SUPERCONDUCTING SUPER COLLIDER: APPENDIX: PETROGRAPHY AND PHOTOMICROGRAPHS

by

Henry S. Brown

NORTH CAROLINA GEOLOGICAL SURVEY
OPEN-FILE REPORT 97-3

DIVISION OF LAND RESOURCES
DEPARTMENT OF ENVIRONMENT, HEALTH
AND NATURAL RESOURCES

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DIVISION OF LAND RESOURCES
Charles H. Gardner,
Director and State Geologist

1997

State of North Carolina

James B. Hunt, Jr., Governor

Department of Environment
Health and Natural Resources
Jonathan B. Howes, Secretary

PREFACE

During 1986 - 1988 the North Carolina Geological Survey (NCGS) conducted geologic investigations to prepare a bid to host the Superconducting Super Collider (SSC), the World's largest atomic particle accelerator. Preparation of the State's bid involved many State agencies and included investigations on the geology and geotechnical characteristics of the proposed site. The geologic information in this open-file report is being released to make available the results of work performed by the North Carolina Geological Survey during the SSC project.

The North Carolina proposal was among the final short list of 7 states and finished behind the eventual winner, Texas. The United States' Congress subsequently stopped funding for the project, and after initial construction startup, the project was discontinued.

Project files for the Superconducting Super Collider are stored at the North Carolina Geological Survey office at 512 N. Salisbury Street (Archdale Building), Raleigh, NC 27604-1148. Telephone (919) 733-2423. Core from the project are stored at the NCGS Coastal Plain office and core storage facility at 4100 Reedy Creek Rd., Raleigh, NC 27607. Telephone (919) 733-7353.

PAC

State of North Carolina

Superconducting Super Collider

February, 1988

Appendix: Petrography and photomicrographs

Office of the Governor
State of North Carolina
Raleigh, NC 27611

Age and Status of Faults Observed in Bedrock at the Proposed North Carolina Site for the Superconducting Super Collider

Faults, variously described as consequences of shearing, fracturing and brecciation, are observed at several locations and in different rock types within the area in North Carolina proposed for locating the superconducting super collider. A review of all available literature and core logs of borings and a study of 21 thin sections of core drilled from bedrock along the proposed route of the SSC tunnel and support facilities indicates the following conclusions can be made concerning the age and status of faults in that location.

Nature and Sequence of Faulting

The oldest faults are ductile shears. Literature indicates that such faulting accompanied creation of the Virgilina synclinorium and occurs primarily along its axis. Shearing was observed in core from one drill hole (SC-12) in the Moriah pluton. This shear is a minor component of a "badly broken zone". Faulting in this plutonic body is located primarily in its border zone and has been described as autoclastic - probably associated with intrusive activity.[1] No other shear zones have been documented in the proposed SSC site. Ductile shear zones have been noted at widely spaced localities throughout the southeastern Piedmont crystalline terrane and have been studied intensely in nuclear power plant site investigations.[2] They have been interpreted to have formed under high confining pressure and/or at elevated temperatures. Brittle deformation exemplified by breccia and microbreccia zones followed ductile shearing and suggests deformation under lowered pressure and/or temperature conditions. The third type of faulting observed in bedrock at the North Carolina proposed SSC site is simple fracturing with relatively minor offsetting of earlier shear and breccia zones. For example, an epidotized breccia zone offset by simple faulting is shown in photomicrograph SC-12, 106.7'. Finally, fracturing that is simple dilation, perhaps more properly identified as jointing, cuts all 3 earlier fault types described above. (e.g., photomicrographs, SC-12,118.5', SC-12, 143.6' and SC-18A, 178.3').

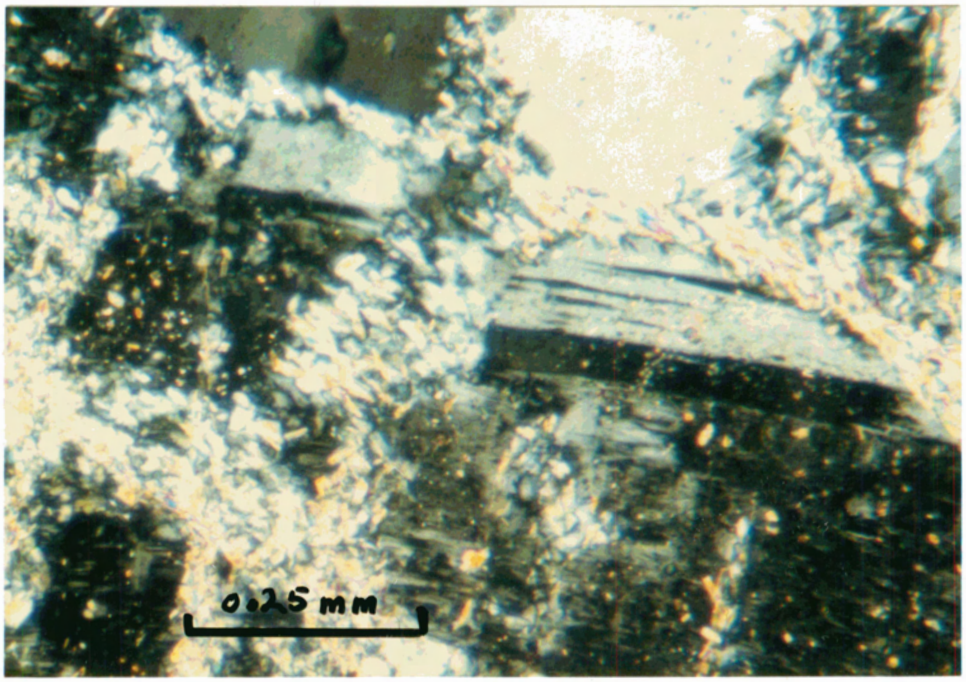
[1] McConnel, K.I. and Glover, Lynn, 1982, Age and Emplacement of the Flat River Complex, and Eocambrian Sub-volcanic pluton near Durham, North Carolina: G.S.A. Spec. Paper 191, p. 133-142.

[2] Gilbert, N.J., Brown, H.S., and Schaeffer, M.F., 1982, Structure and Geologic History of a Part of the Charlotte Belt, South Carolina Piedmont: Southeastern Geology, Vol. 23, p. 129-145.

Age and Status of Faults

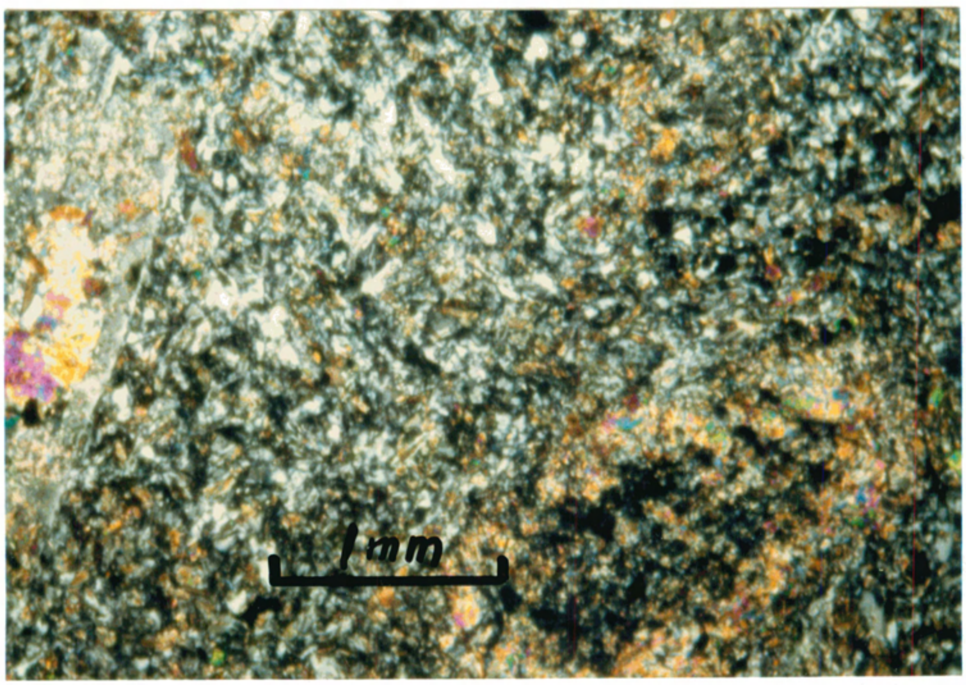
Thin section studies conducted on core drilled from the North Carolina proposed SSC site confirms field mapping observations and literature conclusions that all faulting at the site occurred prior to mid Paleozoic greenschist-rank regional metamorphism. Examination of accompanying thin section photomicrographs will show that all shear, breccia and simple faults have been filled in by, or served as the locus of, the greenschist-rank metamorphic minerals quartz, epidote, white mica and chlorite. Simple dilation or joint fractures that cut all other types of faults are filled primarily by calcite with minor quartz and chlorite - the somewhat "cooler-temperature" members of the greenschist facies group of minerals. There is no evidence that any faulting has occurred subsequent to dilation fracture infilling by calcite, chlorite and quartz. The general sequence of faulting (type and age) and fault healing observed at this proposed SSC site is similar to that noted elsewhere in the southeastern piedmont.[2]

[2] Ibid.



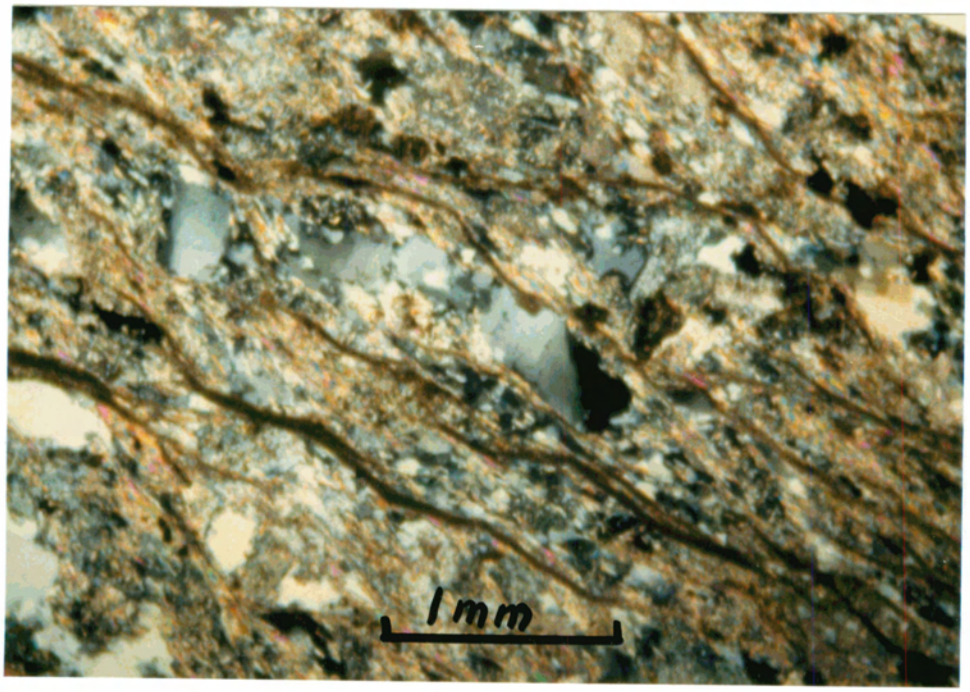
Core from granite (SC-4, 143.7')
(crossed nicols)

This plutonic rock was somewhat strained followed by incipient greenschist-rank metamorphism. Essential minerals are microcline, plagioclase and quartz. Much white mica and minor calcite is developed primarily along grain boundaries.



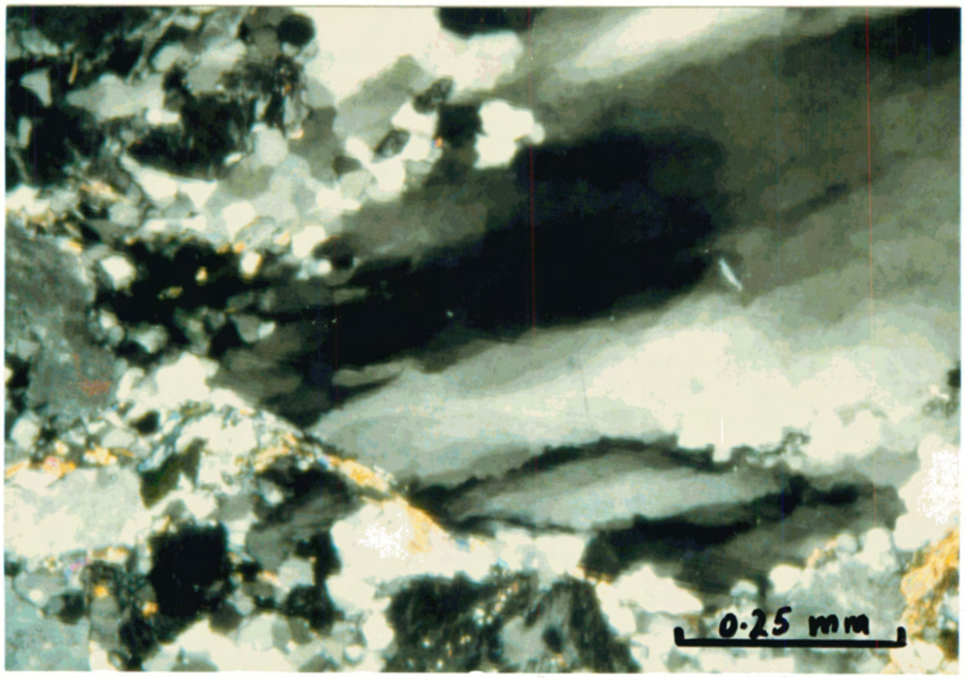
Core is from metabasalt porphyry (SC-5, 70.1')
(crossed nicols)

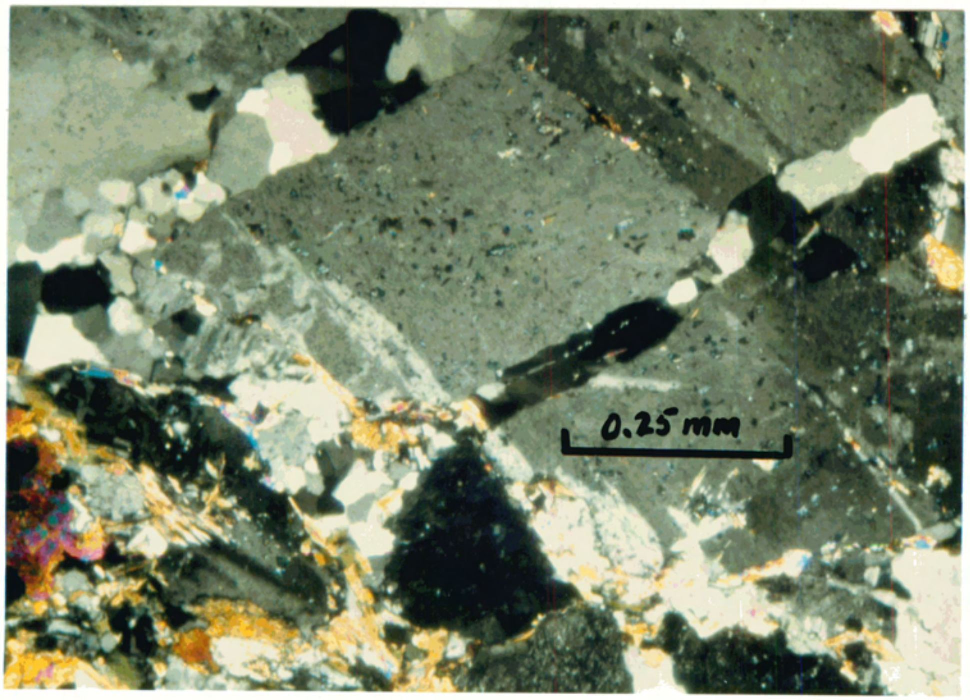
This is a typical view of the greenschist-rank alteration superimposed on a porphyritic basalt. Essential minerals are plagioclase, biotite and epidote. The latter two minerals are secondary. Other minerals include hornblende, chlorite, white mica, sphere and opaque minerals.



Core from rhyolitic metatuff (felsic) (SC-6, 82.4')
(crossed nicols)

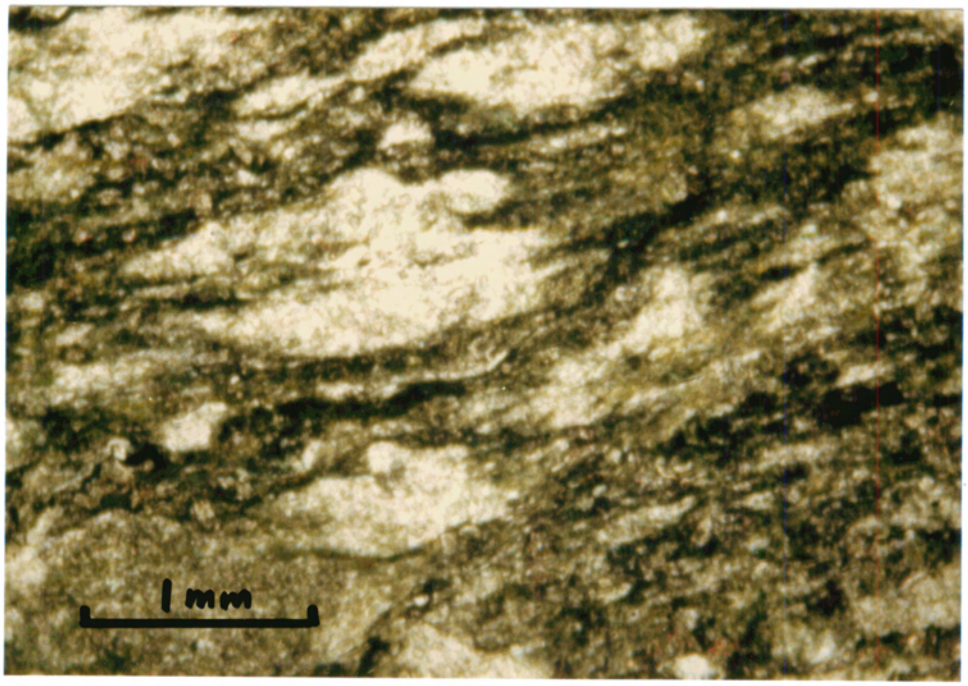
Feldspars, much altered to white mica, and quartz with chlorite-lined, undulatory seams are seen in this dynamically metamorphosed felsic volcanic tuff. Secondary minerals, mica, calcite and chlorite are greenschist-rank metamorphic minerals.





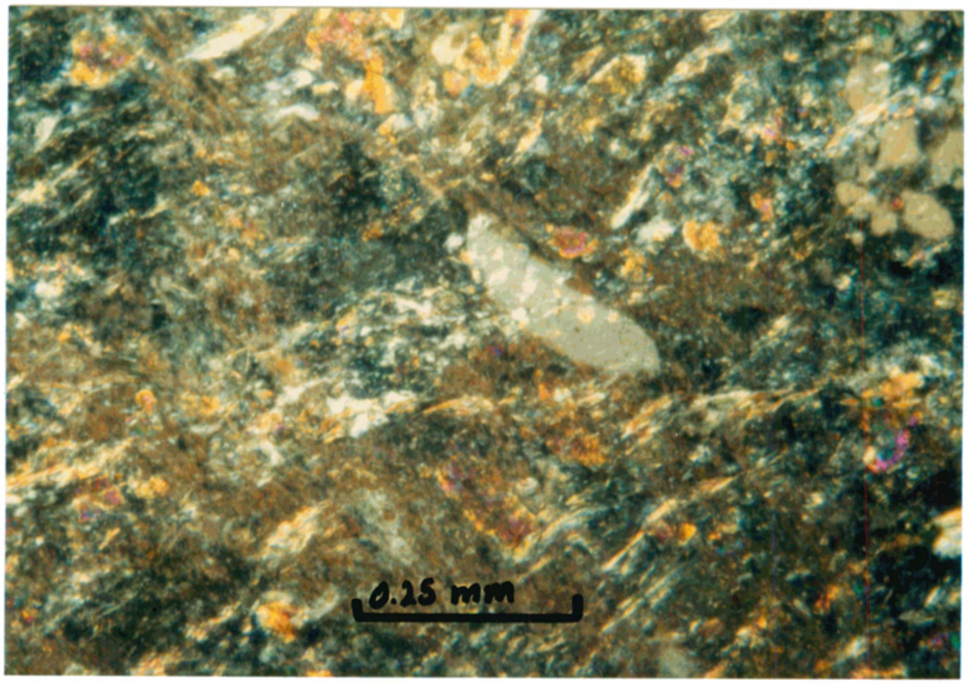
Core from Roxboro Granite pluton (SC-7, 255.3')
(crossed nicols)

This rock has been strained and recrystallized. The top view shows strained quartz partially polygonized through recrystallization. The bottom photo shows thin, irregular fractures (non-offsetting) along which quarts and white mica have been developed.



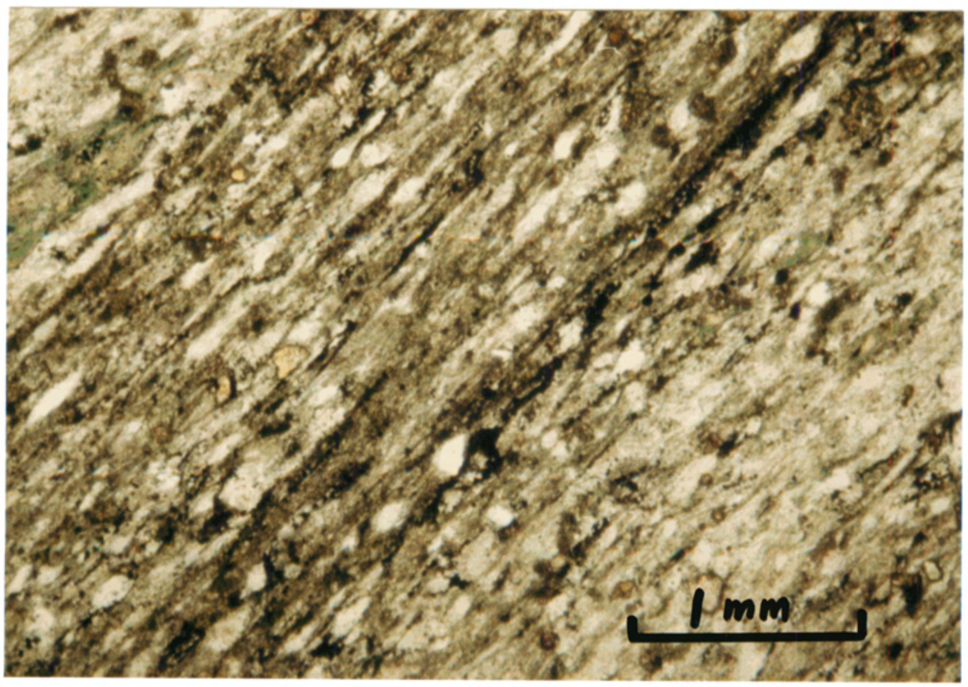
Core from Schistose mafic metatuff (SC-8, 169.6')
(plain polarized light)

This section shows effect of dynamic, regional metamorphism to the greenschist rank on a mafic tuff conglomerate. There is extensive development of epidote and chlorite.



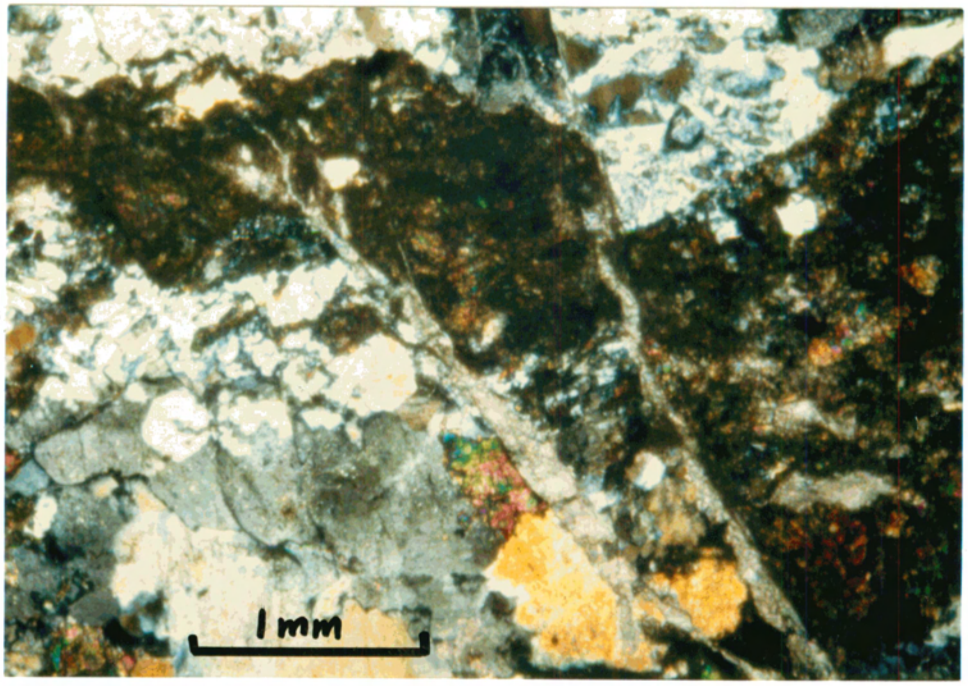
Core from schistose crystal metatuff (SC-9, 188.5')
(crossed nicols)

Extensive development of epidote and micaceous minerals (that impart directional fabric) in an intermediate composition crystal (vitric?) metatuff.



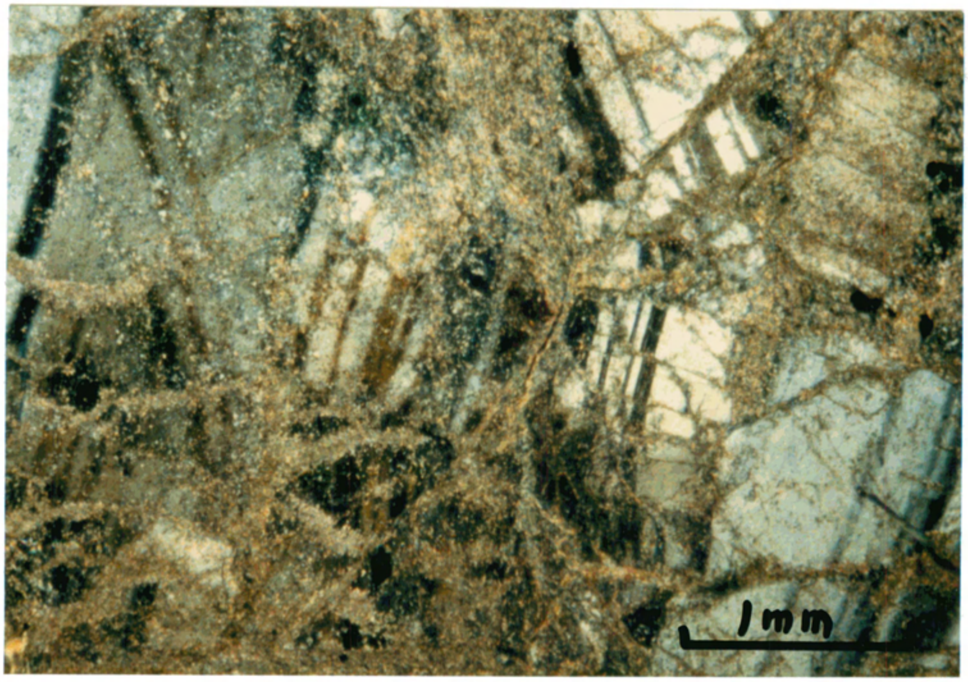
Core is from a phyllitic, felsic tuffaceous siltstone (SC-10, 159.4')
(plain polarized light)

This sample of metasiltstone shows schistosity developed parallel to bedding. The rock is composed essentially of white mica, chlorite and quartz.



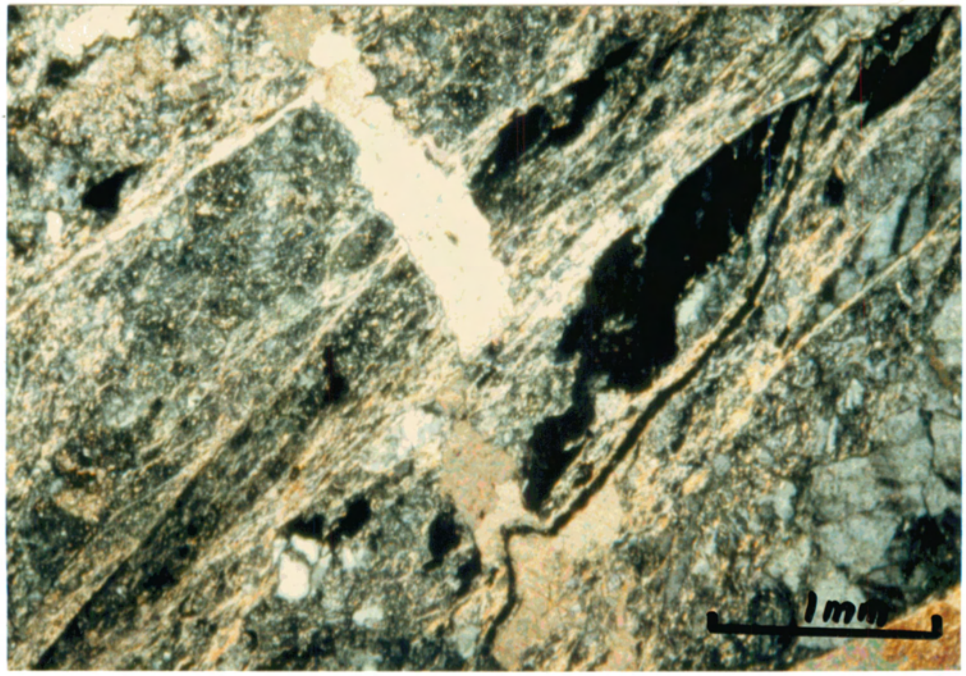
Core from disturbed rock in Moriah pluton (SC-12, 106.7)
(crossed nicols)

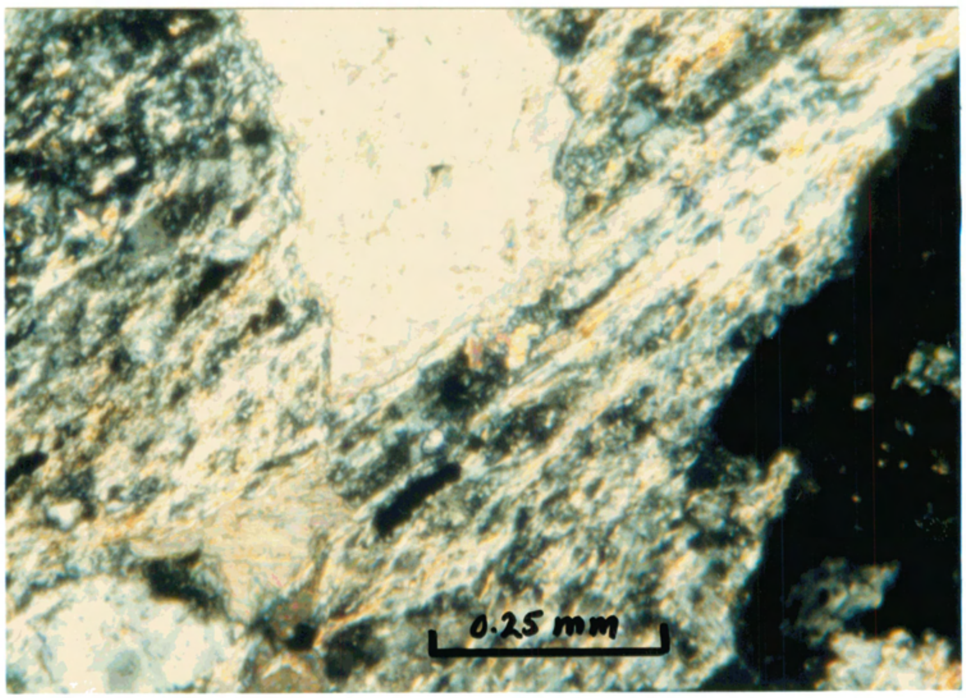
This section contains an old brecciated zone that controlled location for extensive development of epidote. Later the epidotized breccia zone was cut and somewhat offset by minor, simple fractures. Finally, calcite veinlets developed along the simple fractures. No faulting has occurred subsequent to calcite veining.



Core from "badly broken zone" in Moriah pluton (SC-12, 118.5')
(crossed nicols)

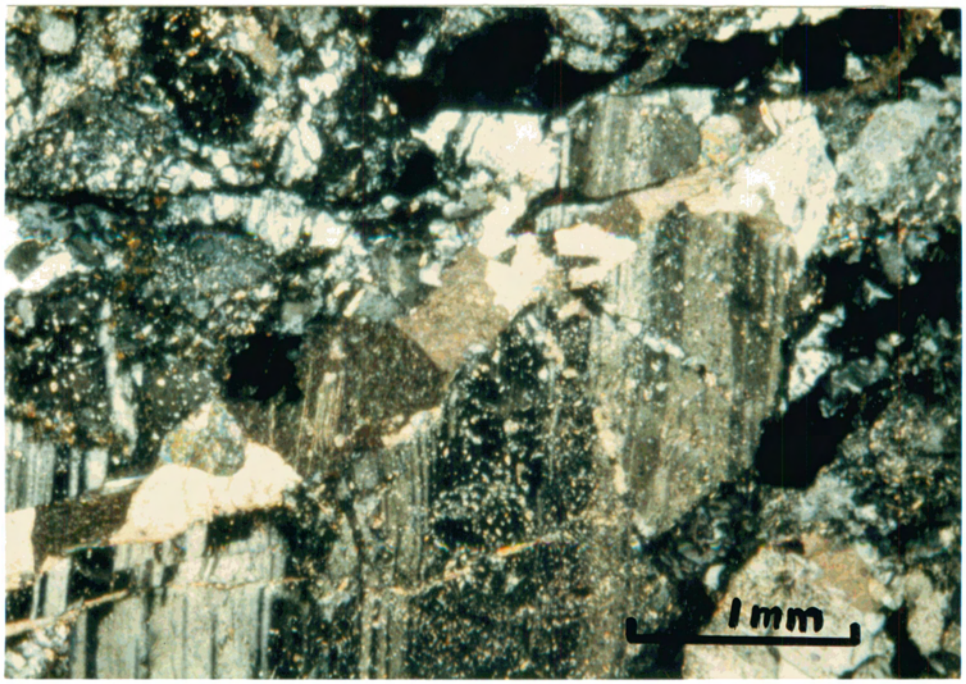
This section shows brecciated plagioclose (black and white laths) crystals in the rock that, subsequent to brecciation, were "healed" by growth of white mica along fracture planes. Note that some mica is also developed within plagioclose grains showing the general pervasiveness of the greenschist-rank metamorphic event that followed fracturing.





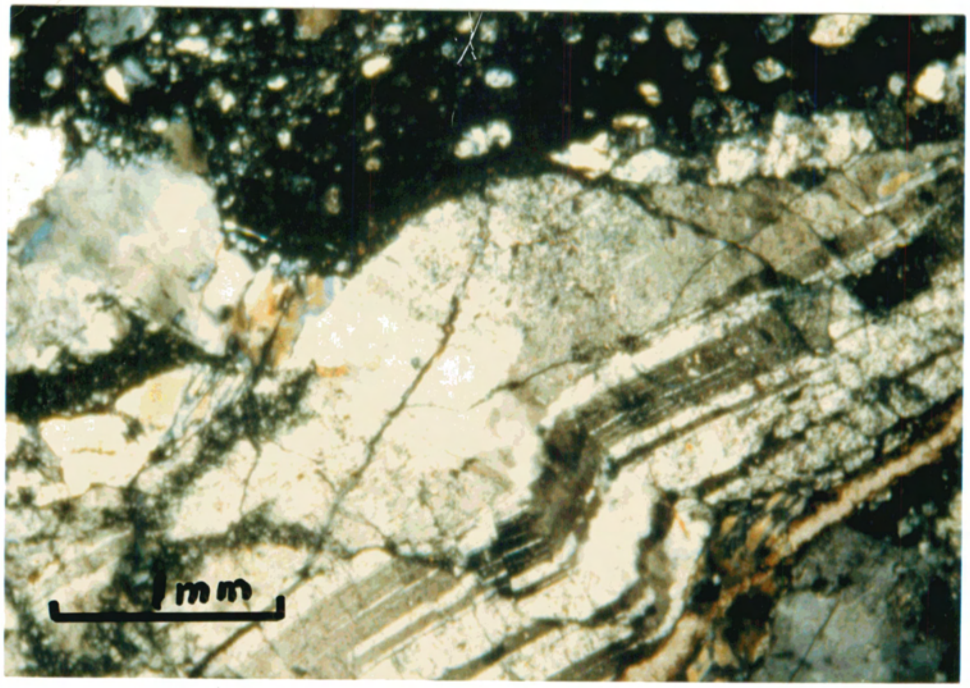
Core from "badly broken zone" in Moriah pluton (SC-12, 118.5')
(crossed nicols)

This section shows a small shear zone with white mica developed along shear planes. Following white mica development, dilational fracturing (jointing?) cut across the older shear zone. Finally, calcite filled in the cross-cutting fracture and some of the older shear planes. The calcite vein makes a right-lateral job at one of the shear planes (mid photo) but it is not faulted at that point.



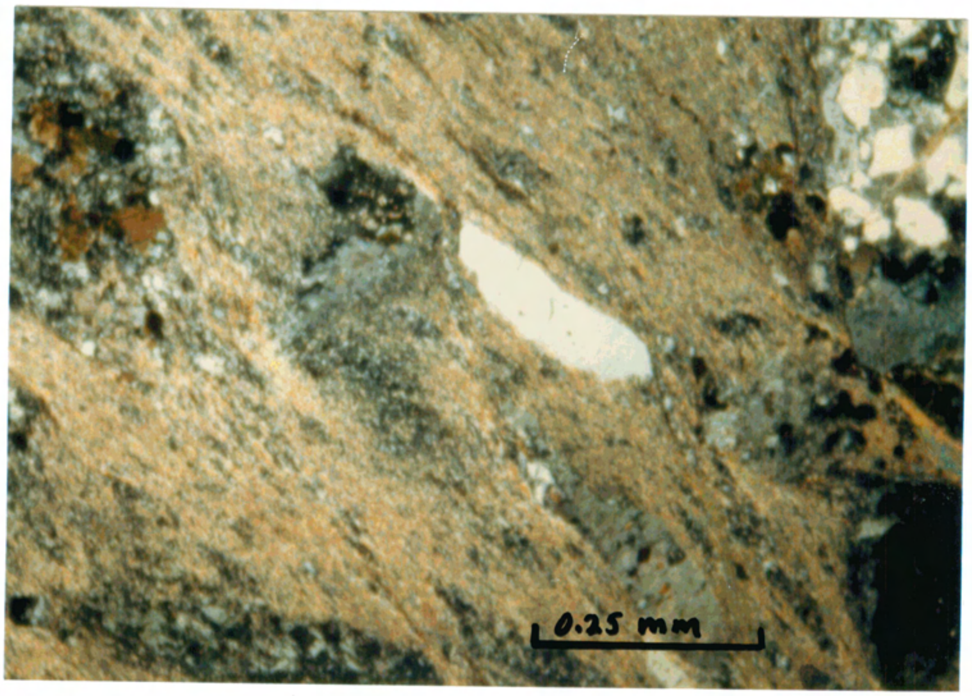
Core from disturbed rock in Moriah pluton (SC-12, 143.6')
(crossed nicols)

This section shows an irregular calcite vein cutting across an old breccia zone. No faulting or fracturing has affected this rock subsequent to development of the calcite vein.



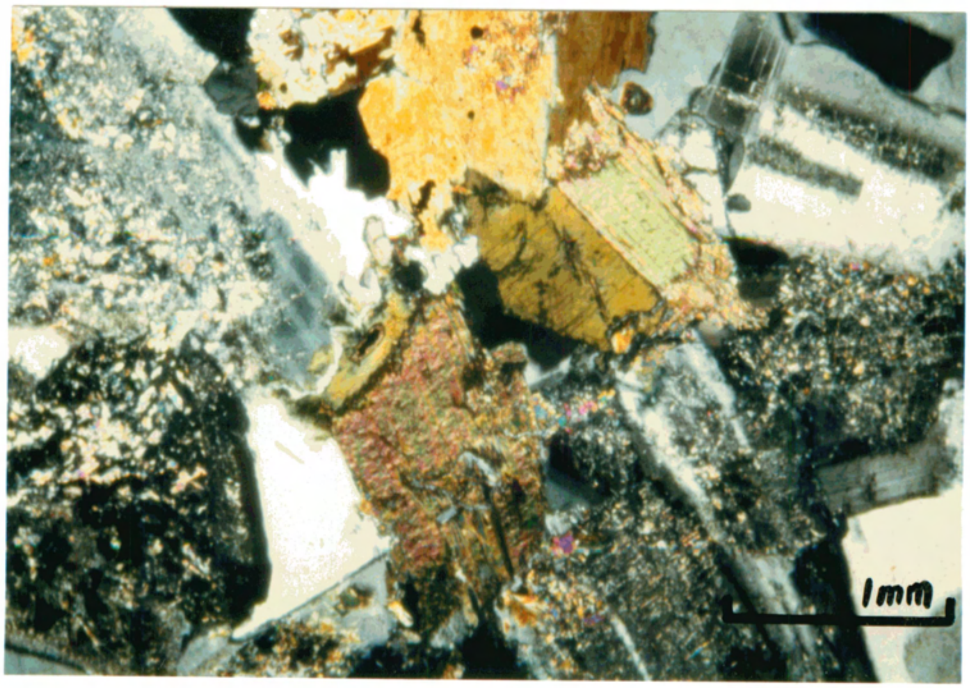
Core from disturbed rock in Moriah pluton (SC-12, 175.5')
(crossed nicols)

This section shows three tectonic episodes, each followed (and healed) by greenschist-rank mineral development. The first event was brecciation (dark zone at top) and subsequent development of fine-grained epidote. The second event was fracturing, with only minor offsetting, that crossed the braccia zone and adjacent rock. The minor offset shows up in the displaced twin lamellae (black and white strips) in the large plagioclase crystal in the lower middle of the photo. This fracturing controlled the later development of a quartz vein that is well-developed on each side but does not completely penetrate the plagioclase grain. A final dilational fracture formed along the lower right margin of the plagioclase grain and cut across the quartz vein. This final fracture was later filled with calcite. (salmon-colored)



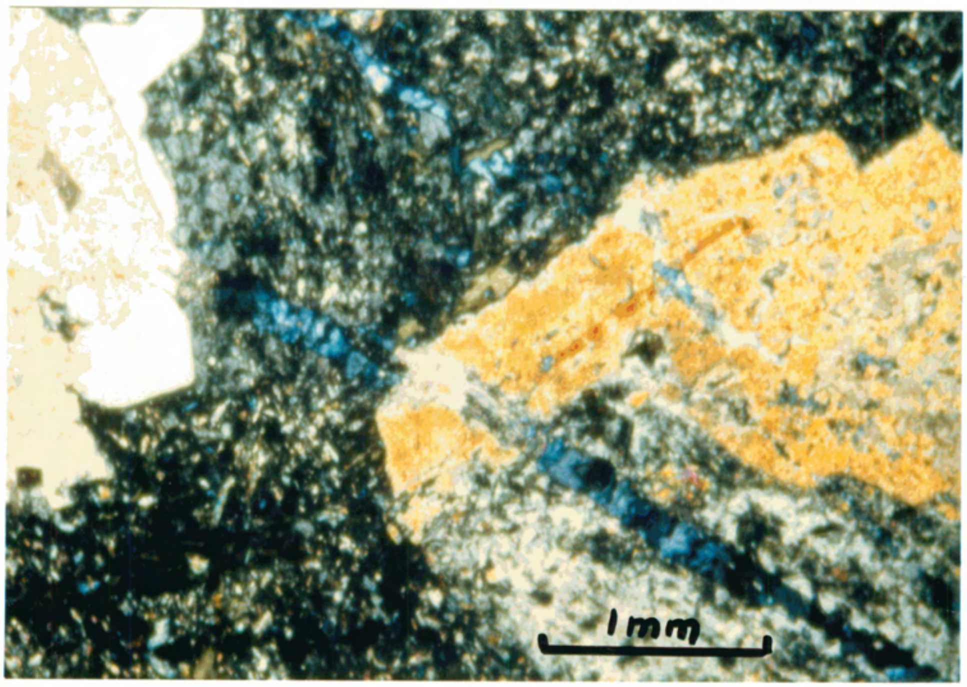
Core from lithic-crystal-vitric ? metatuff (SC-13, 134.5')
(crossed nicols)

This schistose rock contains fragments of various rocks as well as crystals and possible (devitrified) glass shards. Schistosity is defined by oriented white mica.



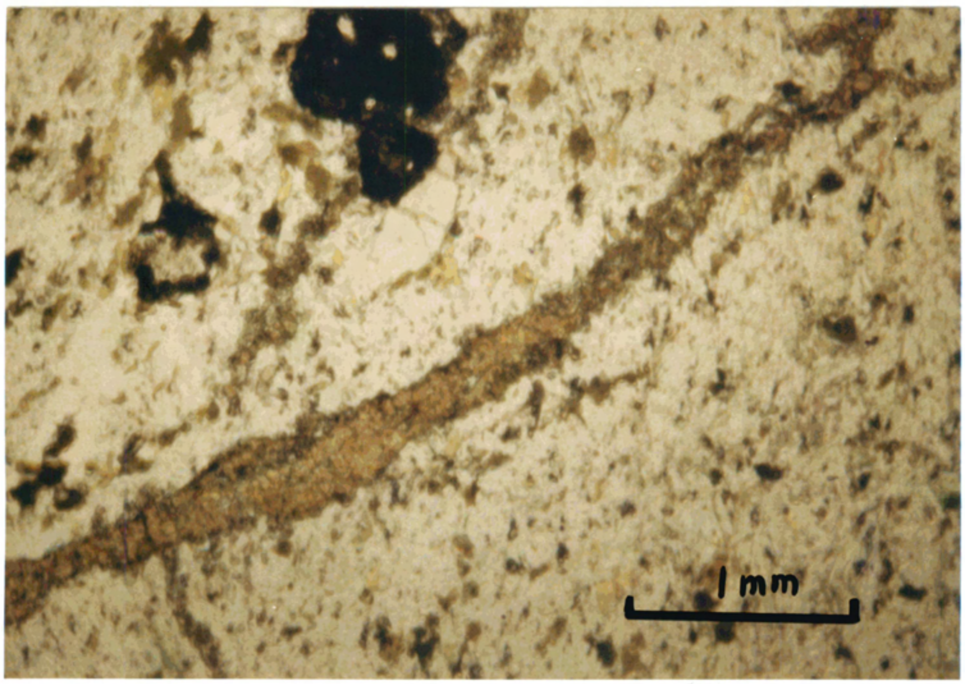
Core from quartz diorite (SC-15, 129.2')
(crossed nicols)

This section shows typical composition and texture of quartz diorite along the eastern arc of the N.C. proposed SSC tunnel location. The rock consists of plagioclase, hornblende, biotite and quartz. Plagioclase shows incipient alteration to epidote and white mica. Biotite appears to have altered from hornblende, which may have, in turn, altered from an earlier pyroxene. The rock has not been deformed.



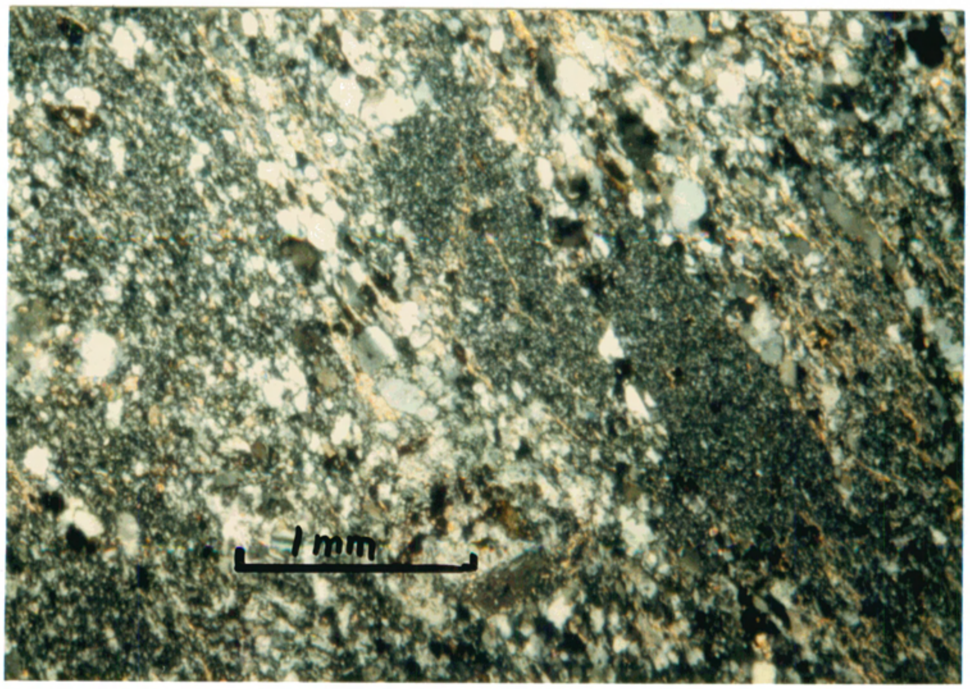
Core is from a body of diorite (SC-18A, 178.3')
(crossed nicols)

This coarsely-crystalline rock is much altered by greenschist-rank minerals. Plagioclase is being replaced by epidote and clinozoisite and hornblende is partly altered to biotite. The rock contains a few thin dilation fractures that were filled with calcite and clinozoisite.



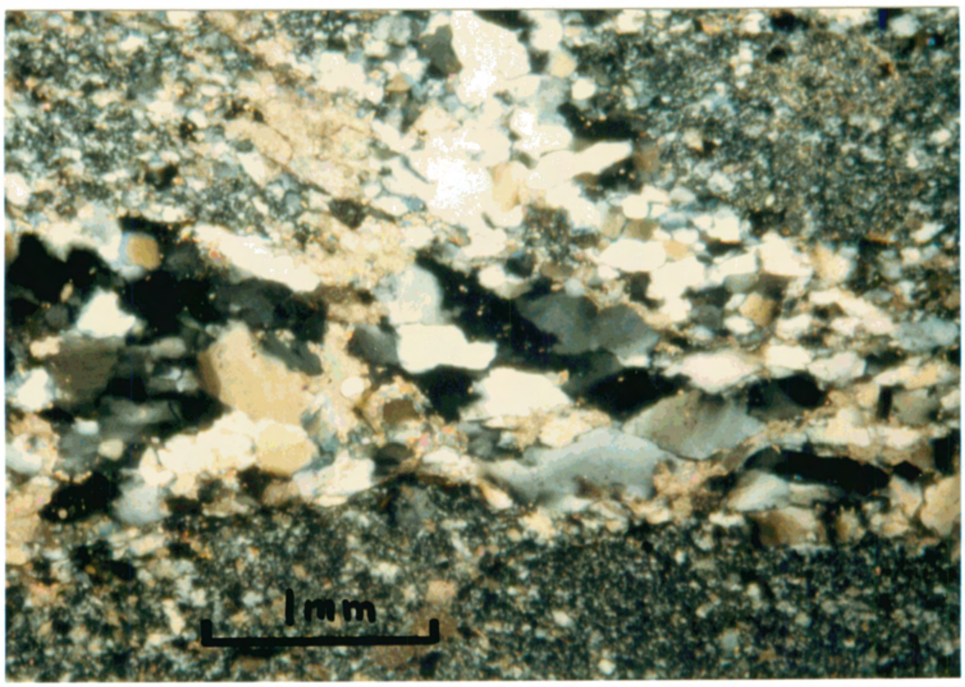
Core from a porphyritic (?) metaandesite (SC-19, 121.0')
(plain polorized light)

This rock consists of relatively large plagioclase and biotite crystals in a fine-grained, felted matrix of plagioclase and biotite. The rock is considerably replaced by greenschist-rank metamorphic minerals. The photo shows irregular veinlets and scattered grains of epidote.



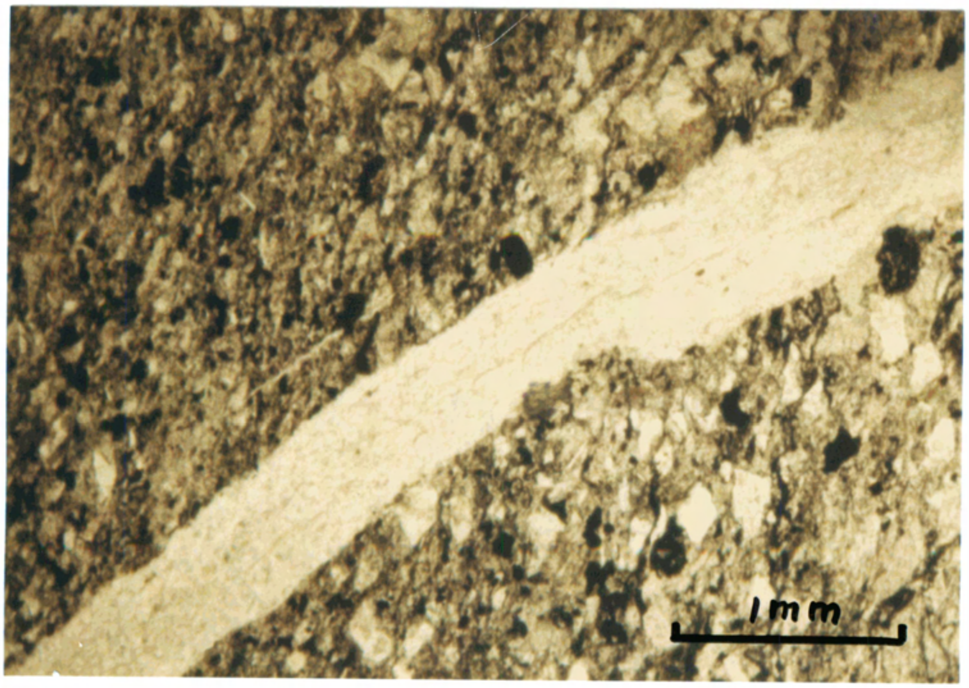
Core is from crystal-lithic-vitric ? metatuff (SC-20, 54.6')
(crossed nicols)

This rock appears to be mostly quartz and devitrified glass (gray, diffuse patches). Oriented secondary micas impart a weak schistosity to the rock.



Core is from a vitric ? -crystal-lithic metatuff (SC-20, 54.6')
(crossed nicols)

This photo shows the generally fine-grained nature of this rock (composed mostly of quartz and plagioclase) and the overprinting by fine-grained white mica and an irregular quartz veinlet (larger black, gray and white grains) partially crossed by calcite grains and irregular veinlet (pink grains).



Core is from tuffaceous metasiltstone (SC-21, 163.8')
(plain polarized light)

This sample shows a weak schistosity development and cross-cutting veinlets. Veinlets are mostly quartz with minor amounts of calcite and chlorite. Bulk of the mineralogy is plagioclase, quartz and white mica.