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October 13th, 1989

A PETROGRAPHIC STUDY OF ROCK SAMPLES FROM THE VANGORDA PROJECT

INTRODUCTION:

42 rock samples were submitted for thin sectioning and petrographic examination.

Samples are numbered as follows:

89-520	89-685B	89-814A
557	686	822
559	687	832
560	688	834*
564	724B	839
588	741	849
598	768B	865
599	771A	887
609	771B	888
614	771D	899
632	782	931
654	784	933
655	793	1023
685A	810	1027

* Two thin sections (834 and 834 L) were cut from this sample, as instructed.

SUMMARY:

This suite includes a range of rock types, some of which show gradational or interlayered character.

The majority show a greater or lesser degree of metamorphic recrystallization. Many are finely laminated, and some show strong microdeformation and cleavage development.

For the most part, the petrographic data are consistent with the nomenclature and groupings set out in your covering letter.

A grouping of samples by mineralogy and texture, based on the petrographic study, is given below. This is followed by a brief discussion of the field groupings in light of the petrography, and an attempt to answer your specific questions.

Individual petrographic descriptions and a set of illustrative photomicrographs are attached.

PETROGRAPHIC CLASSIFICATION:

A. Cataclastic Rocks

Samples 724B, 771A and 832: These are plagioclase-rich rocks showing proto-mylonitic fabrics. The first two are strongly pervaded by fine-grained tourmaline; the last has accessory biotite and minor hornblende. The protolith is indeterminate, but could be a quartz diorite intrusive.

Sample 822: This rock consists essentially of compact sillimanite; it appears intensely and complexly sheared.

B. Intrusive and Meta-intrusive Rocks

Samples 771D and 834: These are foliated granites. The first is of leucocratic composition and shows parallel elongation of recrystallized quartz; it is in semi-gradational, conformable contact with a laminated quartz/plagioclase/chlorite rock. The second sample is a biotite granite showing lensey networks of granulation/recrystallization.

Sample 741: This rock is a foliated quartz diorite. It shows laminar segregation of plagioclase and biotite, with minor development of sillimanite, but is not obviously sheared. Tourmaline is a prominent accessory.

Sample 520: This rock is a non-foliated, but partially altered and/or recrystallized diorite, composed essentially of plagioclase and actinolite (after coarsely porphyritic hornblende). Epidote is a prominent accessory.

Sample 655: This rock is apparently an altered, but undeformed, ultramafic. It is composed of tremolite pseudomorphs in a matrix of chlorite.

Samples 614 and 899: These are fine-grained porphyries, texturally compatible with origin as minor intrusives. Both contain minor quartz phenocrysts. The first is of dacitic composition; the second is somewhat more potassic, and is classifiable as a trachyandesite. They are apparently unmetamorphosed.

C. High Grade Metamorphics

Samples 632, 784, 849 and 1027: These rocks are typical pelitic schists. Quartz is dominant over plagioclase; biotite is abundant, together with lesser muscovite; staurolite is the characteristic accessory, sometimes accompanied by andalusite and/or garnet.

Sample 768B: This rock is of similar general character to the previous group, but has plagioclase > quartz, has no staurolite, and contains accessory tourmaline and diopside.

D. Greenschist Metasediments and Metavolcanics

i) Chlorite phyllites:

Samples 557, 559, 814A and 865: These are fine-grained, laminated rocks composed of various combinations of chlorite, plagioclase and calcite. They could represent calcareous tuffites.

Sample 931 has similar mineralogy to the above group, but shows ovoid segregations of non-chloritic composition.

Samples 564 and 588: These rocks have quartz rather than plagioclase intergrown with the chlorite. The first lacks the strong laminar foliation characteristic of the rest of the samples classified as phyllites.

ii) Sericite phyllites:

Samples 599 and 688: These are laminated rocks composed predominantly of quartz and sericite. They probably represent metamorphosed siltstones.

iii) Meta-greywackes;

Samples 839, 887 and 933: These are laminated rocks having plagioclase dominant over quartz, and with biotite as the typical accessory.

iv) Meta-tuffs:

Samples 598, 609, 782, 888 and 1023. These are a somewhat diverse group of rocks, distinguished by a strong predominance of feldspars over quartz, and by the presence of hornblende, actinolite or pyroxenes - suggesting meta-andesitic derivation. They mostly show fine-grained, laminated fabrics, possibly indicative of derivation from bedded tuffs. 609 and 1023 include major K-feldspar (trachyandesites?).

v) Metacalcareous rocks:

Samples 654 and 687: These are metamorphosed, more or less impure limestones. The first includes interlaminated felsitic material; the second is a relatively pure marble.

Sample 560: This rock appears to be a conglomerate of dolomite pebbles(?) in a quartz-chlorite matrix.

vi) Calc-silicate rocks:

Samples 685A, 685B, 686, 771B and 810: These rocks are mainly of non-laminated texture, and may be of metacalcareous (skarnic) and/or metavolcanic affinities. Except for 685A they contain little or no actual carbonate, but are distinguished by major contents of calc-silicate minerals (epidote in 685A, epidote and actinolite in 685B and 810, actinolite in 686, and epidote and diopside in 771B). 685B and 686 have major plagioclase, and 810 has quartz plus K-feldspar.

Sample 793: This rock may be related to the previous group. It consists of a boudin-like segregation of actinolite, in schistose chlorite with porphyroblastic tourmaline.

DISCUSSION

Queries will be addressed in order, as per your covering letter. Please refer to the individual petrographic descriptions and photos for additional information.

Tie Fault:

89-834: This rock is strongly strained. It is traversed by anastomosing networks of microgranulation.

89-724B and 771A: The field identification as 'ultracataclasites' is appropriate (though rather a mouthful!). The dark banding and patches reflect impregnation by fine-grained tourmaline. Ductile effects (proto-mylonitization) apparently show superimposed brittle fracturing in 771A. The latter rock contains traces of staurolite and andalusite, and may be a modified Mt. Mye schist.

89-771B: This is a calc-silicate rock composed almost totally of epidote and diopside. It shows no cataclastic features and, in fact, is notably lacking in directional fabric. It has a skarnic look.

89-771D: This is a leucogranite in which a foliation is defined by elongate segregations of sheared, microgranulated quartz. It could be syntectonic. The country rock consists of laminated, fine-grained quartz, plagioclase and chlorite - not recognizably metacalcareous or sheared. There is some evidence of contact assimilation/hybridization.

89-768B: This is a rock of similar general character to the Mt. Mye schists, but contains no staurolite, and has plagioclase dominant over quartz. Rare lenses of quartz-carbonate-diopside indicate weak metacalcareous affinities. Accessory tourmaline may relate to proximity to the granite. The rock does not appear particularly sheared.

89-832: This is a rock of similar mineralogy to 768B, but with accessory hornblende rather than diopside, and with no tourmaline. It is strongly cataclastic, like 724B and 771A, and, like the latter sample, shows probable late fracturing superimposed on the protomylonitization.

Mt. Mye Formation

Unit 1CD

89-632, 741, 784, 849, 1027: These are all similar rocks (quartz-biotite-muscovite-staurolite-andalusite schists) except for 741, which is a foliated quartz diorite with accessory tourmaline. It shows minor development of sillimanite, but is not obviously sheared.

The schists show no recognizable earlier fabrics or recognizable folding of S2 by later phases. Porphyroblast development appears to be contemporaneous with S2 (partial rotation).

Unit 3D

89-839, 887, 782: Classified as meta-greywackes. 839 does not have calc-silicate mineralogy.

89-865: A plagioclase-rich rock (feldspathic siltstone or wacke) with chloritic laminae.

89-810: An impure siltstone/wacke with metacalcareous (epidote-actinolite) intercalations. Strongly deformed.

89-598, 1023: Probable meta-andesitic tuffs. Diagnostic minerals are hornblende in 598 and pyroxene in 1023. The rocks are feldspathic, including considerable K-spar.

89-741: Foliated quartz-diorite (see Unit 1CD).

Unit 3C

89-598, 609, 888: Classified as meta-andesitic, probably tuffs.

598 has hornblende (the dark bands). 609 has major K-spar (trachyandesitic). 888 has actinolite and chlorite, and the plagioclase is sericitized (retrograde effects?); it is strongly deformed.

89-793 is a lens of compact actinolite intercalated in a chloritic schist. The crystals on S2 (hand specimen) are tourmaline.

Unit 3G

89-599: Sericite phyllite. No calc-silicates.

89-668: Should this read 688^{Ne}? if so, it is a sericite phyllite like 599, but undeformed and with calc-silicate intercalations.

89-933: Meta-greywacke.

Vangorda Formation

Unit 5B

89-822: This is a strongly deformed, massive sillimanite rock (shear zone?). Not a carbonaceous phyllite.

89-588: Chlorite-quartz phyllite, with metacalcareous or tuffaceous laminae. Strongly deformed. Not graphitic. Graphitic metasediments are not, in fact, represented in this suite.

Unit 5C

89-520: Meta-diorite. Yes, probably a sill or dyke.

89-655: Altered ultramafic. Appears unmetamorphosed.

89-557: Chlorite-plagioclase phyllite with limestone interbeds. This is a metasediment (though abundance of plagioclase could indicate tuffaceous affinities). No recognizable relation to 520.

89-560: Dolomite conglomerate(?) with quartz-chlorite matrix. Not an intrusive.

89-564: Chlorite-quartz phyllite. No evidence of igneous affinities. Generally similar to 557 (but quartz rather than plagioclase). No recognizable relation to 520.

Unit ~~5B7~~ 5E

89-559, 814A: Chlorite-plagioclase phyllites with calcitic intercalations. Two very similar, bedded rocks, 814A being the more strongly deformed. They could be meta-tuffites. No indication of the de-carbonization process. No mineralogical indication of relationship to meta-basic dykes.

Unit 5B3

89-654, 687: Limestones. 654 has felsitic (tuffaceous?) intercalations.

Unit 5D(?) Shrimp Lake

89-685A, 685B, 686: Porcellanous-textured (skarn-like) calc-silicate rocks.

685A is composed of epidote and calcite; 685B of plagioclase, epidote and tremolite/actinolite; and 686 of plagioclase and tremolite/actinolite. The first is clearly metacalcareous; the other two could be of meta-basic volcanic affinities.

Menzie Creek Formation

89-931: Apparently a fine-grained chlorite-plagioclase phyllite, with ovoid segregations of chlorite-free, non-foliated felsite, plus carbonate. Origin uncertain. Probably not a variolitic basalt.

Dykes

89-614: Porphyritic dacite. K-spar and quartz phenocrysts in plagioclase groundmass. Unaltered.

89-899: Porphyritic trachyandesite. Plagioclase and quartz phenocrysts in k-spar/plagioclase groundmass. Weak to moderate sericite-carbonate alteration.



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PHOTOMICROGRAPHS

All photos are by cross-polarized transmitted light at a scale of 1cm = 0.17mm, except where otherwise stated.

A. CATACLASTIC ROCKS

Sample 724B Neg. 159-3: Typical field. Shows protomylonitic fabric of oriented sub-angular remnants of quartz and plagioclase (white, greys) in cryptocrystalline matrix consisting largely of tourmaline (dark). Brown flecks are biotite, also seen as a cross-cutting veniform segregation at right.

Sample 771A Neg. 159-4: Remnant granulated masses of plagioclase and quartz in intensely tourmalinized matrix. Part of sharply defined cataclast of strongly strained quartz at top right. Note veinlet and late, discordant fractures. Principal veinlet is filled by K-feldspar (blue-grey) and chlorite (dark).

Sample 832 Neg. 159-5: Complex fabric of granulated quartz/plagioclase, permeated by biotite (brown). Field shows dislocation by network of later fractures.

Sample 822 Neg. 159-6: Intensely sheared fabric of compact sillimanite (orange-greys). Note elongate sheared remnants of quartz (grey) at centre. Field includes accessory chlorite in imbricated areas between shear planes at lower right.

B. INTRUSIVE ROCKS

Sample 771D Neg. 159-7: Elongate quartz segregations defining foliation in leucogranite. Other components (greys and black) are plagioclase and K-feldspar. Traces of biotite are just distinguishable (orange flecks) on contact of quartz clumps (bottom left, bottom centre).

Neg. 159-8: Gradational contact zone of the granite. Intrusive occupies upper right diagonal half of field. Note accessory biotite (green-orange). Lower left portion is foliated wall rock or hybridized material, with abundant chlorite (bluish flakes).

Sample 834 Neg. 159-9: Foliated/granulated granite, showing microgranular recrystallized quartz (upper left, bottom right) and intergranular networks of finely granulated material with fine-grained biotite (brown). Coarse grey prismatic grains are plagioclase and K-feldspar. Bright colours (centre) are muscovite.

Sample 741 Neg. 159-35: Quartz diorite, showing igneous fabric, of subhedral plagioclase (greys) with interstitial biotite (colours), partially altered to chlorite (flaky, bluish).

Sample 741 Neg. 159-10: Plane polarized light. Shows pockets of oriented biotite (brown), partly altered to chlorite (greenish). These are interstitial to sub-rounded masses of plagioclase (whitish). Note euhedral tourmaline prisms (dark olive green: examples circled) within the biotite.

Sample 520 Neg. 159-11: Typical field of metadiorite. Actinolite pseudomorphs after hornblende (e.g. top left, bottom right) recrystallized in matrix of microgranular plagioclase (grey, speckled). Note pocket of felted chlorite (dark) at upper left, with included small grains of epidote (yellow). Dark brown area at top right is sphene/leucoxene.

Sample 655 Neg. 159-12: Typical field of non-foliated, altered ultramafic. Note blocky/prismatic pseudomorphs, composed of fine-grained, lattice-textured aggregates of tremolite. Interstitial phase is chlorite (dark blue-black) with random laths and clusters of tremolite (white-yellow-orange). Opaques (black) occur as fine-grained inclusions in some tremolite pseudomorphs (e.g. centre) and in the chlorite (lower centre).

Sample 614 Neg. 159-13: Typical field of porphyry. Shows small phenocrysts of quartz (left; one shows myrmekite-like halo in the groundmass) and larger euhedral phenocryst (dark, twinned; upper right) of fresh K-feldspar. Groundmass is felsitic plagioclase (speckled greys, black) with tiny biotite flecks (brownish).

Sample 899 Neg. 159-14: Typical field of porphyry. Shows 3 types of phenocryst: quartz (grey, embayed form; at left), plagioclase (bottom right, speckled with sericite and carbonate), and altered biotite (lamellar intergrowth of bluish chlorite and buff carbonate; centre top). Groundmass (dark, flecked) is felsitic plagioclase and K-spar. Note diffuse patches of carbonate alteration (light brown) at top right.

C. HIGH GRADE METAMORPHICS

Sample 1027 Neg. 159-15: Plane polarized light. Shows staurolite porphyroblasts (yellow, with fractures) in schist. Area at upper right is porphyroblast of andalusite, with inclusions of biotite (brown) and staurolite. Light coloured matrix is quartz and plagioclase (e.g. bottom right) and schistose muscovite (bottom left) interleaved with biotite. Note elongate opaque inclusions (black) in staurolite; in this case the orientation of these parallels the prevailing foliation.

Sample 632 Neg. 159-36: Plane polarized light. Shows porphyroblasts of staurolite (yellow) and garnet (pinkish white: bottom) in biotite-muscovite schist. Note elongation of the staurolite parallel to the foliation. The garnet is a portion of a euhedral crystal which has grown with divergence of the enclosing schistosity. Compare orientation of opaque inclusions in the porphyroblasts and the matrix.

Sample 768B Neg. 159-18: Plane polarized light. Shows concentration of oriented prismatic tourmaline (olive greens) in biotite schist. Matrix is quartz/plagioclase (whitish) and biotite (dark red-brown).

D. GREENSCHIST METAMORPHICS

Probable Metasediments:

Sample 559 Neg. 159-19: Typical field of calcareous chlorite-plagioclase phyllite. Note crenulate fabric of chlorite (dark, greenish) with intergrown felsitic plagioclase (light flecks). Carbonate interlaminae (buff coloured, mosaic-texture) contain disseminated grains of plagioclase (white).

Sample 557 Neg. 159-20: Shows typical phyllitic fabric of crenulate crumpling with development of axial plane cleavage. Dark (black-greenish) is chlorite; greys are plagioclase; buff-coloured flecks are calcite.

Sample 865 Neg. 159-21: Non-calcareous chlorite phyllite. Alternating laminations are chloritic (dark, greenish) and feldspathic (greys: centre, bottom right). Coarser mosaic area at top left is a quartzose lens.

Sample 931 Neg. 159-22: Chloritic phyllite with ovoids. Photo shows fine-grained chloritic matrix (dark, greenish) with minor intergrown plagioclase (light specks). Field includes portions of two ovoids. These are composed of felsitic plagioclase, with diffusely disseminated and patchily segregated carbonate (brown).

Sample 688 Neg. 159-23: Undeformed sericite-quartz phyllite. Typical field, showing lensey interlamination of sericite (green-orange) and quartz (greys, black).

Sample 599 Neg. 159-24: Sericite-quartz phyllite showing typical crenulated fabric. Note sinuous cleavage defined by micron-sized rutile (dark brown).

Sample 839 Neg. 159-25: Typical metagreywacke. Shows biotite (brown) intimately intergrown with clumpy plagioclase (greys). Field includes lensey segregations of quartz (coarser grained; inclusion-free greys).

Sample 933 Neg. 159-26: Another meta-greywacke. Brown biotite intimately intergrown with felsitic plagioclase. Lenticular segregations contain intergrown quartz (clear white, greys). Dark schlieren of fine-grained micas and opaques.

Sample 560 Neg. 159-30: Conglomerate(?). Shows portions of several pebbles(?) of fine-grained dolomite (buff-brownish: mosaic fabric). Interstitial phase is chlorite (dark, greenish) and fine-grained quartz (greys, white). Note minor disseminated quartz in the dolomite masses.

Probable Metavolcanics:

Sample 609 Neg. 159-27: Typical field showing laminated alternations of amphibole (orange-pink) and feldspars (greys-black). Note relict granular, igneous-looking (possibly tuffaceous) fabric of the feldspars.

Sample 888 Neg. 159-28: Lensy intergrowths, and partial laminar segregations, of sericitized plagioclase (lightest, pastel colours), chlorite (blue-black) and actinolite (colours; with diffuse, brownish limonite-leucoxene). Possible andesitic tuff derivation.

Sample 1023 Neg. 159-29: Contact of pyroxene band (coarse, sub-prismatic grains) and potassic felsite band (dark). Pyroxene grades to actinolite/carbonate at extreme right.

Calc-silicate Rocks:

Sample 810 Neg. 159-31: Typical field, showing aggregates of prismatic epidote (blue-yellow-orange-pink) intergrown with areas of fine-grained quartz/plagioclase (greys, black). Brown, mottled areas within the epidote are altered pyroxene. Field includes sinuous schlieren or microshears with fine-grained rutile (black) and epidote (colours).

Sample 686 Neg. 159-32: Shows sinuous/laminated intergrowth of felsitic plagioclase (speckled greys, white) and fine-grained, fibrous acicular tremolite/actinolite (dark, with lighter orange/green flecks).

Sample 685B Neg. 159-33: Shows ptymatically deformed plagioclase veinlets(?) (white/greys: twinned) in minutely fine-grained matrix (dark) of actinolite, epidote and felsitic plagioclase.

Sample 771B Neg. 159-34: Typical field of skarnic rock, showing feldspar-free composition. Granular aggregates of epidote (blue-grey-yellow) intergrown with pyroxene (orange-red prismatic grains and dark, altered, fine-grained material). Brown translucent grain (extreme left centre) is sphene/leucoxene.

Estimated mode

Plagioclase	30
Actinolite	45
Hornblende	trace
Chlorite	4
Sericite	2
Epidote	14
Apatite	trace
Sphene)	5
Leucoxene)	
Ilmenite	trace

This is a non-foliated rock of patchy, heterogenous texture. In thin section it shows distinct evidence of meta-igneous character.

It is now composed predominantly of plagioclase and actinolitic amphibole. The former occurs as random, blocky/granular to meshwork aggregates, of grain size 0.1 - 0.5mm, more or less strongly impregnated by minutely microgranular epidote, and lightly flecked with sericite. Minor chlorite is an interstitial component.

The plagioclase forms a groundmass or matrix phase to abundant, coarse (0.5 - 3.0mm) masses of bladed actinolite. These mostly consist of accreted acicular patches of irregular outlines, but sometimes develop compact form and subhedral outlines.

The actinolite masses have clearly developed by recrystallization of original olive-brown hornblende - occasionally recognizable as relict cores. Inclusions of groundmass plagioclase are also seen.

Other constituents are clumps of felted chlorite, sometimes with clusters of euhedral epidote: these occur marginal to, and as patches within, the actinolite - possibly representing a partial alteration or retrograde metamorphic effect. Another prominent component is leucoxene, as irregular, brown, cryptocrystalline patches and skeletal clusters, 0.2 - 1.0mm or more in size, sometimes with relict opaque cores (ilmenite?).

This rock is a typical, partially recrystallized meta-diorite.

SAMPLE 89-560 CRYPTO-CONGLOMERATIC, SILICEOUS/CHLORITIC DOLOMITE

Estimated mode

Quartz	27
Carbonate	50
Chlorite	20
Rutile)	3
Leucoxene)	

This is a fine-grained, non-foliated rock showing an obscure, coarsely fragmental or porphyroblastic texture. This is defined by more or less close-packed, discrete, equant/ovoid, augen-like, grey masses in an apparent siliceous matrix.

In thin section the ovoid masses are found to be composed of mosaic aggregates of carbonate, of grain size 0.0 - 0.1mm, with minor interstitial grains, clumps and wisps of quartz and/or felted chlorite. Unlike the carbonate in most of the other rocks of the suite, this is unreactive to dilute acid, and is apparently of dolomitic composition.

The matrix phase is composed of the same minerals, but in different proportions and heterogeneously distributed. Quartz, as microgranular aggregates of similar grain size to the carbonate, is the predominant component. Chlorite is also relatively common, as felted pockets and streaks (especially adjacent to carbonate masses), and as areas of minutely interstitial intergrowth with quartz.

The chlorite locally defines an irregular, streaky to crumpled foliation tangential to the carbonate augen - possibly related to compaction.

Leucoxene, as irregular, small, diffuse patches and flecks, 0.02 - 0.2mm in size, is a notable accessory within the matrix phase (apparently absent from the carbonate masses).

Carbonate is a minor component of the matrix phase, as diffuse flecks and intergrown streaks. It is also seen as discrete, rather well-formed porphyroblast-like grains, up to 0.5mm or more in size.

It is possible that the fine-grained quartzose component also includes a little plagioclase.

Some irregular, discordant streaks of chlorite transect augen and matrix.

This rock appears to be a form of dolomite breccia or conglomerate. The carbonate-rich masses could also be disrupted interbeds in an impure silty carbonate rock. However, they are typically well-rounded and apparently undeformed, and the rock, as a whole, does not have a strongly sheared fabric. The fragmentation is thus thought to be premetamorphic in origin. Subsequent recrystallization has modified the original distribution.

Estimated mode

Quartz	30
Chlorite	63
Rutile)	7
Leucoxene)	

On the macroscopic scale this is a fine-grained, weakly foliated, grey rock with prominent light brown flecks.

In thin section it is found to be of simple composition, consisting predominantly of a compact, felted to weakly oriented aggregate of fine-grained chlorite, of grain size 10 - 50 microns.

Quartz (possibly with a minor component of plagioclase) is the principal accessory. It occurs as more or less densely disseminated grains of similar size to - and intimately intergrown with - the chlorite flakes of the matrix. It is sometimes clustered as wisps, clumps and augen-like bodies, to 0.5mm or so in size. Occasional coarser segregations of mosaic quartz often show contorted form, discordant to the weak foliation, in the manner of disrupted veinlets or laminae.

The brown flecks, seen in the etched cut-off block, are found to consist of elongate/angular, skeletal clusters of sub-opaque material, 0.05 - 0.5mm in size - presumably rutile and/or leucoxene. These show a general preferred elongation parallel to the overall, weak foliation of the matrix, but appear independent of (superimposed on) the chlorite/quartz segregations - in the manner of porphyroblasts.

It shows no recognizable igneous features.

The origin of this rock is obscure. The strongly chloritic composition, with intimately intergrown quartz, seems more characteristic of a form of exhalative chemical sediment (impure chert) than a typical metabasite.

Estimated mode

Quartz	56
K-feldspar	8
Epidote	12
Carbonate	4
Chlorite	19
Rutile	1

This rock shows a fine-grained, intensely contorted fabric of metasedimentary aspect. The presence of accessory K-feldspar (showing yellow cobaltinitrite stain) aids in the delineation of the primary laminated structure in the cut-off block. Minor remobilization of the K-spar is also noticeable.

In thin section the rock is found to consist essentially of a fine-grained intergrowth of quartz and chlorite, with intercalations of carbonate and epidote.

The quartz forms an anhedral mosaic of somewhat flattened grains, 20 - 100 microns in size, with interstitial, well-oriented chlorite flakes. These two components were probably originally in delicately interlaminated relationship, but the fabric is now strongly contorted by crenulate microfolding. Occasional relics of discrete thin quartzose laminae are still recognizable.

The calcareous intercalations consist, in some cases, of rather coarsely recrystallized carbonate clumps or lenses which host well-formed, prismatic epidote crystals, to 0.5mm in size. Elsewhere the epidote is developed with little or no associated carbonate, and is of finer grain size - similar to that of the quartz/chlorite matrix, within which it forms contorted interlaminae.

K-feldspar occurs partly as a finely intergrown accessory with the quartz, but is readily distinguishable in thin section only where it forms coarser mosaics intergrown with, and marginal to, some of the carbonate-epidote segregations. Occasional remobilized/porphyroblastic clumps of K-spar show grain size up to 1mm or more.

A distinct shear cleavage paralleling the axial planes of the microfolding is emphasized by threads of rutile, often with minutely fine-grained epidote.

The rock is of phyllitic character, though somewhat coarser grained than others of the suite. It is not graphitic.

SAMPLE 89-598

META-ANDESITE TUFF?

Estimated mode

Quartz	15
Plagioclase	56
K-feldspar	5
Hornblende	18
Epidote	3
Chlorite	2
Carbonate	trace
Tourmaline	trace
Sphene)	1
Leucoxene)	
Apatite	trace

This is a rock of heterogenous texture. Macroscopic examination of the slide and/or cut-off block indicates a fine-grained, somewhat potassic aggregate, showing a minutely crenulated fabric with diffuse streaks and patches (disrupted interbeds?) of a dark mafic mineral. This assemblage is cut by a stockwork of later veinlets.

These relationships are less clearly distinguishable under the petrographic microscope. The rock is found to consist predominantly of a microgranular aggregate of turbid, saussuritized feldspars, of grain size 0.02 - 0.1mm. The principal accessory is quartz, as disseminated granules and aggregated, sub-parallel streaks and patches, of grain size 0.05 - 0.15mm. Interstitial flecks of chlorite and epidote and sinuous, partially continuous trains of fine-grained sphene or rutile and leucoxene, are minor components.

Blue-green, fibrous/acicular to bladed, prismatic hornblende is the other principal constituent. This occurs in segregated pockets and veniform zones, interstitial, and in poikiloblastic enveloping relationship, to the matrix feldspar and quartz. In some cases it occurs in apparent meshwork to sub-ophitic intergrowth with coarse prismatic plagioclase, on a scale of 0.5 - 2.0mm. This assemblage appears to constitute some of the veniform segregations prominent on the etched cut-off block.

The original character of this rock is unclear. The mineralogy and texture suggest that it may have been an intermediate tuff. The hornblende and coarser plagioclase may represent andesitic crystal intercalations, possibly modified by remobilization and recrystallization.

Estimated mode

Quartz	40
Plagioclase	10
Biotite	10
Sericite	40
Sphene	trace
Opagues	trace
Limonite	trace

This is a fine-grained rock of metasedimentary aspect, showing a wispy, sinuous, lensey/laminar fabric.

Thin section examination shows that it has a simple mineralogy and texture, consistent with the field classification as a non-calcareous phyllite. It was probably derived from a fine-grained, shaly greywacke.

The non-micaceous component in this rock appears to consist predominantly of quartz, though there is some intimately intergrown plagioclase. Plagioclase-rich segregations are also seen as small clumps of twinned grains, and lenses and streaks of minutely felsitic texture.

The quartz forms a recrystallized, anhedral aggregate, of grain size 0.02 - 0.2mm, in which grain shapes are partially elongate or flattened. Some lensey laminar segregation of slightly coarser and finer grain sizes is also observable.

The quartzose component is interlaminated with abundant micaceous schlieren, composed of well-oriented flakes of sericite and/or pale, greenish-brown biotite.

Some mica also occurs intergrown with the quartz.

The rock exhibits a typical phyllitic fabric of parallel schlieren of micas, emphasized by films of fine-grained sphene, opagues and limonite. This represents a shear cleavage separating quartzo-feldspathic lenses and laminae in which the interstitial micas show random or oblique/arcuate orientation, reflecting an overall crenulate microdeformation.

Estimated mode

Plagioclase	42
K-feldspar	35
Hornblende	20
Epidote	1
Chlorite	trace
Sphene	2

This is a fine-grained, quartz-free rock of feldspathic composition. It includes a notable content of K-feldspar as laminar intercalations, together with laminae rich in a dark mafic constituent. The laminae show sinuous deformation, with local displacement associated with kinking and micro-shears.

The feldspars are in the form of a rather heterogenous aggregate, of grain size 0.02 - 0.5mm or more. This probably represents varying degrees of recrystallization and breakdown of an original fabric of igneous aspect. Remnants of well-twinned, coarse, prismatic grains are recognizable, showing more or less intense granulation and platy shearing.

The plagioclase is distinguishable from the K-spar in thin section by its turbidity (mild saussuritization), and the two minerals show intimate wispy intergrowth, as well as a degree of laminar segregation and grain-size variation, on the scale 0.5 - 2.0mm.

Pale, blue-green hornblende is the principal accessory. It forms irregular clusters and networks of fibrous/acicular to bladed prismatic aggregates - typically interstitial to relatively coarse remnant feldspars. It is mainly well-segregated, but is also seen as occasional small, dispersed wisps and pockets.

Small grains and clumps of well-crystallized sphene, 0.02 - 0.2mm in size, are a minor accessory, as random grains and small, irregular wisps and trains. Surprisingly, it occurs chiefly in the feldspathic host away from the amphibolitic zones.

The rock is cut by a few discrete, late, hairline veinlets of granular epidote.

This appears to be a recrystallized trachyandesite, possibly of tuffaceous character.

Estimated mode

Plagioclase	70
Quartz	15
K-feldspar	10
Biotite	5
Pyrite	trace

This is a fine-grained, porphyritic, leucocratic, igneous rock, whose composition (phenocrysts of K-feldspar and tiny quartz euhedra in a white-etched, plagioclase-rich matrix) is clearly apparent from macroscopic examination of the cut-off block.

The K-spar phenocrysts (sanidine) are 0.2 - 2.0mm in size, often sharply euhedral, but occasionally showing partial resorption by the matrix. They are totally fresh and clear. Quartz phenocrysts tend to be slightly smaller, and are sometimes clumped. They are typically surrounded by thin halos or reaction zones in the groundmass.

The plagioclase groundmass shows a diffuse mosaic granularity, on the scale 0.05 - 0.1mm, overlain by a minutely microlitic fabric which may be partially an unmixing of accessory quartz, and also includes tiny flecks and incipient flakes of pale biotite.

The groundmass fabric exemplifies the near-glassy/diffusely devitrified character typical of many high-level, sub-volcanic, felsic porphyries.

The rock appears fresh and unmetamorphosed.

	PHASE	FEATURE	QUALITY ≥ 1	STATION
①				
①	1	PS1	"	
②	2	PS2 AXIAL PLAN	"	
③ ✓	LIP 2	INTERSECTN FOLD AXIS	"	
④ ✓	LIP 3	CRENULATN	"	
⑤ ✓	3	AXIAL PLAN CS3	"	
⑥ ✓	3	FOLD AXIS		
⑦ ✓	BLANK	FRAC X		

FRACTURE
 STRETCH
 MINERAL

Estimated mode

Quartz	40
Plagioclase	15
Biotite	20
Chlorite	2
Muscovite	12
Andalusite	4
Staurolite	3
Garnet	4
Tourmaline	trace
Rutile	trace
Opagues	trace

This is a fine-grained, schistose rock with scattered, small, brown porphyroblasts.

It consists predominantly of quartz and accessory plagioclase, in streaky/lenticular alternation with biotite and accessory muscovite.

The quartzo-feldspathic component exhibits a rather varigranular, anhedral/interlocking, often crenulate-margined texture, of grain size 0.03 - 0.4mm. Local strong grain flattening and clumpy, accretive recrystallization are recognizable.

The micas tend to be well-segregated, as ragged, moderately well-oriented flakes, to 0.5mm in size, concentrating as well-defined, sinuous schlieren, which are emphasized by films of intergrown dust-sized rutile. Muscovite forms some discrete schlieren, and also occurs intergrown with biotite. The biotite locally shows retrogression to chlorite.

Staurolite and andalusite form fragmentary/poikilitic to subhedral porphyroblasts, chiefly associated with the micaceous component. Staurolite is generally as discrete grains, 0.5 - 1.0mm in size; andalusite is generally coarser, as granular masses. Staurolite is sometimes seen enclosed within andalusite.

Garnet forms euhedral porphyroblasts to 5.0mm in size.

Both garnet and staurolite porphyroblasts typically have small included opaques - generally arranged concordant with the prevailing schistosity, but occasionally oblique to it. The schistosity of the surrounding micas diverges sharply around the garnet porphyroblasts.

No remnants of original fabrics are recognizable. The schistosity is not noticeably crenulated by later folding.

Estimated mode

Quartz	10
Sillimanite	82
Chlorite	5
Sericite	2
Rutile	1

This is a rock of distinctive mineralogy, unlike any previous samples of the suite.

It is composed largely of compact, fine-grained, fibrous sillimanite, and is intensely and complexly deformed.

Minor chlorite and sericite - of finely felted to foliaceous habit - occur interlayered with the strongly oriented, contorted sillimanite mass, and are developed in kinks and microshears.

Quartz occurs as sporadic, irregular, recrystallized masses. It is also seen as contorted veniform or laminar threads, and as minute droplets within the compact sillimanite.

Wisps and horsetail schlieren of micron-sized, sub-opaque material (rutile?) occur throughout, delineating the internal contortions in the sillimanite mass. Similar material(?) occurs in more dispersed form as swarms of minute, included needles.

The origin of this rock is unknown. It possibly represents the metamorphic product of some unusually aluminous protolith - e.g. a clay-rich or hydrothermally altered material. Alternatively it may be a product of localized, intense (high temperature/high stress?) metamorphic conditions.

SAMPLE 89-654

LAMINATED SILTY LIMESTONE

Estimated mode

Plagioclase	18
Sericite	3
Calcite	70
Mineral X	7
Sphene(?)	2
Chalcedony	trace

This is another fine-grained rock, showing a delicately laminated fabric. It is of metacalcareous type. Half of the slide is occupied by a band or concordant segregation of compact carbonate.

The latter consists of an equigranular, mosaic aggregate, of grain size 0.1 - 0.2mm. Minor sericite occurs as an intergranular component of partially oriented, Fe-stained flakes in sporadic wispy intercalations of finer-grained carbonate.

The laminated phase consists of fine-grained, micritic carbonate, with varying proportions of interstitial, minutely felsitic plagioclase (of grain size 5 - 30 microns). This assemblage is rendered turbid, in transmitted light, by a high content of micron-sized, sub-opaque granules, and sheafs of minute, colourless needles. These components show no preferred orientation but, rather, exist as a diffuse meshwork and dissemination throughout. The granules may be sphene, and the needles could be actinolite.

The laminated texture (on a scale of 1 - 2mm) is defined by thin intercalations of pure carbonate within the carbonate-felsite intergrowth.

The lack of directional fabric (other than the compositional layering) in this rock is notable.

The slide is cut by a few hairline veinlets of carbonate, some of which include segments of minutely spherulitic material - thought to be chalcedony.

Estimated mode

Chlorite	52
Serpentine	5
Tremolite	40
Carbonate	1
Hornblende	trace
Rutile	trace
Opagues	2

This is a non-foliated rock, exhibiting a macroscopic texture of close-packed, varigranular, equant bodies - somewhat suggestive of a coarse fragmental or an ultramafic intrusive.

In thin section it is found to be of simple composition, being essentially an intergrowth of colourless, fibrous/acicular tremolite and pale green felted chlorite.

The granular macroscopic texture consists of more or less clearly defined pseudomorphs, 1 - 4mm in size, composed of oriented lattice-works of fine-grained tremolite in a matrix of chlorite. These often exhibit a tri-directional, pseudo-hexagonal fabric of uncertain origin. They often contain fine-grained, opaque inclusions in parallel, network or concentrically-zoned distribution.

A few pseudomorphs appear to be composed predominantly of serpentine. Others include small patches of carbonate.

The pseudomorphs are set in an interstitial phase of chlorite, with irregularly intergrown, randomly-oriented clumps of flaky/acicular tremolite, and discrete grains of disseminated opaque oxides.

This rock is devoid of feldspar, and appears to be an altered peridotite. Its original composition is uncertain. Remnants of pale brown hornblende are locally recognizable within the tremolite masses, and a few pseudomorphs show the boxwork form characteristic of serpentine after olivine.

The original fabric is largely preserved, and there is no evidence of deformation or dynamic metamorphism.

668
SAMPLE 89-688

SERICITIC PHYLLITE WITH METACALCAREOUS OR
METAVOLCANIC INTERCALATIONS

3 D after
SB

Estimated mode

Quartz	22
Plagioclase	8
K-feldspar	3
Sericite	54
Chlorite	8
Epidote	4
Actinolite	1
Rutile	trace
Opaques	trace

This is another fine-grained rock showing strikingly even, sharp, undisturbed, varve-like laminations.

It is of similar composition to 89-599 except that it includes intercalated metacalcareous or meta-basic volcanic bands. It consists mainly of laminar alternations, on a scale of 0.1 - 1.0mm, of microgranular quartz and compact, parallel oriented sericite.

The quartzose component is of grain size 10 -100 microns. Grain shapes - except in a few relatively coarse lenses - are typically strongly flattened and highly oriented parallel to the plane of lamination. A minor component of intergrown plagioclase (not readily distinguishable in thin section) may be present - especially in the form of minute interstitial wisps included within some of the sericitic laminae.

The rare, slightly coarser quartzo-feldspathic lenses locally include some K-feldspar.

The sericite is a pale greenish variety. In addition to the predominant strongly oriented form, it also occurs as an interstitial component in some of the quartzose laminae: in this mode it often defines a weak fabric oblique to the bounding sericite schlieren.

Approximately 20% of the slide consists of a laminated lithotype (concordant with the sericitic phyllite) of contrasted mineralogy. This contains mainly chlorite instead of sericite, and includes thin, discrete laminae of well-crystallized epidote with associated clumps and wisps of fibrous/spherulitic actinolite. Micron-sized rutile and opaques are prominent in the chlorite.

This latter lithotype may represent an interbedded, impure, limestone or andesitic tuff component in the original argillaceous siltstone.

Estimated mode

Carbonate	53
Actinolite	5
Plagioclase	4
Sericite	2
Epidote	36

This is a very fine-grained, porcellanous rock showing a crude, lensey banding.

The thin section shows that it is composed essentially of an intergrowth of carbonate and epidote. The carbonate is reactive to dilute acid, and is apparently mainly calcite.

The carbonate partly forms bands of a minutely fine-grained aggregate, of grain size 10 - 30 microns - typically with minutely intergrown interstitial granules and needles of actinolite.

Carbonate also occurs as coarser-grained mosaics, of grain size 0.1 - 0.5mm, dusted throughout with minute inclusions of calc-silicates. This coarser carbonate forms diffuse, banded segregations, or lines of clumps of porphyroblastic or relict aspect.

Epidote occurs in minutely fine-grained form, often intergrown with felsitic plagioclase and clusters of stubby, non-oriented sericite flakes. Locally the microgranular epidote concentrates as compact masses, and develops incipient coarser, porphyroblastic form.

The epidote concentrations form diffuse patches and bands, and typically surround and form a matrix to the lines and clusters of coarser carbonate clumps.

This rock is non-foliated, and has the aspect of a skarnified or hornfelsed impure (silty, possibly tuffaceous), micritic limestone.

Estimated mode

Plagioclase	33
K-feldspar	3
Actinolite	38
Epidote	20
Carbonate	4
Sphene)	2
Leucoxene)	

This is a minutely fine-grained, non-laminated rock of porcellanitic aspect, in which abundant feldspathic threads (contorted veinlets or laminae?) define a complex, ptygmatically microfolded fabric.

It consists of a homogenous, felsitic aggregate of plagioclase (and minor intergrown K-spar), of grain size 10 - 50 microns, which is densely pervaded by tiny granules of epidote and a meshwork of minute needles of actinolite. The distribution of wisps of less heavily impregnated felsite, trains of epidote granules and diffuse films of cryptocrystalline sphene/leucoxene, defines a complexly crenulated fabric.

The fluidally contorted feldspar threads consist of varigranular aggregates of equant grains, 0.02 - 0.3mm in size. In the coarser areas these show well-defined twinning. They show gradational contacts with the enclosing host rock, and appear to represent laminar zones of calc silicate-free feldspar, which have been complexly deformed and remobilized. Coarser grain size is developed in fold crests, and the threads show pinching by attenuation and thickening by superposition of hairpin folding. Some of the remobilized, recrystallized feldspar bodies contain relatively coarse-grained inclusions of epidote and acicular/prismatic actinolite.

In one area of the slide, the ptygmatic threads and pockets contain a major component of granular carbonate.

The origin of this rock is uncertain. Its fine grain and homogeneity is notable. It may have originated as an impure marl or a mafic-intermediate tuffite.

Estimated mode

Plagioclase	56
Tremolite	37
Carbonate	2
Epidote(?))	5
Sphene(?))	
Opagues)	trace
Limonite)	

This is a porcellanous rock showing varve-like, lensy/laminar, compositional segregations.

It is composed predominantly of felsitic plagioclase and minutely fine-grained, fibrous tremolite/actinolite.

The plagioclase is mainly in the form of an equigranular aggregate, of grain size 5 - 20 microns. Occasional slightly coarser bands, composed of interlocking anhedral aggregates of grain size 20 - 100 microns, have a saccharoidal texture reminiscent of some albitites.

Tremolite/actinolite occurs throughout, mainly segregated as thin, laminar segregations of compact, sub-oriented, acicular grains, 10 - 50 microns in size. It also occurs in more dispersed form, as concordant wisps and individual, partially oriented needles and clusters within the felsitic laminae.

More or less abundant interstitial plagioclase is recognizable within the tremolitic laminae, and the two components exhibit a gradation from highly segregated to intimately intergrown. The apparent laminar texture is, in fact, an echelon arrangement of thin lenses - probably reflecting primary bedded compositional heterogeneities.

Some of the tremolitic lenses have a little intergrown carbonate, and carbonate is also recognizable in association with disseminated tremolite in some of the coarser plagioclase bands.

Another component, as evenly disseminated, minute, high-relief granules, 5 - 15 microns in size, occurs throughout both the tremolitic and feldspathic components: this may be epidote or sphene.

This rock is probably a mildly recrystallized, intermediate ash-tuff with impure limey intercalations (now converted to calc silicates).

SAMPLE 89-687

FINE-GRAINED MARBLE

Estimated mode

Carbonate	93
Sericite	5
Chlorite	1
Sphene	1
Quartz	trace

This rock is a fine-grained, rather pure marble, consisting essentially of a microgranular mosaic aggregate of carbonate (predominantly calcite), of grain size 10 - 50 microns.

Interstitial sericite, as minute, essentially non-oriented flakes, occurs as a disseminated accessory, along with minor, disseminated, high relief, micron-sized granules which may be sphene (or epidote?).

The carbonate aggregate shows irregular, streaky/clumpy heterogeneities, distinguished by slight variations in grain size (locally reaching 200 microns) and in the percentage of accessory sericite.

A few diffuse streaks and wisps of minutely interstitial chlorite are also seen.

The rock is mildly recrystallized, but essentially non-foliated. The local textural heterogeneities possibly reflect relict soft-sediment brecciation effects. A pelley, cryptofragmental fabric is apparent on the macro scale (see cut-off block).

Estimated mode

Plagioclase	50
K-feldspar	1
Quartz	10
Biotite	3
Sericite	5
Tourmaline	30
Opagues	1

This is a rock of heterogenous texture on the macro scale. It consists of laminated felsitic material, with wispy and cryptofragmental intercalations and sporadic coarse angular patches of a dark, unetched material (see cut-off block).

The thin section shows that the rock is of specialized composition, consisting predominantly of plagioclase and tourmaline.

The plagioclase is predominantly in the form of fine-grained felsitic aggregates, but includes more or less abundant, angular, clast-like (to locally subhedral prismatic) grains, to 0.2mm in size, which have the aspect of crystal clasts in a tuff or relicts in a cataclasite.

The matrix is more or less strongly pervaded by fine-grained sericite, biotite and tourmaline and, in some areas, the matrix to the plagioclase clasts is largely composed of these minerals. Elsewhere they are more diffusely disseminated, or form irregular schlieren and networks throughout the felsite.

For the most part, the micaceous minerals and the tourmaline show minutely felted texture, and lack the strongly foliaceous habit one would expect of a cataclasite.

The accessory quartz, on the other hand, occurs mainly as streaks and boudin-like lenses of intensely strained, stretched grains showing extensive granulation.

The coarse, angular, fragment-like area of dark material seen in the cut-off block is largely composed of felted, microgranular tourmaline. Tourmaline also forms interstitial networks within the siliceous boudins, and can locally be seen as marginal replacements of quartz.

The origin of this rock is obscure. It looks tuffaceous, but is certainly partly cataclastic.

The strong, pervasive tourmalinization may be largely post-tectonic.

Estimated mode

Plagioclase	56
Quartz	10
Biotite	15
Chlorite	5
Muscovite)	6
Sericite)	
Sillimanite	4
Tourmaline	2
Rutile)	2
Sphene)	

This is a distinctly foliated rock which, on the macro scale, appears to consist of granular plagioclase, in which a laminar structure is defined by intergrown networks and clumps of a foliaceous component and sporadic laminar/lensy zones enriched in granular quartz.

In thin section the rock is found to be relatively coarse-grained, and composed predominantly of irregular aggregates of fresh plagioclase, of grain size 0.2 - 2.0mm. The plagioclase forms sub-oriented grains and somewhat elongate clumps, alternating with clumpy/streaky aggregates of stumpy, sub-oriented grains of fresh brown biotite and lesser intergrown muscovite, 0.2 - 0.5mm in size. Locally the biotite is altered to chlorite.

Euhedral tourmaline is a prominent intergrown accessory in the biotite.

Fibrolitic sillimanite, grading to minutely felted sericite, is developed as intergranular wisps and pockets through the micaceous zones, and also occurs as hair-like inclusions in quartz grains.

Quartz is an intergrown accessory in the feldspathic aggregates. It is generally somewhat smaller in grain size than the plagioclase, and tends to occur as sporadic, elongate concentrations of grains. Quartz is often included within coarser plagioclase, and graphic to myrmekitic textures are common.

This rock shows clear evidence of igneous (quartz diorite) ancestry. The prominent banding may be partly a remnant primary feature (e.g. in a contact or hybrid zone of an intrusive), possibly emphasized by recrystallization under stress. The lack of strong schistose orientation and schlieren development in the micas is distinctive.

Estimated mode

Quartz	25
Plagioclase	35
K-feldspar	1
Biotite	30
Muscovite	2
Garnet	trace
Andalusite	trace
Tourmaline	3
Carbonate	1
Pyroxene	2
Actinolite	trace
Opagues	1

This rock generally resembles the other high-grade biotite schists constituting the group classified as Mt. Mye Formation, Unit ICD. It differs in lacking staurolite, and in containing notably high proportions of tourmaline and accessory diopside.

The quartzo-feldspathic component consists of a varigranular aggregate of quartz and intergrown plagioclase, of grain size 0.05 - 0.25mm. Sinuous/laminar and lenticular variations in grain size and proportions of quartz/plagioclase are common. The fabric varies from a blocky mosaic to intercalated zones of strongly flattened grains. Small, distinct, well-twinned plagioclase grains have somewhat the aspect of relict phenocrysts or crystal clasts.

Fresh, red-brown biotite is the other major component. This forms well-oriented flakes and intergranular networks, and concentrates as irregular, semi-continuous schlieren, in which constituent flakes reach as much as 1mm in size. Some biotite schlieren have intergrown muscovite.

A few concordant zones are distinguished by a high content of olive-green, euhedral tourmaline (grains 0.05 - 0.5mm) intergrown - generally in concordantly oriented clusters - within the biotite.

One 3mm laminar zone of strongly recrystallized quartz is distinctive for containing strings of carbonate and associated subhedral grains, 0.1 - 0.8mm in size, of fresh diopside.

Another zone includes sporadic, coarse, augen-like grains and grain clumps of fresh plagioclase, to 2.0mm or more in size. These contain minor intergrown quartz, and appear to be relict primary features rather than porphyroblasts.

Rare, undoubted porphyroblasts of anhedral garnet and of partially sericitized andalusite are also seen.

Sample 89-768B cont.

This is a biotite schist, showing possible indications of igneous or hybrid parentage. It does not exhibit any obvious shearing or mylonitization.

Estimated mode

Quartz	18
Plagioclase	36
K-feldspar	trace
Sericite	8
Andalusite	2
Staurolite	trace
Chlorite	trace
Tourmaline	36
Rutile)	trace
Opagues)	

This is another heterogenous-textured frock of somewhat similar macroscopic appearance to 724B. It displays an irregular, lensey/laminated fabric, apparently deformed and disrupted by complex fracturing. The thin section confirms the resemblance to 724B, in that the rock contains abundant fine-grained tourmaline.

The texture is highly variable. Plagioclase and quartz make up the bulk of the rock, occurring intergrown as platy aggregates of crenulate-margined, elongate, intensely strained grains, 0.02 - 0.2mm in size.

This textural type grades - or alternates in angular/patchy to lensey fashion - with a proto-mylonitic variant consisting of individual small quartz and feldspar grains or composite augen, scattered through a structureless, minutely felsitic matrix. The latter is often diffusely impregnated with cryptocrystalline tourmaline.

Tourmaline - always as very fine-grained, non-oriented aggregates - also occurs in diverse manner throughout the rock, as schlieren, networks, veinlets and small discrete patches.

Sericite is a minor associate of the tourmaline, and occurs in similar textural mode. There are also some patches of felted sericite which are clearly derived by breakdown of andalusite - more or less extensive remnants of which occur as cores to these patches. Rare, small, fragmentary grains of staurolite are also seen in some sericite schlieren.

The slide is cut by a late hairline veinlet of K-feldspar with intergrown chlorite.

The rock appears to represent an intensely sheared and partially mylonitized quartzo-feldspathic (possibly igneous?) protolith which has been further disrupted by brittle fracturing. The paragenesis of the tourmaline is obscure, but it shows no oriented fabric, and may be largely of post-cataclastic introduction.

SAMPLE 89-771B

EPIDOTE-DIOPSIDE SKARN

Estimated mode

✓ <u>K-feldspar</u>	2
Carbonate	3
Diopside	30
Epidote	60
Leucoxene	5

This is a streaky, crudely-banded rock of specialized mineralogy. It is notable for its essential lack of quartz and feldspar.

It consists of a varigranular aggregate of epidote and more or less altered pyroxene, of grain size 0.01 - 1.0mm. The two minerals occur partially segregated in crudely banded relationship, and there are also banded, or conformable vein-like, variations in grain size.

Much of the epidote is a very fine-grained, compact aggregate, but it also occurs as bands of coarse, bladed or meshwork texture. The pyroxene tends to exhibit anhedral to subhedral prismatic form. It typically shows strong, brownish, sub-opaque (leucoxene? limonite?) pervasive alteration.

A few bands contain intergrown carbonate and/or minutely felsitic plagioclase.

Minor hairline veinlets of redistributed(?) epidote cross-cut the crudely banded fabric.

Grain orientation is essentially random throughout, and this rock shows no evidence of cataclastic involvement. It has more the aspect of a banded skarn, of metasomatic or contact metamorphic origin.

Estimated mode

Quartz	26
Plagioclase	40
K-feldspar	18
Biotite	2
Chlorite	10
Sericite	2
Epidote	1
Apatite	trace
Tourmaline	trace
Rutile	1
Opaques	trace

This slide appears to consist of two distinct rock type in sharp contact.

Macroscopically, one is notably coarser-grained, and is distinguished by a major content of K-feldspar (see stained cut-off block). It has the appearance of a granitoid intrusive.

The other is fine-grained, and shows a distinct, even, laminar foliation. The same foliation direction is, however, recognizable in the coarser, intrusive unit, and the contact (which is somewhat gradational) also parallels this direction.

In thin section the differences between the two components are less striking - at least as regards texture.

The granitoid unit is notably leucocratic, and consists of a varigranular aggregate of K-feldspar, plagioclase and quartz in which the feldspars form anhedral-subhedral grains up to 2.0mm in size. The quartz is predominantly in the form of irregular/elongate segregations of flattened, crenulate-margined (but not exceptionally strained) grains, 0.1 - 0.5mm in size.

More or less extensive development of a fine-grained (probably granulated or recrystallized) phase of intergrown quartz and feldspar is seen as streaks and networks between the coarser feldspar grains. Grain size in this material is in the range 10 - 100 microns.

Accessories are limited to sporadic clusters and small, sinuous wisps of partially chloritized biotite (generally sub-concordant and sometimes concentrating on the contacts of the elongate quartz clumps), and sporadic small, individual subhedra of apatite and tourmaline. The latter show no conformity to the general direction of foliation.

Sample 89-771D cont.

This rock has the appearance of a partially sheared and recrystallized microgranite. Much of the foliation could well have been induced by near-contact flow effects in a partially crystallized mush during intrusion - the coarser feldspar grains being undeformed.

The other lithotype differs in having much less K-feldspar and much more chlorite. It shows a general grain size range of 0.05 - 0.3mm, and consists of somewhat irregular, laminar alternations of quartz-rich, plagioclase-rich and chlorite-rich composition.

The anhedral granular fabric of the quartz and plagioclase in this lithotype has a meta-igneous aspect and, in many respects, looks like a rather finer-grained, more strongly foliated version of the granitic unit.

The chlorite forms sinuous strings and networks of sub-oriented flakes, tending to be associated with the plagioclase and the contacts of the more quartzose laminae. Rather abundant fine-grained sphene or rutile flecks are associated with the chlorite, as well as rare specks of epidote. Minor biotite occurs with the chlorite - suggesting that the latter may be largely an altered form of biotite.

The plagioclase in this lithotype is typically somewhat saussuritized (clouded with diffuse sericite and cryptocrystalline epidote.)

Small grains of tourmaline and apatite - the same accessories seen in the granitic unit - are present near the contact. An additional accessory is an opaque oxide, as sporadically scattered small grains.

This rock type is of uncertain origin. It could represent the sheared and/or hybridized, fine-grained contact zone of a granitic sill. There is no indication of metacalcareous affinities.

Estimated mode

Quartz	10
Plagioclase	53
K-feldspar	10
Biotite	15
Hornblende	1
Pyroxene	10
Sphene	1
Opaques	trace

This is a fine-grained feldspathic rock showing a strong, slightly lensey, small-scale, laminar foliation, defined by compositional segregations of K-feldspar, plagioclase, quartz and mafics, on the scale 0.2 - 1.0mm (see stained cut-off block).

In thin section the average grain size is found to be in the range 0.05 - 0.2mm. The fabric is a typical granoblastic one, and all constituents are strikingly fresh.

The predominant component is plagioclase, as sub-polygonal aggregates of rather even-sized, equant to elongate grains. Quartz and K-feldspar occur as intergrown accessories but, for the most part, show strong segregation as thin laminae or lenses.

Grain flattening is rather common, particularly in the quartz-rich laminae. Grain elongation is concordant with the direction of compositional lamination. The foliation is also emphasized by slight grain-size differences between laminae.

Biotite is the commonest mafic, occurring as well-oriented flakes and semi-continuous, intergranular networks and segregated schlieren, particularly in the feldspathic laminae.

Clino-pyroxene is another prominent accessory, as well-segregated trains and semicontinuous laminae of elongate, anhedral grains. These tend to be relatively coarse - in some cases reaching as much as 1.0mm. Well-crystallized subhedral grains of sphene are typical trace associates of the pyroxene segregations.

One thin lamina of green hornblende is also seen.

The protolith of this rock is uncertain. The strongly recrystallized and mineralogically segregated pyroxene may be of metacalcareous derivation, but the predominant character of the rock is quartzo-feldspathic. No garnet or aluminosilicates, typical of pelitic origin, are present, and the rock may be the result of the amphibolite grade metamorphism of a felsic tuff with calcareous intercalations.

Estimated mode

Quartz	37
Plagioclase	12
Biotite	30
Muscovite	10
Chlorite	trace
Staurolite	10
Tourmaline	trace
Rutile)	1
Opagues)	

This is a rather fine-grained, schistose rock, with prominent small, brown porphyroblasts.

In thin section it is found to consist of quartz and accessory plagioclase with abundant micas - predominantly biotite. The porphyroblasts are staurolite.

The quartzose matrix is mainly of grain size 0.1 - 0.3mm. It is an anhedral, granular mosaic, commonly showing crenulate grain boundaries. Elongate grain shapes (sometimes reaching 0.5mm in size) and minutely fine-grained granulation/recrystallization are locally developed, and rather strong strain polarization is observable throughout.

Plagioclase is a randomly to streakily intergrown accessory, mostly somewhat finer-grained than the quartz.

Fresh, red-brown biotite, with accessory interlaminated muscovite, forms abundant, strongly oriented flakes and sinuous, anastomosing schlieren throughout. These separate irregular laminae and small, lenticular bodies of the quartzo-feldspathic matrix. Tiny elongate granules of rutile and ferruginous opaques occur within some of the micaceous schlieren.

Staurolite forms elongate to irregular, sub-equant, sometimes fragmentary grains, 0.1 - 1.5mm in size, closely associated with the micaceous schlieren. They sometimes contain oriented inclusions of opaque granules, similar to those in the enveloping micas. Mostly these inclusions show a distribution conformable to the schistosity (consistent with the tendency for the staurolite grains to be elongated parallel to this same direction). Locally, however, they indicate some rotation of the porphyroblasts.

Minor alteration of biotite to chlorite is observed in contact with the staurolite porphyroblasts.

SAMPLE 89-793 ACTINOLITE LENS IN TOURMALINE-CHLORITE SCHIST

Estimated mode

Quartz	12
Actinolite	86
Chlorite	2
Plagioclase	trace
Sericite	trace
Biotite	trace
Tourmaline	trace
Opaques	trace

This sample consists of a lenticular mass (boudin?) of specialized mineralogy, intercalated with a strongly schistose fine-grained lithotype.

The portion sectioned (and referred to by the above estimated mode) is almost entirely made up of the boudinaged phase, but a small corner of the enveloping schist is also recognizable in the slide.

The latter phase is seen to consist largely of compact, foliaceous chlorite with trains of elongate opaques and tiny quartz or plagioclase granules. It shows a sharply gradational contact with the massive actinolite rock, by way of a thin zone containing oriented acicular amphibole and minor biotite.

The dark, elongate, prismatic grains in the chlorite rock (also seen as meshworks of prisms on schistosity planes in the hand specimen) are tourmaline.

The material of the boudin is of simple mineralogy, consisting of a random aggregate of varigranular, pale green actinolite with a pockety, interstitial phase of quartz. The actinolite ranges in grain size from 0.05 - 2.0mm, and forms felted, microgranular and coarsely bladed aggregates. Marginal to the sporadic quartz pockets, it shows strikingly fibrous/acicular, habit with meshworks of slender needles penetrating the quartz.

The origin of this rock is obscure.

SAMPLE 89-810 META-CALCAREOUS TUFF OR SEDIMENT

Estimated mode

Quartz	37
Plagioclase	8
K-feldspar	20
Epidote	20
Secondary amphibole(?)	10
Carbonate	1
Acicular mineral	1
Sericite	1
Rutile	2

This is a heterogenous, clumpy/streaky rock showing throughgoing, sinuous/sub-parallel partings (fracture cleavage?).

In thin section it is found to be composed predominantly of quartz and feldspars, together with major accessory proportions of epidote and a brown mineral of secondary aspect.

The quartz and feldspars occur intergrown as a rather even, anhedral aggregate, of grain size 30 - 100 microns. This locally shows partial grain elongation and, in some areas (recognizable by the distribution of intergranular accessory minerals), is affected by tight crenulate folding.

The discrete partings are in the nature of a fracture cleavage parallel to the axes of crumpling and the local grain elongation. They consist of sinuous, horsetailed microshears demarked by micron-sized sub-opaques (rutile?), cryptocrystalline epidote and - occasionally - by imbricated chlorite flakes.

Well-crystallized epidote occurs throughout as flecks and networks intergranular to the quartz-feldspar, and also concentrates as more or less extensive, irregular, coarser-grained clumps composed of aggregates of grains up to 0.2mm or more in size (rarely to 0.5mm), possibly representing remobilized calcareous segregations related to microfold crests.

The epidote segregations are commonly closely intergrown with patches of a brown, minutely felted material which has the aspect of secondary amphibole. Locally this material shows relict prismatic aggregate structure, and includes a component of carbonate. It may represent altered pyroxene, and is clearly of metacalcareous derivation, like the epidote.

The epidote of the granular segregations sometimes contains webs of unidentified colourless needles.

This rock is probably a recrystallized and strongly deformed felsic tuff or feldspathic siltstone with calcareous interlaminae.

SAMPLE 89-822

SILLIMANITE SHEAR ROCK

Estimated mode

Quartz	10
Sillimanite	82
Chlorite	5
Sericite	2
Rutile	1

This is a rock of distinctive mineralogy, unlike any previous samples of the suite.

It is composed largely of compact, fine-grained, fibrous sillimanite, and is intensely and complexly deformed.

Minor chlorite and sericite - of finely felted to foliaceous habit - occur interlayered with the strongly oriented, contorted sillimanite mass, and are developed in kinks and microshears.

Quartz occurs as sporadic, irregular, recrystallized masses. It is also seen as contorted veniform or laminar threads, and as minute droplets within the compact sillimanite.

Wisps and horsetail schlieren of micron-sized, sub-opaque material (rutile?) occur throughout, delineating the internal contortions in the sillimanite mass. Similar material(?) occurs in more dispersed form as swarms of minute, included needles.

The origin of this rock is unknown. It possibly represents the metamorphic product of some unusually aluminous protolith - e.g. a clay-rich or hydrothermally altered material. Alternatively it may be a product of localized, intense (high temperature/high stress?) metamorphic conditions.

Estimated mode

Plagioclase	64
Quartz	10
K-feldspar	2
Biotite	18
Hornblende	4
Rutile)	2
Sphene)	
Opagues	trace

This is a streaky, crudely foliated rock of strongly feldspathic composition.

In thin section it is found to exhibit a heterogeneous texture, showing features consistent with cataclastic origin. It resembles 771A and 724B except that no tourmaline is present, and there is a minor accessory component of hornblende.

It is composed predominantly of felsitic plagioclase (with minor intergrown K-spar) of grain size 5 - 50 microns. This is host to more or less abundant, coarser, individual, sub-rounded grains, angular to irregular clumps and augen-like bodies of plagioclase and quartz. This proto-mylonitic texture clearly results from cataclastic granulation.

The bulk of the quartz in this sample occurs as a few lenses of irregular/elongate, strongly strained grain aggregates.

Biotite, as fine-grained, poorly formed flakes, scaly aggregates and felted masses, is an abundant accessory. It forms intergranular networks in the coarser, microgranular areas of feldspar and quartz, and diffuse impregnations of the finely granulated felsitic material. Felted biotite locally forms the matrix to small quartzo-feldspathic remnants.

Pale green hornblende occurs as localized clusters of fragmentary (embryonic porphyroblastic) grains, generally separate from the biotite.

The distribution of biotite and of wisps of micron-sized rutile defines an irregular, patchy, sinuous/contorted fabric. This appears to represent a complex cataclastic sequence of brecciation, granulation and deformation - possibly with some late fracturing.

Estimated mode

Quartz	15
Plagioclase	40
K-feldspar	35
Biotite	7
Muscovite)	3
Sericite)	
Apatite	trace
Zircon	trace
Rutile)	trace
Opaques)	

This rock is clearly recognizable, in the stained cut-off block, as a strongly foliated, partially sheared and granulated granite.

The coarse, augen-like masses of K-feldspar are probably remnants of an original porphyritic fabric. They are now somewhat rounded - as are the predominant, smaller, polygranular clumps of plagioclase and intergrown K-spar - and outlined by sinuous zones of granulation and quartz mobilization.

In thin section the primary grain size appears to have been in the range 0.2 - 2.0mm. For some reason, the coarse K-spar phenocrysts seen in the cut-off block do not appear to be represented.

An original aggregate of fresh, subhedral plagioclase, anhedral K-spar and interstitial microgranular quartz is permeated by an intergranular network of incipient granulation/recrystallization, and is traversed by anastomosing zones of more intense granulation. The latter produce felsitic streaks (often permeated by diffuse networks of felted sericite) from the feldspar, and deformed, highly strained, crenulate-margined, fine-grained aggregates from the quartz.

Accessories are biotite and muscovite. These partially show redistribution as sinuous wisps of tiny flecks, but mainly appear unaffected by the cataclasis - occurring as rather coarse, non-oriented, well-formed flakes.

Other accessories are seen in rare traces only. No tourmaline was recognized.

The rock appears devoid of hydrothermal alteration. There is no observable difference between the A and B sections (different directions of cut).

Estimated mode

Quartz	30
Plagioclase	52
Biotite	15
Sericite	2
Tourmaline	trace
Rutile)	1
Opagues)	

This is a fine-grained rock of quartzo-feldspathic composition.

It is of simple mineralogy, consisting essentially of laminar alternations, on the scale of 0.5 - 2.0mm, of quartz and plagioclase.

The quartzose laminae are aggregates of anhedral, often elongate, moderately strained grains, 0.05 - 0.4mm in size.

The feldspathic laminae consist of close-packed, blocky to elongate, subhedral-anhedral grains of plagioclase, of similar grain size to the quartz. A distinct preferred elongation of the long axes of these grains, parallel to the lamination, is often observable. A few plagioclase laminae are of finer, felsitic texture, with grain size in the range 0.02 - 0.1mm.

The accessory biotite is strongly concentrated in the feldspathic laminae, as intergranular flakes, pockets and networks. It generally shows strong orientation parallel to the foliation, but does not segregate as discrete schlieren. Minute biotite flecks, down to a few microns in size, are also seen as inclusions within some plagioclase grains.

The plagioclase is often dusted with micron and sub-micron sized inclusions, some of which are recognizable as rutile and opaques. Rare, tiny euhedra of tourmaline are a trace constituent.

Lesser amounts of intergranular biotite are also seen in some of the quartzose laminae.

A little quartz is intergrown with some of the plagioclase laminae, but generally there is a high degree of segregation.

The delicate, undeformed lamination of this rock probably reflects a primary structure. Possibly it was a bedded fine-grained tuff or tuffaceous siltstone. The strong grain orientation indicates a superimposed metamorphic effect, with more or less extensive recrystallization.

SAMPLE 89-849

MICA SCHIST

Estimated mode

Quartz	46
Plagioclase	10
Biotite	18
Muscovite	12
Chlorite	8
Garnet	1
Staurolite	5
Sericite	trace
Opaques	trace

This is a typical high-grade pelitic schist. Macroscopic examination shows a strong, sinuous foliation defined by a rather high content of micas. The mica schlieren outline lenticular segregations of quartzo-feldspathic composition. The rock also contains a few prominent garnet porphyroblasts and relatively abundant, smaller porphyroblastic clumps of a brown mineral, associated with the micaceous schlieren.

Grain size of the quartzo-feldspathic matrix is 0.5 - 3.0mm. It appears to be composed largely of quartz, as a sub-polygonal to somewhat flattened, crenulate-margined aggregate. However, it is likely that some plagioclase is also present, as an intergrown accessory. This is essentially indistinguishable in thin section (being untwinned and totally fresh and clear).

Biotite is the predominant mica, though muscovite is a common intergrown accessory. The micas occur as small, intergranular flecks within the siliceous lenses, but are chiefly segregated as rather irregular schlieren and clumps.

The biotite shows extensive alteration to chlorite. This is manifested as incipient interlaminated wisps, grading to complete conversion.

The principal porphyroblastic component is staurolite. This forms clusters of small, ragged to subhedral grains, 0.1 - 1.0mm in size, sieved with quartz inclusions. These mostly occur within and marginal to micaceous schlieren. They locally show partial alteration to chlorite and sericite.

Rare garnet occurs as individual euhedra and ragged skeletal masses to 2 or 3mm in size. The latter form is developed within quartzose lenses and shows elongation oblique to the foliation.

The distribution of small opaque inclusions, within the porphyroblasts and the surrounding matrix, suggests complex deformation, now virtually obliterated by the prevalent schistosity.

SAMPLE 89-865

LAMINATED META SEDIMENT OR TUFF

Estimated mode

Quartz	15
Plagioclase	50
Chlorite	27
Biotite	trace
Sericite	2
Carbonate	3
Actinolite	2
Sphene	trace
Rutile)	1
Opagues)	

This sample is a fine-grained rock exhibiting a delicate, slightly sinuous, but undeformed laminar texture, on a scale of 0.5 - 1.0mm.

It consists of an aggregate of grain size 0.03 - 0.3mm, composed predominantly of plagioclase, with lensey/laminar segregations of quartz.

The laminar fabric is defined by variations in grain size, and by numerous thin zones containing more or less abundant, partially oriented, intergranular chlorite, or, in a few cases, made up of well-oriented, fine-grained sericite. The chloritic/micaceous zones also contain trains of micron-sized granules and elongate wisps of sphene, rutile and opaques.

Occasional well-twinned subhedral plagioclase grains, which appear to be primary remnants (crystal clasts?), are seen scattered through the rather evenly recrystallized aggregate.

At one side of the slide, there is a 1mm selvedge which is of quartz-rich composition, and is distinguished by the development of fibrous clusters and occasional, randomly-oriented clumps of prismatic actinolite. Traces of carbonate are associated.

The slide is cut by discordant veinlets. One, 0.5 - 1.0mm in thickness, is of carbonate with chlorite selvedges. The other, 0.1 - 0.2mm in thickness, is of intergrown carbonate and quartz.

This rock is probably a recrystallized feldspathic siltstone or wacke - or fine-grained tuff - with minor metacalcareous intercalations.

SAMPLE 89-887

META-GREYWACKE

Estimated mode

Quartz	23
Plagioclase	37
K-feldspar	5
Biotite	1
Chlorite	14
Sericite	17
Carbonate	1
Epidote	trace
Apatite	trace
Rutile)	3
Leucoxene)	

This is another fine-grained, laminated rock - similar to many others of the suite except that it appears to be cut by a stockwork of hairline veinlets and zones of crushing and/or alteration.

The unaltered rock consists of laminated alternations, on a scale of 0.5 - 2.0mm, of quartzose, plagioclase-rich and micaceous composition. Some lensy and diffuse intergrowth of these components is also seen.

The quartzo-feldspathic matrix is of grain size 0.05 - 0.2mm, and quartz segregations are in the form of crenulate-margined, locally flattened/elongate, anhedral mosaics. Feldspars (which include accessory K-spar) tend to form distinct clumps and streaks of stubby, equigranular grains (sometimes having the aspect of primary, unrecrystallized remnants).

The micas are principally sub-oriented chlorite or well-oriented sericite, as zones of intergranular flakes and thin, coalescent schlieren. They typically include concordant trains and wisps of fine-grained rutile.

The cross-cutting features are of various kinds. Some hairline veinlets are sharply defined and composed of granular K-feldspar and plagioclase, sometimes with epidote and chlorite. Others are more ill-defined, and appear to be composed of felsitic plagioclase. The main discordant zone (about 1cm thick) is composed of turbid, saussuritized felsite showing a patchy cryptofragmental texture, with clast-like masses or pockets of microgranular quartz, and of sparry carbonate.

This rock is probably a meta-greywacke. The discordant zones are of obscure origin, but clearly cross-cut the foliation and are apparently post-metamorphic.

Estimated mode

Quartz	2
Plagioclase	9
Sericite	20
Chlorite	20
Actinolite	42
Carbonate	1
Sphene	2
Rutile)	3
Leucoxene)	
Opagues	1

This is another fine-grained, laminated rock. Its fabric appears somewhat more irregular (sinuous/lensy) than that of some others of the suite.

Thin section examination shows that it is of distinctive composition - low in quartz and rich in mafics. Fibrous actinolite is the principal component, along with abundant chlorite. Plagioclase appears originally to have been in the form of rather even-grained aggregates, of grain size 0.03 - 0.1mm. It is now largely converted to fine-grained sericite.

The foliation is defined by variations in the constituent mineral proportions, as laminae and lenses on the scale 0.2 - 2.0mm.

The two principal components are sericitized feldspar with interstitial flakes and laminar streaks of chlorite; and fibrous/acicular actinolite, sometimes with diffuse patches of carbonate or clumps of granular quartz. Various degrees of intimate intergrowth of these are also observed.

Small grains of well-crystallized sphene, and trains and wisps of micron-sized rutile and opaques, are principally concentrated in the chlorite/feldspar laminae.

The actinolite occurs as sub-oriented, acicular masses and meshwork aggregates. The chlorite also shows partial orientation, but the foliation is principally defined by the rapid, laminar compositional variations rather than individual grain orientation.

No relict primary features, in the sense of phenocrysts or fragments, are recognizable, and the nature of the protolith is debatable. It may have been a bedded mafic tuff. The mineralogy is certainly consistent with the field classification of a meta-basite.

Traces of crenulate crumpling are recognizable in some of the chlorite/plagioclase laminae between the rutile partings. The outline of the thickest actinolite lens shows lobes which suggest possibly isoclinal folding parallel to the foliation.

SAMPLE 89-899

TRACHYANDESITE

Estimated mode

Quartz	8
Plagioclase	54
K-feldspar	12
Sericite	7
Chlorite	8
Carbonate	10
Apatite	trace
Rutile)	1
Opagues)	

This is a non-foliated rock of clearly defined, porphyritic igneous character.

Phenocrysts, 0.2 - 2.5mm in size, make up some 35-40% of the rock. These are predominantly euhedral plagioclase, showing weak to moderate pervasive alteration to fine-grained sericite and minor carbonate. Quartz phenocrysts are also prominent; these are typically somewhat rounded and surrounded by chill or reaction zones in the adjacent groundmass. The least abundant, and generally smallest, phenocryst type is an original mafic (probably biotite), now totally pseudomorphed by various proportions of intergrown chlorite, carbonate and rutile/opagues.

The phenocrysts are randomly scattered through a felsitic/microgranular groundmass, of grain size 0.02 - 0.1mm, composed predominantly of intergrown plagioclase and K-feldspar. Minor interstitial chlorite, sparse flecks of sericite and carbonate, and traces of rutile/opagues are the remaining groundmass constituents.

This rock shows no apparent recrystallization or metamorphic effects. Its texture is consistent with a minor intrusive body such as a dyke, and it has the composition of a mildly altered, rather leucocratic trachyandesite.

SAMPLE 89-931 CHLORITIC PHYLLITE WITH FELSITIC OVOIDS

Estimated mode

Plagioclase	52
Chlorite	42
Carbonate	6
Quartz	trace
Rutile	trace

This is a rock of distinctive appearance on the macroscopic scale, unlike any others of the suite. It is a fine-grained, grey rock containing abundant, sharply defined, sub-parallel, ovoid bodies, 0.3 - 5.0mm in size. These display a white etch in the stained cut-off block, suggesting possible feldspathic composition.

In thin section the rock is found to be of simple mineralogy - similar to such other samples as 89-557.

The grey matrix is made up predominantly of very fine-grained, compact, oriented chlorite with accessory interstitial felsitic plagioclase, of grain size 5 - 10 microns. The chlorite exhibits a small-scale, crenulated fabric of typical phyllitic type. Flecks of cryptocrystalline rutile concentrate as sub-parallel wisps, defining a weak cleavage, parallel to the axial plane of the crumpling.

The ovoid bodies are composed of slightly coarser felsite (5 - 25 microns) with only very minor chlorite, as minute, randomly oriented, individual flakes. Fine-grained carbonate is a prominent accessory component in these bodies, as more or less abundant flecks and small clumps, locally aggregating to patches of 0.5mm or more.

The rutile cleavage wisps in the groundmass typically diverge around these ovoids, and there is local coarsening and segregation of groundmass chlorite marginal to them, in the manner of pressure shadows. The ovoids tend to show elongation in the general direction of the cleavage, and some are stretched and deformed.

Their origin is unclear. They appear to be, at least in part, pre-tectonic, and may represent authigenic/redistributional segregations, (nodules) in an original shale or mafic ash tuff.

Estimated mode

Quartz	32
Plagioclase	20
Biotite	20
Sericite	25
Opaques	2
Limonite	1

This is another fine-grained foliated rock, composed essentially of quartz, plagioclase and abundant micas.

The quartzo-feldspathic matrix shows a grain size of 0.02 - 1.5mm. There is a tendency for lensy segregation of relatively coarser quartz aggregates, which show an anhedral mosaic texture with interstitial networks of biotite. These have a distinctly metasedimentary aspect.

Other areas of matrix have intergrown plagioclase - typically as diffuse, very fine-grained, felsitic patches dusted with micron-sized opaques.

The coarser mosaic lenses alternate with foliaceous, locally anastomosing schlieren, composed of fine-grained sericite, interstitial felsite and abundant films and wisps of opaque dust and acicular granules. Crenulate deformation is occasionally recognizable within these zones.

Biotite forms rather irregular schlieren and clumps, and also occurs abundantly as networks within quartzose aggregates. In the latter mode, it shows finely felted, randomly-oriented habit. Sporadic irregular clumps of limonitized opaques and derived staining occur within some of the better segregated schlieren.

The rather heterogenous, lensily-laminated fabric of this rock suggests that it may be derived from a greywacke, possibly with argillaceous or ashy intercalations.

Sample 89-1023 cont.

Traces of crenulate microfolding and shear textures are sometimes recognizable within the felsite/sericite component.

The rock possibly originated as a felsic tuffite with calcareous or mafic interlamination.

Estimated mode

Quartz	22
Plagioclase	9
Biotite	22
Muscovite	14
Staurolite	15
Andalusite	18
Opagues	trace

This is another of the high-grade metamorphic schists of the suite. This one is distinctive for its high content of staurolite and the presence of abundant andalusite. It is notably fresh and free of retrograde features.

As in the other samples of this type, plagioclase appears minor compared with quartz. The overall abundance of the quartzo-feldspathic component is proportionately lower in this sample, by virtue of the high content of staurolite and andalusite.

Quartz forms varigranular aggregates of crenulate-margined, anhedral, locally flattened or elongated grains, 0.05 - 0.5mm in size. Plagioclase occurs as segregated clumps and lenses of similar grain size.

Abundant interlaminated biotite and muscovite form well-oriented, individual grains within the quartz/plagioclase, and segregate as more or less close-spaced, sinuous, anastomosing schlieren, up to 1mm or more in thickness.

A few concordant zones of much finer-grained, felted sericite are also seen.

The staurolite forms equant to elongate, fragmentary/skeletal poikiloblasts, 0.2 - 1.5mm in size. These sometimes occur within the micaceous schlieren, and sometimes in adjacent quartzo-feldspathic streaks.

Andalusite occurs in like mode, as irregular, aggregated patches, up to 2 or 3mm in size, often enveloping oriented remnants of matrix quartz and biotite.

Porphyroblast development apparently overlapped the strong shearing which produced the overall lensey, gneissose fabric. Some staurolite grains are strongly elongated concordant with local mica orientation; others are strongly discordant to it. The orientation of opaque inclusions indicates rotation of porphyroblasts in some cases.

Samples in Storage, no petrography

3C 89-592

89-590

89-701

3G 89-637B

89-867

89-674

1C0 89-1001

89-1010

89-633

89-607

3D

A) pure : 89-788

89-597

89-606

89-859

89-1025 (drk, bi?/carb?)

B) pelitic w/ calcsil bands

89-863

89-612

89-594

89-625

89-668 (calcsil?)

89-844

89-887 (metabas?)

SE 89-687

89-976

89-901

SA 89-919

SB7 89-504

89-635

89-945

SB 89-554 (w/ ? uns)

89-678

89-675

89-677

89-588

89-587

SC 89-691

89-501

89-503

89-795

89-989, A, B (Swim o. 1st)

SC Solid 89-547

Shrimp SB/D

89-689

89-686

89-695

89-685

89-803

Tread claims 89-817 A, B

89-820

89-821

Miscellaneous

Earn Grp chert 89-925
89-927

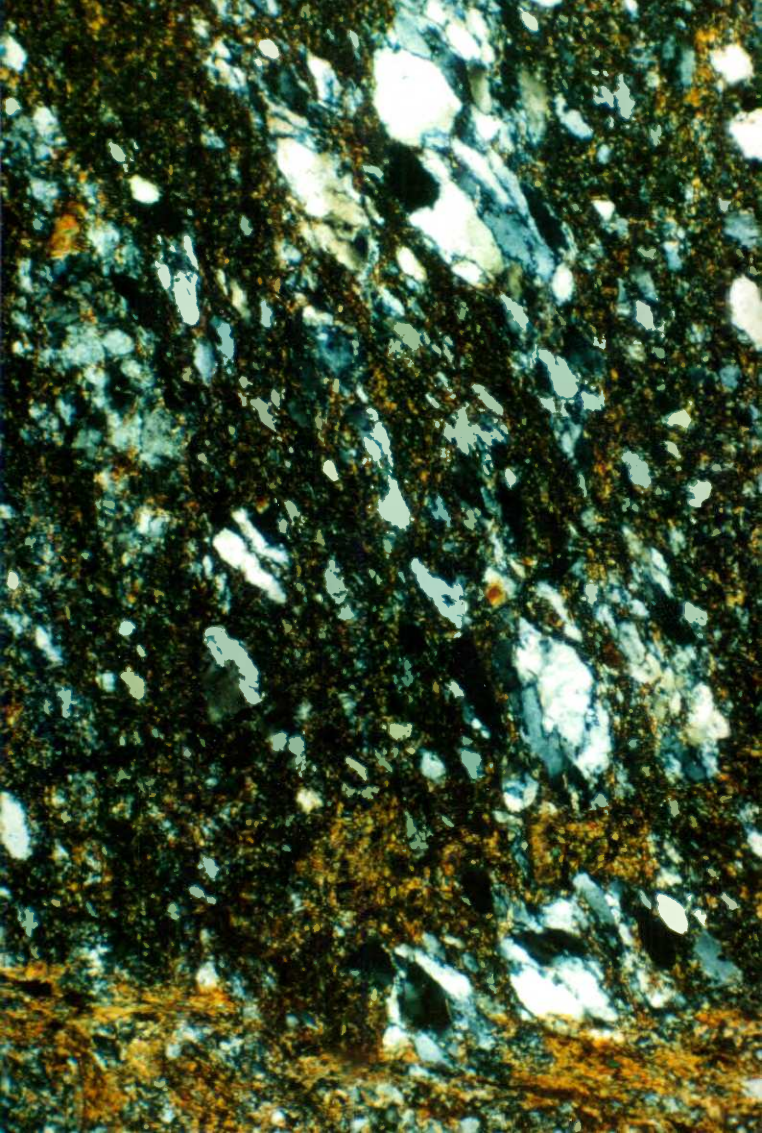
SDs crinoid ls (Swim)
89-972

Menzie Crk 89-943
89-931
89-929B (?)

Dykes 89-656 (10F)
89-790 (10F)
89-958 (10E)
89-771C (10AB)
89-768A (10AB)

10AB 89-611 (oriented) } The Fault
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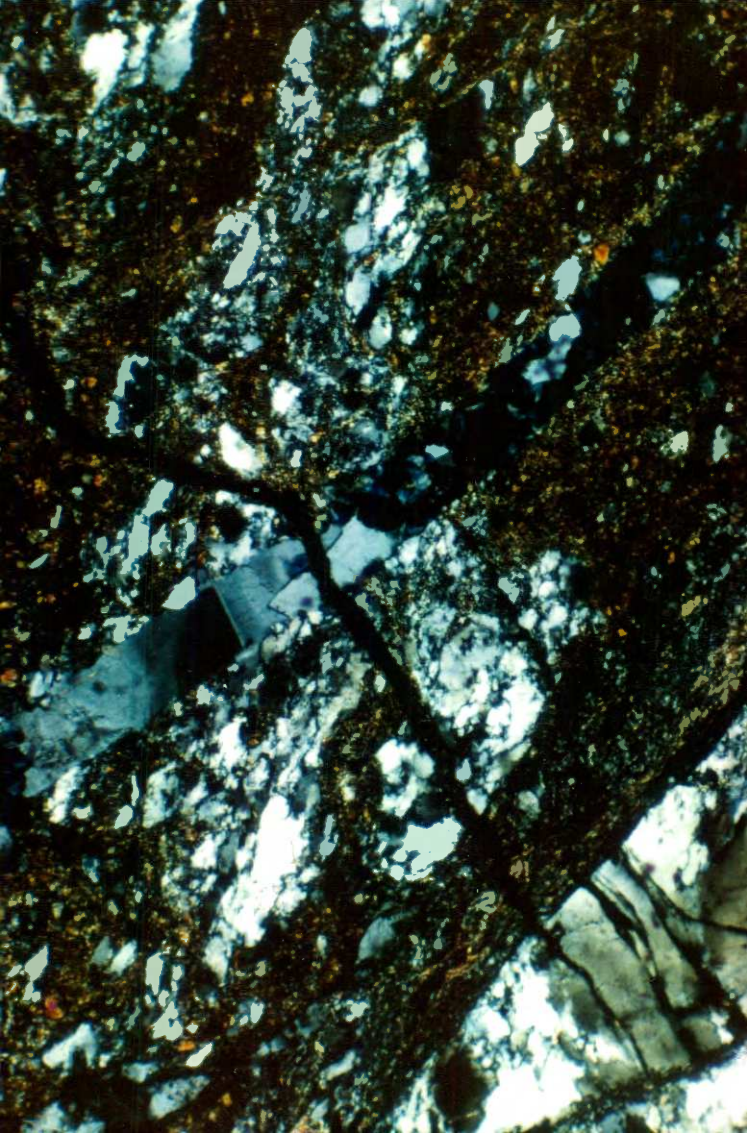
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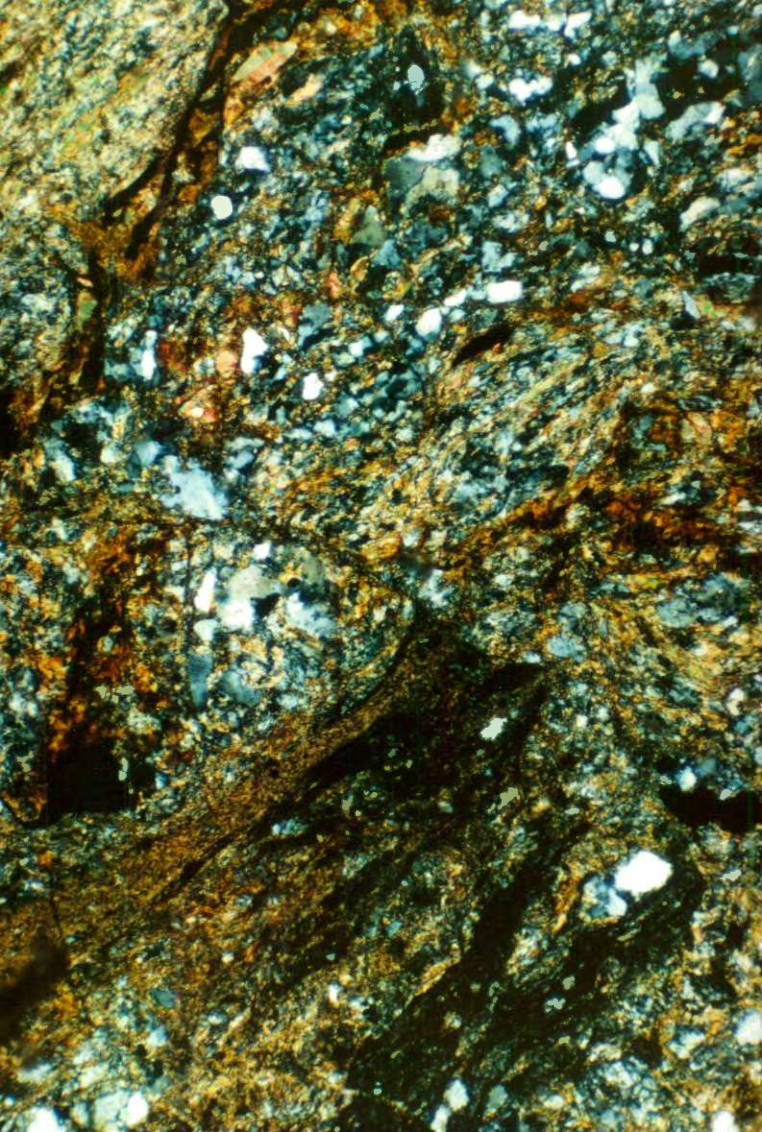


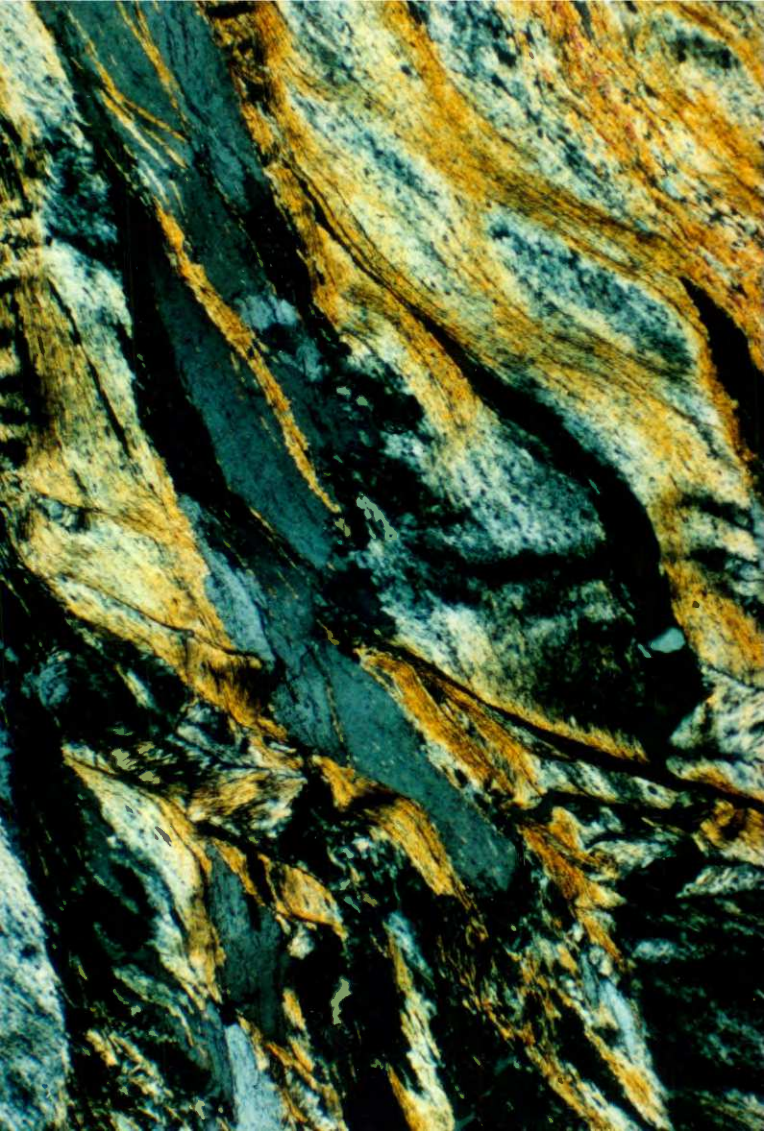
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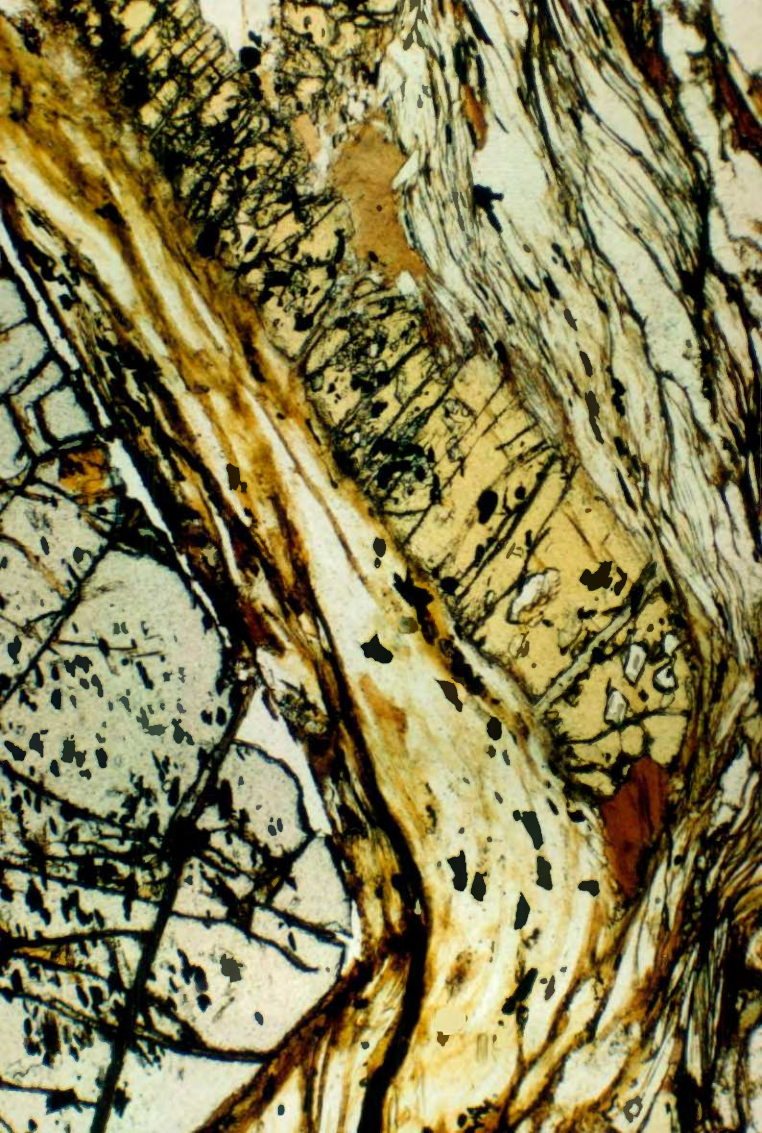




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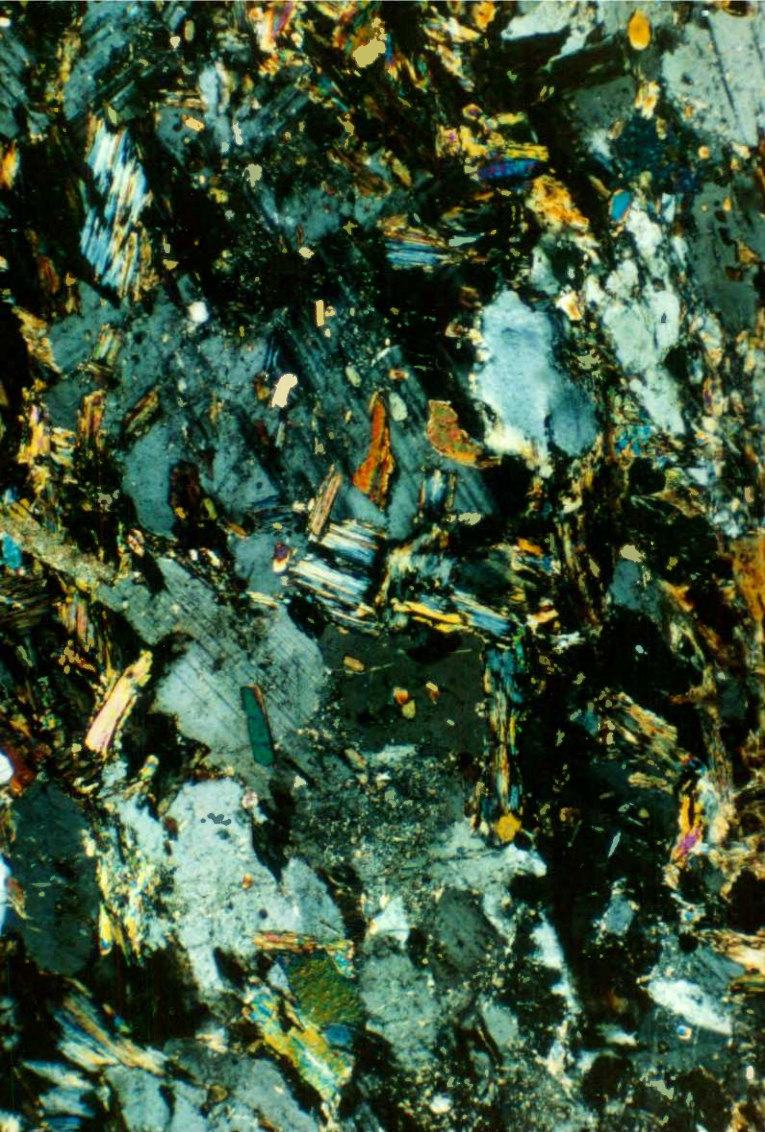
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SERVICES**

534 ELLIS STREET,
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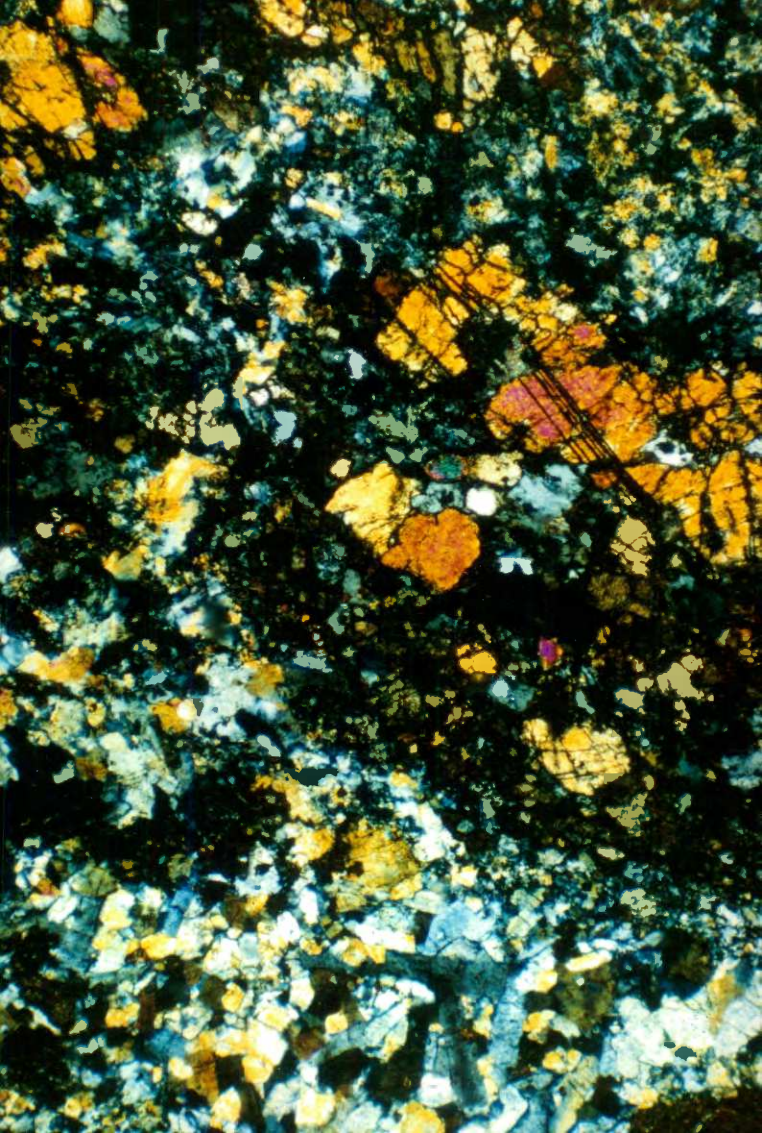
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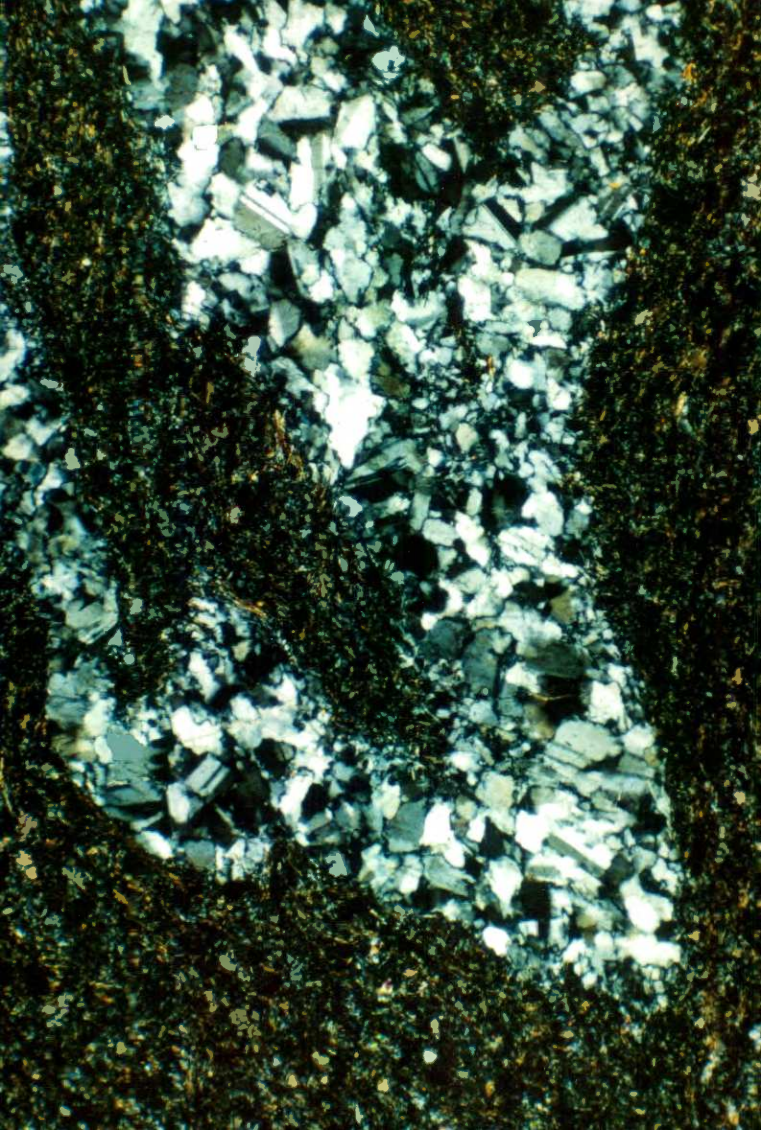


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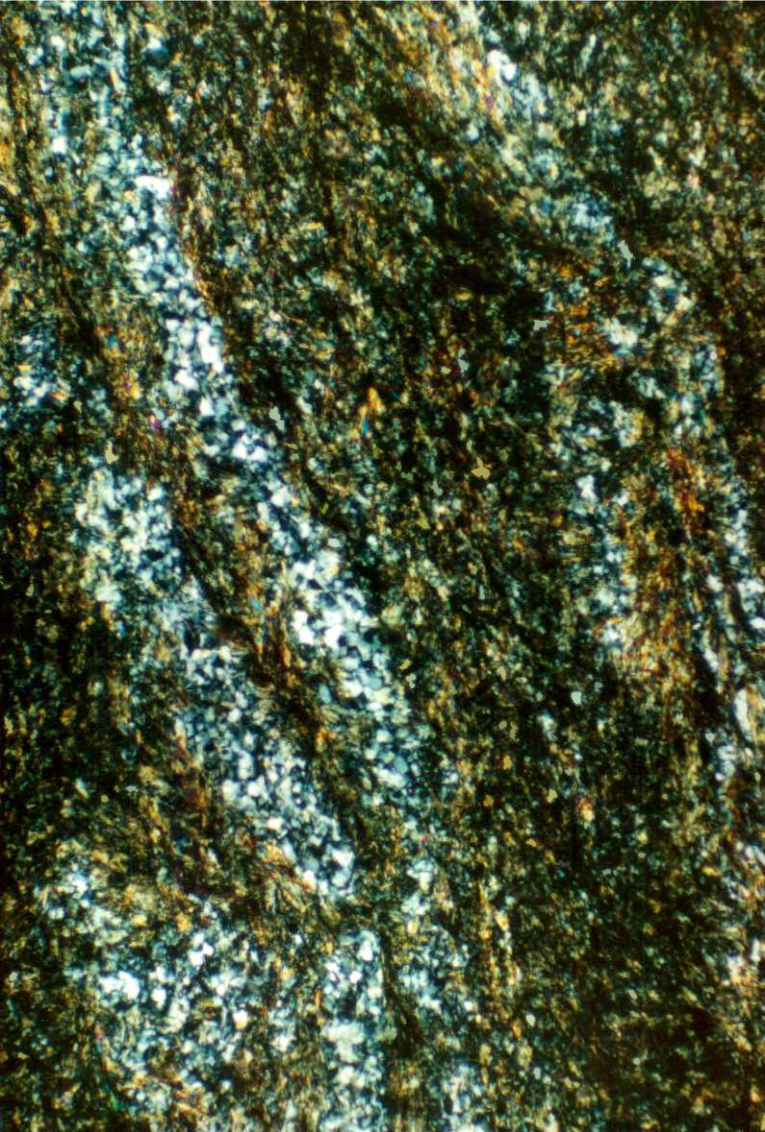


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**HARRIS EXPLORATION
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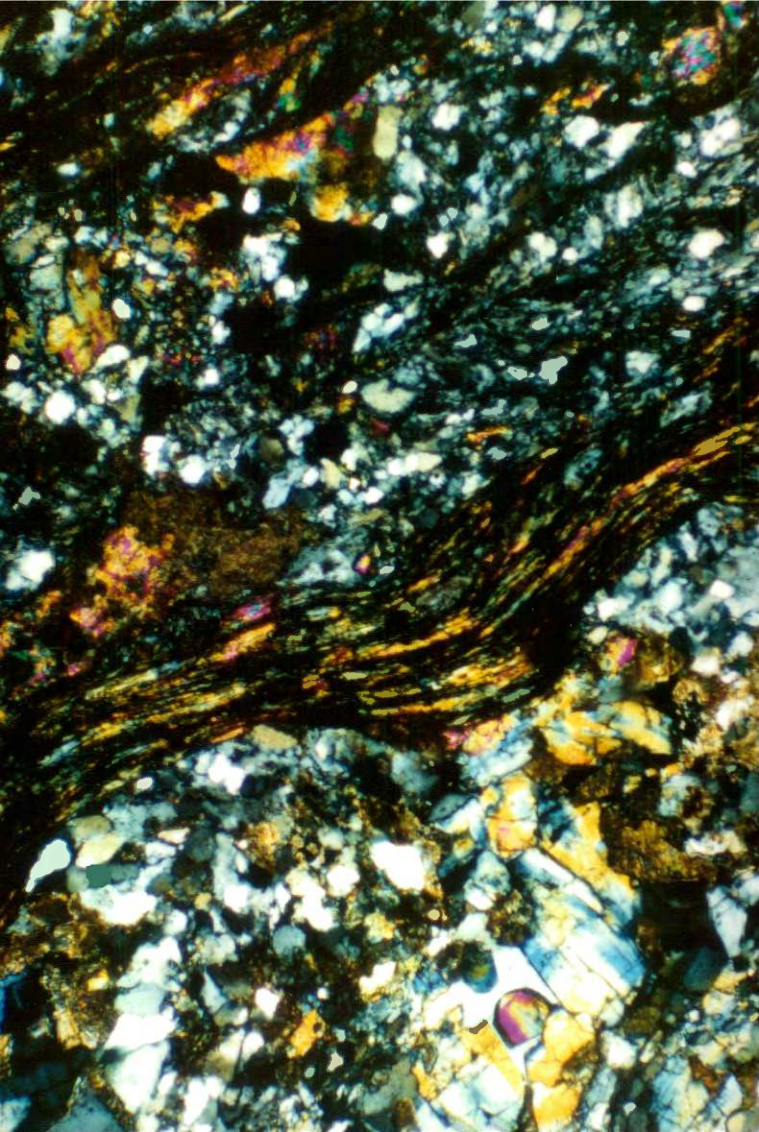
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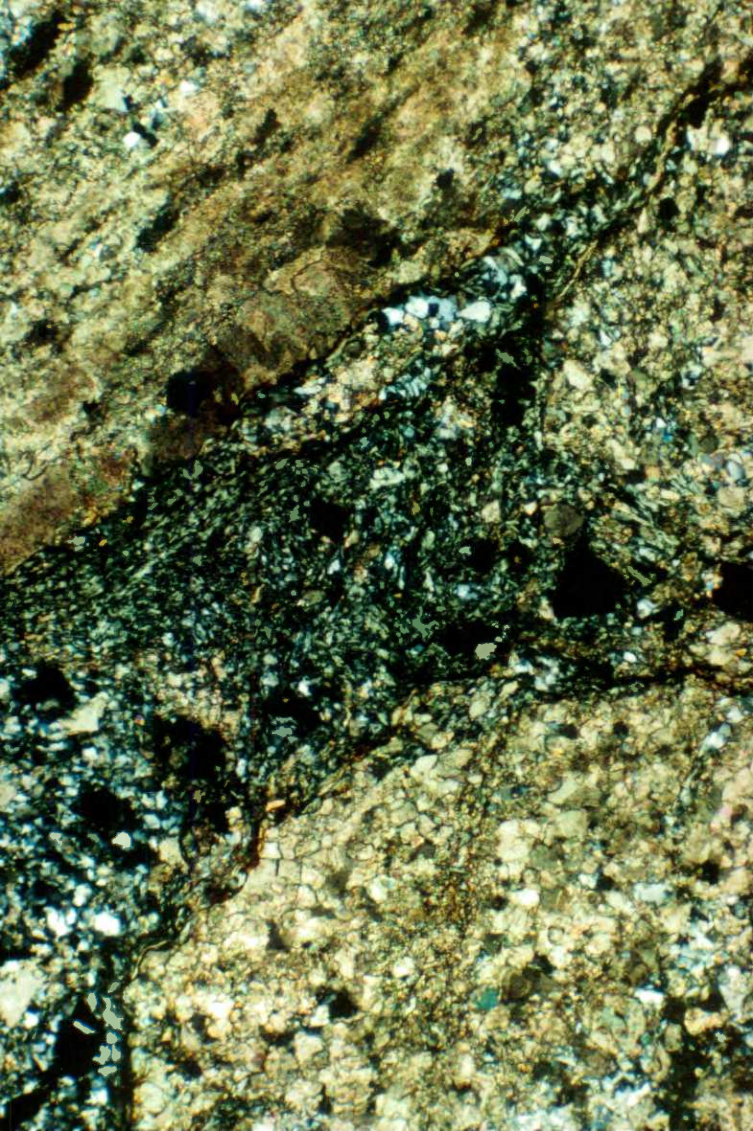


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SERVICES**

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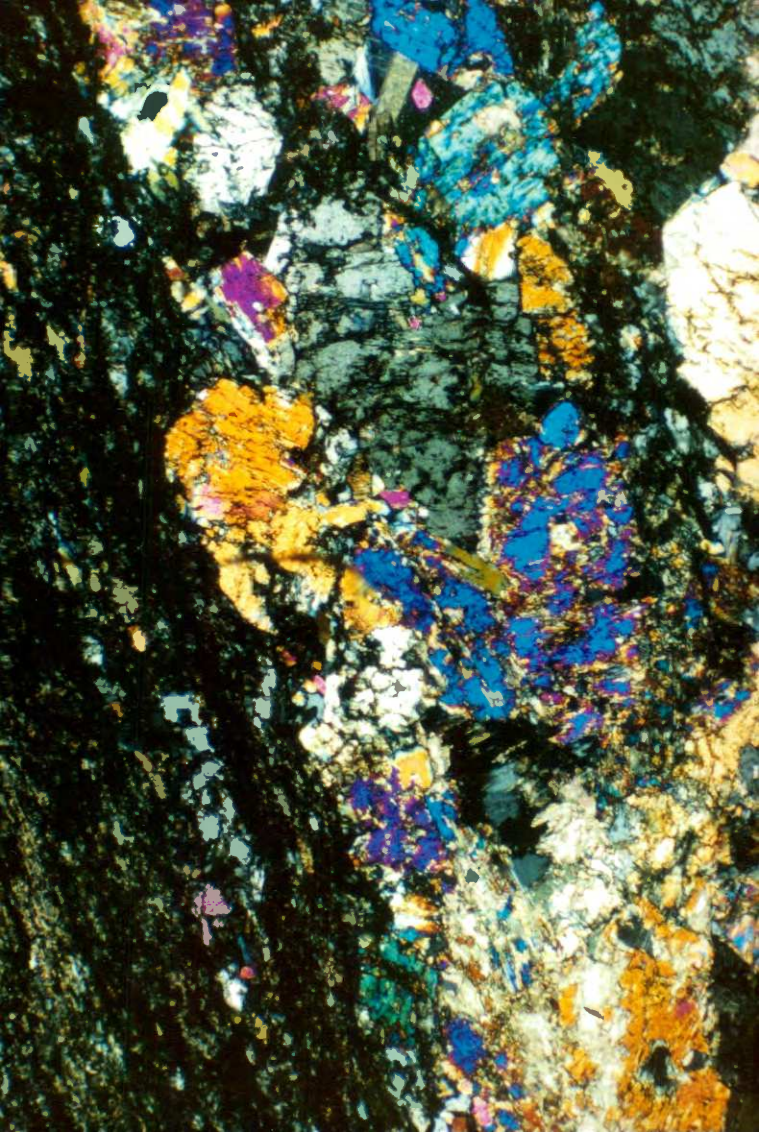


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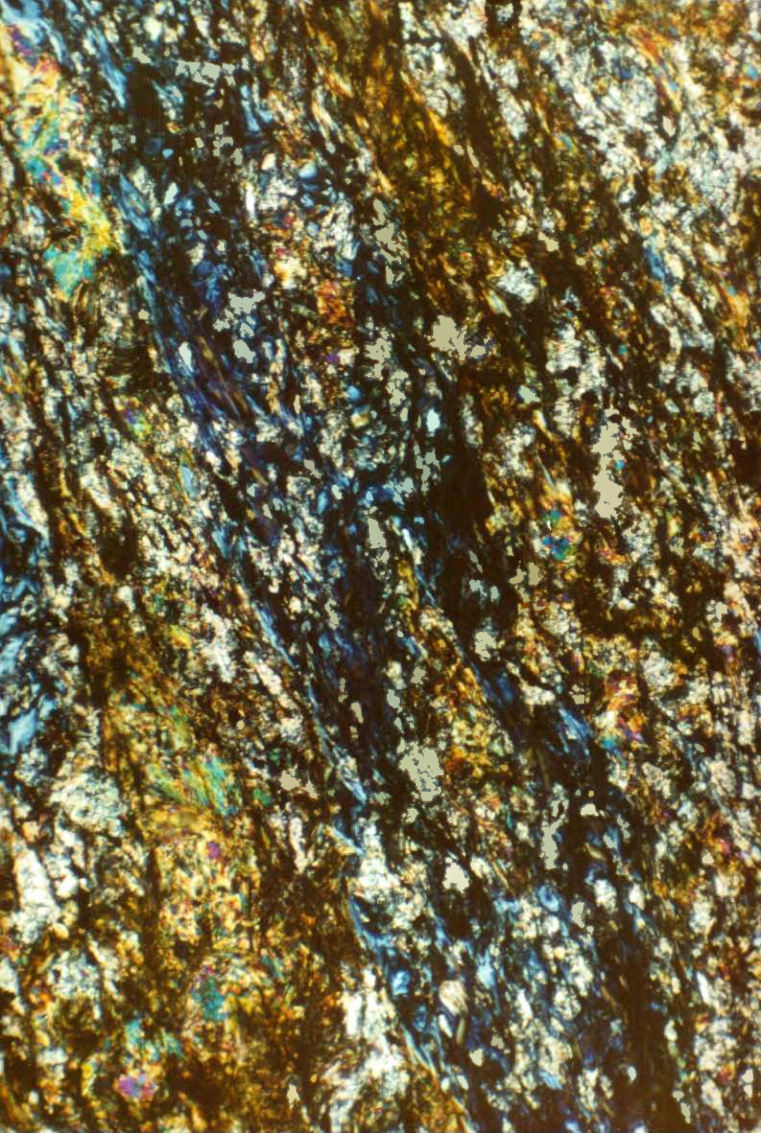
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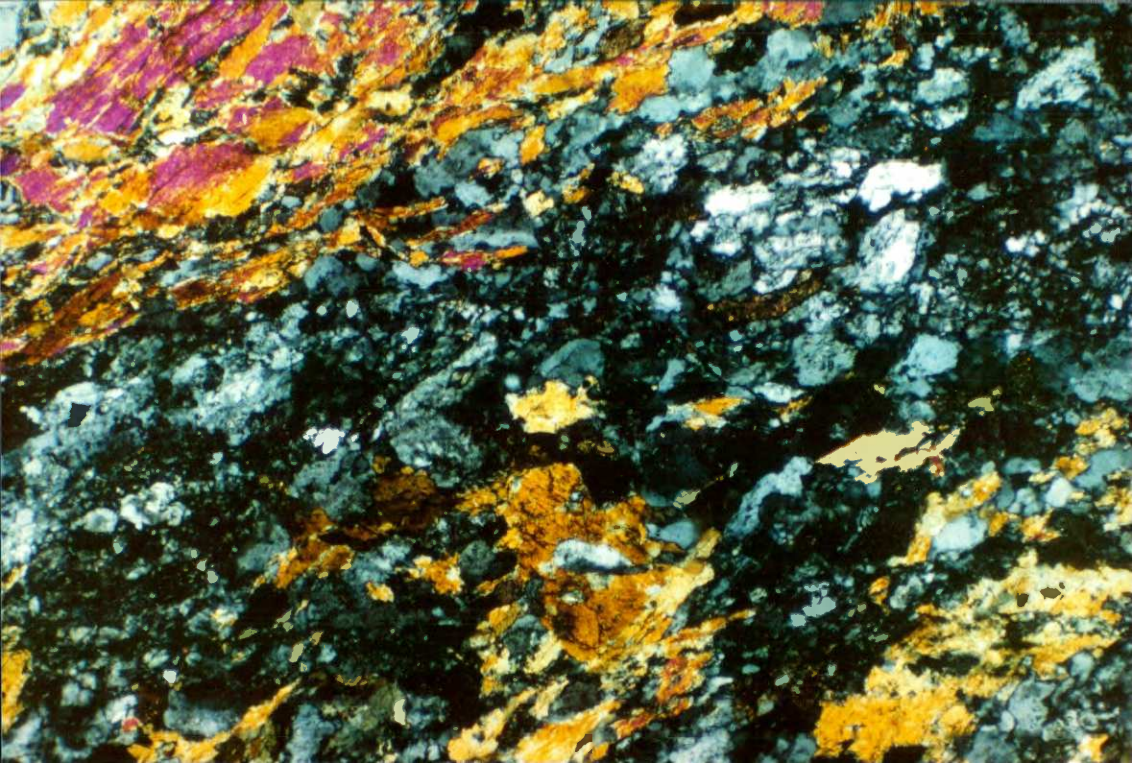


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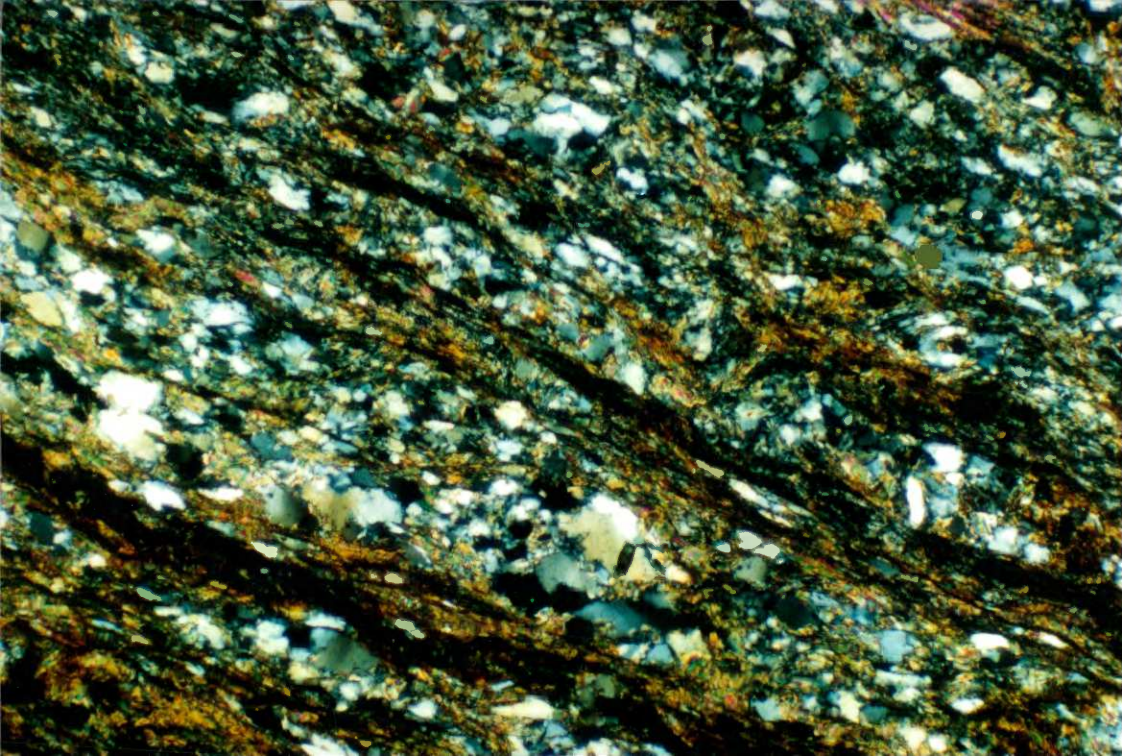
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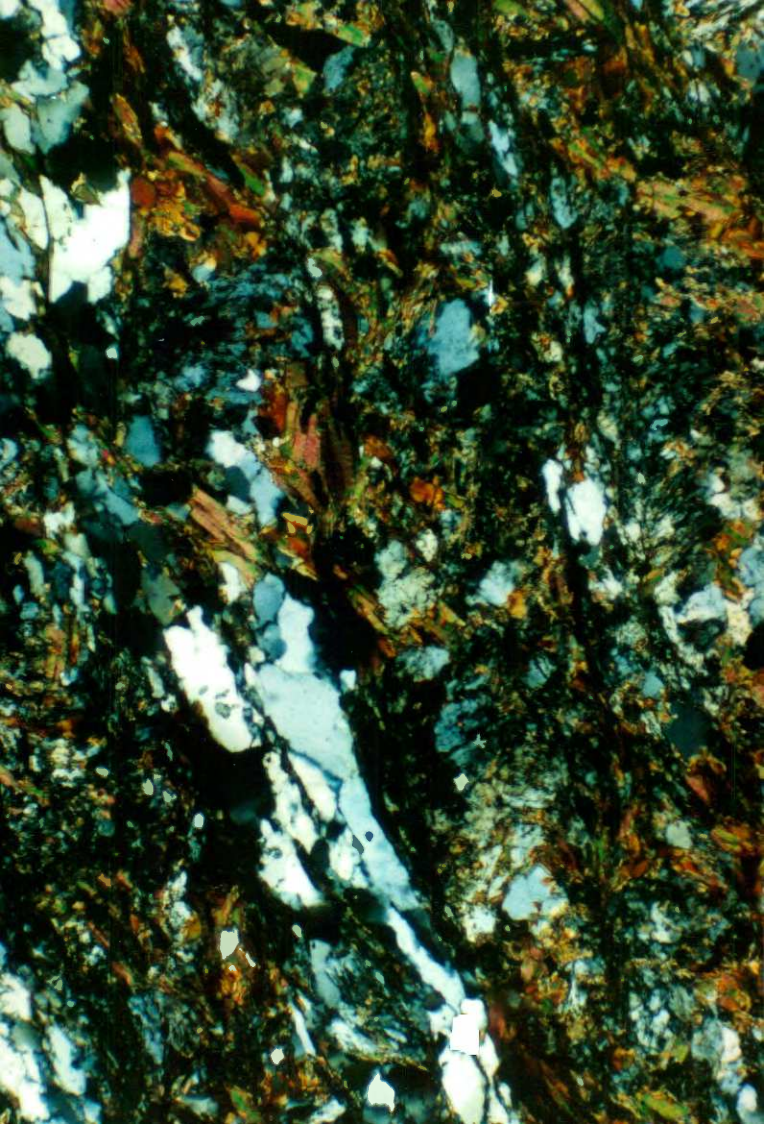
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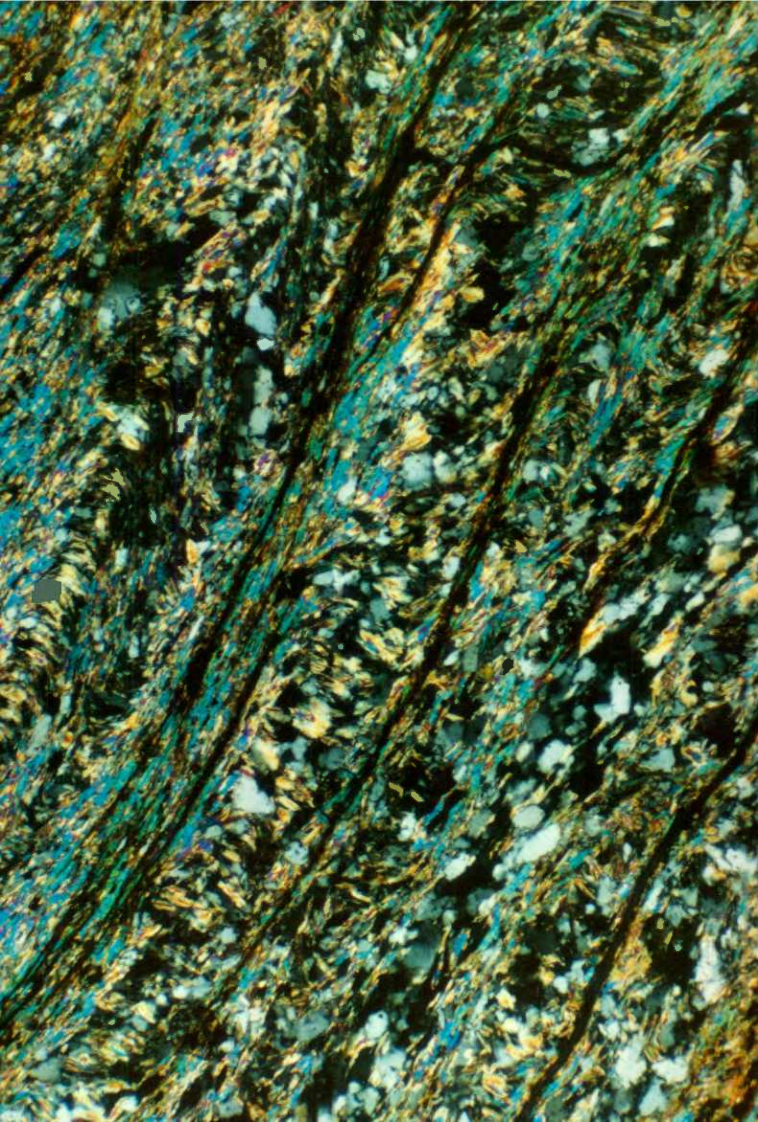


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SERVICES**

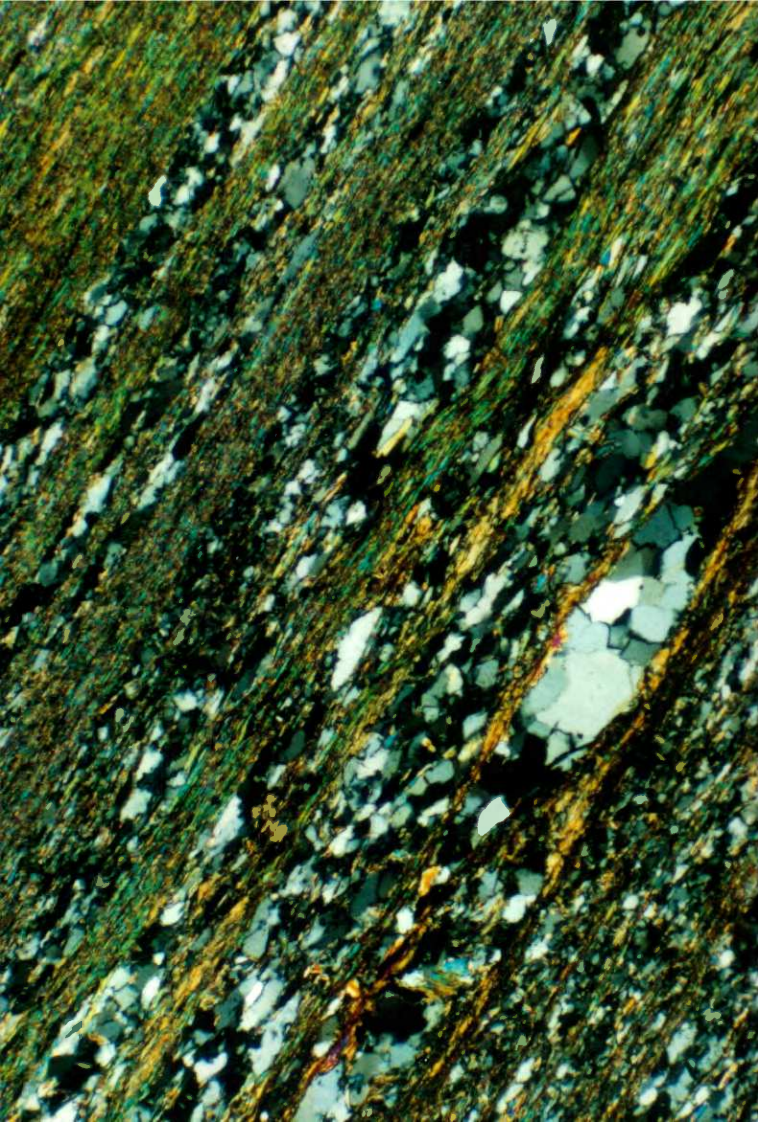
534 ELLIS STREET,
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**HARRIS EXPLORATION
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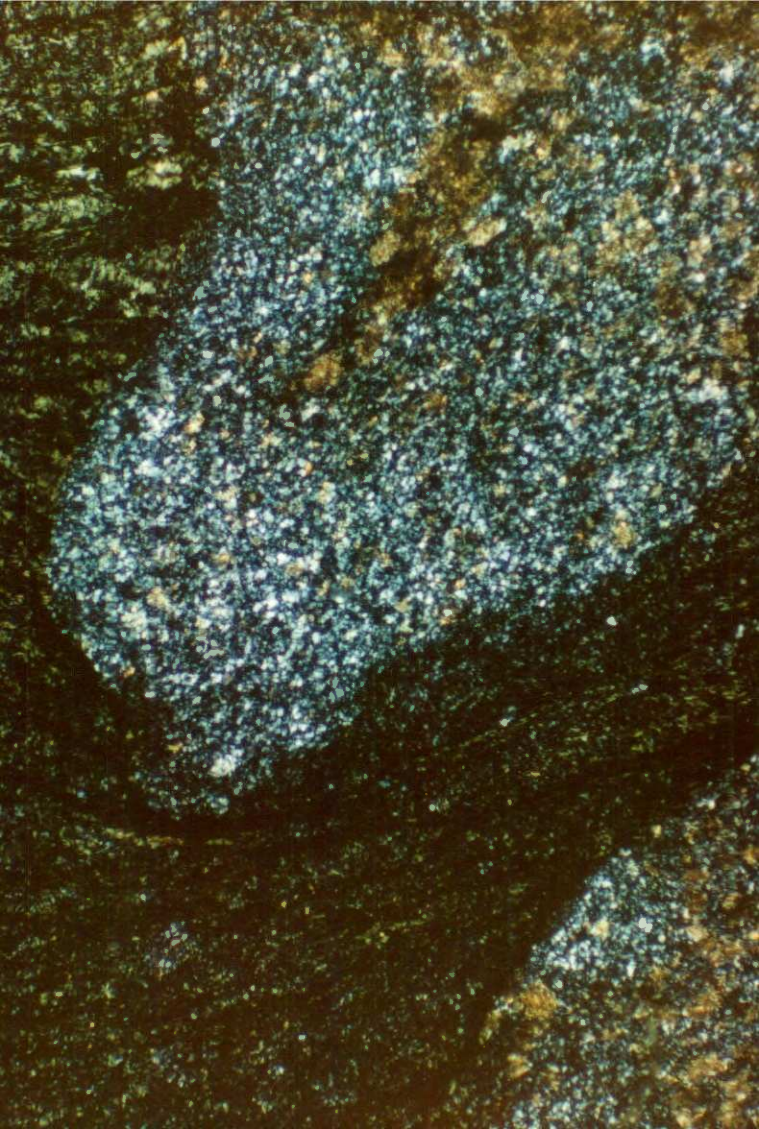


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**HARRIS EXPLORATION
SERVICES**

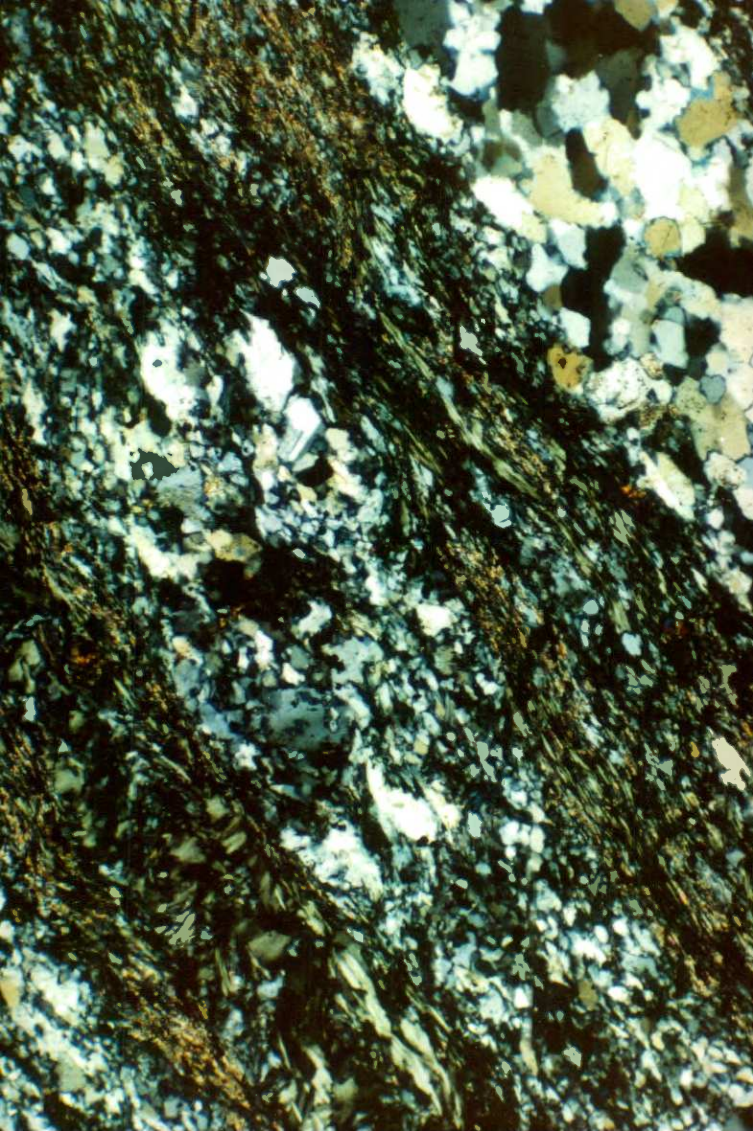
534 ELLIS STREET,
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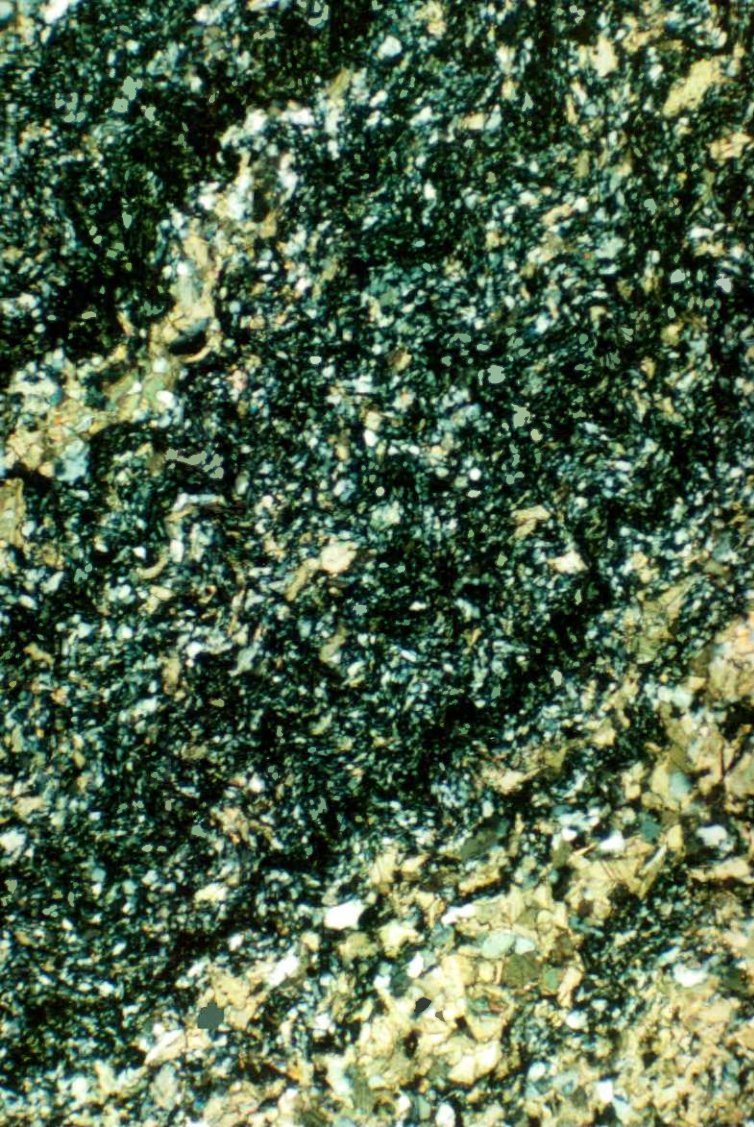


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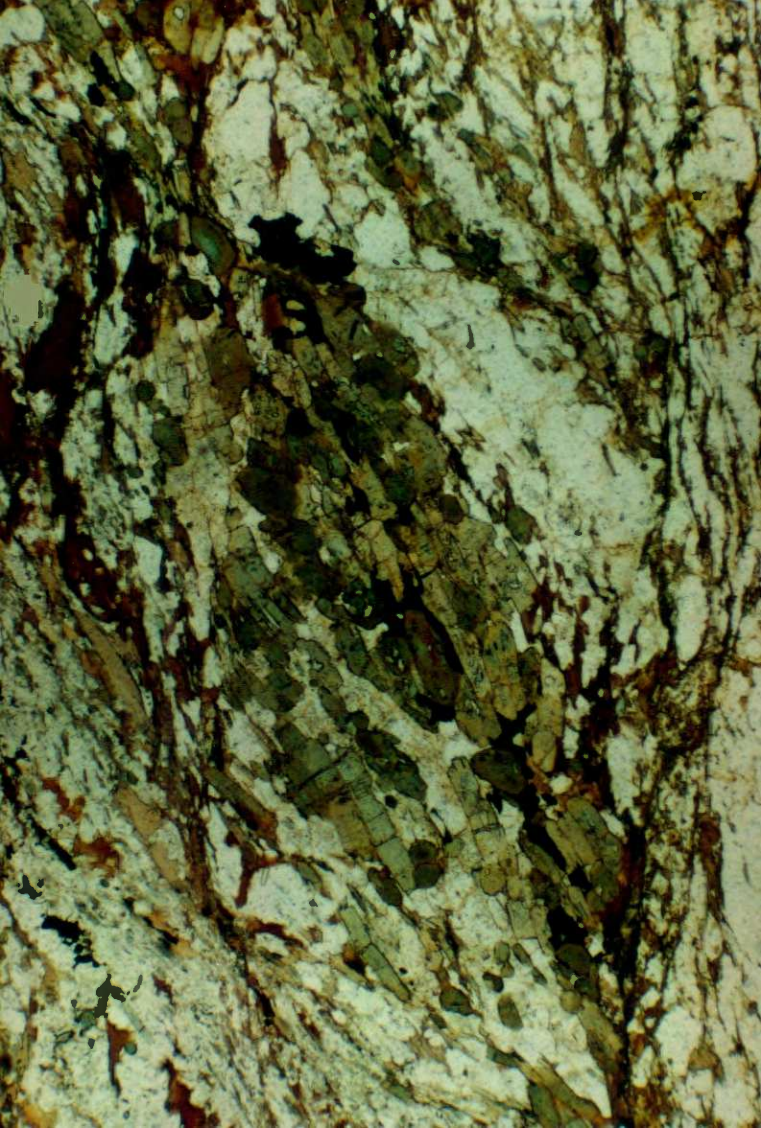
534 ELLIS STREET,
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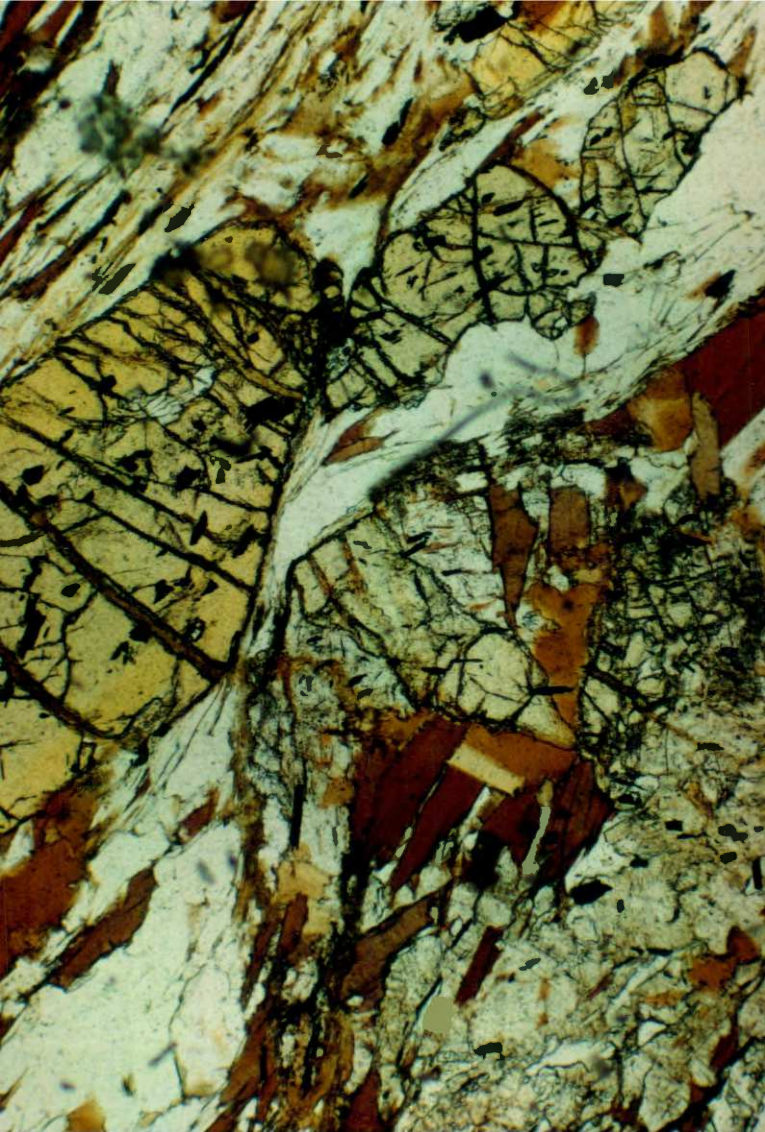


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SERVICES**

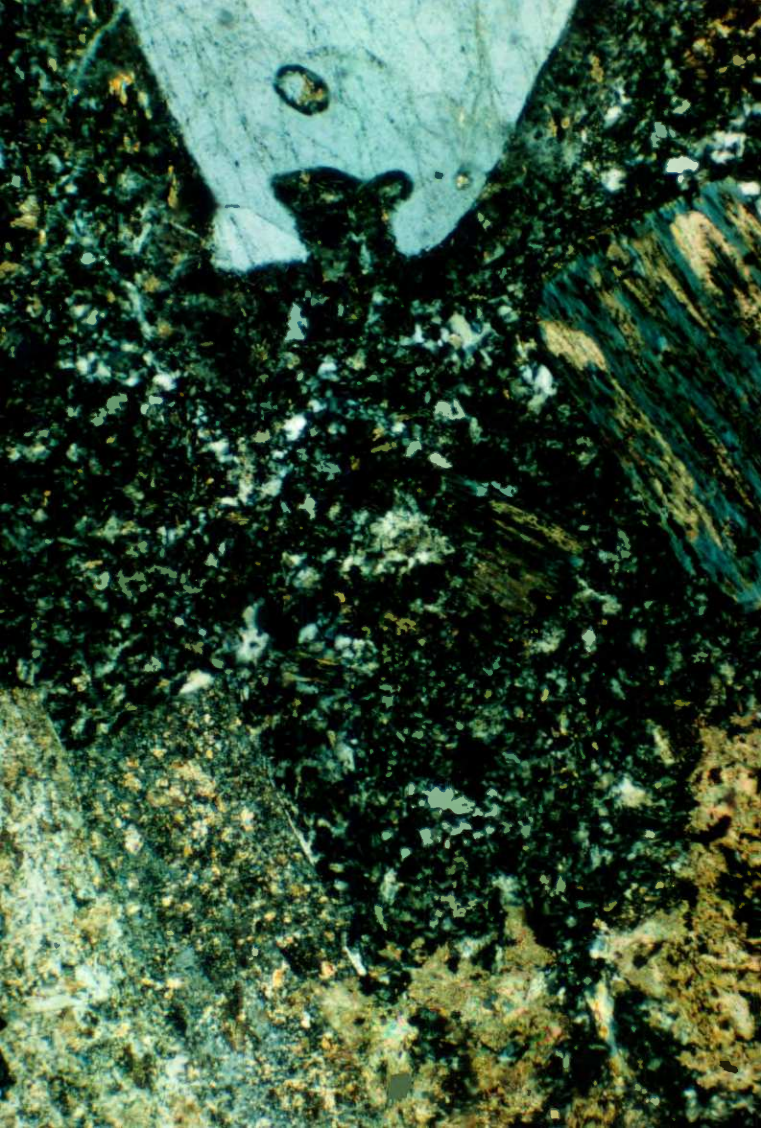
534 ELLIS STREET,
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SERVICES**
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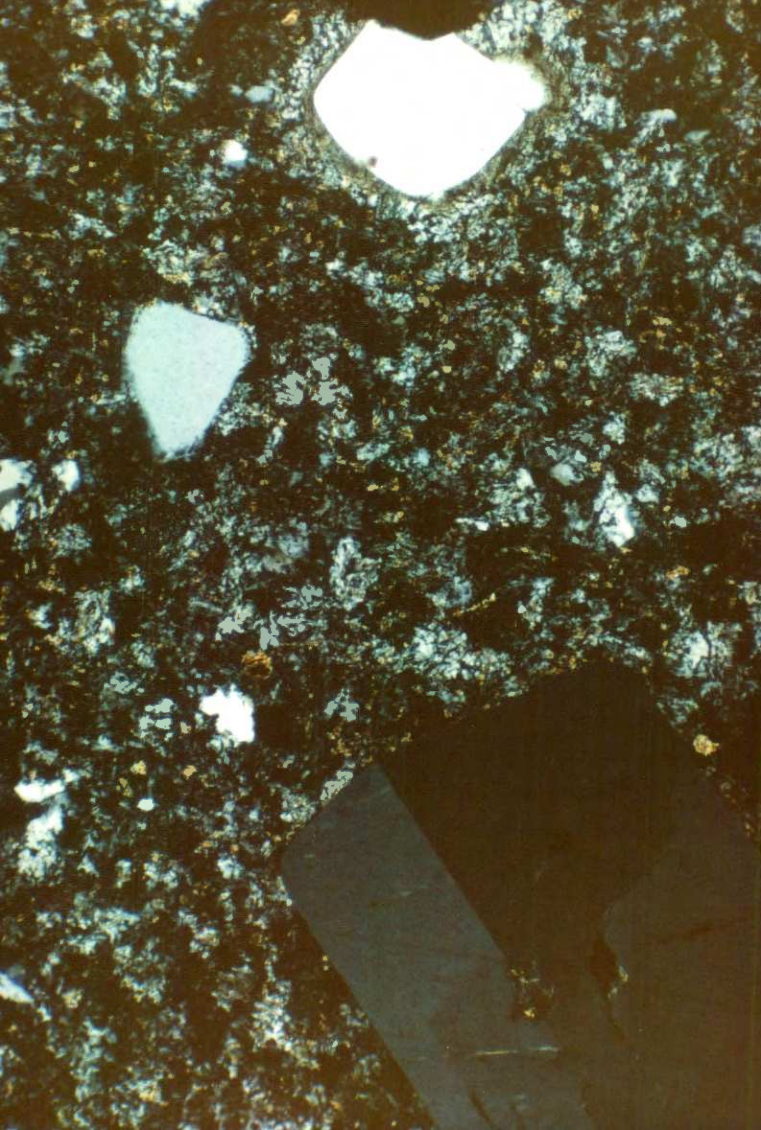


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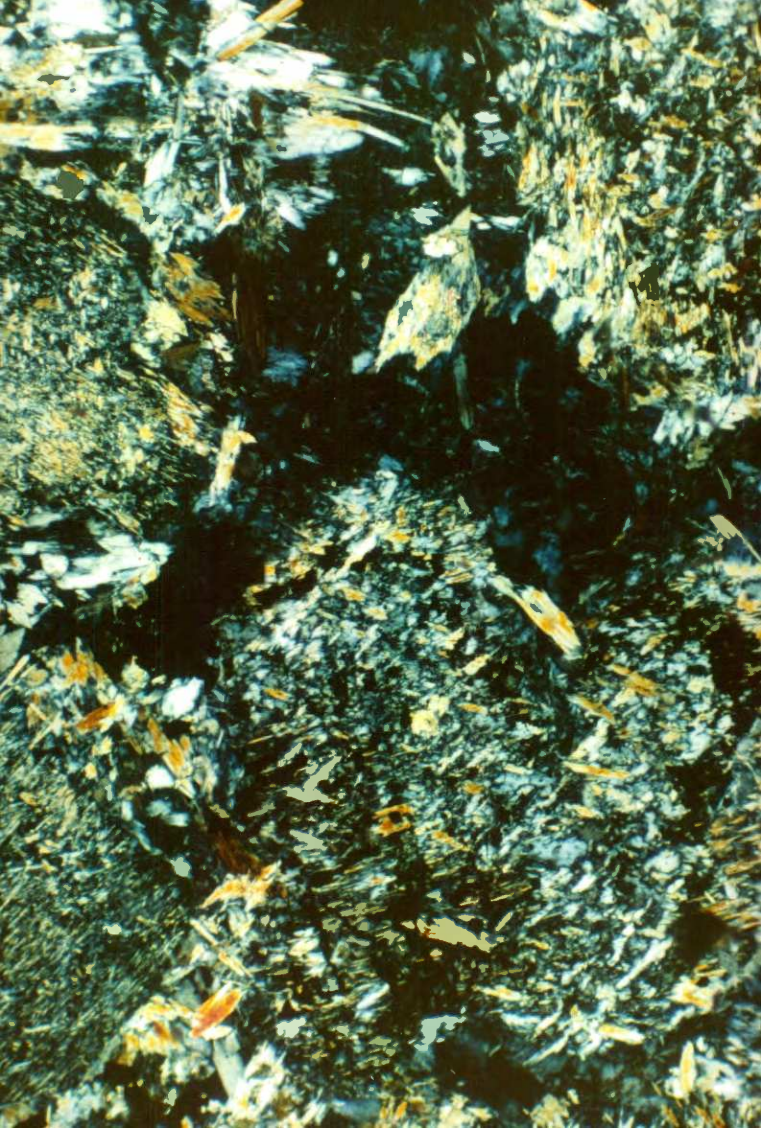
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SERVICES**

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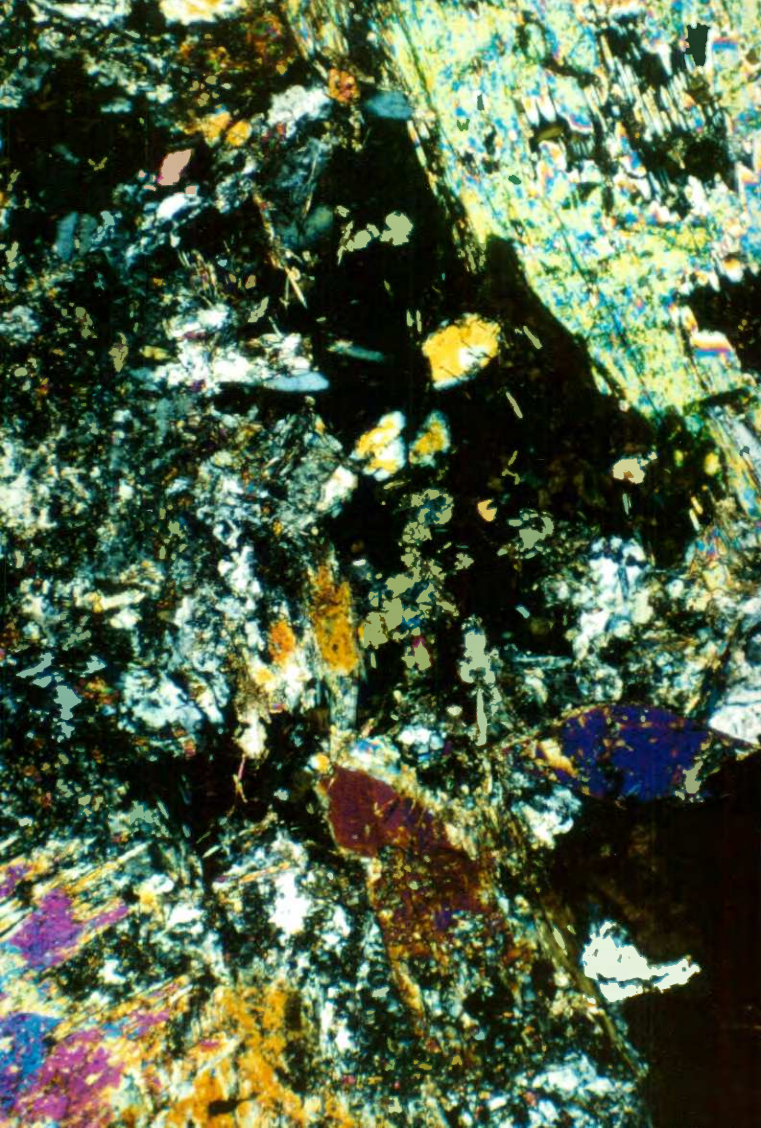
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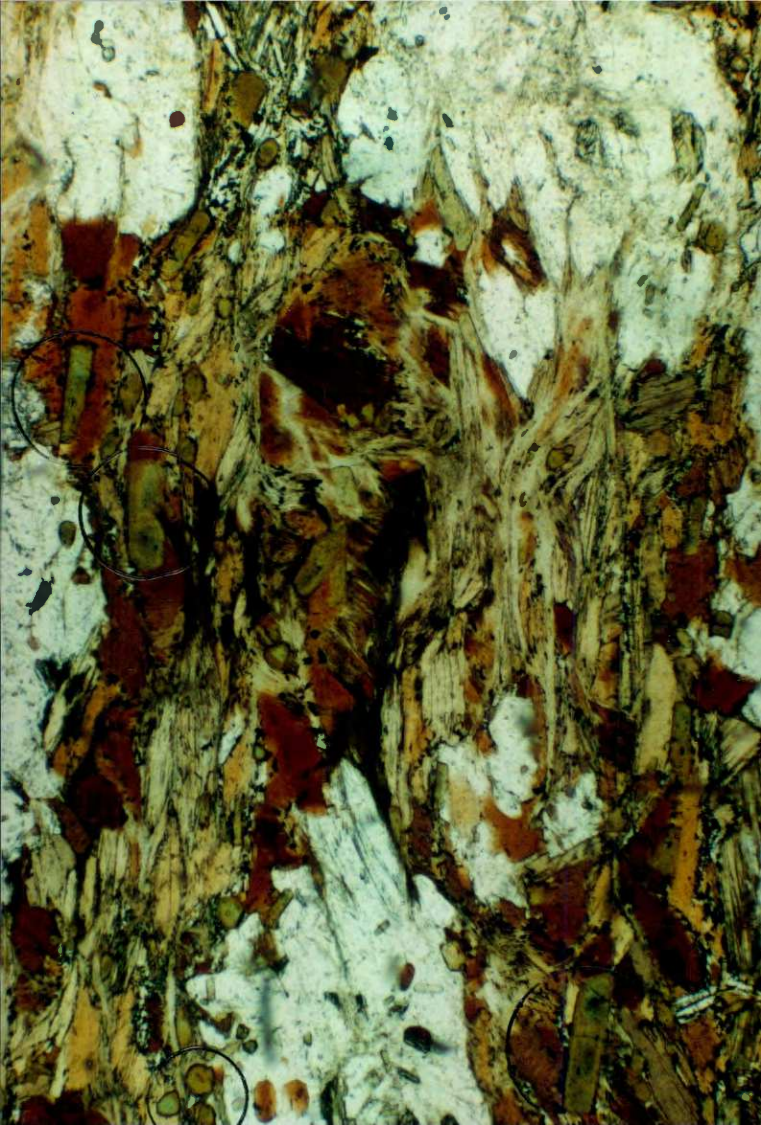
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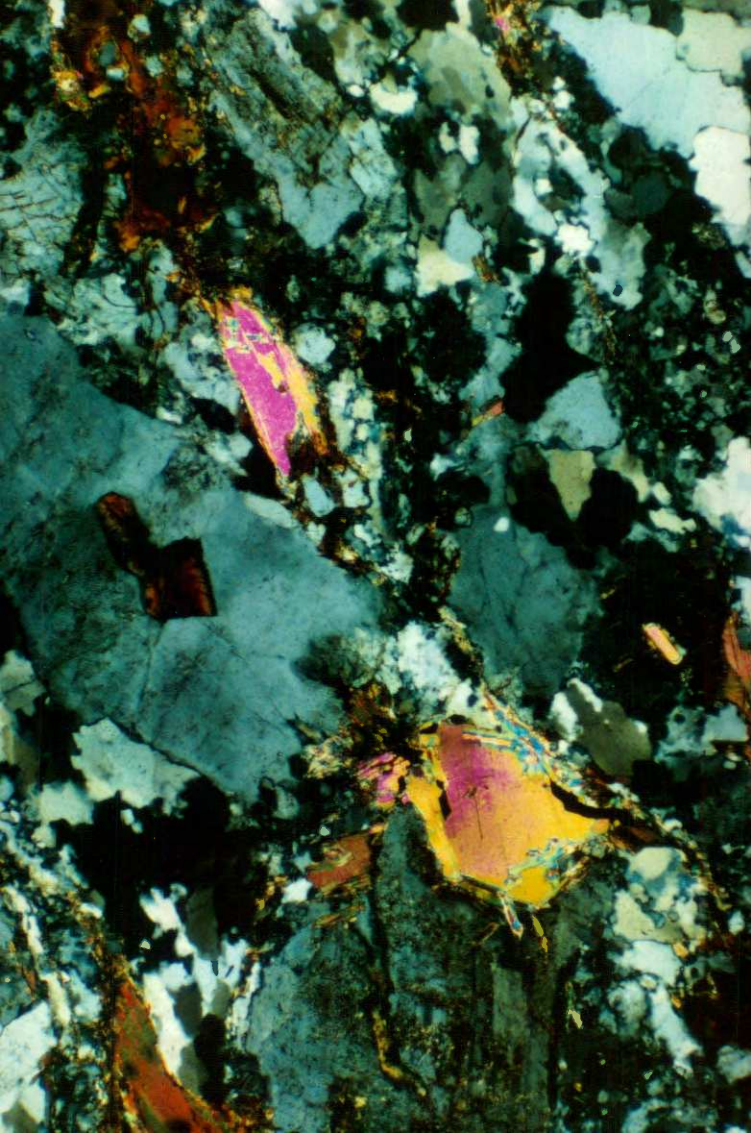


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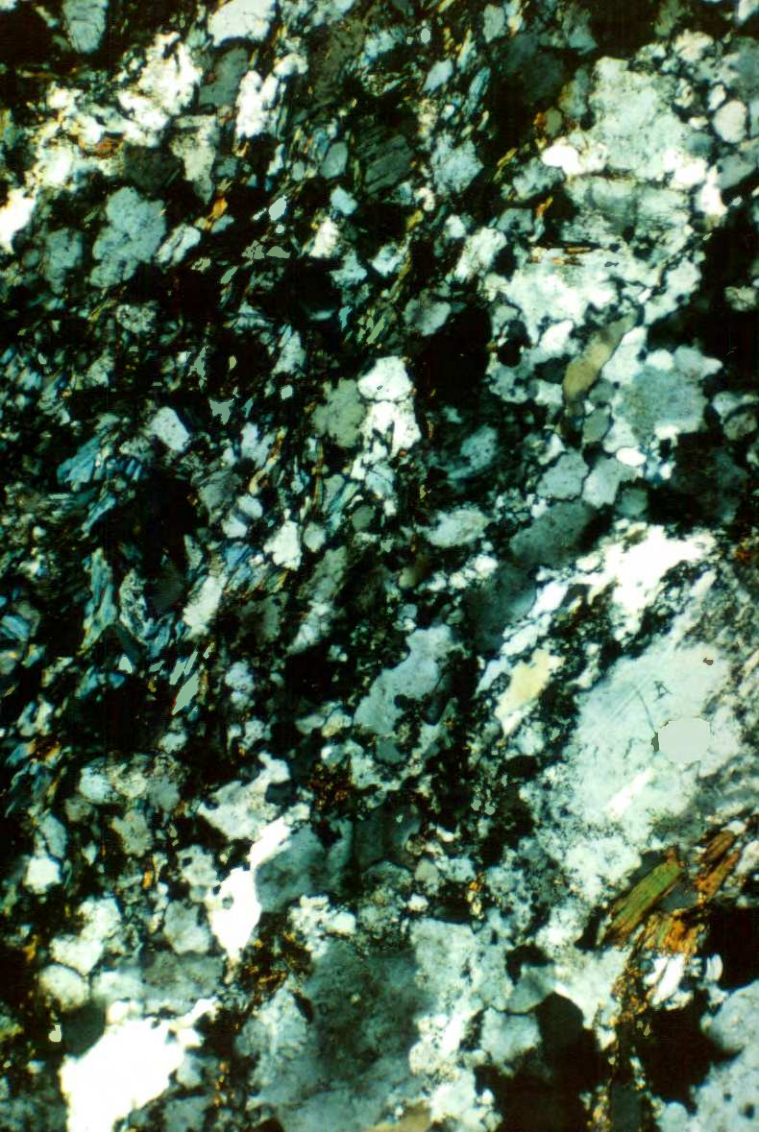


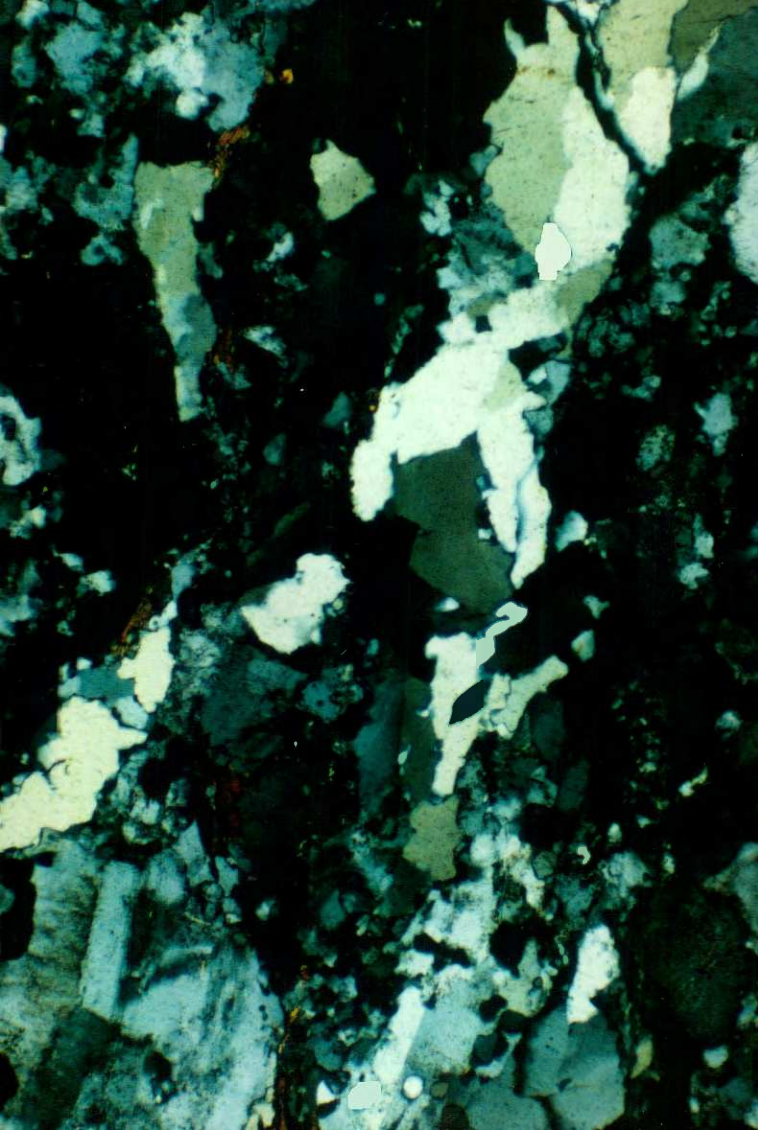


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