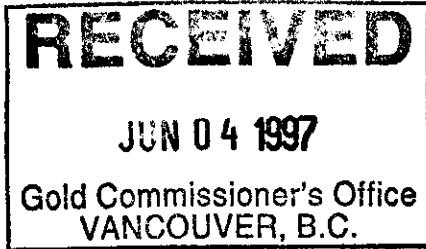


**DIAMOND DRILLING AND PETROGRAPHIC REPORT**

**The CANDO GROUP of four claims**



**Keitha #1, 2; Neely #1, 2.**

Consisting of a total of 4 units  
Victoria Mining Division  
UTM 92 B 13 W .

Latitude 48°49'32" Longitude 123°58'35"  
Elevation 800 m

**Report prepared for Helen Peterson**

FMC #132566  
8700 Vicars Street  
Chilliwack, B.C.  
V2P 6V8

Ph. 604-792-2937  
Fax 604-792-1310

By

**K.E. NORTHCOTE AND ASSOCIATES LTD.**

2346 Ashton Road R.R. #1  
Agassiz, B.C. V0M 1A0

Ph. 604-796-2034  
Fax 604-796-2034

CHILLIWACK / SQUAMISH BRANCH  
2346 ASHTON ROAD R.R. #1  
AGASSIZ, B.C. V0M 1A0

K.E. Northcote, Ph.D., P.Eng.  
April 25, 1997

25,020

**Diamond Drilling and Petrographic Report  
CANDO GROUP OF CLAIMS**

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**Diamond Drilling and Petrographic Report  
CANDO GROUP of Claims  
Keitha 1 and 2; Neely 1 and 2  
Victoria Mining Division**

**Terms of Reference**

K.E. Northcote and Associates Ltd. was contracted, March 4, 1997, by Helen Ulla Peterson to describe approximately 20' of core from the CANDO GROUP of claims. This core was drilled by Raider Exploration company, September 19, 1996 in order to supplement outcrop to assist in ongoing prospecting for rhodonite mineralization. In addition to core description, a petrographic report of four thin sections was completed using the core provided by Helen Petersen.

This report was prepared to document the drill core with the intention that all or some portion of the cost of drilling and report preparation be applied as Assessment work. The core was described and petrographic analyses were performed to the best of the writer's ability. However, K.E. Northcote and/or K.E. Northcote and Associated Ltd. bears no responsibility that the reported cost of drilling or this report will be accepted as Assessment Work by the Ministry of Employment and Investment, Energy and Minerals Division, Mineral Titles Branch.

**Location of Claim and Accessibility**

The Keitha 1, 2 and Neely 1, 2 claims of the CANDO GROUP are located in the Victoria Mining Division NTS 92B/13W, Latitude 48°49'32", Longitude 123°58'35" at approximately 2600 feet (800m). They are on the top of the ridge on the north side of Cowichan Valley at a point 6.4 km east of Cowichan Lake Village. Figures 1 and 2.

The claims overlap the Hill 60 rhodonite/Mn property (Minfile 092B 027) and are assessable by four-wheel-drive vehicle from Cowichan lake road. Figure 3.

**Claim Documentation\***

The CANDO GROUP consists of Keitha 1 and 2 and Neely 1 and 2 claims. These claims are 2 post claims consisting of 1 unit each staked on a common location line Brg 298°. The claims are 100% owned by Helen Ulla Peterson 8700 Vicars Street, Chilliwack B.C. V2P 6V8 , telephone 604 792 2937

<u>Claim Name</u>	<u>Title No</u>	<u>No of Units</u>	<u>Old expiry</u>	<u>New expiry</u>
Keitha 1	334 179	1	97/03/04	2001/03/04
Keitha 2	334 180	1	97/03/04	2000/03/04
Neely 1	334 181	1	97/03/04	2000/03/04
Neely 2	334 182	1	97/03/04	2000/03/04

Claims grouped as CANDO GROUP 97/03/04

\*Documentation from Mineral Titles Branch, Mineral Tenure Master Report 97/03/04.

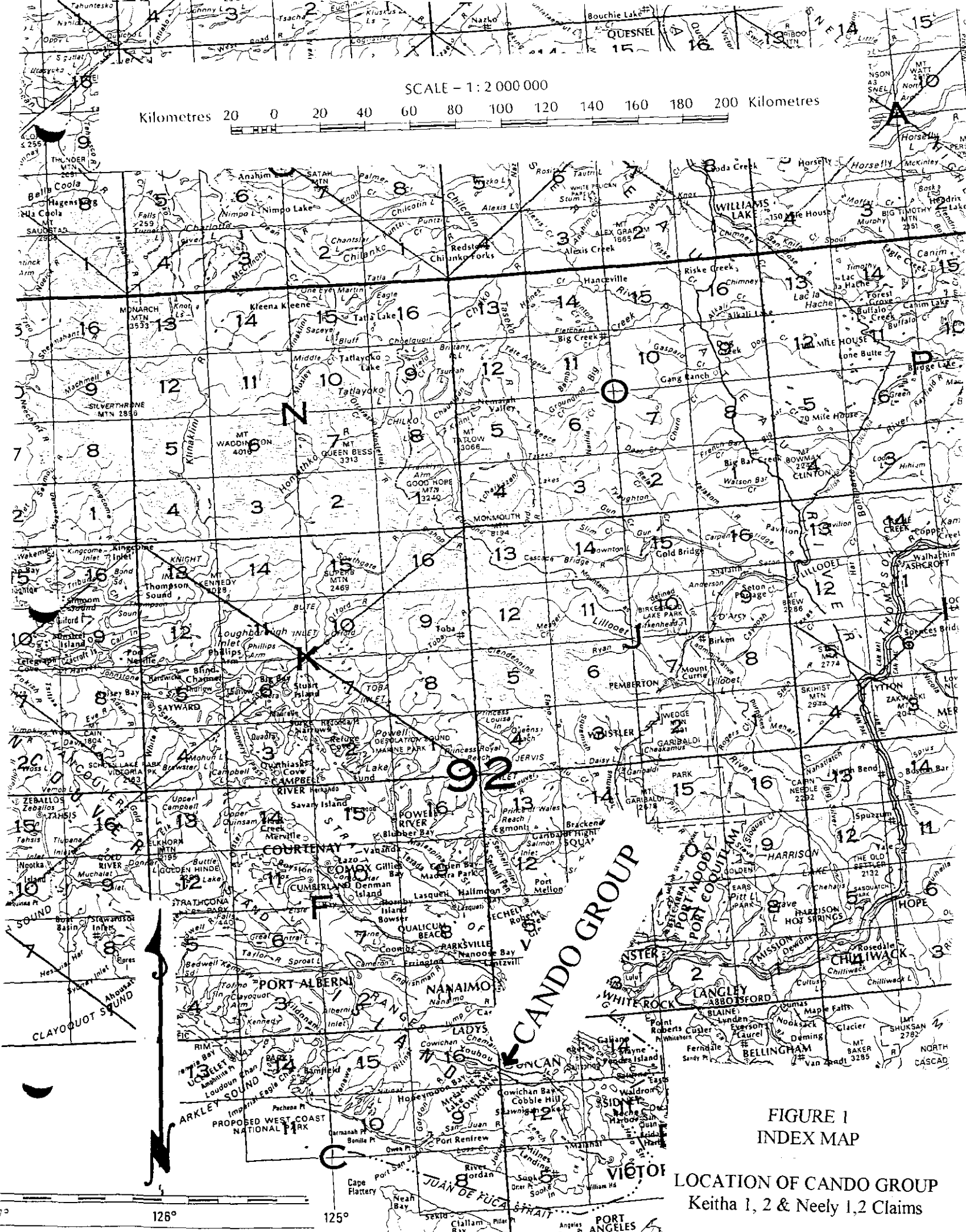
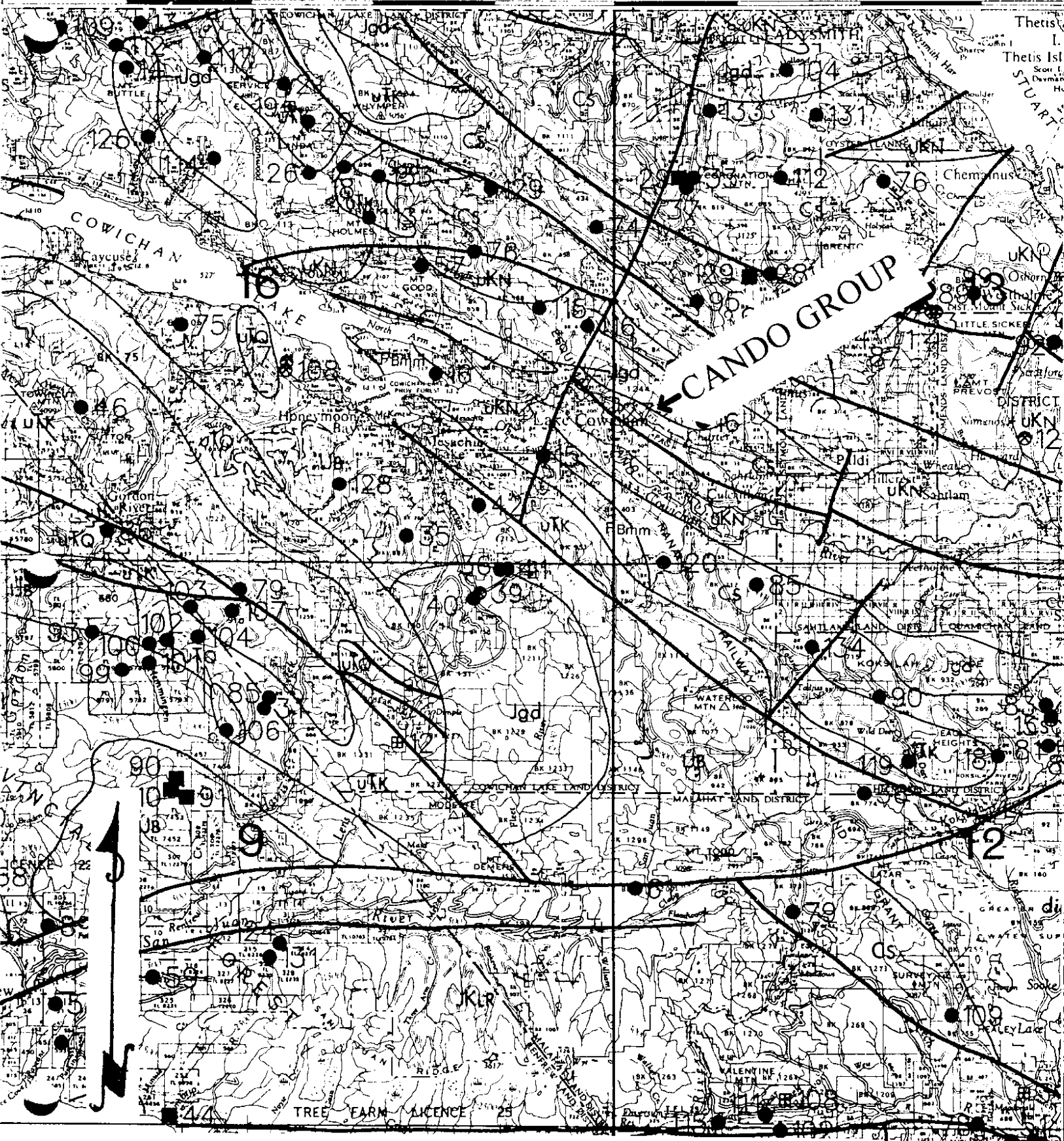


FIGURE 1  
INDEX MAP

LOCATION OF CANDO GROUP  
Keitha 1, 2 & Neely 1,2 Claims

DUNSMUIR LAND DISTRICT

DOUGLAS LAND DISTRICT



Scale 1:250 000

FIGURE 2

LOCATION OF CANDO GROUP

Keith's 1, 2 & Neely's 1, 2 Claims



Kilometres

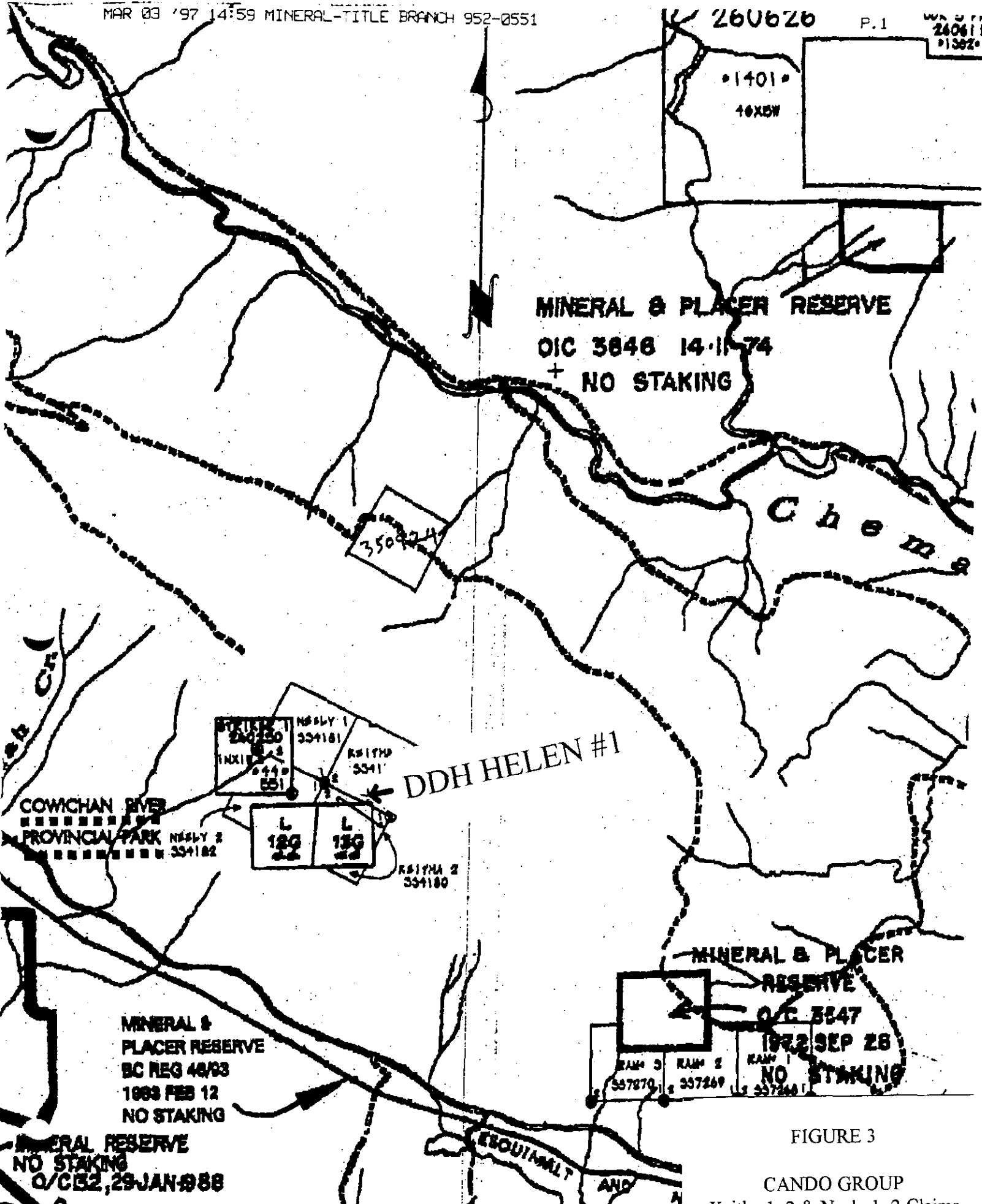
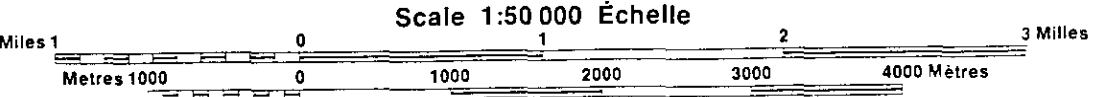


FIGURE 3

CANDO GROUP  
Keitha 1, 2 & Neely 1, 2 Claims  
Location of DDH Helen #1



## **Previous Work**

The Keitha 1, 2 and Neely 1, 2 claims were staked March 4, 1995. Work done on the claims has consisted of prospecting until September 1996 when DDH Helen #1 was drilled.

## **Location of Drill Hole**

Diamond Drill Hole Helen #1 is located in claim Keitha #1 at a point 200 m bearing 313° from Keitha #1 initial post. Figure 3.

## **Diamond Drill Hole Helen #1**

DDH Helen #1 was drilled vertical to a depth of 21 feet (6.4 m). Core description forms Appendix A. A petrographic report from core samples taken at 4, 10, 11 and 19 feet forms Appendix B. The drill core is stored in Chilliwack.

**Geological Setting**    Taken directly from Minfile Hill 60, 092B 027

The CANDO GROUP of claims overlaps the Hill 60 claims so the Minfile Hill 60 geology description can be applied to the CANDO GROUP.

The CANDO GROUP of claims is underlain by tuffaceous chert of Mississippian Pennsylvanian Fourth Lake Formation, Buttle Lake Group (formerly the upper part of Muller's Myra Formation, (Sediment-Sill Unit). Using the Hill 60 deposit as a reference point, the Fourth Lake Formation is in contact, a few hundred metres to the north, with a west-northwest trending contact with granodiorite of Early to Middle Jurassic Island Plutonic Suite (formerly called Island Intrusions). Several hundred feet to the south the Fourth Lake Formation forms a west-northwest trending contact with volcanic of the Devonian Nitnat Formation Sicker Group (Open File 1988-8). The tuffaceous chert is intruded by large masses of gabbro (informally called Mount Hall Gabbro) that are coeval with the Upper Triassic Karmutsen Formation, Vancouver Group.

## **Cando Core Lithology**

Core from DDH Helen #1 corresponds to rocks comprising the Fourth Lake Formation. The drill core consists of thin layered siliceous (cherty) crystal-lithic tuffaceous rocks which have been metamorphosed to biotite-amphibole hornfels. Introduction/remobilisation of silica and introduction of K-feldspar forms distinct walled veinlets and diffuse fracture/breccia infillings and impregnations. The relative amounts of original and introduced silica is not readily apparent. No radiolaria were noted as mentioned by Fyles. No rhodonite mineralization was noted in the drill core or thin sections

The metamorphic overprint indicates probable close proximity to an intrusive event; probably the Middle Jurassic Island Plutonic Suite (Island Intrusions) in Karmutsen-related gabbro intrusions.

**References from Minfile 092B 027**

EMPR Map 65 (1989)

EMPR AR 1918-296; 1919-237; 1924-368

EMPR Bull 37, pp67,68

EMPR OF 1988-8, 1992-1, 1992-9

EMPR Fieldwork 1982, p46; 1987, pp81-91

EMPR ASS RPT 18871

EMPR Report by Turner, 1918; Sargent, 1939. etc.

GSC OF 463

GSC.MEM 13; 96

GSC MAP 42A; 1386 A; 1553 A

GSC P 64-37, p19; 72-44; 72-53; 75-1A, p23; 79-30.

Cowley, P. (1979) Correlation of Rhodonite Deposits on Vancouver Island and Saltspring Island, British Columbia, Unpublished B.Sc Thesis UBC



## CERTIFICATE

I, Kenneth E. Northcote of 2346 Ashton Road, R.R. #1, Agassiz, B.C. do hereby certify that:

1] I have been practising as a professional geologist for a period of approximately 45 years for petroleum exploration companies, mining exploration and consulting companies, federal and provincial agencies.

2] I obtained a Ph.D. in geology from U.B.C. in 1968 and qualified for registration with the Association of Professional Engineers of B.C. in 1967.

3] I have not personally inspected the property. This report is the result of analyses of core supplied by Helen Petersen .

4] I have no interest either directly or indirectly in the properties of Helen U. Petersen, nor do I expect to receive any.

5] I consent to the use of this report in, or in connection with a prospectus relating to the raising of funds.

Dated at Agassiz, B.C. this    day of May, 1997

K.E. Northcote, Ph.D., P.Eng.

APPENDIX 'A'

DDH Helen #1 Core Descriptions

K.E. Northcote

HELEN PETERSON CLAIMS CORE DESCRIPTIONS DDH H.P. #1			By K.E.Northcote April 14, 1997						
			"Paksack" drill, 1" diameter core. Inclination: Vertical, Total depth 21'						
Interval	Lithology	Colour	Lithic fragments	Crystal fragments	Alt'n / metamorphism	Structure	Fracture filling	Mineralization	Recovery
0' to 4'	Overburden, two frags "Cherty" crystal / lithic tuff (hornfels). Sediment	Moderate brown-grey, flecked / speckled light cream-grey	Siliceous (cherty), to > 2cms. Conspicuous. Med brn-gry, micxtalline	Plagioclase, very few quartz.	Biotite (hornfels) sericite chlorite. Silicification original / introduced?	Rubble in overburden Filled fractures Bedding rotated	Quartz, sericite, Fe stn.	Traces pyrite	2 - 4" frags Overburden
4' to 5'	"Cherty" crystal / lithic tuff (hornfels). Sediment	Diffuse, mottled / patchy med. green/grey-brown & dark brown. Flecked cream-grey	Not conspicuous Lithic fragments similar to groundmass.	Plagioclase <0.5 to >2mm Traces quartz.	Biotite (hornfels) sericite chlorite/amphibole. Silicification, original vs. introduced not apparent	Fractures, weak to mod 5-10/ft, mostly filled. Bedding @ 45° to CA	Quartz, amphibole, wk Fe stain. Solid infilling w/ diffuse impregnation.	Traces pyrite	1' = 100%
T.S. @ 4'									
5' to 10'	"Cherty" crystal / lithic tuff (hornfels). Sediment	Diffuse, mottled / patchy med. green/grey-brown & dark brown. Flecked / speckled cream-grey.	Not conspicuous Lithic fragments similar to groundmass.	Conspicuous plagioclase Sharp to diffuse outlines. Traces qtz. Both <0.5 to 2 mm	Biotite (hornfels) sericite chlorite/amphibole. Silicification, original vs. introduced not apparent	Fractures, weak to mod 5-10/ft, mostly filled. Bedding @ 45° to CA	Quartz, amphibole, wk Fe stain. Solid infilling w/ diffuse impregnation.	Traces pyrite	5' = 100%
10' to 15'	"Cherty" crystal / lithic tuff (hornfels). Sediment	Similar to above but with conspicuous diffuse patches/mottling dark brown and pale grey- green. <1" to 6". Varied intensity flecked/ speckled by pale cream- grey.	Not conspicuous Lithic fragments similar to groundmass.	Less conspicuous plag & quartz(?) as above. Sharp to diffuse outlines. Both <0.5 to 2mm.	Patches of dark brown biotite hornfels & light grey green silica mixed w/ amphibole, (chlorite)	Local breccia and frags infilled & impregnated by silica & amphibole, less chlorite, carbonate, bio.	Quartz, amphibole, w/ wk. chlorite, sericite, carbonate, biotite, and epidote.	Weak pyrite & assoc Fe stain	5' = 100%
T.S. @10'									
T.S. @11'									
15' to 20'	"Cherty" crystal / lithic tuff (hornfels). Sediment	Diffuse patches/mottling med. green/grey-brown & dark brown. <1" to 6". Varied intensity flecked / speckled by pale cream- grey. Locally appears "pseudogranitic".	Conspicuous cherty & tuffaceous with diffuse outlines	Conspicuous plagioclase Sharp to diffuse outlines. Traces qtz. Both <0.5 to 2 mm	Biotite (hornfels) sericite chlorite/amphibole. Silicification, original vs. introduced not apparent	Fractures, weak to mod 5-10/ft, mostly filled. Bedding @ 45° to CA	Quartz, amphibole, wk Fe stain. Solid infilling w/ diffuse impregnation.	Traces pyrite	5' = 100%
T.S. @19'									
20' to 21'	"Cherty" crystal / lithic tuff (hornfels). Sediment Rec. 3" as above								3" = 25%
21' E.O.H.									

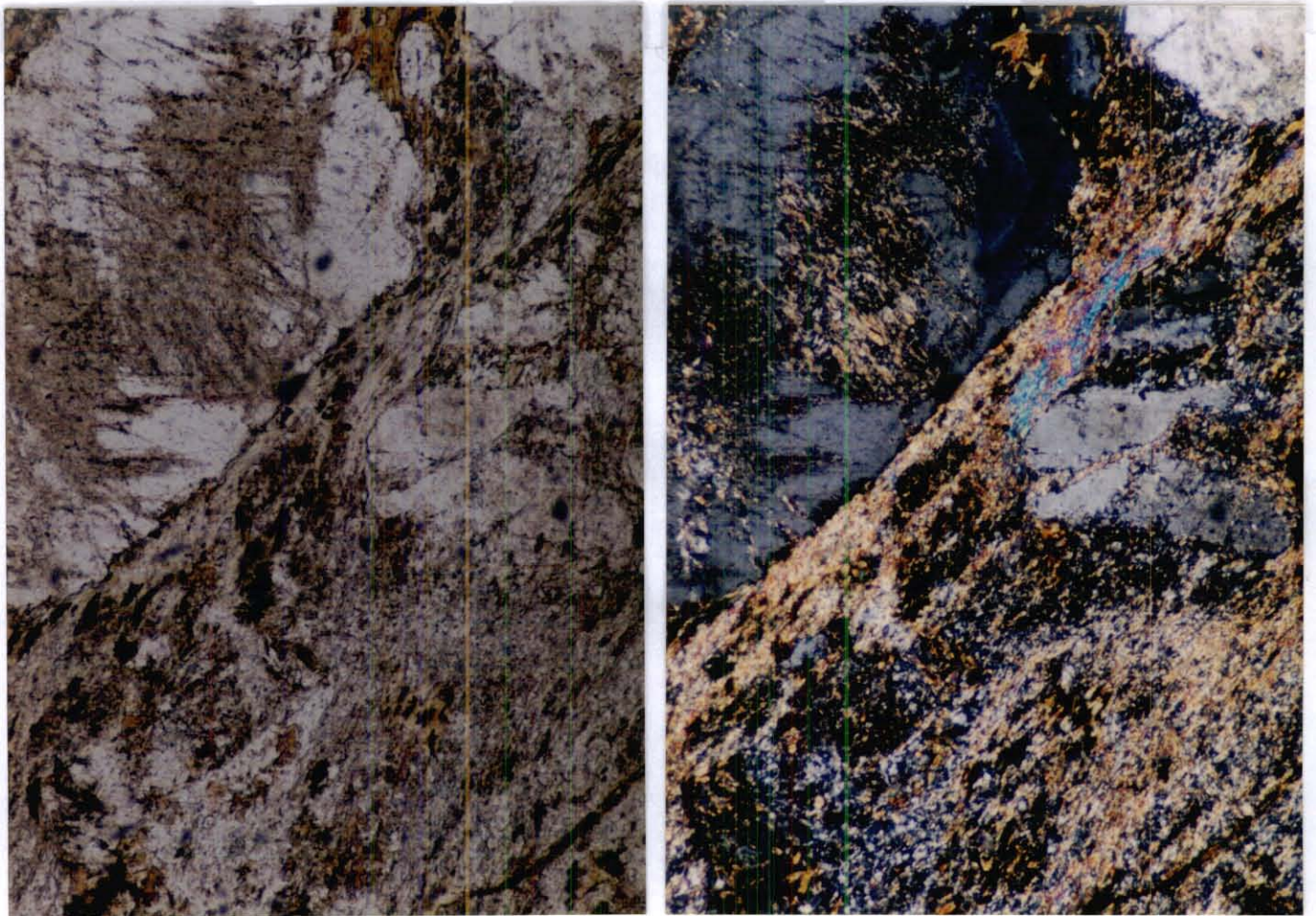
APPENDIX 'B'


DDH Helen #1 Petrographic Descriptions

K.E. Northcote

HELEN PETERSON    PETROGRAPHIC REPORT

DDH Helen #1 @ 4'  
Siliceous metacrystal (lithic) tuff



Photomicrographs 97 R VI- 1 and 2    Plane and Cross Polarized light  
Scale 0.1 mm    

**Summary description**

Layered/foliated, metamorphosed siliceous crystal tuff.

Composed of crystal fragments of plagioclase (albitic), siliceous lithic fragments (microcrystalline aggregates) with superimposed alteration. Few subrounded/euhedral quartz crystals/fragments.

[1] Continued

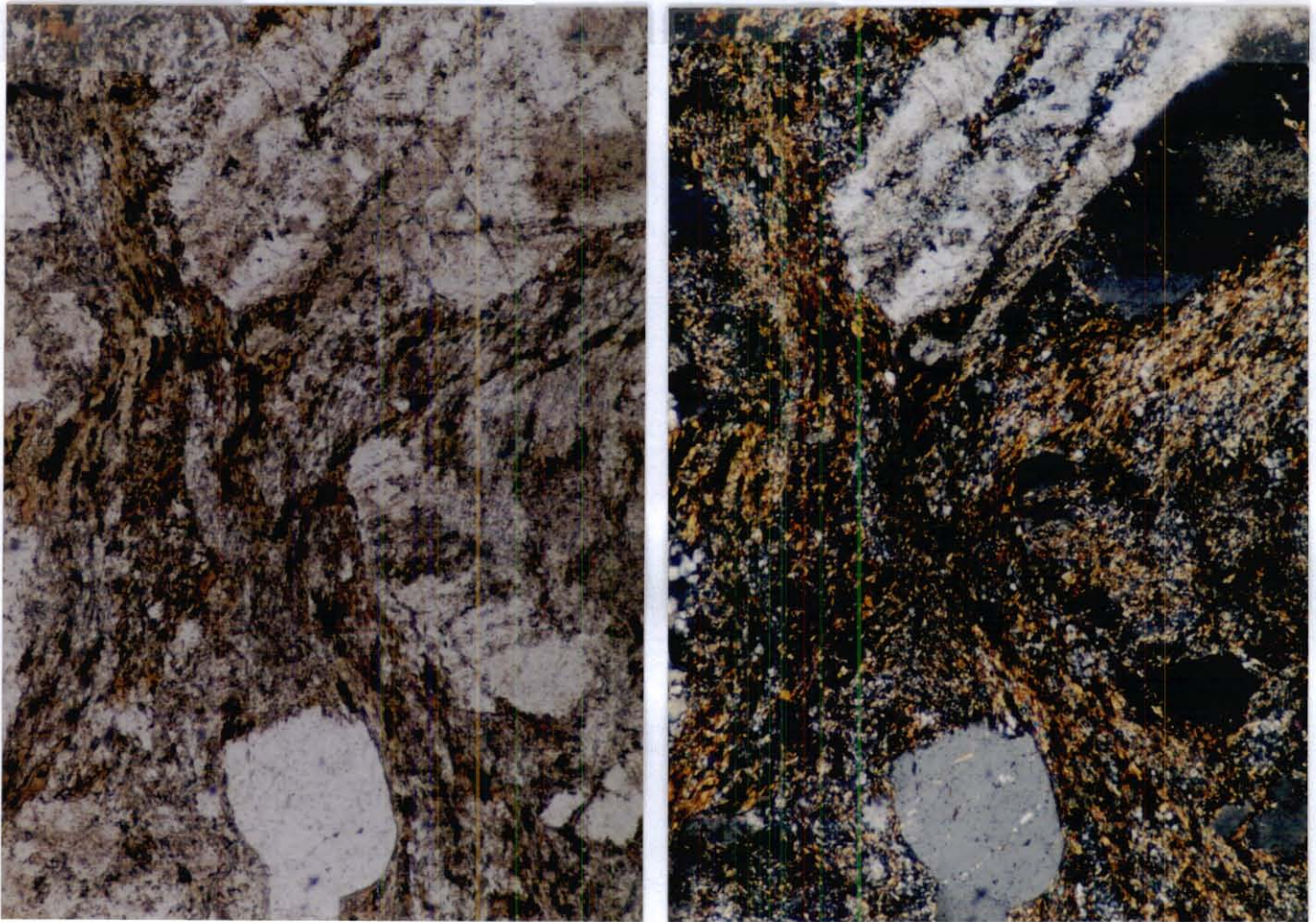
In a microcrystalline siliceous groundmass with an undetermined amount of original quartz intermixed with plagioclase.

Alteration: plagioclase cores sericitic cores with albitic zoned margins. Siliceous tuffaceous/cherty fragments have an overprint of microcrystalline biotite (and sericite) clearly outlined by semiopaque brown dusting. The siliceous groundmass has a strong overprint of microcrystalline sericite and biotite as disseminations and concentrated in screens and irregular partings in layering/foliation planes; grading to coarser concentrations of foliated/felted biotite/chlorite/sericite some exhibiting distinct fracture control.

Few late microveinlets of K-feldspar follow and cross foliation.  
No rhodonite was identified in the thin section.

### Microscopic description

#### Transmitted light



Photomicrographs 97 R VI-3 and 4 Plane and Cross Polarized light  
Scale 0.1 mm

[1] Continued

### Protolith

#### Crystal fragments

Plagioclase; 18-20%, anhedral/subhedral (<0.1 to <2.0 mm). disseminated fragmental grains. Scattered crystals, most featureless; few grains with narrow polysynthetic twinning. Albitic(?) composition. Some conspicuous zoning with felted sericite-altered cores with featureless or zoned margins. Obtained both (+) and (-) biaxial interference figures. Nibbled fragment edges by partial assimilation by groundmass.

Quartz; <1%, euhedral/anhedral (one fragment 0.85 mm). Has a rounded resorbed outline.

#### Lithic fragments

Siliceous fragments; 18-20%, subangular, (<0.1 to several mm). Show some variation in grain-size, texture and composition but mainly consist of microcrystalline siliceous grains (chert). Others with an undetermined amount of original quartz and plagioclase. Overprint of fairly uniformly disseminated microcrystalline sericite and biotite; generally finer than that in groundmass. Not readily distinguishable from groundmass, but fragments have sharp boundaries marked by differences in siliceous content, grain-size, intensity of biotite-sericite overprint and by dusted appearance. Note: siliceous lithic fragment in sample reject is (>1 cm). No "radiolaria" were noted in suspected cherty fragments or in groundmass.

#### Groundmass

Original material; ( 55-60%) Siliceous. Masked by biotite, sericite, chlorite overprint.

Quartz; ?%, anhedral (microcrystalline). Intermixed with suspected plagioclase. Lacks etching in stained slab. Masked by biotite-sericite-chlorite overprint. Suspect quartz >> plagioclase.

Plagioclase; ?%, anhedral (microcrystalline). Suspected, not positively identified. Moderate to strong patchy overprint of sericite. Alteration of plagioclase? Masked by biotite-sericite-chlorite overprint. Suspect plagioclase << quartz.

#### Alteration assemblage (Percentages, as rough estimates, included in host).

Biotite; 25-30%, anhedral (microcrystalline to 0.05 m). Finer material, disseminated overprint in lithic fragments and groundmass. Coarser material as foliated/felted irregular partings, screens shows foliation/layering and fracture control.

Sericite; 18-20%, anhedral (microcrystalline). Finer material, disseminated overprint with biotite

[1] Continued

in lithic fragments and groundmass. Slightly coarser material as foliated/felted segregations, screens etc as for biotite.

Chlorite; 12-15%, anhedral (microcrystalline to <0.05 mm), disseminated among biotite-sericite in groundmass and as irregular felted clusters among coarser biotite-sericite segregations.

Dusting; 4-6%, anhedral (submicroscopic to microgranular(?))

[a] A brown discolouration of lithic fragments

[b] aggregates of (microgranular to .01 mm) grains form diffuse clusters of undetermined semiopaque material, concentrated mainly in biotite clusters or segregations.

Veinlets 2-3%

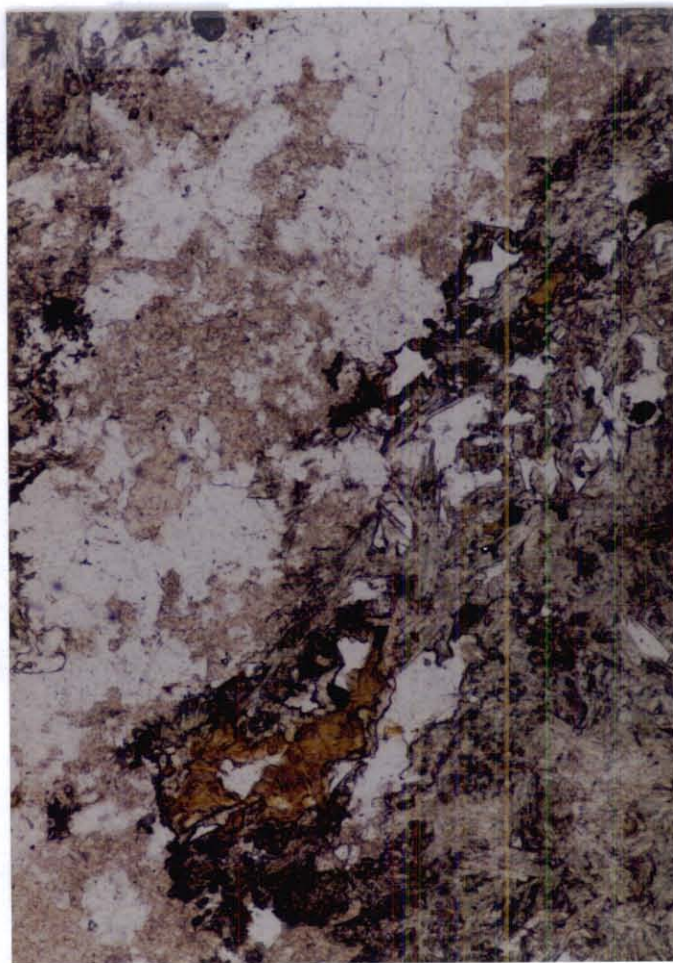
K-feldspar; 0.5-1%, anhedral (microcrystalline to 0.1 mm). Irregular interlocking grains fill microfractures which follow and cross layering/foliation. Conspicuous in stained off-cut.


Quartz; not positively identified. Suspected. See [2]. Too fine to obtain an interference figure.

No rhodonite was noted in thin section or stained off-cut.



[2] DDH Helen #1 @ 10"  
Metacrystal lithic tuff, siliceous. Veined.



Photomicrographs 97 R VI-5 and 6 Polarized and Cross Polarized Light  
Scale 0.1 mm 

#### Summary description

Crystal lithic tuff protolith similar to [1] but shows more intensely sericitic-altered plagioclase crystal fragments, less conspicuous barely recognizable lithic fragments; one partially resorbed quartz fragment. In a more conspicuous siliceous groundmass composed of very fine interlocking quartz and lesser suspected plagioclase. Cherty appearance.

The plagioclase fragments show evidence of partial resorption, are more abundantly sericitic than in [1] but show similar featureless albitic patches particularly at margins of grains. Relic polysynthetic twinning is visible in some fragments. Lithic fragments appear as siliceous microgranular patches, quartz-like in plane polarized light, darker (lower birefringence) under cross polarized light, The groundmass appears more siliceous than [1].

[2] Continued

Composite, irregular quartz veinlets approximately in bedding plane with associated sericite, amphibole, epidote and traces (+) carbonate, biotite and pyrite.

Layering/bedding followed and cut by microveinlets of K-feldspar and very minor quartz  
No rhodonite was noted in thin section or off-cuts.

**Microscopic description**

**Transmitted light**



**Photomicrographs 97 R VI-7 and 8 Polarized and Cross Polarized Light**

Scale 0.1 mm 

Crystal/lithic fragments

Plagioclase; 18-20%(?), subhedral/euhedral (<0.1 to 2.0 mm). Fragmental. Varied intensity of microcrystalline sericite/"clay" alteration with associated featureless albitic patches and

[2] Continued

margins. Ghost-like relic polysynthetic twinning. Resorption/alteration intensity of some grains leaves only irregular outlines of fragment remnants which are difficult to distinguish from lithic fragment remnants.

Quartz; <0.5%, subhedral (0.3 to 0.6 mm). Shape modified by resorption. Very sparsely disseminated original quartz grains.

Lithic fragments; 6-8%(?). Siliceous microcrystalline fabric. Siliceous and disseminated sericite. Darker and finer textured under crossed Nicols than general groundmass.

### Groundmass

Quartz; 15-18%(?), anhedral (microcrystalline to .03 mm) aggregates of irregular grains show varied grain-size and abundance relative to feldspar and forms irregular "deformed" linear patterns of slightly coarser aggregates of grains. Relative abundance of original versus introduced silica is not obvious.

Plagioclase; 10-12%(?), anhedral (microcrystalline to <.02 mm). Aggregates of irregular grains, intermixed with quartz. Clay alteration. Becomes strongly sericitic in vein envelope.

### Alteration/segregation/vein

Sericite; 10-12%, partially included with plagioclase, anhedral (microcrystalline to .03 mm).  
[a] Alteration of feldspar crystal and fragments, groundmass lithic fragments.  
[b] Envelope of increased intensity around composite quartz vein. Associated with amphibole, pyroxenite (?)

Amphibole; 8-10%, anhedral (microcrystalline to >1.0 mm). Ragged blades, loosely felted. Associated with quartz minor albite. Very pale green pleochroic, biaxial (-) with large 2V. Second order birefringence.

Clay; 8-10%(?), anhedral (microcrystalline, dusting of plagioclase crystal and lithic fragments and groundmass.

Biotite(?); <0.5%, anhedral (microcrystalline to 0.1 mm). Clusters of irregular grains associated with epidote. Not confirmed.

Quartz; 15-18% (includes original quartz in groundmass), anhedral (microcrystalline to >0.5 mm). Irregular interlocking grains, fracture controlled irregular veinlets, few lensoids, and diffuse and irregular impregnations into wall rock.

Epidote; 4-6%, anhedral (microcrystalline to 0.1 mm). Very irregular grains, aggregates of extremely fine grains with semiopaque dusted appearance. Local slightly coarser patches

[2] Continued

produce a characteristic yellow pleochroic and anomalous blue-grey birefringence.

Carbonate; 2-3%, anhedral (microcrystalline to  $>0.1$  mm). Irregular clusters of aggregates of grains. Interstitial to felted amphibole and epidote.

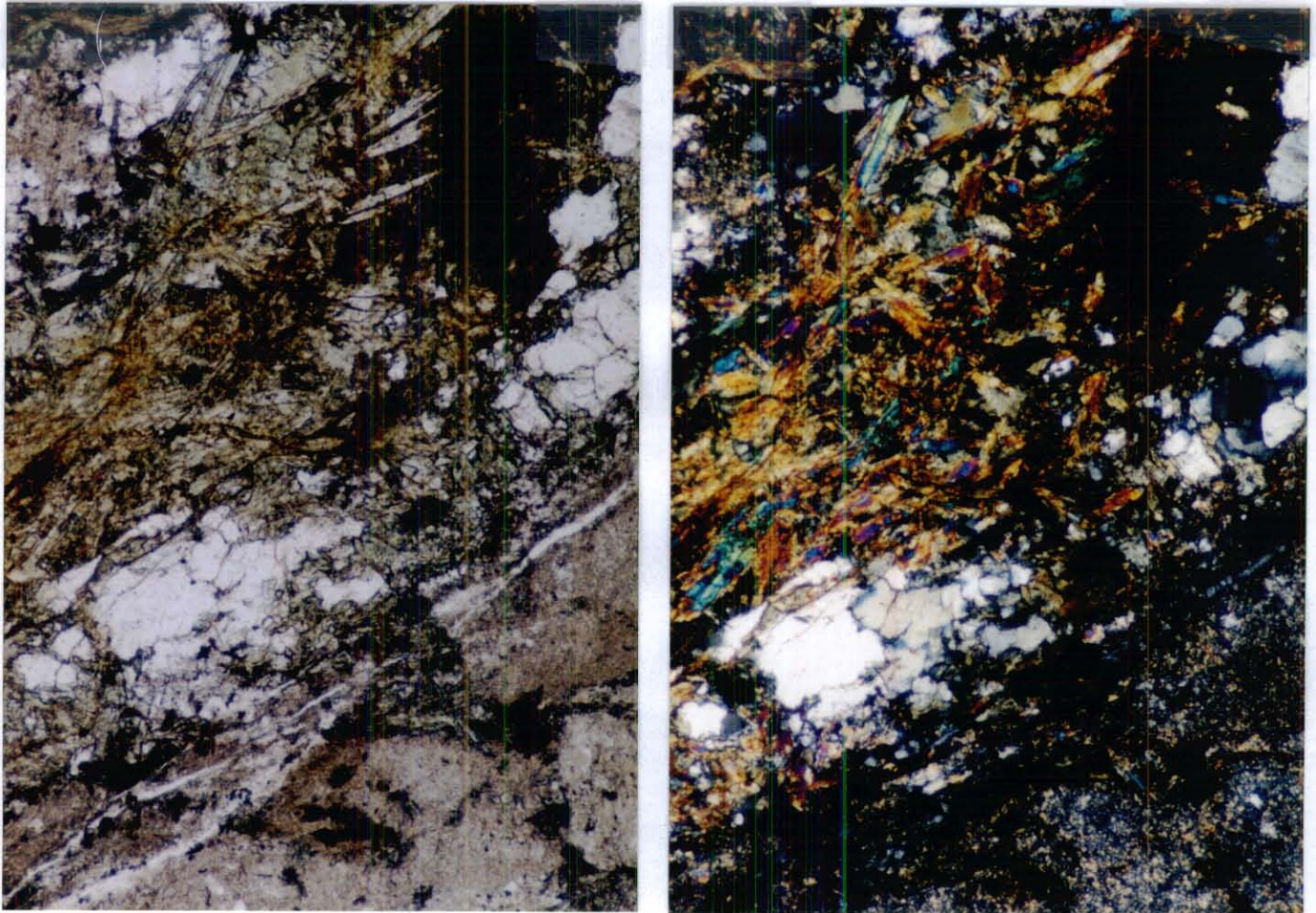
“Late” veinlets

K-feldspar; 4-5% and others as mixtures consisting of chlorite, quartz sericite, carbonate, K-feldspar, and amphibole.

Opaques

Pyrite; 1-2%, anhedral/subhedral ( $<.05$  to  $0.1$  mm). Linear clusters of grains in composite quartz veinlets. Associated iron-stain.

[3] DDH Helen #1 @ 11'  
Metacrystal lithic tuff, siliceous. Veined



Photomicrographs 97 R VI-9 and 10 Polarized and Cross Polarized Light  
Scale 0.1 mm 

#### Summary description

Siliceous metacrystal lithic tuff protolith and veining similar to [2]. Intensely sericite-altered plagioclase crystal fragments; lithic fragments, if present, are obliterated.

In a conspicuously siliceous groundmass composed of very fine to fine interlocking quartz and altered plagioclase. Much of the quartz of the groundmass is coarser than in [2] and is fracture and breccia matrix controlled; probably introduced with associated composite quartz veining.

The plagioclase fragments are much more intensely sericitic than [2] with diffuse albitic patches,

[3] Continued

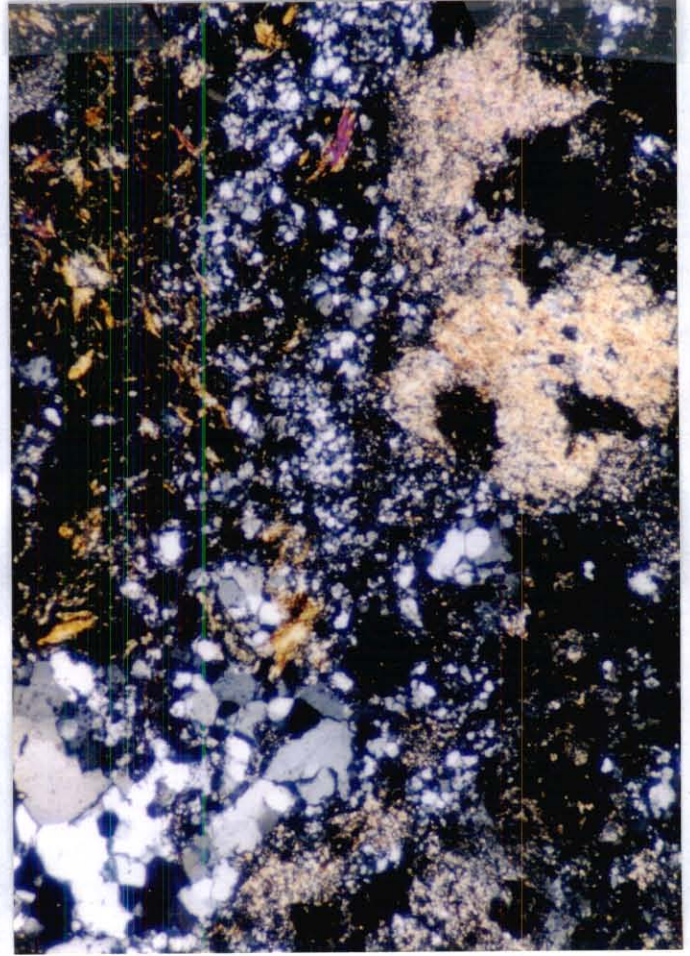
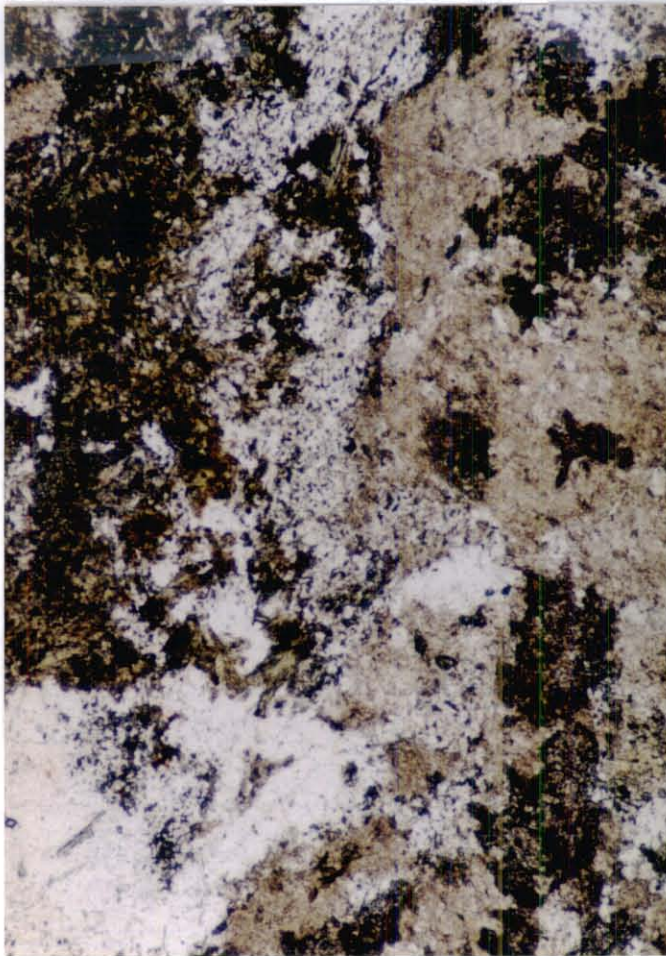
suspected epidote microgranules.

Quartz veining is very irregular fracture and breccia matrix controlled with more conspicuous diffuse irregular impregnation of wall rock. Associated suite of minerals associated with veining is similar to [2] consisting of loose felted masses of amphibole with interstitial and associated segregations of microgranular epidote, muscovite/sericite chlorite, very minor biotite, carbonate and oxidized pyrite/hematite and associated iron-staining.


Late irregular microveinlets and diffuse clusters of K-feldspar, others of amphibole, mixtures of quartz, amphibole, K-feldspar, chlorite and iron-stain.

### Microscopic description

#### Transmitted light



Photomicrographs 97 R VI- 11 and 12 Polarized and Cross Polarized Light

Scale 0.1 mm 

[3] Continued

Crystal/lithic fragments

Plagioclase; 20-25%, included in alteration assemblage, subhedral/anhedral pseudomorphs (<.01 to 1.5 mm). Fragmental. Original textures obliterated by sericite/clay alteration with associated featureless albitic patches with common optical orientation. Suspected microgranular epidote alteration. Carlsbad twinning preserved by sericite orientation.

Quartz; original crystal fragments were not noted in thin section

Lithic fragments; obliterated by intense alteration if originally present.

Groundmass

Quartz; 25-30% (total), anhedral (microcrystalline to 0.05 mm)

[a] Original quartz; suspect some of the finer (microcrystalline) quartz may have been original. Ratio of original to introduced quartz is not known.

[b] Introduced quartz, coarser aggregates, fracture and breccia matrix controlled, see Veining/impregnations below.

[c] Quartz veins; see below.

Plagioclase remnants (?); 10-15%(?) anhedral (microcrystalline?). Not positively identified but microcrystalline sericite flecks may be an alteration product of original plagioclase in groundmass.

Alteration assemblage/vein envelopes

Sericite/muscovite; 18-20%, included with feldspars, anhedral (microcrystalline to 0.1 mm).

[a] Strong felted alteration of feldspars with clay/albite and suspected epidote completely replacing albite. [b] Coarser sericite/muscovite forms segregated clusters intermixed with amphibole, chlorite, epidote as envelopes in wall rock flanking quartz veins.

Clay; 2-3%, anhedral (microgranular). [a] Irregular patches of low birefringent microcrystalline aggregates intermixed with sericite.

Albite; 1-2%, anhedral (<.02 to 0.3 mm). Not as conspicuous as in [2]. Some show adjacent remnants in same optic orientation.

Amphibole; 15-18%, anhedral (<.05 to >0.5 mm). Occurs most abundantly as loose to locally tight felted masses forming envelopes at the margins and clusters in quartz veins. Small amount occurs in late (?) microveinlets. Acicular and ragged prismatic habits. Iron-stained.

Chlorite; 4-5%, anhedral (<.05 to 0.2 mm). Felted plumose. Forms segregations among

[3] Continued

amphibole clusters in vein envelopes. Lesser amount occurs in late microveinlets.

Carbonate; traces, anhedral (microcrystalline). Very minor amounts associated with sericite/muscovite in envelopes in wall rock flanking quartz veinlets.

Biotite; traces, anhedral (microcrystalline to <0.05 mm). Few small clusters associated with sericite-muscovite in envelopes at vein margins.

Quartz; See Veins/Impregnations, below

Epidote; 12-15%, anhedral, (microcrystalline to 0.1 mm). occurs mainly as aggregates of microcrystalline grains forming dark dusted- appearing masses among amphibole sericite-muscovite, chlorite etc. envelopes associated with quartz. Also aggregates of microcrystalline grains form small clusters of grains in similar optical orientation forming pseudomorphs after plagioclase? Microcrystalline component not positively identified but few slightly coarser patches of associated grains show properties consistent with epidote.

#### Veins/impregnations

Quartz; < 25-30%, anhedral (microcrystalline to <0.5 mm). As coarser fracture controlled veinlets, lensoids and local breccia infilling. Finer aggregates as diffuse impregnations of groundmass. Original versus introduced quartz ratio not known. Previously described as cherty with some evidence of radiolaria (J.T. Fyles, Bulletin #37, 19 ), but in this section appears to be mostly introduced/remobilized. No estimate of original versus introduced quartz.

#### Late veins/segregations

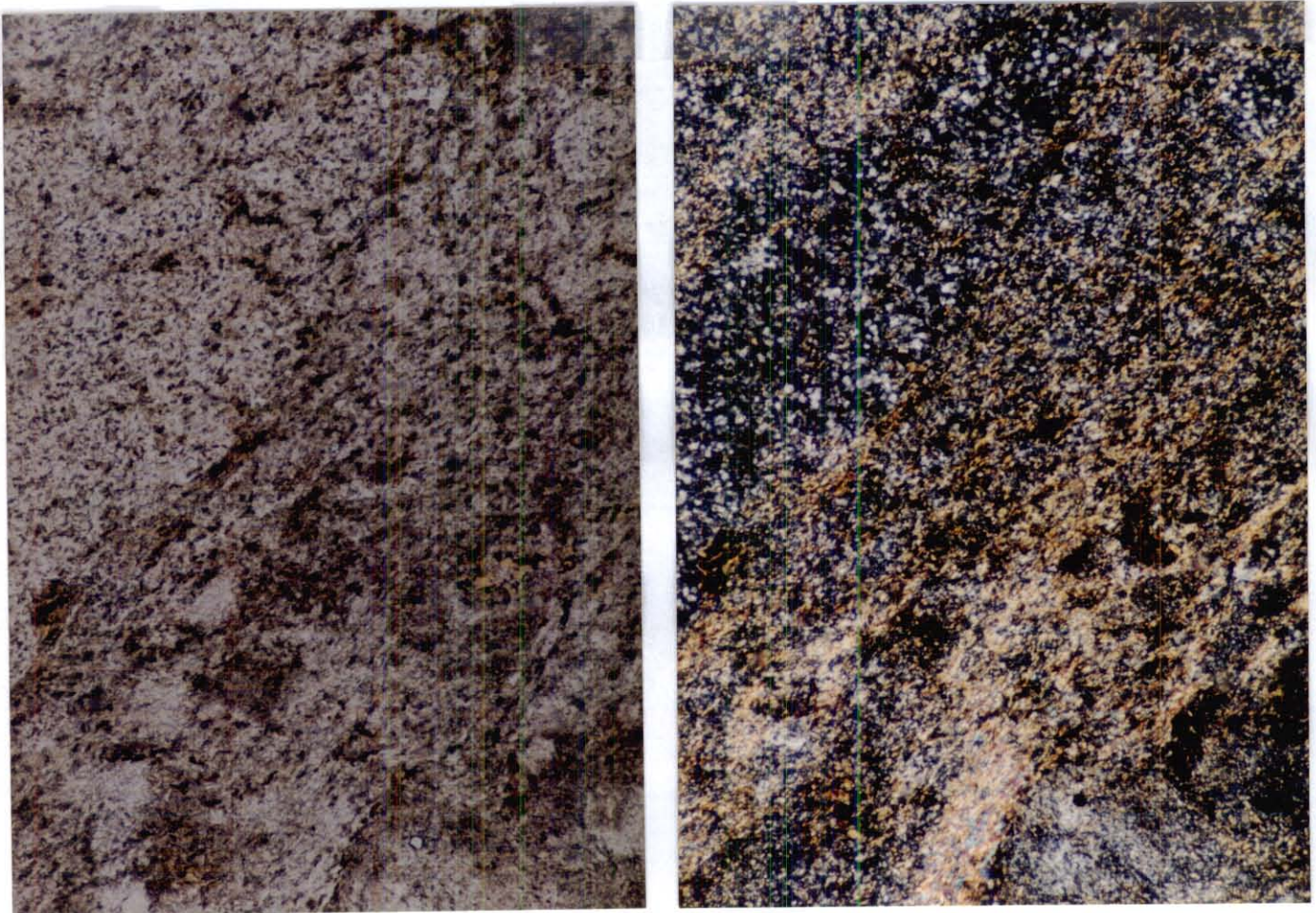
K-feldspar (?); 6-8%, anhedral (microcrystalline to <0.05 mm?). As diffuse K-stained segregations which appear to be associated with quartz. Most conspicuous in etched/stained off-cut block.

#### Opaques

Pyrite; 1-2%, subhedral/anhedral (<0.05 to 0.2 mm). Generally strong oxidized to mixture of hematite and associated iron-section.



**[4] DDH Helen #1 @ 19'**  
**Metacrystal lithic cherty tuff**



**Photomicrographs 97 R VI-15 and 16 Polarized and Cross Polarized Light**  
Scale 0.1 mm

**Summary description**

Metacrystal lithic cherty tuff, layered/foliated. Composed of crystal fragment remnants of altered plagioclase, secondary biotite clusters representing altered mafics, very sparse quartz fragment remnants. Abundant lithic fragments, similar in appearance to altered groundmass but discernable because of fragment outlines and colour differences. In a tuffaceous patchy siliceous, altered plagioclase-rich groundmass. Deformed, with shear planes.

Plagioclase crystal fragments are altered to varied intensity by sericite and albite with fragment outlines clearly visible. Possible relic mafic fragments are represented by irregular clusters enriched in fine felted biotite. The groundmass consists of diffuse concentrations of very fine

[4] Continued

quartz; sericite-altered plagioclase with a conspicuous overprint of segregated, foliated screens, discontinuous networks and linear partings of fine sericite and biotite in foliation plane.

Fracture controlled sericite and biotite in foliation plane. Late fractures with K-feldspar and very minor quartz, traces carbonate, epidote. Note: light and dark layering in stained off-cut not as conspicuous in thin section. Fewer plagioclase fragments in darker layer.

### **Microscopic description**

#### **Transmitted light**

##### Crystal/lithic fragments

Plagioclase; 25-30%, subhedral/anhedral (0.1 to >1.5 mm). Shows varied intensity of alteration to sericite, "clay" and featureless patches of albite. Some grains subrounded by resorption. Others show relic polysynthetic and Carlsbad twinning. Stained slab shows variations in abundance between light and dark (fewer) "layers".

Altered mafic; 8-10%, anhedral pseudomorphs (<0.2 to >1.0 mm). Consists of irregular clusters of very fine felted biotite. Diffuse outlines but distinct. Deformed, trails off into shear planes.

Lithic fragments; 12-15%, irregular outlines, (<0.5 to >3.0 mm). Darker than plagioclase fragments, entirely composed of microcrystalline grains with strong sericite-"clay".

Quartz; 0.5-1.0%, anhedral (0.2 to 2.0 mm). Few grains subangular, partly resorbed; others recrystallized (?) showing aggregates of interlocking grains (<.05 to 0.2 mm).

##### Groundmass

Plagioclase; 20-25%, anhedral (microcrystalline to .01 mm). Not confirmed. Presence indicated by sericite/"clay" alteration overprint on irregular featureless grains which appear to be a mix of plagioclase (albite?) and quartz.

Quartz; 20-25%, anhedral, (microcrystalline to >.02 mm). occurs as diffuse segregations among similarly diffuse sericite/plagioclase (?) segregations. Varied degrees of intermixing. Relative abundance of original versus introduced quartz not apparent.

Alteration/segregations % included with host minerals.

Sericite; 25-30%, anhedral (microcrystalline to <.05 mm).

[a] Disseminations, felted clusters overprint on plagioclase crystal and lithic fragments and microcrystalline groundmass.

[b] Conspicuous foliated discontinuous screens/networks/partings superimposed on

[4] Continued

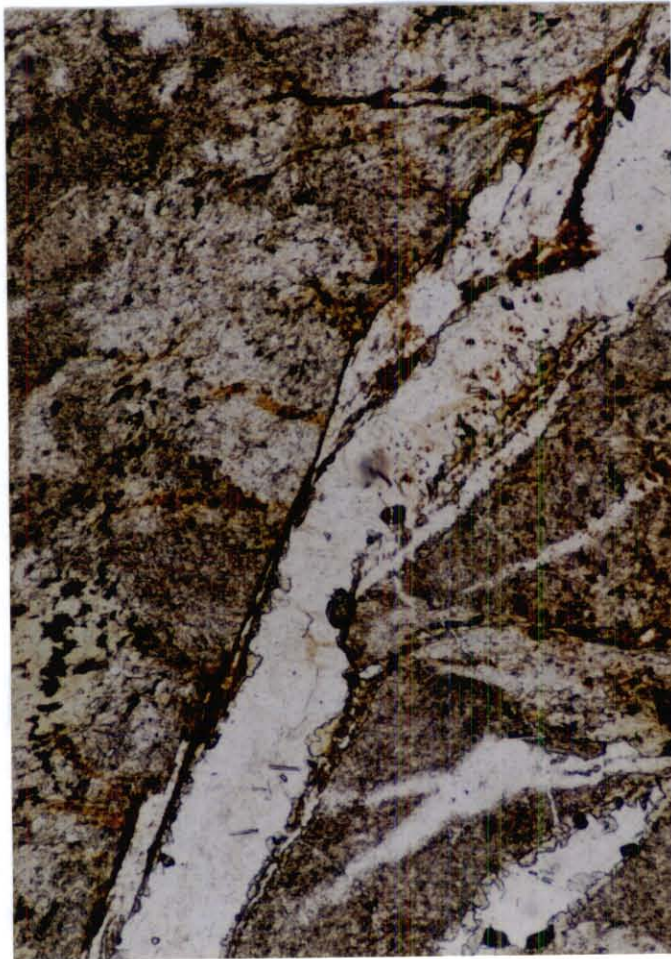
groundmass. Filling microfractures.

Quartz; see Groundmass, above. Relative abundance of original vs introduced quartz in groundmass not apparent.

Biotite; 12-15%, anhedral (microcrystalline to .05 mm). Occurs as irregular but distinct felted clusters replacing earlier mafic fragments. Deformed, trail off into shear/foliation planes.

Carbonate; traces, anhedral (microcrystalline to .02 mm ). Few small clusters associated with quartz.

“Clay”; 2-3%, anhedral (microcrystalline (?)). Semiopaque dusting associated with sericite alteration of plagioclase.



**Photomicrographs 97 R VI-13 and 14 Polarized and Cross Polarized Light**

Scale 0.1 mm 

[4] Continued

Late fracture fillings/veinlets.

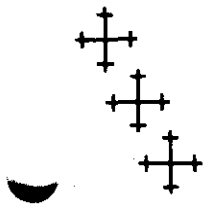
K-feldspar; <<<0.5%, anhedral (<.01 to >0.5 m). Irregular interlocking grains in discontinuous pinching and swelling microveinlets. Intermixing with very minor carbonate, very localized minor quartz.

Carbonate; <<<0.5%, anhedral (microcrystalline to 0.2 mm). Scattered small clusters (to >0.5 mm), associated with K-feldspar in microveinlets.

Quartz; traces (+), euhedral/anhedral (<.02 to .05 mm). Few clusters of grains associated with K-feldspar microfracture infillings traces lining walls of veinlets.

Sericite; see Alteration/segregations, above. Occurs as conspicuous microfracture fillings. Appears to be earlier than K-feldspar; associated with earlier sericitic alteration

Epidote; traces, anhedral/subhedral (microcrystalline to <.05 mm ) Occurs at margins of K-feldspar microveinlets.



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