault as above, but a second set of slickenside striations defined by "calcozincite." This second set appears to be younger than that documented above for the same fault, but the evidence for this age relation is not clear. In any event there were two definite episodes of fibrous mineral growth within this fault, with orientations similar to those documented for faults nos. 1041 and 1042 above.

Fault no. 1045

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-45	N59E/86SE	(S49W)	(68)	68 SW

Comments: Fault in ore. Fault surface is lined with cream-colored, fibrous to splintery calcite, in most places several mm thick, but locally as much as 1.5 cm. Prominent step faces in the accretionary material indicate that the NW side of the fault is the upthrown block. Note the steep dip here; this is anomalous for this set of faults; more are listed below.

Note: Faults nos. 1041 through 1045 are all different portions of the same prominently curved fault cutting high-grade franklinite-willemite-zincite ore. The ore minerals here constitute 40-60% of the rock.

Fault no. 1046

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-46	N80W/44NE	N59W (N61W)	18 (19)	(28 NW) (26 NW)

Comments: Fault in franklinite-calcite-willemite-zincite ore. "Calcozincite" (fibrous calcite and zincite) lines fault surface and in most places is 3-4 mm thick, locally as much as 5 mm. Step faces in this material indicate that hanging wall probably moved to the NW. The wallrock adjacent to this fault is strongly sheared within 0.5 cm of the fault, and locally within 3 cm of it.

Fault no. 1047

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-47	N53E/83SE	(N66E)	(61)	62 NE

Comments: Numerous step faces in fibrous accretionary calcite lining this fault indicate that NW block of this fault is the upthrown side (normal fault).

Fault no. 1048

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-48	N71E/66NW	N14E (N21E)	60 (62)	(75 NE) (71 NE)

Comments: Fault is coated with fibrous accretionary calcite 1-2 mm thick. Sense of slip unknown.

Fault no. 1049

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-49	N36E/66NW	S58W (S84W)	59 (40)	(45 SW) (70 SW)

Comments: Fault in willemite-calcite-franklinite ore with minor zincite. Fault surface is coated with fibrous calcite and zincite ("calcozincite") 0.5-1 cm thick; fiber orientations relative to fault surface show that hanging wall moved up (reverse fault).

Fault no. 1050

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-50	N58E/53NW	N04W (N02W)	50 (49)	(72 NE) (71 NE)

Comments: Minor fault in franklinite-willemite-calcite ore with minor zincite. Tiny step faces in fibrous accretionary calcite (coating about 1 mm thick) suggest hanging wall moved up.

Fault no. 1051

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-51a	N60E/68NW	N48W (N73W)	61 (67)	(83 SW) (71 SW)

Comments: Fault in franklinite-willemite-calcite ore with minor zincite. Fault surface is lined with fibrous accretionary calcite 2-15 mm thick. Fiber orientations relative to fault surface suggest that hanging wall is the upthrown block. See fault no. 1052 below for information on a younger slip episode on this same fault.

Fault no. 1052

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-51b	N60E/68NW	N32E (N17E)	59 (49)	(55 NE) (68 NE)

Comments: Same fault as no. 1051 above, but a different and younger set of slickenside striations. These are subtle, but they are a definite set of striae that appear as tiny scratches on irregular surfaces within the fibrous accretionary calcite deposited during the previous fault episode. Sense of slip unknown for this second set.

Note: Fault nos. 1051-1052 cuts across and postdates a minor fault 3-6 mm wide of orientation N09E/65SE. The slip sense on this older fault could not be determined, but it contains a brown, nonfluorescent mineral, possibly magnussonite (sample 1000-4 taken here). The vein also contains tiny angular bits of brecciated calcite. The vein is definitely sheared. Individual franklinite grains are neatly cut off at the vein walls and cannot be matched from one side of the vein to the other. The fibrous accretionary calcite of fault nos. 1051-1052 plates over the truncated mineral fill of the sheared vein.

Fault no. 1053

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-52	N64E/67NW	N04E (N18E)	59 (64)	(77 NE) (69 NE)

Comments: Minor fault with fibrous accretionary calcite 1-3 mm thick on fault surface; sense of slip unknown.

Fault no. 1054

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-53	N70E/68NW	N27E (N34E)	56 (59)	(68 NE) (63 NE)

Comments: Minor fault in franklinite-willemite-calcite ore with minor zincite. Tiny step faces in a thin coating of fibrous accretionary calcite suggest that the hanging wall is the upthrown block.

Fault no. 1055

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-54	N54E/70NW	N09W (N11W)	68 (68)	(80 NE) (81 NE)

Comments: Minor fault in franklinite-willemite-calcite ore with minor zincite. Fibrous accretionary calcite and zincite ("calcozincite") line fault; orientation of fibers relative to fault surface indicates hanging wall is probably the upthrown block.

Fault no. 1056

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-55	N82W/35NE	S86E (S84E)	02 (03)	(05 SE) (03 SE)

Comments: Irregular, laterally extensive fault with exposed length of about 5 m. Fault surface is coated with fibrous accretionary calcite and zincite ("calcozincite") 1-15 mm thick. Orientation of fibers relative to fault surface suggests upper plate moved to the W. This fault truncates faults nos. 1050, 1055, and 1057, all of which are reverse faults of NE strike and steep NW dip. *Note:* Bearing as originally recorded was N86W, an impossible value (but by a trivial amount); undoubtedly S86E was meant.

Fault no. 1057

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-56	N49E/73NW	N28W (N21W)	72 (73)	(86 NE) (84 NE)

Comments: Minor fault in franklinite-calcite ore with minor zincite. Slickenside striations are defined by fine scratches on bare fault surface; sense of slip unknown.

Fault no. 1058

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-57	N62E/68NW	N26E (N23E)	57 (56)	(63 NE) (65 NE)

Comments: Minor fault in franklinite-calcite ore with minor zincite and willemite. Slickenside striations are defined by fine scratches on fault surface; sense of slip unknown.

Fault no. 1059

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-58	N40E/58NW	N18E (N12E)	38 (31)	(37 NE) (45 NE)

Comments: Minor fault with a thin (1-2 mm) coating of fibrous accretionary calcite and zincite ("calcozincite"); sense of slip unknown.

Fault no. 1060

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-59	N71E/33NW	N28E (N25E)	25 (24)	(48 NE) (51 NE)

Comments: Fault in franklinite-zincite-calcite ore with minor willemite. Fibrous accretionary calcite, locally accompanied by zincite ("calcozincite") lines fault surface. Sense of slip uncertain; probably hanging wall moved to the SW.

Fault no. 1061

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-60	N86E/27NW	N86W (N67W)	13 (04)	(09 SW) (30 SW)

Comments: Laterally extensive fault, traceable for at least 15 m along the walls of the stope. Fault surface is undulatory along dip and lined with fibrous accretionary calcite and "calcozincite" (fibrous calcite with zincite) of varying thickness, from a bare film to as much as 3 cm. Multiple step faces in accretionary calcite suggest upper plate moved to the W. Locally this fault forms a zone 1.5-2 cm thick of closely spaced anastomosing fractures enclosing lenses of highly sheared franklinite-zincite-willemite ore (willemite is minor component of ore in upper plate). Individual zincite-rich layers in the ore are truncated at the fault, and ore layers in the upper block cannot be matched to those in the lower block; more than minor slip is indicated.

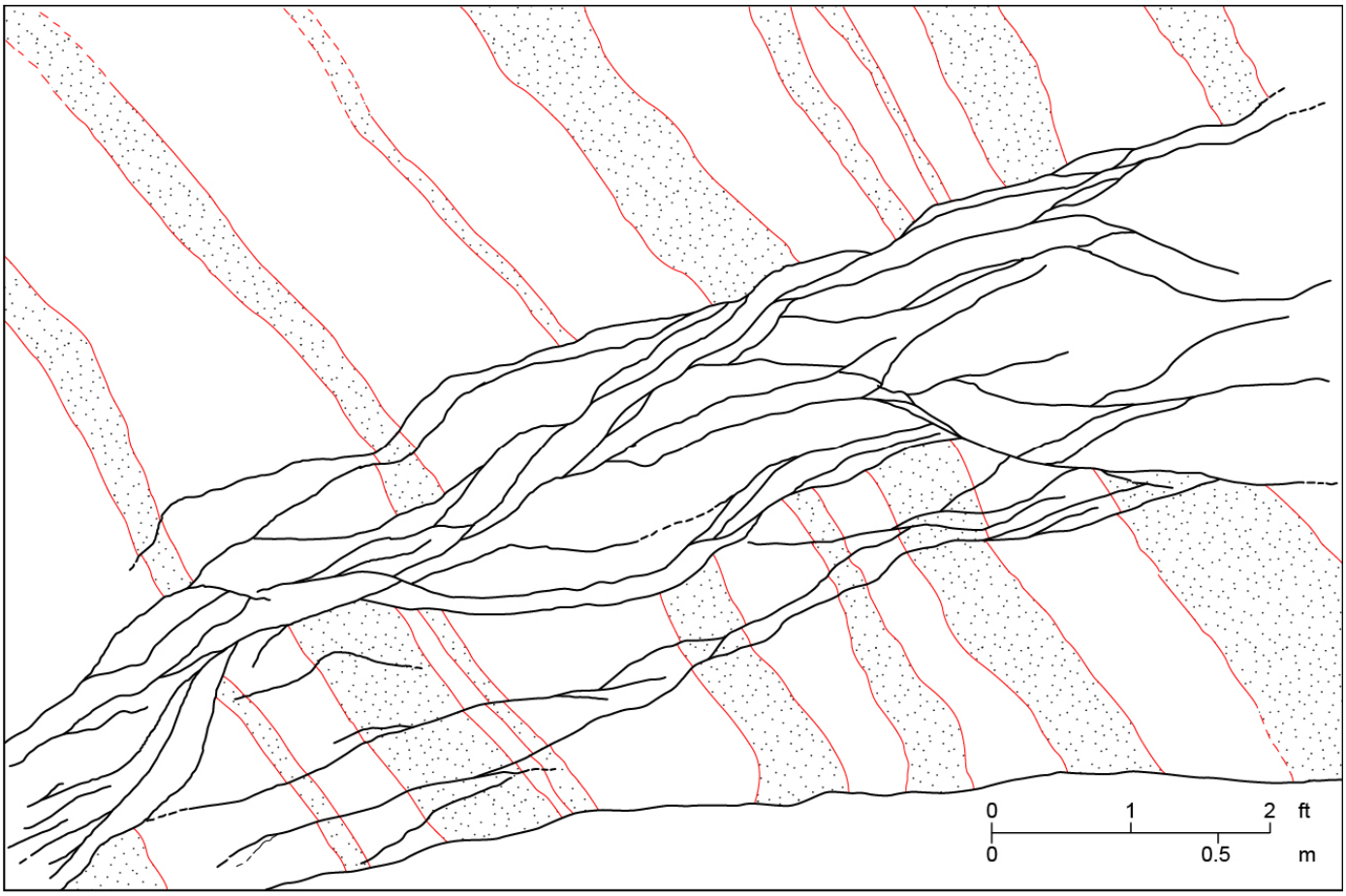
Note: This fault, part of a braided fault zone 2-3 feet thick, was sketched in detail (illustration on following page) and photographed. The ore above and below the fault zone is prominently layered and consists of nearly pure zincite-franklinite layers alternating with layers of the same two minerals, but with 20-50% calcite. The apparent dip of the layers in the plane of the sketch averages about 60^{o} to the right (northeast). Several measurements of the orientation of the compositional layers in this area:

N30W/62NE N36W/58NE N36W/65NE N41W/59NE N10W/67NE N32W/60NE
Median: N34W/61NE (n = 6)

The ore above and below the fault zone is zincite-dominant; that within it generally is not, and apparently has been removed by hydrothermal fluids flowing along that zone.

The fault strands as mapped in the sketch include both discrete surfaces, commonly veined with secondary hydrothermal minerals, and thin zones of fault breccia within which no discrete fractures can be seen. The breccia masses along the faults are lenticular and in some places occupy the entire space between two strands of the fault zone. Most are 1-3 cm thick, but locally, some are 7-8 cm thick. Much of the breccia is cemented by sphalerite. Most of the sphalerite is medium-grained and pale honey brown, but locally this grades into cryptocrystalline, reddish-brown sphalerite of the type sometimes mistaken for friedelite. Where breccia is absent, many of the fault surfaces are lined with fine-grained, ivory-colored carbonate and secondary willemite to form veins generally ranging in thickness from 1 mm to 1 cm, but locally as much as 2 cm. "Calcozincite" is rare *within* most of the fault zone but is a prominent component of slip surfaces that cut the layered zincite ore both above and below the main part of that zone.

On the next page is a drawing of the braided fault zone at this locality, as revealed in a near-vertical wall of the stope. The fault zone was first sketched in the field, using a steel tape to measure distances to the nearest one-half inch. Later, a set of numerous overlapping photographs (35-mm color slides) from several individuals (Bernard Kozykowski, Steven Misiur, Earl R. Verbeek) was used to add detail by enlarging each slide and projecting it onto the base map. The plane of the sketch is S30W (left) to N30E (right); the view direction is thus about N60W. As noted in sketch, measurements are in feet. The view direction is at only a modest angle from the average direction of slip during the initial stage of moment on these faults. The stippled layers in the drawing depict zincite-rich ore.



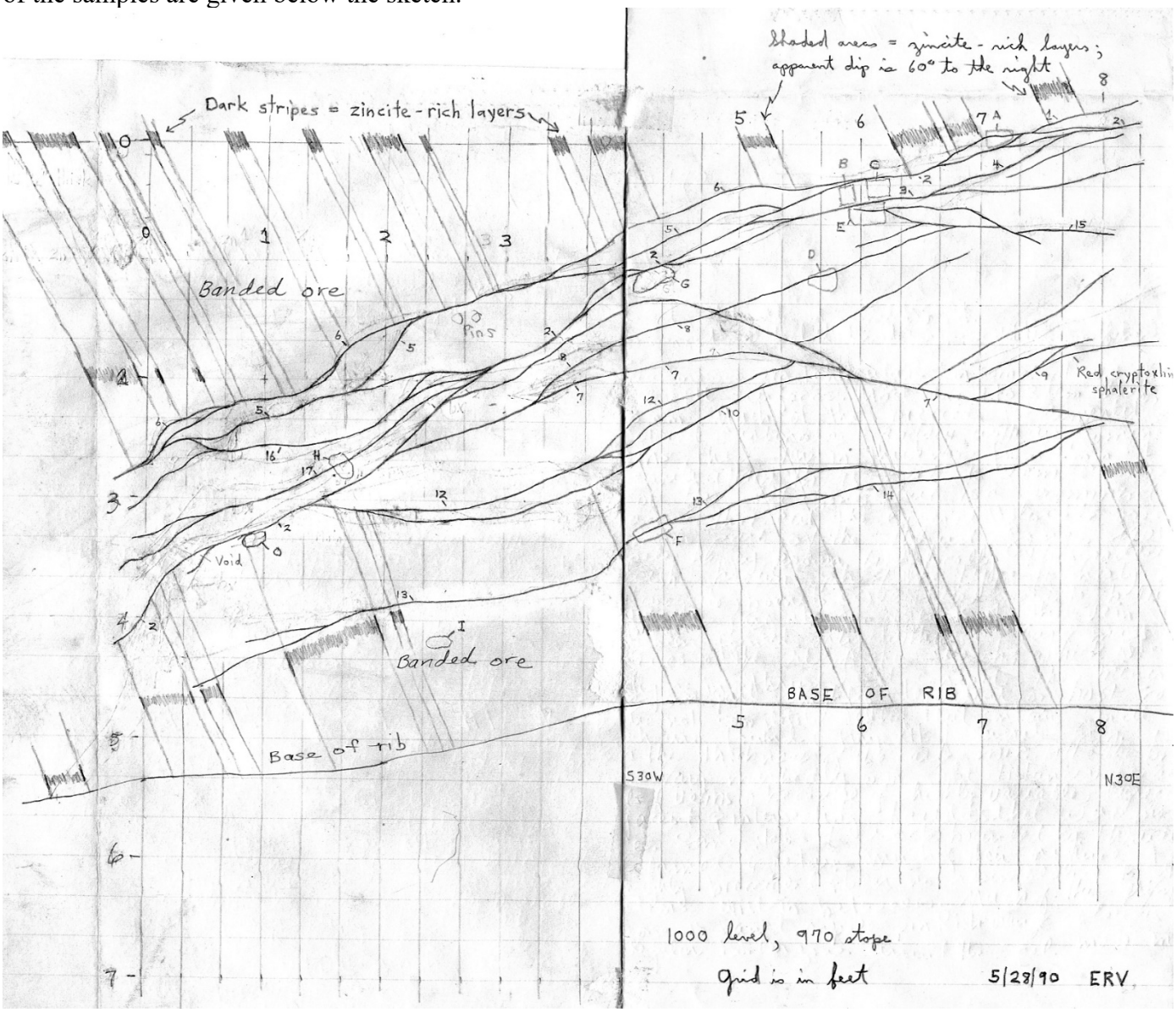
In addition to sphalerite, chalcopyrite, bornite(?), and their green and blue alteration products are also components of the local fault-vein system, but only within the coarse-grained marble, not where the fault cuts the ore. The mineralogy of the veins, then, is highly dependent on host-rock lithology. Some of the veins are not completely sealed but contain small, lenticular cavities lined with tiny crystals of several different minerals, as yet unidentified.

The thickness of both the breccia zones and the hydrothermal mineral veins lining the faults varies markedly within short distances because of nonmatching walls of the veins after slip and because of variable degrees of interaction among adjacent and intersecting fault strands that were moving at the same time. Some slabs of rock bounded by fault strands within the thrust-fault zone are relatively undeformed and retain much of their original texture, whereas others are highly brecciated and bear no resemblance to the original rock. All gradations exist between these two extremes. Much of the primary calcite in the ore within the fault zone is stained a pale pinkish-orange color, as is also the calcite within an irregular border zone wherever ore has been placed in fault contact with marble along the hanging wall of the East limb.

As shown in the sketch, the fault surfaces within this zone are highly curved. The axes of these curved segments are roughly parallel to one another and to the original direction of slip along these surfaces. Several measurements of these axes: 03/S58E 08/N42W 06/N39W 02/S27E 05/S30E
The average of these measurements indicates an original transport direction of about N40W, in good agreement with that found in many other parts of the mine. In many places, however, such faults were

reactivated and show different directions of slip, as indicated by some of the slip vectors documented at this station.

Shown below is our original field sketch of this fault zone. The lettered areas on the sketch indicate places where samples were taken for later study. Selected faults are indicated by small numbers. Brief descriptions of the samples are given below the sketch.



Brief descriptions of the samples follow.

A. Thin vein through this sample is fault 1; fibrous base is fault 2. Arrow points up and is on front face of sample.

B. Top vein is fault 2; bottom is fault 3; breccia cemented by sphalerite between.

C. Same as B but taken a few inches farther NE; fine example of sphalerite-cemented breccia.

D. Thin brown vein near top edge of sample is fault 8; brown is serpentine(?) with secondary willemite.

E. Anastomosing tiny willemite veinlets; top surface of sample is fault 3 and oriented arrow is N58E/74NW. From franklinite-calcite ore in thrust zone; good example of minutely veined ore.

F. "Calcozincite" vein (= fault 13) in zincite-franklinite-calcite ore. Oriented arrow is N86W/76SW. Good and typical example; numerous such veins here.

G. Breccia below fault 2 (forms top white part of sample); cemented by sphalerite. Oriented arrow is N35E/70SE.

H. Sphalerite breccia vein, = fault 17.

I. Fragments (unoriented) of unmapped subhorizontal "calcozincite" veinlet of different attitude from faults mapped here and not, apparently, related to them.

J. Solid sphalerite vein with franklinite ore above and barren white calcite below; franklinite ore is in bleached zone where zincite has been removed by hydrothermal fluids.

K. Like J but larger, and with carbonate within 10-cm-thick sphalerite vein (gray – mostly sphalerite?). Marked face is N40W/55NE.

L. Zincite-depleted ore. Oriented face is N03W/69SW. Should make petrographic thin section of this sample to study textural aspects of zincite removal.

M. Sulfides (note blue mineral) in minor thrust fault through calcite marble and ore.

N. Banded secondary willemite from "sole fault" at base of calcite marble.

O. Bleached ore in zincite-rich layer just below fault 2; fine example of bleached ore near thrust-fault contact.

Note: Samples L through N were taken from a part of the fault zone to the right (NE) of the area of the sketch map.

Continuing now with fault readings at station 5:

Fault no. 1062

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-61	N48E/48NW	N26E (N12E)	33 (23)	(31 NE) (47 NE)

Comments: Minor fault in franklinite-zincite-calcite ore with minor willemite. Fault surface is coated with 2-5 mm of fibrous accretionary calcite with zincite ("calcozincite"); sense of slip unknown.

Fault no. 1063

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-62	N65E/87NW	(N08E)	(86)	88 NE

Comments: Minor fault in franklinite-zincite-calcite ore with minor willemite. Fault surface has thin coating of fibrous accretionary calcite with zincite ("calcozincite"); sense of slip unknown.

Fault no. 1064

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-63	N12E/76SE	(N78E)	(75)	84 NE

Comments: Minor fault in franklinite-zincite-calcite ore with minor willemite. Fault surface has coating 1-3 mm thick of fibrous accretionary calcite with zincite ("calcozincite"); step faces in accretionary material indicate normal sense of slip.

Fault no. 1065

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-64	N37E/62NW	N10W (N01W)	48 (54)	(66 NE) (57 NE)

Comments: Minor fault in franklinite-willemite-zincite-calcite ore. Fault surface has coating 2-6 mm thick of fibrous accretionary calcite with zincite ("calcozincite"); hanging wall is probably the upthrown block (reverse fault).

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Fault no. 1066

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-65	N59E/50NW	N14E (N20E)	37 (40)	(57 NE) (52 NE)

Comments: Minor fault in franklinite-zincite-willemite-calcite ore. Fault surface has coating 3-10 mm thick of fibrous accretionary calcite with zincite ("calcozincite"); orientation of fibers relative to fault surface suggests hanging wall is upthrown block (reverse fault).

Fault no. 1067

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-66	N48E/71NW	N03E (N19E)	55 (64)	(72 NE) (60 NE)

Comments: Minor fault in ore. Fault surface has coating 1-3 mm thick of fibrous accretionary calcite with zincite ("calcozincite"); sense of slip unknown.

Note: Faults nos. 1068 through 1073 below are all exposed on SE wall of stope.

Fault no. 1068

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-67	N54E/63NW	N25W (N19W)	62 (63)	(85 NE) (82 NE)

Comments: Fault in franklinite-calcite-willemite ore with minor zincite. Fault surface has thick (1-3 cm) coating of fibrous accretionary calcite with zincite ("calcozincite"). Numerous step faces in accretionary material indicate that the hanging wall is the upthrown block (reverse fault).

Fault no. 1069

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-68	N24W/65SW	(S43W)	(63)	80 SE

Comments: Minor fault with a coating 1-2 mm thick of fibrous accretionary calcite with zincite ("calcozincite"). Step faces in accretionary material suggest that SW side of fault is the upthrown block (reverse fault).

Fault no. 1070

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-69	N34E/90	(N34E)	(80)	80 NE

Comments: Minor fault in zincite-franklinite-calcite ore. Fault surface is coated with 1-5 mm of fibrous accretionary calcite with zincite ("calcozincite"); step faces in this material suggest that SE side of fault is the downthrown block.

Fault no. 1071

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-70	N10E/79SE	(S44E)	(76)	82 SW

Comments: Minor fault in zincite-franklinite-willemite-calcite ore. Mineral-streaked fault surface with zincite grains locally smeared out along it; fault surface also bears thin film of fibrous accretionary calcite with zincite ("calcozincite"). Tiny step faces in accretionary material suggest that slip sense is normal, but this is uncertain at best.

Fault no. 1072

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-71	N46W/39SW	N57W (S77W)	34 (09)	(14 NW) (63 NW)

Comments: Fault in zincite-franklinite-calcite ore. Fault surface is coated with fibrous accretionary calcite with zincite ("calcozincite") 5-10 mm thick. Fiber orientations relative to fault surface indicate that the hanging wall moved up and to the SE. *Note:* Obviously the agreement between readings for this fault is poor, possibly because the bearing was affected by magnetism of the ore. The plunge, however, would not be affected by this and is a straightforward measurement to make. Assuming the plunge measurement of 34^{o} is accurate, the calculated bearing is S77W and the pitch is 63 NW.

Fault no. 1073

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-72	N72W/32SW	S53E (S59E)	08 (11)	(22 SE) (15 SE)

Comments: Fairly large fault with exposed length of at least 8 m; exposed height is comparable. The fault surface is coated with 3-15 mm of fibrous accretionary calcite and secondary willemite; slip sense unknown. This is one strand of a fault zone ranging in width from 5 to 25 cm and consisting of irregular, branching and intersecting surfaces enclosing elongate, lensoidal masses of ore. The thickness of the mineral fill along individual fault strands pinches and swells (because the walls do not match after slip has occurred) and ranges from nearly zero to almost 3 cm. Fibrous calcite and fine-grained secondary willemite make up the bulk of the fault-filling material, but locally the faults contain small angular clasts of brecciated calcite. Locally, too, the ore adjacent to the faults is brecciated for distances up to 3 cm from the fault surfaces. The breccia is of finer grain size than that of the original rock and consists of angular clasts of calcite and franklinite embedded in a fine-grained, brown matrix containing much secondary willemite.

Fault no. 1074

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-73	N56E/48NW	N49W (N64W)	44 (47)	(80 SW) (69 SW)

Comments: Fault in franklinite-willemite-zincite-calcite ore; slip sense unknown. Fault is filled with fibrous accretionary calcite and zincite ("calcozincite") and pyrochroite 1-4 cm thick over an exposed length of 5 m. Calcite in the wallrock immediately adjacent to the fault has a chalky luster and is locally so altered as to be scratched with a fingernail. *Note:* The bearing reading given above is probably more accurate than the plunge.

Note: The pyrochroite from this fault was pale lavender when first collected but darkened rapidly upon exposure. After one day it was dark violet-brown, after two days it was dark brown with little trace of any violet color, and ultimately it became totally black.

Fault no. 1075

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-74	N48E/58NW	N31W (N42W)	58 (58)	(84 NE) (90)

Comments: Minor fault in franklinite-zincite-calcite ore with minor willemite. Fault is filled with fibrous accretionary calcite and secondary zincite ("calcozincite") 1-3 mm thick; step faces in this accretionary material indicate that the hanging wall is the upthrown block (reverse fault).

Fault no. 1076

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-75	N48E/53NW	N36W (N27W)	52 (53)	(86 NE) (81 NE)

Comments: Fault in franklinite-zincite-calcite ore with minor willemite. Fault surface is coated with fibrous accretionary calcite and secondary zincite ("calcozincite"); sense of slip unknown.

Fault no. 1077

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-76	N52E/51NW	N32W (N22W)	50 (51)	(86 NE) (80 NE)

Comments: Minor fault in franklinite-zincite-calcite ore with minor willemite. Fault surface is coated with a thin film of fibrous accretionary calcite and secondary zincite ("calcozincite"). Probably this is a reverse fault, but sense of slip could not be determined with certainty.

Note: Faults nos. 1074 through 1077 are members of a prominent set of such faults along the NW wall of the stope. Faults nos. 1078 through 1080 below were measured near the NE end of the SE wall of the stope.

Fault no. 1078

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-77	N47E/34NW	N35E (N41E)	04 (08)	(14 NE) (07 NE)

Comments: Fault in zincite-franklinite-calcite ore. This is one strand of a gently dipping fault zone here and is filled with 0.5-1.5 cm of a fine-grained white carbonate, locally with some secondary zincite. Sense of slip unknown.

Fault no. 1079

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-78	N35E/39NW	S57W (S39W)	03 (17)	(27 SW) (05 SW)

Comments: Fault in zincite-franklinite-calcite ore. The fault surface is undulatory and is coated with 1-5 mm of "calcozincite" (fibrous accretionary calcite with secondary zincite). Sense of slip unknown.
Note: Slip vector as recorded in our original field notes (bearing S57E) is impossible. Probably S57W was meant instead. If so, the calculated values are as shown above, but these data should not be used during computer analysis.

Fault no. 1080

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-79	N02W/28SW	N02W	(00)	(00)

Comments: Fault in ore. The fault surface is undulatory and is coated with a carbonate mineral and very fine-grained sphalerite 3-20 mm thick. A fibrous mineral seen locally on the fault surface indicates the slip direction, but the sense of slip is unknown.

Fault no. 1081

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-80	N30E/10NW	S45W	(03)	(15 SW)

Comments: Fault in ore. A white fibrous mineral on the fault surface indicates the slip direction, but the sense of slip is unknown. This is the lengthy fault indicated by the small numerals "2" on the sketch map of the braided fault zone several pages previous (p. 219). This area is near the northeast end of the northwest wall of the stope. *Note:* Bearing was given originally as N45E, an impossible value. Almost certainly S45W was meant. Fatigue setting in; two mistakes in three faults.

STATION 6 – Near cross member, but in marble near mine coordinates 1300N, 800W.

Fault no. 1082

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-81	N58E/63SE	S35E (S68E)	58 (63)	(89 NE) (72 NE)

Comments: Prominent fault in marble, about parallel to the NE rib. The marble is strongly sheared in a zone about 3-4 cm thick along the fault, and subsidiary shear surfaces cut the marble for a distance of at least 7 cm to either side. Graphite grains streaked out on the fault surface define the slickenside striations, but the sense of slip is unknown.

Fault no. 1083

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-82	N61E/64SE	S30E (S29E)	64 (64)	(89 NE) (90)

Comments: Prominent and gently curving fault exposed on SE rib; character similar to that of fault 1082 above. The axes of the curved undulations in the fault surface are parallel to the slickenside striations; obvious relationship here. Possible step faces suggest the hanging wall is the downthrown block, but this is not a reliable indicator of slip sense because the nature of the material in which these faces occur is unknown. It may be accretionary calcite plated on the fault surface, but this could not be determined with any degree of reliability.

Fault no. 1084

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-83	N43E/67SE	S45E (S30E)	66 (67)	(89 SW) (83 SW)

Comments: Minor fault with graphite-streaked surface; sense of slip unknown. The length of individual streaks is 1-2 cm and indicates amount of slip. This fault is in the hanging wall of fault 1083 and is probably related to it; it is only 3 cm distant from the main shear surface.

Fault no. 1085

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-84	N44E/64NW	N10W (N10W)	59 (59)	(72 NE)

Comments: Minor fault in marble, a small shear zone 2 cm thick. Fibrous accretionary calcite 1-2 mm thick coats part of fault surface; sense of slip unknown. The calcite is translucent and underlain by graphite-streaked marble. Numerous other slip surfaces along this same fault are coated with films of an olive-green mineral resembling actinolite or possibly a chlorite.

Fault no. 1086

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-85	N30E/72SE	(S41E)	(71)	84 SW

Comments: Prominent zone 25 cm thick of strongly sheared marble, in small subdrift perpendicular to, and 4 m SE of, the SE rib of the main drift here. Local step faces in material of uncertain composition (fibrous accretionary calcite? Sheared marble?) suggest hanging wall is downthrown block.

Fault no. 1087

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-86	N68E/73SE	S36E (S66E)	67 (73)	(86 NE) (74 NE)

Comments: Graphite-streaked fault surface in marble. Multiple step faces in films of fibrous accretionary calcite on fault surface suggest hanging wall is downthrown block, but this is not certain.

Fault no. 1088

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1000-87	N42E/62SE	S52E (S70E)	60 (62)	(88 NE) (79 NE)

Comments: Graphite-streaked fault surface in marble, locally coated with fibrous accretionary calcite. Sense of slip is recorded in our field notes as normal, but how this was determined was not recorded.

Notes on collapse breccia in and near shaft station and nearby recharger room:
Masses of collapse breccia in the Franklin Marble are well exposed in this area, roughly between mine coordinates 1230N, 985W and 1270N, 1030W. The clasts range in size from small fragments 2-3 cm across to large blocks at least 1 m across. Most of the clasts are subangular to angular, but some are notably rounded, with smooth and curving edges. The breccia is polylithologic; lithologic differences between adjacent clasts show that at least some of them are out of place with respect to the surrounding wallrock. The lithogic differences among the clasts show up in several ways: as differences in grain size, presence versus absence of visible layering, and differences in abundance, size, and habit of fluorescent diopside and norbergite. Some of the clasts are rich in one or both minerals; others lack them completely. No ore fragments were seen among the clasts; they are all derived from the Franklin Marble and are white to pale gray in color. These clasts are enclosed in a medium-gray, medium-grained, recrystallized matrix that around some clasts appears darkest within a 2-mm-thick border zone. Overall, this material has all the characteristics of a classic collapse breccia. Unlike the breccia in the “mud zone” beneath the Passaic pit, which was long exposed at the surface and is deeply weathered, the breccia here is a recemented rock with a relatively fresh appearance.

The best exposure of this collapse breccia is high on the SW rib and back of the shaft station, about 20 feet from the shaft opening. This breccia is in large, unsorted masses completely lacking any appearance of internal layering and bears no resemblance to a fault breccia. Numerous faults, both high- and low-angle, cut through the breccia (an indication of its old age) and locally juxtapose breccia against unbroken marble. Movement on the faults broke through individual breccia clasts so that angular slivers of the breccia clasts are sandwiched between individual fault strands. These slivers are elongate with their long dimensions parallel to the fault strands and are quite unlike the more equant chunks of collapse breccia from which they were derived.

1100 LEVEL

STATION 1 – Southwest of safety exit, between it and the bulkhead door, at mine coordinates 1425N, 830W.

Note: The faults on this level were measured during the earliest (1989) stages of our fault study. Descriptive detail of their nature is lacking for most of them, especially as compared to faults measured in later years.

Fault no. 1089

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-1	N25W/58SW	S15E (S12E)	20 (15)	(18 SE) (24 SE)

Comments: Graphite-streaked fault surface in marble; slip sense undetermined.

Fault no. 1090

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-2	N35W/60SW	S25E (S25E)	16 (16)	(19 SE) (19 SE)

Comments: Dark, graphite-streaked fault surface in calcite marble. Fibrous accretionary calcite and a dark green film (serpentine?) on the fault surface show that slip sense was right-lateral (hanging wall moved to northwest). This is one of several such faults in this area (see also faults nos. 1089, 1091, 1092), some of which have lenticular voids along them, with openings of several millimeters.

Fault no. 1091

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-3	N30W/60SW	S16E (S21E)	15 (23)	(27 SE) (17 SE)

Comments: Dark, graphite-streaked fault surface in marble; fibrous accretionary calcite on fault surface suggests right-lateral sense of slip.

Fault no. 1092

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-4	N48W/57SW	S27E (S23E)	33 (28)	(34 SE) (40 SE)

Comments: Graphite-streaked fault surface; sense of slip unknown. Minor fluorite coats fault surface.

STATION 2 – Between bulkhead doors and corner, southwest of safety exit, at mine coordinates 1380N, 860W.

Fault no. 1093

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-5	N12E/54NW	S66W (S59W)	45 (48)	(67 SW) (61SW)

Comments: Graphite-streaked and calcite-coated fault surface in marble. Well-developed fibrous accretionary calcite indicates that hanging wall moved up and to the NE. This is one of numerous such faults in the area, all of them minor and closely spaced, only 20-40 cm apart.

Fault no. 1094

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-6	N06W/63SW	S04E (S06W)	22 (04)	(04 SE) (25 SE)

Comments: Dark, mineral-streaked fault surface in marble; sense of slip unknown. Note: The measured bearing is almost coincident with the strike line, making it difficult to tell, in this case, if the slickenside striations plunge toward the north or toward the south. The measured bearing of N04W should have been given as S04E; a bearing of N04W on this fault is impossible (by 2°).

Fault no. 1095

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-7	N19E/31NW	S87W (S87W)	29 (29)	(71 SW) (71 SW)

Comments: Mineral-streaked fault surface; sense of slip unknown. This fault is coated with a soft, silvery mineral, not yet identified (sample taken).

Fault no. 1096

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-8	N51E/72SE	S50E (S66E)	70 (72)	(87 NE) (81 NE)

Comments: Dark, mineral-streaked fault surface; sense of slip unknown.

STATION 3 – Shaft station, at mine coordinates 1275N, 920W.

Fault no. 1097

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-9	N63W/10SW	S22E (S01E)	05 (09)	(43 SE) (64 SE)

Comments: Mineral-streaked and calcite-coated fault surface in marble. Fibrous accretionary calcite indicates upper plate moved to the NW.

Fault no. 1098

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-10	N24W/84NE	N21W (N23W)	13 (27)	(27 NW) (13 NW)

Comments: Mineral-streaked fault surface in marble; sense of slip unknown. This fault cuts through and offsets fault no. 1097 above.

Fault no. 1099

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-11	N41W/70NE	N40W (N39W)	07 (03)	(03 NW) (07 NW)

Comments: Dark, mineral-streaked fault surface, partially coated with calcite. Fibrous accretionary calcite indicates the NE fault block moved to the NW (left-lateral fault).

Fault no. 1100

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-12	N08E/79SE	S69E (S42E)	76 (79)	(87 SW) (81 SW)

Comments: Mineral-streaked fault surface. Hanging wall is downthrown block, but how this was determined was not recorded in our original field notes.

Fault no. 1101

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-13	N07E/62SE	S82E (S83E)	62 (62)	(90) (90)

Comments: Mineral-streaked and calcite-coated fault surface. Fibrous accretionary calcite indicates that hanging wall is downthrown fault block.

Fault no. 1102

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1100-14	N20W/59NE	S26E (S24E)	07 (10)	(12 SE) (08 SE)

Comments: Mineral-streaked fault surface, also coated with fibrous accretionary calcite. Sense of slip was recorded as probably left-lateral, but the evidence for this was not recorded.

1200 LEVEL

STATION 1 – Main haulage drift in footwall of West limb, at approximate mine coordinates 1155N, 850W.

Note: Faults on this level were measured during the earliest stages (1989) of our work in the Sterling Mine. Descriptive detail for many of them is thus sparser than is typical for faults measured later.

Fault no. 1103

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-1	N04E/85SE	S85E (S55E)	84 (85)	(90) (87 SW)

Comments: Graphite-smeared fault surface with minor accretionary calcite in places. Fault no. 1104 below is same fault with different episode of movement.

Fault no. 1104

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-2	N04E/85SE	S03E (S01W)	29 (55)	(55 SW) (29 SW)

Comments: Same fault as no. 1103 above, but a different set of slickenside striations. It was not clear at this locality which was the younger set; the two geologists on the scene reached different tentative conclusions.

Fault no. 1105

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-3	N15E/77SE	S78E (N84E)	76 (77)	(89 NE) (85 NE)

Comments: Prominently mineral-streaked fault surface in calcite marble, also with calcite accretionary fibers on fault surface. Hanging wall is downthrown side. This fault cuts off no. 1106 below and is thus younger.

Fault no. 1106

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-4	N45W/37NE	N56E (N67E)	35 (36)	(81 SE) (72 SE)

Comments: Mineral-streaked fault surface in marble; sense of slip unknown. This fault is older than no. 1105 above, which cuts it off.

Fault no. 1107

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-5	N23E/76SE	S83E (S87E)	75 (75)	(86 NE) (85 NE)

Comments: Mineral-streaked fault surface in marble; hanging wall is downthrown side.

Fault no. 1108

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-6	N26E/90	n.a.	90	(90)

Comments: Mineral-streaked fault surface in marble; southeast side is downthrown block.

Fault no. 1109

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-7	N14E/88NW	S20W (S15W)	30 (72)	(72 SW) (30 SW)

Comments: Prominently mineral-streaked fault surface in marble; sense of slip unknown. Two sets of slickenside striations are present on this fault surface; see fault no. 1110 below for second set. The striae recorded here appear to be the older set, but not definitely so. Minor violet fluorite coats the fault surface. Note: For such a steeply dipping fault the measured bearing is subject to large error, but the plunge is not; thus the measured plunge of 30° is here considered accurate. Nevertheless the measured plunge of 30° calculates to a bearing within 5° of that measured. Going the other way – calculating the plunge from the measured bearing – is definitely not recommended, as even a small error in the bearing measurement results in a large error in the calculated plunge.

Fault no. 1110

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-8	N14E/88NW	N79W (N76W)	88 (88)	(90) (90)

Comments: Prominently mineral-streaked fault surface in marble; same fault as no. 1200-7 above. For this set of striae the southeast side of the fault was downthrown. These striae were stated in our field notes to possibly be younger than those described above, but our evidence for this was not recorded and was deemed "not definite" (note also that the opposite conclusion was reached, on the basis of firm evidence, for faults nos. 1111 and 1112 below). Minor violet fluorite coats the fault surface.

Fault no. 1111

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-9	N01E/88SE	N38E (N17E)	83 (86)	(87 NE) (83 NE)

Comments: Prominently mineral-streaked fault surface in marble. Many of these striae, probably graphite streaked out along the fault surface, are 1-5 mm wide and several centimeters long. The east side of this fault is the downthrown block. Individual graphite streaks are themselves prominently scratched by the fine-scale striae of the second set, described below (fault no. 1200-10).

Fault no. 1112

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-10	N01E/88SE	N06E (N02E)	33 (68)	(68 NE) (33 NE)

Comments: Prominently mineral-streaked fault surface in marble; same fault as described above (fault no. 1200-9). The striae of this set consist of scratches cut into the more steeply plunging graphite streaks described above. Individual striae when examined with a hand lens can be traced from one graphite streak into an adjacent one. These relations suggest the straie of the shallowly plunging set described here are younger than the graphite streaks of the steeply plunging set. For this set, the shallowly plunging striae, the east side of the fault appears to have moved down and to the south (i.e. an oblique right-lateral fault), but this is uncertain.

Fault no. 1113

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-11	N32W/73NE	N62E (N58E)	73 (73)	(86 SE) (90)

Comments: Slightly graphite-streaked and calcite-coated fault surface in marble. Sense of slip unknown.

Fault no. 1114

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-12	N06E/82SE	S44E (S39E)	80 (79)	(83 SW) (82 SW)

Comments: Mineral-streaked fault surface in marble. East side is downthrown block.

Fault no. 1115

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-13	N18E/68SE	N78E (N90E)	67 (65)	(78 NE) (83 NE)

Comments: Fault in marble. Well-defined accretionary calcite on fault surface shows clearly that the hanging wall (east side) moved down.

Fault no. 1116

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-14	N07E/83SE	S02W (S10E)	67 (36)	(36 SW) (68 SW)

Comments: Fault in marble; slip sense unknown.

Fault no. 1117

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-15	N42E/57NW	N15E (N17E)	33 (35)	(43 NE) (40 NE)

Comments: Mineral-streaked fault surface in marble, encrusted with fibrous accretionary calcite. Our field notes indicate that the hanging wall moved down and to the northeast (oblique right-lateral fault), but the evidence for this conclusion, and our degree of confidence in it, were not recorded.

General comment on faults at this station: As shown by the data above, many of the faults in this area have N to NNE strikes and steep SE dips. These faults have somewhat curved surfaces, especially so in dip. Some are quite small, only 1-2 m in vertical extent, and they are fairly tight, with little void space along them. The faults are locally anastomosing and in places are spaced only 10-20 cm apart. Thin coatings of fluorite are seen on many of them. *Note:* Offsets of mineral layers of several cm to 10 cm were commonly observed along faults of this set and confirm that the southeast side is the downthrown block.

STATION 2 – Near entrance to shaft station on north side, within a triangular area with corners at mine coordinates 1305N, 930W; 1345N, 930W; and 1320N, 905W.

Fault no. 1118

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-16	N27E/71NW	N08W (N16E)	30 (59)	(65 NE) (32 NE)

Comments: Mineral-streaked fault surface in marble. Well-developed fibrous accretionary calcite on fault surface clearly indicates hanging wall (west side) moved north and up (oblique right-lateral fault).

Fault no. 1119

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-17	N37E/65SE	S34E (S53E)	65 (64)	(82 SW) (90)

Comments: Fault in marble. Sense of slip uncertain, but hanging wall appears to be the downthrown block. This fault appears to cut across and slightly offset fault no. 1118 above, but this is not definite.

Fault no. 1120

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-18	N64W/64SW	S19W (S08W)	63 (64)	(87 SE) (82 SE)

Comments: Mineral-streaked fault surface in marble. Fibrous accretionary calcite on fault indicates hanging wall is the downthrown block.

Fault no. 1121

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-19	N21E/85SE	N55E (N34E)	68 (81)	(83 NE) (69 NE)

Comments: Mineral-streaked fault surface in marble. Calcite accretionary fibers suggest that east block of fault is the downthrown side. This fault definitely offsets fault no. 1123 below.

Fault no. 1122

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-20	N16W/70SW	Due S (S05E)	28 (37)	(40 SE) (30 SE)

Comments: Striae on this fault appear to be mechanical scratches on fault surface. The hanging wall appears to have moved up and to the north, but the slip sense here is quite doubtful. However, this fault clearly offsets fault no. 1121 described above and is definitely younger.

Fault no. 1123

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-21	N82E/25NW	N29W (N50W)	19 (24)	(71 SW) (51 SW)

Comments: Mineral-streaked fault surface in marble. Calcite accretionary fibers indicate upper plate moved to the NW. This fault is offset by no. 1121 above and probably by no. 1124 below and thus appears to be the oldest of the three.

Fault no. 1124

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-22	N61W/55SW	S21W (S14W)	54 (55)	(86 SE) (81 SE)

Comments: The hanging wall of this fault is the downthrown block, but no particulars were recorded. This fault crosscuts fault no. 1121 and is probably, but not definitely, younger than it.

Fault no. 1125

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-23	N13W/68NE	---	---	---

Comments: No striations are visible on this fault with certainty, but this fault cuts through no. 1124 above and resulted in 2 cm of normal dip separation along it. This is one of the youngest faults here and is one member of numerous such faults.

Fault no. 1126

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-24	N50E/73SE	S23E (S20E)	72 (72)	(85 SW) (84 SW)

Comments: Mineral-streaked fault surface in marble. Calcite accretionary fibers on fault surface indicate hanging wall moved down.

Fault no. 1127

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-25	Horizontal	N52W	00	n.a.

Comments: Fault in back; not measurable but nearly horizontal. Sense of slip uncertain, but striae on fault surface are clearly defined.

Fault no. 1128

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-26	N29E/73NW	S47W (S64W)	62 (45)	(48 SW) (67 SW)

Comments: Mineral-streaked fault surface in marble. Calcite accretionary fibers suggest that hanging wall (NW side) moved up and to the NE.

STATION 3 – At safety exit, to both sides of door and on both ribs of drift, north of shaft station, along main haulage drift in footwall of West limb, at approximate mine coordinates 1470N, 850W.

Fault no. 1129

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-27	Horizontal	N28W	00	n.a.

Comments: Fault in back; not measurable but nearly horizontal. Accretionary calcite on fault is in places at least 1 cm thick and suggests that upper plate moved NW.

Fault no. 1130

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-28	N35E/80SE	S42E (S49E)	80 (80)	(88 SW) (89 SW)

Comments: Mineral-streaked fault surface in marble. The hanging wall (SE side) probably is the downthrown block, but no particulars were recorded.

Fault no. 1131

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-29	N14E/47SE	S52E (S43E)	42 (44)	(73 SW) (66 SW)

Comments: Dark, mineral-streaked fault surface in marble. Sense of slip unknown.

Fault no. 1132

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-30	N22E/89NW	N44W (N05W)	88 (89)	(89 NE) (88 NE)

Comments: Mineral-streaked fault surface in marble. NW side of fault probably is the upthrown block, but no particulars were recorded for this fault.

STATION 4 – About 120 ft east of safety exit, in drift in hanging wall of West limb leading to stopes in the cross member, at mine coordinates 1470N, 715W.

Fault no. 1133

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-31	N67W/67SW	N67W	00	00

Comments: Large fault extending across the back and both ribs. The fault is undulatory along its dip, and slip along it has opened numerous lenticular voids, many 2-5 mm wide at their widest points, but some up to 2 cm. Dip separation across this fault appears to be about 3 cm. Accretionary calcite on fault indicates hanging wall moved to the NW (right-lateral slip). Minor brecciation occurred as a result of movement, and the hanging wall is cut by numerous small antithetic faults 2-5 cm long. This is one of several such faults in this area, all of similar character and with poorly developed slickenside striations.

Fault no. 1134

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-32	N36W/20NE	S61E (S88E)	16 (09)	(26 SE) (54 SE)

Comments: Calcite accretionary fibers on fault surface, fully 3-6 cm thick, clearly indicate that the upper plate of this fault moved to the NW. Two measurements were made of slickenside striations on this surface (16/S58E, 16/S64E), the average of which is given above.

Fault no. 1135

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-33	N57W/58SW	---	---	---

Comments: Fault surface is coated with accretionary calcite and chlorite(?), and shows a right-lateral offset of about 12 cm as measured on several compositional layers in the marble. No slickenside striations were visible on this fault to determine a slip vector. This right-lateral fault offsets the low-dipping fault no. 1136 below and is thus younger.

Fault no. 1136

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-34	N40W/08NE	S64E (S79E)	05 (03)	(24 SE) (39 SE)

Comments: Fibrous accretionary calcite 2-3 cm thick on fault indicates upper plate moved to NW. This fault is offset about 12 cm by fault no. 1135 above and is thus older.

Fault no. 1137

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-35	N47W/52SW	N48W (N51W)	05 (03)	(02 NW) (06 NW)

Comments: Fault surface is coated with fibrous accretionary calcite and a pale green mineral resembling chlorite (later note: probably serpentine); the accretionary calcite indicates right-lateral movement. This fault offsets fault no. 1138 below, confirming the age relationship of the pair 1135 and 1136 above.

Fault no. 1138

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-36	N05E/08SE	S58E (S34E)	05 (07)	(63 SW) (39 SW)

Comments: Fibrous accretionary calcite 1-3 cm thick coats fault surface and indicates that upper plate moved to the NW. This fault is offset by no. 1137 above. Note: For such a low-dipping fault, the measured bearing is to be trusted much more than that calculated from the measured plunge.

STATION 5 – Backfilled stope along subdrift leading to cross member, at mine coordinates 1525N, 715W.

A mylonite zone 25-30 cm thick is exposed here. Two readings on overall orientation of zone: N20E/52SE, N37E/60SE. S-C relationships here suggest reverse sense of slip during mylonite formation, but these appear neither consistent nor convincing. The first two faults listed below merge with the base of the mylonite zone but are younger faults indicative of brittle failure.

Fault no. 1139

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-37	N42E/88SE	S12W (S15W)	85 (86)	(86 SW) (85 SW)

Comments: Fault is filled with calcite and fibrous tremolite(?) 1 mm – 3 cm thick, but sense of slip was not determinable. This fault merges with the base of the older mylonite zone.

Fault no. 1140

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-38	N38E/85NW	N09W (N09W)	83 (83)	(85 NE) (85 NE)

Comments: Fibrous accretionary calcite in fault is 3 mm – 1.5 cm thick and suggests SE side of fault is downthrown.

Fault no. 1141

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-39	N13E/84NW	(N43W)	83 N	(86 NE)

Comments: Fibrous accretionary calcite as much as 0.5 cm thick within the fault suggests that the SE side is downthrown. *Note:* As stated below for a nearby fault, the rock here is magnetic, and the measured bearing of N11E is quite at odds with a plunge of 83°. Inasmuch as the plunge is not affected by magnetism, and is likely to be an accurate number, it was used for calculation of the bearing.

Fault no. 1142

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-40	N07E/73NW	(N48W)	72 N	(86 NE)

Comments: Accretionary calcite is present on the fault, but its sense of slip could not be determined. The slickenside striations pitch steeply on the fault surface (as indicated by the plunge reading being nearly equal to the dip), but the rock is magnetic, so the bearing of the striations could not be measured. An attempted measurement yielded a bearing of S06W, obviously in error; the bearing must instead be determined by construction.

STATION 6 – Subdrift entrance to cross member stopes on west side, at mine coordinates 1310N, 800W.

Fault no. 1143

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-41	N70E/73SE	S36E (S40E)	72 (72)	(85 NE) (84 NE)

Comments: This is a large, nearly planar fault zone exposed for 7-8 m along strike and extending from the sill to the back. Marble within the fault zone appears fine-grained and highly sheared within a zone at least 15-20 cm thick; on foliation surfaces parallel to the fault the marble is prominently lineated. Sense of slip undetermined.

Fault no. 1144

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-42	N03W/27NE	S57E (S43E)	18 (22)	(57 SE) (43 SE)

Comments: Mineral-streaked (probably graphite) fault surface in marble. Amount of slip is indicated by length of the individual streaks, about 10-12 mm. Sense of slip not determined.

Fault no. 1145

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-43	N30E/39SE	S50E (S45E)	38 (39)	(82 SW) (78 SW)

Comments: Minor fault with mineral-streaked surface; sense of slip unknown.

Fault no. 1146

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-44	N44E/81NW	N29W (N18W)	80 (81)	(88 NE) (86 NE)

Comments: Minor fault with mineral-streaked surface; sense of slip unknown. Individual streaks 2-4 cm long indicate amount of slip on fault.

Fault no. 1147

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-45	N02W/15NE	S35E (S24E)	07 (10)	(34 SE) (23 SE)

Comments: Mineral-streaked fault surface in massive marble. Step faces in a pale green, fibrous to splintery mineral (probably serpentine) that locally coats the fault surface suggest upper plate moved to the NW.

Fault no. 1148

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-46	N47E/83SE	S30E (S13E)	82 (83)	(88 SW) (86 SW)

Comments: Minor, mineral-streaked fault surface in marble; streaks 1-2 cm long indicate amount of slip. This fault locally cuts through the low-dipping fault no. 1147 above and is younger. Parts of this fault, however, terminate against no. 1147, and as that fault is approached the length of the mineral striations approaches zero. Interesting relation, a minor fault only partially cutting through a pre-existing fault because the amount of slip was so small.

STATION 7 – East limb of ore near keel, at approximate mine coordinates 780N, 660W.

Fault no. 1149

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-47	N66E/48SE	S05E (S02E)	46 (46)	(77 SW) (75 SW)

Comments: Fault in lean franklinite-calcite ore with minor willemite. Dark minerals streaked out on fault surface define the slickenside striations, but sense of slip could not be determined.

Fault no. 1150

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-48	N47E/48SE	S18E (S13E)	44 (45)	(73 SW) (69 SW)

Comments: Fault in lean franklinite-calcite ore with minor willemite. Dark minerals streaked out on fault surface define the slickenside striations, but sense of slip could not be determined.

Fault no. 1151

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-49	N65W/51NE	S70E (S71E)	08 (06)	(08 SE) (10 SE)

Comments: Scratched and lightly polished fault surface in very lean franklinite-calcite ore; sense of slip not determined.

STATION 8 – East limb drift about 20 ft S of 1040 crosscut, at mine coordinates 1020N, 470W.

Fault no. 1152

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-50	N05E/57SE	S36E (S41E)	48 (45)	(58 SW) (62 SW)

Comments: Nearly planar fault, but locally branching, in franklinite-calcite ore of moderate grade. Scratches in the fault surface define the slickenside striations, but sense of slip could not be determined.

Fault no. 1153

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-51	N59E/63SE	S15E (S02E)	60 (62)	(83 SW) (76 SW)

Comments: Minor fault, sinuous, with trace length of only 1.2 m, in coarse-grained calcite marble with minor franklinite. Scratched fault surface, but sense of slip undetermined. Exposed in back.

STATION 9 – 1200 crosscut, at mine coordinates 1200N, 460W, opposite subdrift leading northward to stopes in cross member.

Note: This is a locality that furnished specimens of axinite-(Mn) and heulandite; see fault below.

Fault no. 1154

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-52	N11E/63SE	---	---	---

Comments: Probable fault parallel to well-developed compositional layering in gneiss. The presumed fault was later etched out by solution and then mineralized, so is now represented by a zone 1-6 cm thick of white, coarse-grained, blocky calcite which opens locally into small pockets containing well-crystallized axinite, heulandite, and fluorite. Solution to create the voids and later mineralization to partly fill them destroyed any evidence of the original fault surface, and the orientation of the fault parallel to compositional layering prevented determination of slip amounts and sense.

STATION 10 – 1020 stope, about 20 ft above 1200 level (John Kolic's magnussonite locality). Mine coordinates for this locality, as given by Kolic and Sanford (1993), are 1075N, 750W.

Fault no. 1155

Field no.	Fault Orientation	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-53	N69W/32NE	S72E (S72E)	02 (02)	(04 SE) (04 SE)

Comments: Planar to gently sinuous fault with a very smooth, almost polished surface. This is the fault that contains magnussonite. Slickenside striations on the fault are subtle and amount to little more than a subdued streaked appearance in colors of red, black, brown, and white on the fault surface. The fault here cuts moderate-grade, salt-and-pepper, franklinite-willemite-calcite ore. This is the largest fault in the local area and can be followed up both ribs and across the back of the stope. The fault offsets the steeply dipping ore-marble contact about 1.5 m, and the sense of offset suggests the upper plate of this fault moved to the NW. Mineral grains in the wallrock are very nearly undeformed right up to the fault surface; there is only a narrow zone of deformation here.

Reference for paper cited above: Kolic, J. and Sanford, S. (1993), *Recent mineral finds from the Sterling mine, Ogdensburg, New Jersey.* The Picking Table, vol. 34, no. 2, p. 12-21.

Fault no. 1156

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-54	N87E/37NW	N79W (N81W)	09 (10)	(17 SW) (15 SW)

Comments: Another segment of the same fault (1155) above, in the same rock type, but measured 2.5 m to the south. The character of the fault is the same as described above; sense of slip not determined.

Fault no. 1157

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-55	N86W/68NE	N18E (N34E)	65 (67)	(85 SE) (78 SE)

Comments: Minor fault, undulatory in dip, in ore. The fault surface is lightly coated with calcite and is furrowed parallel to the calcite fibers; the furrows have wavelengths of about 2 cm and amplitudes of about 0.5 cm. Trace length 3 m on rib. Sense of slip not determined.

Fault no. 1158

Field no.	**Fault Orientation**	**Bearing** (slickenlines)	**Plunge** (slickenlines)	**Pitch** (slickenlines)
1200-56	N39W/44SW	S52W (S73W)	42 (44)	(89 NW) (74 NW)

Comments: Mineral grains that have been lightly smeared onto the fault surface define slickenside striations here. Most of the fault is *not* so striated; instead the striations occur in ill-defined zones about 3-10 cm wide that pitch only gently on the fault surface. The striated zones are thus about perpendicular to the striae themselves. In detail the fault is seen to be composed of *en echelon* segments, each of which dips SW-ward a little more steeply than the mean fault surface. These surfaces are striated, but the rock-cut step faces between them, which face upward on the footwall, are not. Sense of slip not determined at the time, but our experience with such features elsewhere (and later) suggests this is a reverse fault.

--- END ---