60001950

Mining District File Summary Sheet

DISTRICT	Rosebud
DIST_NO	4010
COUNTY If different from written on document	Pershing
TITLE If not obvious	Rosebud petrographic reports
AUTHOR	Vance, R; Langstaff G; Brewer N; Paster T Allen K
DATE OF DOC(S)	1990 - 1998
MULTI_DIST Y / N? Additional Dist_Nos:	
QUAD_NAME	Sulphur 7½'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine; Newmont Gold Co.; Rosebud JV North Equinox
COMMODITY If not obvious	gold; silver
NOTES	Petrographic reports; correspondence; geology; handwritten notes; photographs NOTE: Some pages are double sided 57p.

Keep docs at about 250 pages if no oversized maps attached
(for every 1 oversized page (>11x17) with text reduce
the amount of pages by ~25)

SS: DD 9/11/08
Initials Date

DB:
Initials Date

SCANNED:
Initials Date

Revised: 1/22/08

3x-16
↳ Geology / Petrography

Petrography

60001950

4010

RB Trailer
4010

6000 1950

NEWMONT GOLD COMPANY
ROSEBUD J.V.

To: Randy Vance Date: October 21, 1998

From: George Langstaff

Subject: **Petrography for North Equinox and Deep RS-422/422.1 Samples**

North Equinox Samples

NWRA-2601: platy outcrop above dense brown rock ("brown flow"/ "Wildrose") northwest of USMM212; variably bleached and grades into reddish brown to very pale grey pseudobreccia above; also sample for whole rock analysis;

- collected to verify that this is the same unit as the dense brown rock below and to determine origin – initially thought to be derived from aphyric glass;

In thin section, the sample has a pilotaxitic fabric with the microlites more or less parallel to faint, sub-mm scale banding defined by variations in the abundance of dusty opaque. The rock has patchy extinction which does not conform to the banding. Equigranular specks of opaque are disseminated throughout. There are very rare, blocky, subhedral feldspar phenocrysts <1 mm, which are severely plucked and locally altered to cryptocrystalline clay(?) – one of four has albite twins. A rectangular opaque grain almost 1 mm long is probably an altered mafic silicate. There are very rare lenses of quartz, probably derived from recrystallization of the matrix. An irregular bleached band has equigranular quartz and opaque and less dusty opaque than nonbleached rock. Otherwise the rock has very minor clay alteration, principally in phenocrysts.

- essentially aphyric, felsic flow, or possibly intrusion, with rare K-spar(?) and plagioclase phenocrysts.

NWRA-2602: dense but fractured, pinkish grey outcrop ("brown flow"/ "Wildrose") northwest of USMM212; also sample for whole rock analysis;

- collected for comparison with 2601 and 2603 – initially thought to be derived from essentially aphyric glass;

In thin section, the sample is very similar to 2601 and consists of extremely fine microlites but without strong preferred orientation. The rock is brecciated (synemplacement?) with faintly banded "clasts" and more strongly banded and locally folded "matrix". The rock has patchy extinction. There are a few coarser microlites and one can be identified as plagioclase. Some of the larger, stubby opaque grains may be altered mafic silicates. There are very rare, stubby, subhedral feldspar phenocrysts <2 mm, which are variably altered to clay(?) – one of five has albite twins but another has a moderate 2V(-) and is probably sanidine. There is some very fine disseminated quartz and very irregular small lenses of quartz which are probably due to recrystallization. Some of the lenses have opaque grains and a pleochroic brown mineral, which may be acmite. There is very minor clay alteration.

- essentially aphyric, felsic flow, or possibly intrusion, with rare K-spar and plag phenos.

NWRA-2603: outcrop of dense brown ("andesite"/ "intrusion") rock near bottom of draw east of ZZ Top; also sample for whole rock analysis;

- collected to evaluate similarity with visually identical samples 2601 and 2602; pale round spots <5 mm in part of unit led me to believe this was a devitrified vitrophyre;

In thin section, this sample is very similar to 2601 and 2602 but banding is extremely faint and there is no patchy extinction (which is probably a nondiagnostic recrystallization phenomenon). Rare coarser feldspar microlites (at least one of which is sanidine) and elongate opaque are foliated but the finer groundmass microlites are not. Blocky to rounded feldspar phenos <2 mm are almost completely altered but one (out of 6) has Carlsbad twins without albite twins and could be sanidine. There are 2 rounded mafic xenoliths 1 mm and 5 mm across. They consist of radial arrays of abundant elongate opaque, altered feldspar, and possibly quartz. The sample has very rare chalcedony veinlets and very minor clay alteration.

- essentially aphyric, felsic flow, or possibly intrusion, with rare K-spar and plag phenos and very rare mafic xenoliths; still indistinguishable from 2601 & 2602.

<u>RS-422/422.1 Samples</u>

1959.1: feldspar-phyric rock but phenocrysts finer than coarsely porphyritic "BMB-type" rock; also sample for whole rock analysis;

- collected for comparison with "BMB-type" and to identify phenocrysts; may actually be "White Alps intrusion"

In thin section, the sample has about 20% variably altered, fractured, commonly zoned, but rarely twinned, euhedral to anhedral plagioclase phenos .5-2 mm long. The groundmass is altered and has only about 40% distinct feldspar microlites, the rest may be devitrified glass. The sample also has about 5% euhedral-anhedral mafic silicate phenocrysts <1 mm long, which are rimmed by opaque and replaced by chlorite(?), calcite, and high-birefringence clay ("sericite"). The shapes suggest these were mostly hornblende. The plagioclase phenos are variably altered to calcite and lesser clay and rarely have what may be albite rims. The groundmass contains minor chunky opaque and rare apatite. There are rare, very fine prismatic, unaltered grains of a brown mineral which may be acmite.

- hornblende+plagioclase-phyric flow or intrusion; phenoandesite.

1984.7: rock with fine mafic phenos and possibly feldspar phenos; also sample for whole rock analysis;

- collected for identification of phenocrysts and to compare with samples which look more like tuffs below;

In thin section, the sample has about 20% subhedral plagioclase phenocrysts <2 mm, about 3% euhedral biotite phenos <.5 mm, and about 1% generally subhedral, poikilitic hornblende <1 mm in an altered microgranular groundmass of quartz and feldspar. Plagioclase is strongly altered to calcite and clay. Hornblende is variably altered to chlorite, colorless high-birefringence clay, calcite, and rarely actinolite(?). Biotite has sphene and opaque inclusions and is commonly discolored to almost colorless but is only

rarely replaced by muscovite. Accessory apatite in matrix and in mafic phenocrysts appears fresh. There are amygdales or xenoliths <1 mm which consist of cryptocrystalline, mosaic quartz+feldspar(?) and chlorite.

- hornblende+biotite+plagioclase-phyric flow or intrusion; phenodacite; the abundance of biotite suggests this is not the same unit as that at 1959.1 and the abundance of plagioclase indicates it is not the same as that at 2113, 2141, and 2318.

2005.6: lithic fragments and rare inconspicuous crystals in a dark red, clayey(?) matrix

- collected to determine if this is pyroclastic or sedimentary and to identify constituents;

In thin section, the sample consists of about 50% matrix which is clouded with abundant opaque, about 28% rock fragments, about 20% crystal fragments and about 2% glass shards. Rock fragments include a pilotaxitic mafic rock, a fuzzy irregularly microgranular rock with quartz(?), a cryptocrystalline rock with some feldspar microlites and larger plagioclase phenocrysts, a trachytic rock with mafic xenoliths, a hornblende+plagioclase-microphyric rock, phyllite, and possibly chert. The crystal fragments are rather coarse and very angular and seem to be derived from a plutonic rock rather than from a porphyritic volcanic rock. They include fresh plagioclase (dominantly andesine?, one fragment has myrmekite), quartz, and K-spar (including perthite, and grid-twinned microcline). There are also rounded to subhedral mafic grains which are variably replaced by chlorite and may be from a different source.

- tuffaceous litharenite; the variety of clast types and rounding of many rock fragments suggest this is not a primary pyroclastic deposit although the glass shards and angular plutonic crystals suggest an explosive event in the source area; the lack of sorting and preservation of angular shards indicates this is probably a mud flow deposit.

2113: rock with rare hornblende and fine black squiggles which I thought might be glass shards;

- collected to determine if this is a tuff or not and to compare with 1984.7 and 2141;

In thin section, the sample contains about 15% euhedral to subhedral hornblende and possibly pyroxene <1 mm in a moderately clay- and calcite-altered groundmass of variably oriented feldspar microlites and very fine granular opaque. The mafic phenocrysts are commonly replaced by chlorite, high-birefringence clay, and rare calcite. It contains about 10% irregularly shaped amygdales (the black squiggles) <2 mm long, which are filled with pale green, cryptocrystalline clay(?), calcite, and spherical to hemispherical clots of darker green clay or chlorite(?).

- hornblende-phyric flow, or possibly intrusion; no evidence that this is pyroclastic.

2141: has more black squiggles and I didn't see hornblende so I thought this could be a different unit than 2113; also sample for whole rock analysis

- collected to compare with 2113 and 2318.1 and to try to identify glass shards

In thin section, the fabric is similar to that of 2113 but with only about 3% subhedral hornblende in a pilotaxitic groundmass of chlorite, dusty opaque, and feldspar microlites weakly altered to clay and calcite. There are a few coarser opaque chunks and needles. The rock contains about 15% irregular amygdales, which are filled with chlorite, calcite,

and chalcedony often in banded, concentric patterns. One amygdale is over 10 mm long and 3 mm wide.

- hornblende-phyric flow, or possibly intrusion; same unit as 2113.

2318.1: another rock with both hornblende phenos and black squiggles but much deeper than 2113 and possibly less altered; also sample for whole rock analysis;

- collected to compare to 2141 and 2113 and to see if it is less altered;

In thin section, this sample is very similar to 2113 with about 10% hornblende microphenocrysts and 10% amygdales in a trachytic to pilotaxitic groundmass of weakly altered feldspar microlites and fuzzy cryptocrystalline material. One 6-sided grain replaced by chlorite may have been biotite. The hornblende is less altered than in 2113 and 2141 but thin calcite veins cut the sample.

- hornblende-phyric flow, or possibly intrusion; same unit as 2113 and 2141.

RS-423 Samples

1206.5: variegated white, red and, grey pseudobreccia(?) of uncertain origin;

- collected to determine if grey "matrix" is actually specular hematite and to better establish paragenetic relations of white argillic(?), red hematitic, and grey ? alteration;

In thin section, the white "clasts" consist of fuzzy, cryptocrystalline material with no identified minerals. The grey "matrix" looks similar but does have <10% equant, opaque specks and some coarser grained patches which may have quartz and/or feldspar. There is one rounded, unidentifed phenocryst. In reflected light, the "matrix' has only very rare, extremely small, reflective grains which could be specular hematite. Red hematite rims are on some but not all white "clasts" and may not be on all sides of the same "clast". The "clasts" are commonly palest immediately adjacent to the hematite rim.

- rock type is uncertain; although the white alteration cannot be younger than the red and grey, it looks possible that all developed contemporaneously due to chemical gradients or other causes.

RB1 PROBABLE ANDESITE FLOW/DIKE. RELICT AMPH, NOW HmOx, ≠ PLAG
WHAT KURTIS CALLED "OSCAR" FLOWS

RB 2 DOZER? TUFF. MORE RELICT PHENOCRYSTS THAN EXPECTED
PRETTY SHOT, PROBABLE WELDED TUFF

RB 3 DOZER. STANDARD APPEARANCE, MASSIVE

RB4 DOZER BRECCIA. POSSIBLY AUTOBXA. RUDDY HEMATIZED ROCK
FLOUR ~~BRE~~ MATRIX, FRAGMT LITHOLOGY SAME AS ABOVE

RB 5 BRECCIA. POSSIBLE LBT SUBUNIT.

RB6 ? POSSIBLE LBT SUBUNIT

RB7 PROBABLE LBT LEOPARD SKIN WELDED TUFF SUBUNIT

RB8 ? POSSIBLE LBT SUBUNIT, MASSIVE. RELICT PLAG ≠ AMPH
VFG GROUNDMASS. POSSIBLE CHOCOLATE

RB9 DOZER? MICROLITE-BEARING

RB10 BUD. LITHIC LAPILLI TUFF. "TYPE". GRN CLAY ALTN

RB11 CHOCOLATE? TWINNED PLAG

RB12 SHEAR BRECCIA PROBABLY LBT LITHOLOGY

RB13 CHOCOLATE BXA. NOTE PLAG PHENOS

RB14 POSSIBLY LBT SUBUNIT

RB15 BXA WITH SIGNIFICANT ALTERATION. PROTOLITH UNCLEAR

RB-16 ? PHENOS SUGGEST NORTHERN RHYOLITE

RB-17 BXA. ~~EITHER~~ CHOCOLATE AFFINITY

★ RB18 BMB OR PORPHYRY DIKE AFFINITY. GLOMEROPORPHYRITIC PLAG, LARGIST AMAT

RB19 WELDED TUFF, LBT AFFINITY

RB20 ? TOO ALTERED

RB21 LBT. SEMI-WELDED TUFF

RB22 POSS. CHOCOLATE

RB23 CHOCOLATE BXA

★ RB24 PROBABLE CHOCOLATE DUE TO PHENOCRYST CONTENT

RB25 LBT MASSIVE → LAMINATED

RB26 ? STR. ALT'N

RB27 ? LBT AFFINITIES

RB 28 LBT? SMALL PLAG PHENO(S)

RB 29 PROBABLE CHOCOLATE AFFINITY. PRETTY SHOT

RB 30 PROBABLE " " " "

RB 31 BASALTIC ANDESITE UNKNOWN AFFINITY

RB 32 ? POSSIBLY VOLCANICLASTICC BXA, LAPILLI LITHIC TUFF OF BUD AFFINITY? NOTHING TO GO ON BUT BXA TEXTURE.

RB 33 LBT AFFINITY BXA.

PETROGRAPHY

JULY 1990

Rosebud, NV

Drill-core amples obtained from Nate Brewer have been examined with the optical microscope and electron microprobe. All samples consist of rhyolitic to rhyodacitic volcaniclastic rocks with the exception of the green-colored Bud Breccia. The Bud Breccia sample is a water-laid rhyolitic crystal/lithic lapilli tuff, and the lithic fragments and groundmass consist of well-foliated glauconite and fine-grained quartz. The glauconite imparts the distinct green color to the rock. This rock contains pyrite and pyrrhotite, but it is probably of early-diagenetic origin like the glauconite. The chief difference between the mineralized hanging-wall rocks and the barren Dozer Tuff in the footwall is the lack of lapilli in the latter. None of the altered breccias contain lithic fragments as in the Bud Breccia.

Alteration began with early diagenesis comprising devitrification of glassy volcanic fragments to K-feldspar and quartz. Early sericitic alteration appears to accompany introduction of disseminated "buck-shot" pyrite, which is accompanied by marcasite, sphalerite, and galena (in the pyrite). The sericitized rocks were then fractured. Fractures filled with quartz, pyrite, marcasite, arsenopyrite, and sphalerite may be the same age of, and feeders for, the disseminated sulfides and sericitization. A later set of fractures contains the mineralizing assemblage consisting chiefly of calcite, stylotypite (Ag-rich tetrahedrite), pyrargyrite (Ag_3SbS_3), aquillarite (Ag_4SeS), naumannite (Ag_2Se), and acanthite Ag_2S. Gold in this assemblage occurs as Ag-rich electrum. Calcite in these veins contains Mn and/or Fe and corrodes earlier pyrite and marcasite. The latest stage consists of veinlets of kaolinite which cut across calcite veins, and replace both the calcite and earlier marcasite. It is uncertain whether the kaolinite is hydrothermal or supergene.

NATE,
PRELIMINARY OF
DICK BEANES
TREATISE

10/22/97

George –
I found this at the mine office. Its a draft, but seems to be pretty good work. I'll try to chase down the final report.
–Randy

Dave

Rosebud, NV Sample Descriptions

Hole RE 41, 11', Pink Rock with Chalcedonic Silica

The wall rock has been fractured by introduced quartz and pyrite. Most of the pyrite has been removed by oxidation leaving empty casts. Supergene jarosite fills open areas in the quartz and is pseudomorphous after pyrite. Sericite appears to corrode quartz. Feldspar minerals are absent.

Hole RE 41, 230.5', Green Rock w/Pyrite Veinlet, Bud Breccia

The sample is composed of schistose mica of glauconitic composition enclosing 1-centimeter and smaller quartz-rich fragments. Discontinuous one-millimeter thick pyrite and marcasite "veinlets" with minor quartz are roughly parallel to schistosity. Pyrrhotite as inclusions in pyrite was the only other sulfide detected.

One late fracture with void space and smectite cuts the quartz-rich fragments and schistosity.

Rock type has been identified petrographically as a rhyolitic crystal/lithic tuff.

Hole RE 41, 362', Transition Between Green & Tan

The rock is similar in appearance to the mineralized samples found at greater depth, and significantly different from the "Green Rock" of 230.5'. It is composed of 2 cm and smaller glass and wall rock breccia fragments which are light tan to light green in color in darker brown matrix. Mineral grains are submicroscopic. Pyrite, marcasite, and sphalerite are disseminated throughout the sample. Sulfide veinlets are not present.

Mn-bearing calcite occurs as very fine-grained disseminations in wall rock, microveinlets, and corrodes and replaces FeS_2. One microveinlet contained rhodochrosite. Mn-calcite is the same age as silver mineralization in deeper samples, but Ag was not detected here.

Petrographic evidence rock was originally a clast-supported, rhyolitic vitric/lithic tuff.

Hole RE 41, 424', Buckshot Pyrite, Marcasite

The sample consists of a ~1" probable glass fragment and numerous smaller wall rock breccia fragments. One millimeter thick veinlets of pyrite, marcasite, and arsenopyrite cut the wall rock fragments. Quartz occurs along the veinlet margins adjacent to wall rock with sulfides at the center. Pyrite, marcasite, and sphalerite are finely disseminated throughout the sample. The disseminated pyrite occasionally contains galena inclusions. Kaolinite occurs as late microveinlets and around

corroded disseminated pyrite.

Gold was not detected in this sample, though the interval assayed 0.3 opt Au. None of the calcite or Ag-sulfosalt mineralization that occurs with Au was found. Presumably this mineralization was in the portion that was assayed indicating potential sampling error problems.

Petrographic evidence suggests that the original rock type was a matrix-supported, rhyolitic to rhyodacitic vitric/lithic tuff.

Hole RE 41, 432', Patchy Buckshot Pyrite, Clay Veinlet

This sample is similar to the one from 424'. It includes a glass fragment and smaller wall rock breccia fragments, two 1-millimeter thick quartz-FeS_2 veinlets, and disseminated fine-grained FeS_2. Black Ag-sulfosalts, aurian Ag, and kaolinite occur after FeS_2 along one of the veinlets. The FeS_2 is fractured and void space is common. Calcite, which forms with the Ag minerals in other samples, was probably displaced by the kaolinite forming the void areas. Traces of rhodochrosite and one instance of calcite were detected in the veinlet.

The FeS_2 of a second veinlet lacking Ag mineralization is relatively intact. Minor breakage has occurred and traces of late Ag minerals and kaolinite are present.

Gold occurs mostly as aurian Ag in the Ag-sulfosalt veinlet. Two instances of aurian Ag were detected in the second veinlet. Gold does not occur in the buckshot pyrite.

Hole RE 41, 434', Sulfide Breccia Veinlet

This sample contains the best examples of all of the paragenetic relations. Wall rock has been strongly brecciated by sulfide and kaolinite. An early sulfide suite composed mostly of pyrite and marcasite is broken and corroded by the main mineralization stage of calcite, stylotypite, pyrargyrite, and aurian Ag. Millimeter sized pyrite crystals have been fragmented by calcite and Ag-sulfosalts which fill the areas between fragments. Euhedral crystals of Ag-sulfosalts occur in the calcite. The calcite was subsequently corroded and replaced by kaolinite.

Hole RE 41, 468', Low Grade But Right Color

Tan colored 10-millimeter and smaller fragments occur in a slightly darker brown matrix. The fragments and matrix are extremely fine-grained mixtures of quartz, sericite, K-feldspar, and albite, and do not appear to be significantly different in the microprobe. Disseminated 250 μm pyrite crystals are common throughout. Late calcite cuts the wall rock. It contains minor Fe, no Mn, is in equilibrium with pyrite, and does not occur with Ag-sulfosalts. The calcite with Ag mineralization in other

samples contains Mn ± Fe, and fractures and corrodes pyrite.

Occasional one millimeter-size patches of kaolinite corroding quartz occur in the wall rock. Age relations between the kaolinite and calcite are not evident.

Hole RE 41, 480', Clay Rich, >1 opt Au

The sample is very fine grained and does not contain visible breccia fragments. While wet it gives an appearance of being rich in clay; water disperses the sample. Microprobe and X-ray diffraction did not confirm an abundance of clay. Quartz and albite are the most abundant minerals. A higher sericite and kaolinite content than other mineralized samples is indicated in the optical microscope, but the friable nature of the fine grained constituents is the cause of the clay-like aspect.

FeS_2, occasionally with galena inclusions, and sphalerite are disseminated throughout. The high gold grade of the interval was not indicated by the specimen. Four aurian Ag grains averaging 4 μm in size was the only gold detected. Silver mineralization and Mn-calcite, which accompany aurian Ag in other samples, were not present in abundance. The split analyzed must have been different from the sample examined.

Late quartz and kaolinite veinlets cut the rock. The aurian Ag was associated with late kaolinite and may have been remobilized.

Original rock type appears to have been a matrix-supported, rhyodacitic lithic tuff breccia.

Hole RE 41, 598.5', Unmineralized Footwall, Dozer Tuff

The sample is similar in appearance to the "Clay Rich" sample from 480', but is light green in color rather than tan. It is aphanitic and cut by 0.5-1 millimeter thick glauconitic mica and Mn-calcite veinlets. The calcite veinlets cross-cut the mica. The sample contains fine grained disseminated pyrite, sphalerite, and galena. FeS_2 and galena also occur in equilibrium with the veining Mn-calcite. This is different from mineralized zones where Mn-calcite is later than and corrodes pyrite.

A different rock type than the mineralized host rocks is indicated by the major quantities of quartz, K-feldspar, and albite present with lesser chlorite. The mineralized zones contain less K-feldspar and lack chlorite. The crystallinity is slightly larger, and larger and more abundant zircon crystals are found.

Petrographic evidence suggests that the original rock type was a rhyodacitic tuff.

Hole RE 52, 405', Pyrite Veinlets and Buckshot Pyrite

Paragenesis of Mineralization at Rosebud, NV
From RE 41 Core Samples

Mineral	Early	Main Stage	Late
quartz	▬	—	
calcite		▬	
kaolinite			▬
pyrite	▬		
marcasite	▬		
arsenopyrite	▬		
sphalerite	▬		
galena	—		
stylotypite		▬	
pyrargyrite		▬	
acanthite		▬	
aguilarite		▬	
naumanite		—	
aurian Ag		—	
electrum		—	
chalcopyrite		—	

stylotypite Ag-rich tetrahedrite
pyrargyrite Ag_3SbS_3
aguillarite Ag_4SeS
naumanite Ag_2Se
acanthite Ag_2S

Rosebud, NV:

Approximately one week was spent on the petrographic analysis of seven thin sections. Rock type were defined and alteration styles described. Of the seven samples, one is essentially unaltered. This sample (90-41), is best described as a rhyolitic crystal/lithic lapilli tuff. The crystal fragments are recrystallized quartz, and the lithic fragments are composed predominantly of very fine-grained quartz intergrown with glauconite. The groundmass is of a similar composition - of well-foliated glauconite and very fine-grained quartz. The glauconite imparts a distinct green colour to the rock.

The altered samples are almost all breccias, none of which appear to have lithic fragments similar to sample 90-41. The samples are either rhyolitic vitric/lithic tuff breccias, rhyodacitic lithic tuff breccias or, as in sample 90-48, simply a rhyodacitic tuff. The breccias have been found to be both clast- and matrix-supported.

Alteration paragenesis is as follows:

: early diagenesis with devitrification of glassy volcanic fragments to K-feldspar and quartz.

: early sericitic alteration, possibly associated with the formation of fine-grained, buck-shot pyrite. Assemblage: intergrown, very fine-grained sericite + quartz, and disseminated, often euhedral pyrite (typically $\leq$ 0.1 mm in diameter).

:fracturing of sericitized breccias was followed by the introduction of quartz + pyrite/marcasite in the hairline fractures.

:main stage mineralization post-dates the quartz+FeS_2 veinlets, where Mn-calcite is associated with sulphide, Au and Ag minerals in microveinlets that transect the altered breccias. The calcite often corrodes sulphides from the earlier quartz-pyrite stage.

:late stage alteration occurs as kaolinite in microveinlets and is also found replacing sulphide minerals.

THEODORE P. PASTER, Ph.D.
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September 27, 1995

Mike Brady
Consulting Geologist
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RE: Petrography of Tertiary Volcanics; RB-1 through RB-7.

SUMMARY

Rock Types
Because of the extremely fine-grained nature of the rocks and the absence of, or poorly preserved nature of, phenos it is very difficult to identify specific feldspars and hence the rock types. NO WAY!

There is no doubt that all of the rocks are closely-spaced in time and in genesis because: 1) They were all vitric initially. 2) They show similar devitrification features. = >75% glass

A quick and dirty procedure for identifying the amount of K-spar in the rocks would be staining for K. This could be done and looked at for $8.00/sample. Let me know if you want this dome ASAP.

Alteration
The major alteration is devitrification.

RB-1 is propylitically altered with some additional carbonate alteration.

RB-7 is either slightly propylitically altered or slightly clay altered.

RB-2, RB-4, RB-6 are slightly carbonate altered.

RB-3 contains some minor zeolite in fractures.

The reddish-colored rocks are oxidized.

Respectfully submitted:

— possibly a basalt = ± all Olivine phenos ~ 9% (Some px?)

PETROGRAPHIC DESCRIPTIONS

Aphyric basaltic andesite (minor Ol) vesicular lava or tuff

RB-1; Propylitically-Altered Vesicular Basalt or Andesite. (TOS)

Phenos (7%):

5% [Ferromag]	0.16-4mm	Relict euhedra 100% replaced with carbonate (Carb) > chert + chlorite (Chl) with limonite or earthy hematite (Ht) in relict cleavages.
2% [Olivine?] (Ol)	0.12-1.0mm	Deformed structures 100% replaced with green fibrous chlorophaeite.

\ mineraloid related to chlorite = pale green

Groundmass (86%):

59% Feldspar (F)	0.05-0.3mm long	Tabular crystals aligned on local scale (trachytic texture). Murky with fine-grained incipient alteration. Can't tell whether it is K-spar or plagioclase (Pl).
20% Chlorite (Chl)	<0.01-0.07mm	Fibrous green mineral in an- to subhedral patches and euhedral relict crystals.
10% Epidote (Ep)	-	Extremely fine-grained material appears to partly replace F.
7% Carbonate +Hematite + Chert	12-50u	Mottled relict subhedral mineral may be amphibole.
4% Magnetite (Mt)	<0.01-0.05mm	Small octahedra with Ht rinds.

Tos

Vesicles (7%):

	0.6-4mm long	Parallel, elongate structures which generally have scalloped edges. 96% filled with coarse Carb with occasional Chl along Carb grain boundaries and between Carb growth layers.

— probably not!

RB-2; Devitrified Acidic or Alkaline Volcanic. (Td) ? Trachyte? Rhyolitic glass

Structures (20%):

	1-4mm	Equant to elongate patches with indistinct boundaries. Generally occur along partly Fe-stained micro-fractures. Consists of Carb patches and small Q subhedra in groundmass of clay.

rock fragments = different comp.

Hgh-Si

Probably dacite to rhyolite tuff

Td

Phenos (tr%):

tr Sanidine	0.3-0.7mm	Euhedra in a cluster in small part of thin section (ts). 60-95% replaced by Carb.

Groundmass (80%):

95% Feldspar/ Quartz, spherulitic.	0.05-0.3mm	Annealed spherulites with abundant inclusions.
5% Quartz	0.02-0.1mm	An-subhedra both monocrystalline and in

[ ] = Totally replaced or destroyed phase.

Rock fragments

polycrystalline aggregates. More or less disseminated in groundmass.

Based on past observations this texture is most common in devitrified rhyolitic glass.

Trachytes

? **RB-3; Devitrified, Possibly Altered ~~Andesitic~~ Glass.** (Td)

Devitrified Glass (98%):

Phenos (tr%);

tr Plagioclase(?) (Pl)	0.1-2.4mm	Sparse, aligned crystals. Cloudy with incipient alteration.

Groundmass (98%);

98% Cryptocrystalline Fibrous Mineral	<0.05mm	Has undulatory extinction. More or less aligned to give a foliation to rock. Apparently a spherulitic F which has been replaced with a zeolite or clay.
2% Magnetite	3-30u	Small disseminated grains.

Td

Vuggy Fractures (2%):

2% Chabazite(?) Zeolite	0.04-0.3mm	Subhedra nucleate in fractures and are commonly radiate.
tr Clay	-	Appears to be an occasional alteration product of zeolite.
tr Limonite(Lm)	-	Stain in portions of fractures.

Vesicle (tr%):

	0.2mm dia.	Contains radiate Q and walls replaced with clay.

RB-4; Brecciated or Tuffaceous(?) Vitric Andesite. (Td)

Andesite (84%): Subangular fragments 0.01-1.3 cm in size.

Phenos (2%);

2% [Ferromag]	0.03-0.07mm	Replaced with limonite (Stained).
tr Feldspar	0.1-0.3mm	Cloudy subhedra with carlsbad or albite twinning.

Td

Groundmass (98%);

98% Feldspar	up to 0.07mm	Poorly crystallized tabular crystals non-oriented to common direction.
2% Magnetite	<0.01-0.05mm	Ragged octahedra with thin Ht rinds.

Voids (1%):

	0.04-2.5mm	Irregular-shaped voids. Sometimes within andesite fragments but mainly interstitial to fragments.

Inter-fragmental Cement (15%):

This material, due to its vitric nature, shows little visual difference from the andesite fragments.

75% Comminuted Vitric Andesite	-	Practically indistinguishable from fragments.
30-5% Carbonate (Carb)	up to 1.2mm in section	Late interstitial cement that is optically continuous for over 4mm.
5% Quartz (Q)	<0.1mm	As anhedra in cherty polycrystalline aggregates interstitial to fragments.
tr Limonite	-	Generally as red stain on surface of fragments but occasionally through portions of cement.

This rock, except for the brecciation, is very similar to RB-3. One fragment deformed over another and slight differences in texture and mineralogy of the fragments suggest that this rock is a tuff.

RB-5; Devitrified ~~Andesitic~~ trachyte Glass Tuff. (Td)

This is the same rock as RB-3 except it is a tuff with the finer-grained matrix being Fe-stained. The Fe-staining is the same as in RB-4 but stronger.

Devitrified Glass Fragments (80%):

See RB-3 for description.

Inter-fragmental Cement (20%):

10% Comminuted Glass	-	Indistinguishable from larger fragments except intermixed with Q and Ht.
5% Quartz	0.01-0.4mm	Sub-anhedra in polycrystalline aggregates interstitial to lithic fragments.
5% Hematite(Ht) or Limonite	-	As opaque stain on glass fragments.

Td

RB-6; Trachyte(?). (Ta)

This rock is similar to RB-1 in that it has trachytic texture. It is different in that it has no Chl, Ol, nor propylitic alteration. It is oxidized.

Phenos (2%):

2% Biotite (Bt)	0.05-0.3mm	Brown anhedra stained and partly replaced with bright red Ht.
tr [Feldspar]	0.08-0.4mm	Euhedra replaced with Carb.

And markers

Groundmass (98%):

87% Feldspar	up to 0.05mm	More or less aligned to common direction. Can't tell whether it is K-spar or Pl.

10% Hematite and/or Ilmenite(Ilm).	1-50u	As grains and plates interstitial to F.
3% Carbonate	0.05-0.7mm	As anhedral patches. Disseminated and often strung out along discontinuous microfractures.

RB-7; Devitrified Trachytic or Rhyolitic Glass. (Tdi)

93% Feldspar	0.05mm long	As indistinct laths with traces of spherulitic or trachytic texture which has been annealed into indistinct super-grains. See RB-2.
5% Quartz	up to 0.12mm	An-subhedra in small polycrystalline aggregates erratically scattered in rock.
2% Hematite	2-24u	As disseminated spherulites and euhedra. Variability in distribution gives mottling to rock.
tr Clay or Chlorite	24u	Blebs up to 0.08mm after ferromag often contain Ht spherulites.

Tdi

September 27, 1995

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October 19, 1995

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RE: Petrography of Tertiary Volcanics; RB-8 through RB-14.

SUMMARY

Rock Types

Samples RB-8 through 14 were stained for K-spar free of charge to help identify rock types. There is quite a bit of K-spar in all of the rocks; some more than others.

Comparing RB-12 of this suite to the first seven samples described suggests that RB-3 and RB-5 are probably trachytes instead of andesites.

Most rocks are trachytic. Those that contain less K-spar and more Pl are fragments in RB-10 (A breccia.), RB-11, RB-13.

Some fragments in RB-10 contain perlitic fractures which suggests a rhyolitic composition.

A welded tuff is present in the breccia or volcanic conglomerate of RB-13. This is the only welded tuff seen in the samples through RB-14.

Alteration

RB-9, RB-11 and RB-12 are lightly argillic-altered.

RB-10 contains variable fine-grained Chl after groundmass Pl.

Carb replaces patches of groundmass in RB-10 and fills or lines voids in RB-10 and RB-13.

RB-14 is moderately silicified.

Respectfully submitted:

PETROGRAPHIC DESCRIPTIONS

RB-8; Trachyte. (Ta)
This rock is nearly identical to RB-6 in texture, grain size, Cal patches.

Microphenocrysts (1%):

1% Sanidine > Plagioclase(Pl)	0.02-0.15mm	More or less aligned laths which are often partly replaced by Carb.

Groundmass (99%):

45% Cryptocrystalline Fibrous Mineral	-	Bundles of fibers have undulatory extinction and are aligned to rock foliation. F is more radiate than spherulitic.
25% K-Spar > Plagioclase(?)	up to 0.08mm	Turbid, indistinct laths and equant grains aligned in bundles.
15% Glass	-	Isotropic phase interstitial to other phases.
7% Calcite (Cal)	0.1-1.0mm	As irregular poikilitic patches of alteration, larger of which, contain mottle specks and stains of Ht.
3% Magnetite (Mt)	2-24u	Euhedra altered on edges to Ht.
3% Biotite (Bt)	0.02-0.1mm	Ragged reddish-brown flakes in randomly scattered clumps.
2% Anatase(?)	2-18u	Scattered subhedra.

Note that part of this section has been stained for K-spar and most F indicates K-spar.

RB-9; Argillic(?)-Altered Vitric Trachyte. (Tri°)
Trachytic texture not distinct as in RB-6 and 7 due to clay alteration. No visible opaques have crystallized.

Phenos (2%): Occasionally in 2mm clusters.

tr [Feldspar] (F)	0.2mm	Relict deformed subhedra either as voids or filled with fine-grained WM/clay or with Q near veinlets.
2% [Ferromag]	0.05-0.35mm	Relict, occasionally deformed euhedra 100% replaced with Chl.

Porphyroblasts (1%):

1% [Pyrite]	0.02-0.08mm	Cubic molds inhomogeneously distributed.

Groundmass (93%):

93% [Feldspar] + Glass	up to 0.1mm	F is aligned, very murky and altered to WM/clay. It stains yellow indicating that

		the WM/clay is K-bearing. Murkyness caused by glass and Lx.
Late Veinlets (1%):		
	3-30u thick	3 parallel veinlets spaced about 4mm apart composed of chalcedony recrystallized into equant Q grains. About 45° to foliation.
Early Veinlets/Vugs (3%):		
	0.01-0.4mm thick	Discontinuous, disrupted, often lensoid, structures perpendicular to late veinlets. Lined with Q and lenses filled with fine-grained WM or illite.

RB-10; Lithic Vitric Trachytic, Andesitic and Rhyolitic(?) Breccia. (Tbs)

Phenos (3%):		
3% Plagioclase	0.2-2.0mm	Fractured, broken, fresh subhedra.
Lithic Fragments (40%):		
	0.4-5.0mm	Subangular fragments of vitric volcanics with rare Pl and Bt phenos. They show varying degrees of devitrification and foliation. Some contain fine-grained Chl. Some have perlitic fracturing (Indicating rhyolite).
Groundmass (57%):		The groundmass also appears to be brecciated and cemented with 3% glass.
89% Feldspar	<0.03mm	Estimated percentages and variable. 50/50 : K-spar/(Pl + Q).
5% Carbonate	<0.01-3mm	Bimodal size. Small euhedra in clumps up to 0.2mm in altered zones in groundmass and larger size as anhedra appear to be cement in vugs in breccia.
3% Glass	-	Interstitial to groundmass fragments.
3% Epidote (Ep)	<3u	As polycrystalline aggregates replace F in patches. May also include Lx in groundmass.

RB-11; Oxidized/Weathered(?) Latite(?). (Tc)

Phenos (13%):		
10% Plagioclase (An_{25})	0.06-4.5mm	Nearly fresh sub-anhedra. Largest are commonly in polycrystalline clumps. Occasionally replaced by clay along fractures.
3% Biotite	0.2-0.7mm long	Indistinct subhedra. Occasionally replaced with clay in patches associated with fractures. May be secondary Bt because phenos have Ht granules on rims. Most small, 0.04-0.3mm, books are aligned and solidly

		replaced with Ht.
Vesicles?(4%):		
	0.2-0.8mm	Spherical structures composed (filled?) of earthy deep red Ht.
Groundmass (86%):		Coarser than most groundmasses seen in the suites thus far.
78% Feldspar	0.01-0.15mm	Inter-grown anhedra nearly micro-spherulitic structure and aligned indistinct tabular crystals.
12% Clay	-	Montmorillonite or illite in ragged diffuse patches which are often Fe-stained near vesicles and in other areas related to microfractures(?).
5% Quartz	0.02-0.17mm	Dispersed anhedra. More often than not in aligned elongate aggregates which may be filled trapped gas voids in volcanics.
5% Hematite/ Limonite(Lm)	2u-0.15mm	Ragged discontinuous dark grains and as stain in clay.
Vugs?(1%):		
	1.6-5mm long	Lensoid cavities aligned to foliation filled with 8% euhedral Q on walls and filled with unusually plumose-formed adularia. Q content is variable. Some small discontinuous veinlets are over 90% Q.

<u>RB-12; Brecciated Trachyte</u>. (Tdi)

Very similar to RB-3 and -5 except this rock is a breccia. Because the F staining of this rock is so strong and uniform this rock (and probably RB-3 and -5) is judged to be a trachyte.

Lithic Fragments (80%):		
	0.2-7mm	Fractured and displaced trachyte. Poor lineation due to flowage is conformable from fragment to fragment. One fragment is a F/Q agglomerate in trachyte.
Cement (17%):		
	Apparently more glassy trachyte with more abundant finely disseminated Ht and Lx than adjacent fragments.	
Tension Gashes and Vesicles(?) (3%):		
	0.01-0.4mm thick	Discontinuous, generally aligned structures occur in cement. Filled with sub-anhedral seriate (<0.01-0.2mm) Q and clay.

RB-13; Latite and Latitic Welded Tuff Fault(?) Breccia. (Tc vent)

Lithic Fragments (92%):

	0.04-12mm	Angular fragments of welded tuff, latite(?) and vitric andesite(?). Many of the fragments are broken and offset.

Welded Tuff and Latite (4%);
Phenos (4%),

4% Plagioclase	0.2-2.5mm	Equant subhedra. Largest are crushed.

Voids (2%),

	0.4-1.0mm	Angular spaces in fractured fragments which are lined with Carb.

Groundmass (94%),

86% Feldspar + Glass	-	Composed of 50% crudely to non-aligned F crystallites intermixed with 50% glass.
10% Hematite	-	Stain in laminae between less-stained glass in tuff.
1-5% K-Spar $\geq$ Plagioclase(An_{25}).	0.05-0.25mm	Tabular crystals aligned to form a foliation (with Bt).
tr-2% [Biotite]	0.04-0.3mm	Books are stained and/or replaced earthy Ht.

Cement (8%):

Appears to be glass or rock powder which is opaque due to strong earthy Ht stain.

The welded tuff has not been seen in the previous samples. The 6% vitric andesite is not described here.

It is not certain that this is a fault breccia. The variety of lithic fragments would suggest this, an intrusive breccia or a lithic tuff. The fragments are not rounded enough for an intrusive breccia. The variety of rock types is not common in tuffs. Another possibility besides a fault breccia is a sedimentary rock from a caldera environment.

RB-14; Silicified Trachytic Tuff. (Tc silic?)

Lithic fragments are the same as RB-9, except instead of clay, the alteration is silica.

Lithic Fragments (60%):

	0.2-10mm	Rounded fragments. K-spar stain and micro-phenos (K-spar) indicate this is a trachyte. All one rock type. Fragments in some areas of section are silica enriched.

[ ] = A phase that has been totally altered or destroyed.

Cement (40%):

Consists of Q (0.1mm) down to 0.01mm in size. Q is generally anhedral, is inter-grown and has wavy extinction. Evidently replaces fine ash because Mt/Ht is present in cement.

Both fragments and cement contain 3%, 1-40u, Mt anhedra which are partly altered to Ht.

October 19, 1995.

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October 30, 1995

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RE: Petrography of Tertiary Volcanics; RB-15 through RB-24.

SUMMARY

Rock Types

The most important rock in this suite, petrographically, is the andesite RB-23. It contains small Pl tabs aligned in a groundmass of relatively coarse K-spar. The groundmass in this case is not devitrified glass so that it can be seen that the Pl gets its trachytic texture from the relatively fluid groundmass. This explains why many rocks of the area have trachytic texture yet have Pl phenos or even aligned groundmass Pl tabs with trachytic texture. As a result, this rock is in many ways similar to RB-2, -3, -5, -11, -12, -13 and -21, all of which have trachytic texture but Pl as the predominant identifiable F. These have been variously called trachyte or latite with many question marks. Being an andesite it also demonstrates a genetic relationship between the trachytes, latites, and andesites.

In the vernacular of petrologists the rocks, at least from trachytes to andesites, appear to be consanguineous.

Alteration

Silicification is common to rocks RB-15, -16 and -20.

Argillic alteration is found in RB-18, -19, -22 and -24.

Carbonate alteration and/or veinlets is in RB-17 (with chlorite), -20, -21 and -23.

Respectfully submitted:

PETROGRAPHIC DESCRIPTIONS

RB-15; Silicified Trachytic Lithic Tuff. (Tc silic?)

Lithic Fragments (80%):

	0.04-8.0mm	Subangular particles. Textures and mineralogy percentages very slightly from particle to particle.

Phenos (tr%);

tr Sanidine	0.05-0.15mm	Fresh, blocky, fractured subhedra.

Groundmass (99+%);

87% Feldspar (F)	<0.1mm	Aligned indistinct crystallites with trachytic texture.
10% Quartz (Q)	0.02-0.1mm	Anhedra in polycrystalline aggregates as patches or indistinct discontinuous veinlets.
3% Magnetite(Mt) > Hematite(Ht)	<2-4u	Disseminated sub-anhedra.

Cement (20%):

75% Chert	<10u	Rather featureless. Tends to be slightly coarser at contacts of lithic fragments and occasionally at centers of inter-fragment areas.
13% Voids	0.08-3.0mm	Some areas interstitial to lithic fragments.
10% Carbonate (Carb)	up to 0.1mm	Anhedra in polycrystalline aggregates up to 0.4mm in size in fractures in chert and in fractures in lithic fragments.
2% Hematite	<1-15u	Dust-like particles disseminated in some chert. Concentration is variable.
tr Monazite(?)	0.04x0.18mm	Rare prism in chert.

RB-16; Silicified Trachytic and Basaltic Lithic Tuff. (Tri?)

Lithic Fragments (65%):

	0.08-12+mm	Subangular fragments. More variety in textures and grain size than RB-15, Also contains some chert-filled vesicular fragments. A large vesicular basalt fragment contains plagioclase (Pl) in spherulitic growths.

Cement (35%):

91% Chert	<0.02mm	Same description as in RB-15 except less Mt/Ht but also up to 10% of 0.06-0.3mm coarse anhedral Q in polycrystalline aggregates scattered in chert.
5% Voids	0.06-3.0mm	Occasionally unfilled segments or centers of interstitial areas.

3% K-Feldspar (K-Spar)	0.05-0.12mm	Fresh subhedra. Probably unaltered crystal tuff.
tr-1% Magnetite/ Hematite	5-30u	Ragged grains inhomogeneously distributed in chert.
tr Biotite (Bt)	0.02-0.08mm long	Rare dark-brown books and ragged flakes.

RB-17; Trachytic Lithic Tuff. (Ta)

Trachyte Fragments (69%):

	0.02-10+mm	Sub-rounded fragments of same rock type.

Phenos (4%);

3% K-Spar	0.05-0.2mm	Blocky subhedra commonly replaced by patches of coarse Carb.
1% [Biotite]	0.05-0.4mm	Relict books 100% replaced with chlorite(Chl) and chloritoid.

Groundmass (96%);

Texture is similar to RB-1.

96% Feldspar	0.02-0.15mm long	F is tabular and aligned in trachytic texture. Well crystallized relative to suite up to this point.
4% Magnetite > Hematite	2-10u	Disseminated irregular grains.

Cement (31%):

Consists of comminuted trachyte plus 3-10% disseminated Ht>Mt. Some areas are stained solid with earthy Ht.

RB-18; Quenched, Slightly Argillic-Altered Andesite. (Tosm)

Phenos (12%):

8% Plagioclase (Pl)	0.2-2.0mm	Euhedra 50+% replaced with patches of illite > Carb.
4% [Ferromag]	0.3-2.5mm	Bt(?). Rounded equant relict 6-sided crystals. Rarely altered to Chl or chert. Commonly replaced by illite with goethite (Gt) - staining along fractures. Contain small columnar prisms of apatite (Ap).

Vesicles (4%):

	0.2-1.2mm	Irregular-shaped equant to elongate structures lined with stubby prismatic Q and filled with clay.

[ ] = Phase is totally altered or destroyed.

Groundmass (84%):

Has micro-radiate texture composed of inter-grown laths of 55% Pl and 20% interstitial K-spar/Q(?). 25% inter-radiate areas composed of Gt-stained clay-altered ferromags.

RB-19; Argillically-Altered Rhyolite or Welded Tuff. (Tri)

Phenos (17%):

12% [Plagioclase]	0.2-2.5mm	Relict sub-rounded fractured euhedra. Replaced along fractures by montmorillonite (Mont) or illite and between fractures by kaolinite.
4% Sanidine	0.3-4.0mm	Fresh fractured, occasionally broken, subhedra.
1% [Ferromag]	0.3-1.6mm	Relict rounded fractured subhedra. Replaced along fractures by Chl and between fractures by Mont or illite. Contain small crystal molds filled with leucoxene (Lx). Possibly Bt books.
tr Quartz	0.3-1.0mm	Sparse embayed corroded crystals.

Porphyroblasts (2%):

	0.02-0.05mm	Empty molds of relict cubes. Probably Py.

Groundmass (79%):

86% [Glass]	-	Light tan. Now replaced by clay.
10% Feldspar, spherulitic	0.03-0.1mm	Equant spherulitic growths surrounded by halos of brown Fe-stain. Form folia which define foliation in rock.
2% [Feldspar + Biotite(?)]	0.02-0.25mm long	Relict tabular crystals aligned to foliation in rock. Now replaced by clay (F) and Chl + clay (Bt).
2% Quartz	<0.01-0.03mm	Anhedra in sutured polycrystalline aggregates as spots and elongate lenses parallel to foliation. devit.?
tr [Opaques]	<0.01-0.07mm	Relict anhedra now replaced by Lx.

Lithic Fragments (2%):

	1.6-3.5mm	Rounded fragments of micro-crystalline glassy rock. chert?

RB-20; Argillic/Silica/Carbonate - Altered Mixed Rock Tuff. (Ts)

Lithic Fragments (65%):

	0.1-23+ mm	Fragments of rhyolitic vitric tuff, andesite(?) and trachyte which are variably altered. Some are silicified, others are kaolinized.

Occasionally, at and near rims, some are partially Carb-altered patches or totally carbonate-replaced relict phenos (molds?).

Groundmass (35%):

94% Chert >> Kaolinite	-	The two minerals are practically identical in thin section(ts). Fine-grained and textureless. Apparently rock is glassy tuff first replaced by fine-grained chert then whatever wasn't replaced by silica later by clay.
3% Carbonate	up to 20u	Anhedra in polycrystalline aggregates in rare fractures in groundmass and occasionally as fragment/groundmass boundaries.
3% Quartz	up to 08	Small prisms as cement to smaller fragments between large fragments in scattered patches in tuff.

Total Carb alteration is about 3% and appears to be later than chert + clay alteration.

RB-21; Fractured Moderately Carbonate-Altered Trachytic Tuff with Quartz/Carbonate Cement. (Ta)

Lithic Fragments (92%):

	0.06-24+ mm	Angular fragments with a couple phenos of Pl, 35% more or less aligned, 0.02-0.2mm, tabular K-Spar, 25% interstitial Carb alteration (After glass?), 5% opaques replaced with Ht and 35% cryptocrystalline interstitial matrix. Ht also stains Carb and matrix.

Cement and Fracture Fillings (8%):

70% Quartz	<0.04mm	An-subhedra line fractures and fill or partly fill inter-fragmental areas.
20% Voids	0.1-1.6mm	Unfilled portions of veins and fragmented areas.
10% Carbonate	<10u	Fills Q-lined fractures and lines voids or partly fills Q-lined voids.

This sample is one of few that has a well crystallized groundmass. In this respect it is similar to RB-17.

RB-22; Moderate Argillically-Altered Devitrified Rhyolite(?). (Tcv)

Phenos (5%):

4% [Feldspar]	0.4-3.0mm	Relict tabular euhedra. 100% replaced by illite ± Q ± relict sulfide. Q sometimes grows on walls of F molds. F is probably Pl. The relict sulfide has been replaced with earthy Ht/Lx(?).

tr Quartz	0.8mm	One rounded embayed anhedron.
tr [Ferromag]	0.2-1.4mm	Relict tabular rounded euhedra. 100% replaced with apple-green Chl. Probably Bt.
tr Sanidine	0.2-2.0mm	Sub-euhedra. Occasionally replaced on rims by kaolinite.

Groundmass (95%):

91% Spherulites	0.05-0.3mm	Fibrous, cryptocrystalline, radiate mixture of F and Q. F is mostly argillized to illite.
8% [Feldspar]	0.03-0.15mm	Relict euhedra 100% replaced by illite.
1% Inclusions	<7u	Disseminated in spherulites. Mostly gaseous.

<u>RB-23; Brecciated Andesite(?).</u> (Ta)

Trachytic groundmass is well crystallized as in -17 and -21.

Lithic Fragments (73%):

	<0.01-3+mm	Sub-rounded fragments all of same rock and all more or less in parallel alignment which gives foliation to rock.

Phenos (4%);

3% Plagioclase (An_{54})	0.2-2.5mm	Fresh euhedra. Often in clots but when as single crystals aligned to foliation.
1% [Ferromag]	0.06-0.8mm	Relict rounded subhedral molds. Fe-stained on walls.

Groundmass (96%);

60% Plagioclase	0.02-0.15mm long	Fresh tabs more or less aligned in a trachytic texture.
36% K-Spar(?)	0.06-0.18mm	Fresh equant anhedra interstitial to Pl. Full of Ht/Lx inclusions.
4% Hematite + Leucoxene	<1u-0.15mm	Disseminated anhedral grains. Probably relict Mt.

Breccia Cement (25%):

Predominately earthy Fe-oxide which stains or fills inter-fragmental areas.

Carbonate Veinlets and Alteration (2%):

	0.2+mm	Both as optically continuous patches in some fragments and as portions of breccia cement. Very localized in section.

The groundmass of this rock is coarse enough to show the F percentages and how the rock has a trachytic texture but is an andesite or even a basalt.

RB-24; Argillic-Altered Vitric Andesite or Latite. (Ts)

Lithic Fragments (65%):

	0.04-30+mm	Angular fragments.

Phenos (22%);

15% [Plagioclase]	0.08-3.0mm	Relict euhedra 100% replaced with kaolinite.
5% Sanidine	0.1-2.5mm	Fresh fractured euhedra.
2% [Ferromag]	0.2-1.2mm	Broken relict subhedra 100% replaced with Lx and Ht(?).

Porphyroblasts? (5%);

tr-		
20% [?]	0.05-0.15mm	Relict rounded subhedra 100% destroyed to voids or occasionally filled with jarosite. Appears in zones in fragments. May be related to cooling. Unstable mineral and may be Py.

Vesicles (1%);

	0.02-0.16mm	Only in some fragments. Filled with polycrystalline Q.

Groundmass (72%);

93% Glass	-	Light-tan now mostly replaced by clay.
5% Spherulites	<0.01-0.06mm	Brown structures in clouds in some fragments.
2% [Ferromag]	0.01-0.16mm	Elongate aligned. May be Lx/Ht-replaced Bt.

Cement (35%):

82% Quartz	<0.01-0.06mm	Anhedra in polycrystalline aggregates fill or line most fractures and inter-fragmental areas.
10% Clay	-	Patches tend to fill centers of some of largest cement patches. Kaolinite?
8% Voids	2-5mm	Non-cemented inter-fragmental areas.

October 30, 1995

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December 8, 1995

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RE: Petrographic descriptions of 9 standard thin sections; RB-25 through -33.

SUMMARY

This is the last of the samples from the project and consists of 5 samples sent 10/19 and 4 sent 11/1.

Rock Types are not new and they are either fresh or contain light to heavy **argillic alteration** (RB-26, 29, 30, 31 and 32).

Quartz content of some of the fresh rocks (RB-29, 32 and 33) is probably deposited through normal cooling and de-gassing in volcanic and is not due to hydrothermal alteration.

Respectfully submitted:

PETROGRAPHIC DESCRIPTIONS

RB-25; Oxidized Pyrite-Bearing Trachyte or Basalt(?).

Phenos (1%):

1% [Ferromag]	0.1-1.8mm long	Relict prisms 100% replaced by Ht and Carb and more or less aligned to produce a foliation in rock.
tr Plagioclase (Pl)	0.3-1.2mm long	Relict crystals with rare, unaltered edge. Replaced by montmorillonite(?), Q and Carb.

Groundmass (99%):

Tbf

79% Feldspar (F)	up to 0.6mm long	Laths in 0.5-2.0mm structures. Some are crudely radiate, others are in sub-parallel clumps. Predominately K-spar but some larger Pl contain iddingsite-like altered cores.
15% Limonite(Lm)/ Clay(?)/Glass(?)	<5u	Yellowish-brown to orange stain interstitial to and on F in 0.4 to 8mm irregular-shaped patches scattered through rock in an almost lace-like pattern. In hand specimen this pattern is purplish. Pl phenos are concentrated in these patches like it is a different rock. Also contains Q patches. Reddish stain in weathered rim of specimen.
3% Biotite (Bt)	0.08-0.4mm	Pinkish-brown ragged subhedra contain disseminated relict Py.
3% [Pyrite] (Py)	<1-20u	Disseminated relict cubes 100% replaced by Ht.
tr Quartz (Q)	0.02-0.1mm	Anhedra in aggregates in centers of Lm/clay/glass patches.

General F texture is most like RB-6 or -8.

RB-26; Argillically-Altered Pegmatite-Cemented Devitrified Breccia or Tuff.

Fragments (50%):

	0.5-10mm	Angular "ghosts" of fragments. Boundaries with cement are diffuse. One Fragment clearly contains devitrification spherules like those described in RB-27.
Tri DREAMLAND 50% Illite(?)	-	As groundmass to Q and K-spar. Percentage is variable from fragment to fragment.
35% K-Spar	0.02-0.25mm	Tabular euhedra 40% altered to clay. Appears to be sanidine or orthoclase. Percentage is variable form fragment to fragment. Probably recrystallized spherulites.

[ ] = Totally destroyed or replaced phase.

15% Quartz	0.01-0.04mm	Equant anhedra in groundmass of clay.

Pegmatite? (50%):

88% Quartz	0.1-0.8mm	Subhedral prisms with clay inclusions.
12% K-Spar	0.1-0.8mm	Euhedra variably replaced with clay. Tend to be concentrated in centers of pegmatite areas. Smaller crystals encapsulated in Q.
tr Muscovite (Ms)	0.05-0.12mm	Sparse ragged books usually in Q.

The original rock type is unrecognizable because of replacement and alteration but the relict spherulites in one fragment suggests it may be like RB-27.

<u>RB-27; Silica-Cemented, Brecciated, Devitrified Trachyte</u>.

Lithic Fragments (70%):

	0.04-20+mm	Angular fragments. Larger are commonly fractured and slightly displaced along the Q-filled fractures. Flow structure is common. Consists of K-spar, fine-grained aplitic matrix and phenos as described below. Fractures and texture are similar to rinds of submarine pillows.

Phenos (1%);

1% Feldspar	0.02-2.6mm	Relict euhedral crystals 100% replaced by fine-grained chert/clay mixture ± coarse Q anhedra.
tr Quartz	0.5-1.6mm	Rounded phenos. Some are polycrystalline.

Spherulites (42%);

42% K-spar	0.04-0.4mm	Devitrification structures arranged in clumps which commonly show flow structure in rock. Composed of rectangular bundles of optically continuous fibers nucleated on small crystals in glass.

Tri? Dreamland

Groundmass (55%);

45% Clay	<3u	In patches which are difficult to distinguish from F.
30% Feldspar > Quartz(?)	<20u	Mostly if not all anhedral F. Usually in clumps of anhedral grains. Has aplitic texture.
25% Quartz	<0.01-0.15mm	In patches of seriate anhedra in discontinuous veinlets in groundmass ("tension gashes"?).
tr	3-30u	Red grains dispersed in groundmass.

Veinlets (2%);

	0.01-0.15mm thick	In all directions and through particles. Predominately Q with thickest containing centers of clay.

Cement (30%):

95-80% Quartz	<0.01-0.15mm	Coarsest crystals on edges of smaller lithic particles. As over-growths for many lithic particles appear to be replaced with Q.
5-20% Hematite (Ht)	<0.1mm	Interstitial to Q. Concentrated along fracture zone in sample.

RB-28; Basalt with Trachytic Texture.

82% Plagioclase (Pl, An_{59})	0.03-1.2mm long	Tabs aligned in trachytic texture. Larger may be partly replaced by Carb.
5% [Ferromag]	0.1-1.2mm long	Relict prisms 100% replaced with phlogopite(?) and green Chl on edges. Occasionally replaced by Carb.
5% Hematite	-	As stain in basalt along tension-gash-like structure across foliation in rock. Gashes are 1-3mm thick in centers and up to 3 cm long.
5% Clay	-	Interstitial to Pl and in centers of some of larger Pl crystals.
3% Magnetite (Mt)	3-50u	Disseminated anhedra extensively altered to Ht.

Ta

The alteration of this rock is oxidation and a very mild propylitic and argillic.

RB-29; Argillically-Altered Vitric Fine to Coarse Tuff or Breccia. (Tc altered near Target VII

Lithic Fragments (90%):

	0.1-24+mm	Angular fragments. Some contain spherulites due to quenching of glass. Texture is similar to RB-26 and -27. Has a faint flow structure.

Phenos (4%);

4% [Feldspar]	0.1-2.0mm	Relict euhedra 100% replaced by clay ± Ht.

Groundmass (96%);

95% Clay	-	Includes altered glass and spherulites.
5% Hematite	up to 0.1mm	In scattered patches which may have been Mt or Py. Also stains clay in area of fractures.

Cement (10%):

45% [Lithic Dust]	-	Dust of lithic fragments now primarily clay >> Ht.
30% Quartz	0.02-0.2mm long	Elongate crystals disseminated in dust and lines some cavities.
25% Clay	-	Pure secondary clay fills some late(?) inter-lithic areas.

This rock could be the same as RB-27.

RB-30; Argillically-Altered Andesite or Latite. (Tc altered in Target VIII

Phenos (19%):

15% [Feldspar]	0.5-4.0mm	Relict euhedra 100% replaced with clay.
4% [Ferromag]	0.2-2.0mm	Relict euhedra 100% replaced with Ht, voids, clay ± reticulated leucoxene-replaced rutile.

Groundmass (81%):

Texture is most similar to andesite or latite.

76% Plagioclase > K-Spar	0.01-0.15mm	Tabular crystals with no common orientation. About 40% replaced by clay.
15% Quartz	0.03-0.1mm	Anhedra interstitial to F.
5% [Pyrite?]	0.02-0.15mm	Cubic-looking empty molds.
4% [Magnetite]	5-40u	Relict subhedra altered to Gt and Lx.

RB-31; Light Argillic-Altered Andesite or Basalt.

Phenos (1%):

1% Plagioclase	0.3-1.0mm	Sparse tabs in rare clumps. Contain some relict ferromags and clay alteration along fractures.
tr Pyroxene	0.02-0.4mm	Sub-anhedra mixed in with clump of Pl.

Groundmass (99%):

90% Plagioclase > K-Spar	0.05-0.4mm	Laths and anhedra 18% replaced by clay along fractures and in patches in crystals. Not aligned to any one direction.
8% [Ferromag]	0.01-0.5mm	Relict elongate subhedra to anhedra 100% replaced with phlogopite(?) and later clay.
2% Hematite	3-25u	Disseminated subhedra.
tr Apatite	0.01-0.1mm long	Scattered slender prisms embedded in F.

Veinlet (tr%):

	0.06mm thick	Linear and across section. Filled with Q.

Fractures (tr%):

	0.01-0.04mm thick	More or less continuous, in two directions and cuts veinlet. Both filled with and irregularly stained on both sides by Ht.

Lapilli

RB-32; Argillically-Altered Vitric Tuff with Silica/Clay Cement. (Wildrose Intrusive)

Lithic Fragments (90%):

	0.08-20+mm	Rounded fragments with wide variety of relict structures which include flow, spherulitic and structureless. 100% replaced with clay. Few particles contain up to 3% of sub-anhedral Lx after Mt(?).

Cement (10%):

70% Quartz	0.01-0.25mm	Anhedra in polycrystalline aggregates and inter-mixed with clay.
30% Clay	-	Probably mostly a result of argillized lithic dust.

This amount of silica between fragments is about normal for rock consolidation in this volcanic environment and does not necessarily mean the rock has been hydrothermally silicified.

Lapilli

RB-33; Silica-Cemented Vitric Tuff. (Wildrose Intrusive)

Probably the same rock as RB-32 except this rock is not altered. See comments in that sample for meaning of secondary Q in pores and inter-fragmental areas of this volcanic rock.

Fragments (90%):

	1.5-13mm	Mostly rounded lapilli appear to have been soft when compacted. Generally fresh glass with particles of Ht. Fragments contain all manner of structures like RB-32. Very porous.

Cement and Pores (15%):

11% Quartz	0.01-0.4mm	Anhedra in aggregates which partly fill pores and inter-fragmental spaces.
4% Voids	0.02-1.0mm	Random voids between glass tuff particles and between spherulites within particles. Also between particles.

Pheno (tr%):

tr K-Spar(?)	1.4mm	Anhedron in spherulitic glass.

PETROGRAPHIC ABBREVIATIONS

Ab = albite
Act = actinolite
Ad = adularia
Amph = amphibole
An = anorthite
Ap = apatite
Aspy = arsenopyrite
Ba = barite
Bn = bornite
Bt = biotite
Cal = calcite
Carb = carbonate
Ch = chrysocolla
Chl = chlorite
Di = diopside
Dm = dumortierite
Dol = dolomite
Ep = epidote
F = feldspar
FM = ferromagnesian
Ga = galena
Gn = gneiss
Gp = graphite
Gr = garnet
Gt = goethite
Hb = hornblende
Ht = hematite
Il = illite
Ilm = ilmenite
K-spar = potassium feldspar
Lm = limonite
Lx = leucoxene Alt of illmenite
Mo = molybdenite
Mont = montmorillonite
Ms = muscovite
Mt = magnetite
Pl = plagioclase
Po = pyrrhotite
Px = pyroxene
Py = pyrite
Q = quartz
Rt = rutile
Sp = sphalerite
Sph = sphene
Tm = tourmaline
u = micron
WM = white mica
Zr = zircon

Hecla
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Theodore P. Paster
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June 24, 1996

Dear Ted,

As per our phone conversation today, enclosed are 9 rock samples (RB-D1 through RB-D4 and RB-C1 through RB-C5) submitted for thin-section analysis. Rock samples RB-D1 through RB-D4 appear to represent a normally graded vesicular rhyolitic flow? with weak to moderate flow lamination. Vesicles are relatively large near the base of the unit (RB-D1) and progressively get finer grained near the top of the unit (RB-D4). Vesicles appear to be filled with chloritic clay, calcite, and or white clay. Rock samples RB-C1 through RB-C5 appear to represent a similar normally graded vesicular? unit which has been moderately to strongly altered and mineralized. Vesicles are also relatively large near the base of the unit (RB-C1 and progressively get finer grained near the top of the unit (RB-C5).

Previously, the RB-D series samples have been assigned to the Dozer Formation and the RB-C series samples have been assigned to the Leopard Skin Tuff. These samples are separated by a large low-angle fault in which hanging wall rocks are altered and footwall rocks are relatively un-altered. Our questions for you are:

1) Are these the same rocks differing only in alteration?

2) What type of rocks are these?

3) Are the apparent vesicles actually vesicles?, fiamme?, or something else?

Please provide a description with photographs from each sample and your conclusions as to the above questions.

Best Regards,

Kurt D. Allen
Mine Geologist

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August 2, 1996

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Petrographic Comparison of Dozer Fm and Leopard Skin Tuff.

SUMMARY

Conclusions
The two series, C and D, represent two different formations (Fms) although the rock type, latite, is essentially the same for both Fms.

The origin of the amygdules is uncertain beyond the observation that they were formed by gas.

Rock Types
On the basis of micro-phenocryst composition, the rocks are **latites** and possibly some **trachyte.** The only identifiable (albeit rather uncertainly) phenos in the rocks are perthite, sanidine and plagioclase. No quartz (Q) phenos were seen. Patches of chlorite (Chl) in the D series could be relict biotite or other ferromagnesian (FM) mineral. Distinguishable groundmass Q in D4 suggests that Fm is a latite.

The size, shape and composition of the phenos are similar for both C and D series so that the rock type for both is the same - at least in composition if not in manner of extrusion and deposition (Flow vs. ash.).

Comparison of Leopard Skin Tuff (C Series) and Dozer Fm (D Series) Samples
The C series rocks have variable groundmass texture but only C4 and C5 exhibit a tuffaceous texture. The D series rocks have a very uniform groundmass texture and commonly contain micro-spherulitic structure. Only one C series sample, C1, has spherulitic texture and this is in a thin layer through the section.

The micro-spherulitic texture is an acidic rock equivalent of variolitic texture. In the author's experience, this texture has only been found in volcanic flows which have been chilled and has not been seen in ash flows or in tuffs except in

fragments of so-textured flows which have been later incorporated in a tuff.

Amygdules

The structures are not fiamme. Their spacing and the difference in surrounding glass texture suggests they were formed by gas and they may have been subsequently deformed. In D4 their alignment askew bedding suggests a mechanism of tension gashing along a strain-slip direction.

Respectfully submitted:

PETROGRAPHIC DESCRIPTION

RB-C1; Argillized Vesicular Latite.

Latite (86%):

Phenos (4%);

3% [Ferromag] (FM)	0.03-0.3mm	Relict euhedra 100% replaced by green mica (stilpnomelane?) or chlorite (Chl).
1% Feldspar (F)	0.05-0.5mm	Euhedral tabs of non-altered sanidine and Q >> clay + Chl - altered Pl aligned to make foliation in rock.

Spherulites (20%);

	0.1-0.4mm	Feldspar/Q(?) spherulites in cluster in 7 mm thick band parallel to foliation.

Groundmass (76%);

76% [Glass]	-	Relict uniform vitric groundmass with no internal structures of note. 100% replaced by clay (kaolinite?) and chlorite with clay as halos up to 0.2mm thick next to fractures.

Vesicles (10%):

	1-10+ mm long	Generally lensoid in section and long axis aligned to common direction and direction of most veinlets. In order of walls to interior, the mineralogy is as follows:
60% Quartz (Q)	0.02-1.0mm	As fine-grained polycrystalline aggregates on walls of vesicles superseded by coarse-grained prisms, often cockscomb toward center of vesicles. Terminated crystals often show distinctive twining due to sudden pressure drop (Boiling of fluids).
30% Clay	-	Relatively coarse-grained, secondary mineral. Predominately illite but some kaolinite is also present.
8% Chlorite (Chl)	<0.03mm	Stilpnomelane(?). As parallel flakes normal to bands in centers of Q-lined vesicles.
2% Sulfide	up to 3mm	Py &/or Aspy. As more or less massive late fillings in largest open vesicles. Lined with clay/Q.

Fractures and Veinlets (2%):

	0.01-2.0mm thick	Discontinuous, anastamosing, pinch and swell veins in zone parallel to foliation. Often connects with vesicles and occasionally merges with vesicles in mineralogy.
2% Quartz	<0.02-0.5mm	Stubby prisms to anhedral in shape.

[ ] = Completely destroyed or replaced phase.

tr Clay/ Chlorite	<0.03mm	Predominately in thin fractures in groundmass.
tr Zircon	0.01-0.03mm	Subhedra in Q in veinlets.

Porphyroblasts (2%):

2% Pyrite (Py)	0.015-1.0mm	Euhedra inhomogeneously disseminated in rock and veins. Often in strings along fractures and veinlets but also disseminated in groundmass of volcanic.

<u>RB-C2; Argillized Vesicular Latite</u>.

Latite (79%):

Same as described in RB-C1 except there are faint ghosts of relict fine-grained aligned groundmass plagioclase (Pl) visible (Which is now totally altered to clay.). There are no spherulites present in this latite but there are some rare clumps of relict F.

Vesicles (10%):

0.4-6mm long Paragenesis: Radiate chalcedony on walls, layer of Chl ± chert, then clay. Q is ± in center of some vesicles and in veins which cut through vesicles and all else.

Fracture Zones (11%):

<1-5mm thick 2 Parallel zones are normal to foliation. Pinch an swell and anastamosing. Composed of varying amounts of clay < Chl on walls and occasionally filling zone segments. Chert > euhedral Py fill center of thickest parts of zones.

<u>RB-C3; Chlorite/Clay - Altered Vesicular Latite (Tuff?)</u>.

Latite (75%):

The same description as given in C2 except about 38% of groundmass is Chl and 58% is clay and 4% is disseminated 2-18u blebs.
Relict texture of groundmass suggests the protolith is a tuff and what was thought to be Pl laths in C2 may be relict ridged glass that is straight rather than shards. The F laths are totally replaced by fine-grained white mica (WM) or illite.

Vesicles (25%):

0.2-11.0mm Some vesicles are extremely elongate, others look similar to those in C1 and C2, i.e. - ovoid to lens-shaped.
Composed of radial chalcedony on walls, a layer of green Chl and filled with coarse Q/± platey sulfide(Arsenopyrite?) and kaolinite.
Some vesicles are hollow inside their Chl lining (Washed

out clay?). Some areas contain vesicles which are missing the Chl layer and are filled with chalcedony or coarse Q.

RB-C4; Fractured and Partly Brecciated Argillized Vesicular Latitic Tuff.

Latite (71%):

Tuff. Groundmass rather indistinct except for variations in Lx content which serves to indicate rounded fragments on order of 0.6 to 4mm in size. Predominately replaced by clay.

One fragment has relict crystalline texture with 0.1-0.5mm long non-oriented F laths and disseminated subhedral Lx >> rutile + tr sulfide laths.

Vesicles (20%):

	0.2-4.0mm long	Same description as given in C3. Also, vesicles are segregated into Chl-layered ones in other half. This segregation was also seen in C3 but areas not half and half there.

Veins and Cement (9%):

	<0.01-1.5mm thick	Majority tend to align to direction and concentrated in at least 10mm wide zone on one end of section which has thin Chl-bearing vesicles. As cement between brecciated latite fragments and in discontinuous veinlets. Predominately filed with polycrystalline aggregates of Q though clay may fill some centers of thicker cement areas. Clay also in thinnest fractures which are discontinuous and have no preferred orientation.

RB-C5; Argillic-Altered Vesicular Trachyte.

Trachyte (88%):

Vesicles (20%);

	0.08-1.2mm	Irregular-shaped and predominately elongate to foliation. Filled with very fine-grained Chl and <7u unidentified disseminated inclusions concentrated near walls. Probably relict ferromagnesian mineral in part.

Phenos (tr%);

tr Feldspar (F)	0.05-0.25mm	Mostly relict sub-euhedral, replaced with Q.

Groundmass (68%);

87% Clay	-	Has replaced most of groundmass.
10% Feldspar	0.02-0.2mm long	Tabs partly altered to give foliation to rock.
3% Leucoxene(Lx)	<10u	Anhedral disseminated blebs in clay.

Porphyroblasts (2%):

2% Sulfide	0.04-0.3mm	Euhedra disseminated in groundmass. Probably Py.

Veinlets (10%):

	0.01-4.0mm thick	Meanders and anastamosing. Contains 55% granular **Q** which is cockscomb in thicker veins. 30% **sulfide** in centers which is shared with 10% **clay** and 5% **voids** (washed clay?). A trace of **barite** is in void of one vein.

RB-D1; Vesicular Latite or Trachyte(?).

Latite (85%):

Groundmass (99+%);

The groundmass is microcrystalline with no foliation.

77% Feldspar	3-30u	Elongate indistinct anhedra with no preferred orientation and in felted mass. Very little Q can be seen..
20% Variolites	0.1-0.6mm	In polycrystalline aggregates in bands which are generally around the vesicles and partings.
2% [Ferromags]	0.01-0.13mm	Disseminated relict subhedra 100% replaced by dark green, very fine-grained Chl.
1% Leucoxene	3-40u	Disseminated sub-anhedra as relict opaque.

Phenos (tr%);

tr Feldspar	0.1-0.4mm	Euhedral tabs of perthite and sanidine(?) generally aligned to one direction parallel to vesicle trend.

Vesicles and Partings (15%):

	2-10mm long	Vesicles are elongate, rounded structures which often contain ragged projections of glass wall rock. Partings are like veins which pinch out in both directions and have the same mineralogy as the walls of vesicles and the same orientation. From walls to interior, the vesicle mineralogy is:
10% Quartz	0.1-0.8mm	Stubby prisms.
2% Chlorite	0.04mm thick	As colloform lining in vesicle. Occasionally as 0.4mm thick banded hemispheres on walls.
10% Calcite	0.2-4.0mm long	As ragged prisms which have grown from one side of vesicle to other.
78% Clay > Voids	-	Fills interior of voids and between calcite prisms.

RB-D2; Vesicular Variolitic Latite or Trachyte.

Latite (84%):

Phenos (3%);

2% Feldspar	0.03-0.27mm	Alkali and plagioclase feldspar tabs aligned to common direction.
1% [Ferromags]	0.02-0.1mm	Sparse relict subhedra 100% replaced by very fine-grained Chl.

Groundmass (97%);

96% Variolites	0.06-0.4mm	Microcrystalline inter-growths of F > Q(?).
1% Leucoxene	2-20u	Disseminated, sub-anhedra after a relict ferromag.
tr Pyrite	0.04-0.07mm	Sparse euhedra.

Vesicles and Partings (15%):

1-8.0mm long — Same description as given in RB-D1.

Fractures (1%):

<0.01-0.2mm thick — Sub-parallel, discontinuous and in same direction as trend of vesicles and partings. Usually filled with clay. Rare thick, open fractures have clay lining.

This is undoubtedly the same rocks except the variolitic texture is pervasive.

RB-D3; Vesicular Latite(?).

Latite (96%):

Same description as D2 except these are about 20%, 0.3 to 1.4mm non-variolitic micro-crystalline patches disseminated in variolites.

Rare 0.7mm plagioclase (Pl) euhedra partly replaced by carbonate (Carb). Other F phenos are absent to rare. Relict FM phenos are only a tr.

Vesicles and Partings (4%):

0.6-4.0mm long — More elongate partings than vesicles. Same mineralogy as in D2 except Chl is brown under the microscope instead of green.

Veinlets (tr%):

<0.01-0.05mm — Few discontinuous and composed of Q each anhedral crystal of which takes up a short segment of vein.

RB-D4; Latite.

Latite (98%):

Phenos (4%);

3% Plagioclase (Pl)	> 0.06-0.3mm	Fresh equant to elongate euhedra with no common orientation.
1% [Ferromag]	0.02-0.1mm	Relict subhedra 100% replaced by drab olive, very fine-grained Chl.

Groundmass (94%);

89-81% Variolites > Micro-crystalline Groundmass Variolites	-	Variolites are 0.2mm diameter and poorly formed micro-crystalline groundmass is <10u and cloudy.
4-12% Quartz > Feldspar	0.01-0.07mm	Clear equant and discontinuous chains gives foliation to rock. Concentration varies from one end of ts to other.
1% Leucoxene	6-30u	Disseminated sub-anhedral specks.

Porphyroblasts (tr%);

tr Sulfide	0.04-0.8mm long	Tabular and equant, disseminated, and in vesicle halos. Pyrite + Arsenopyrite(?).

Partings (2%):

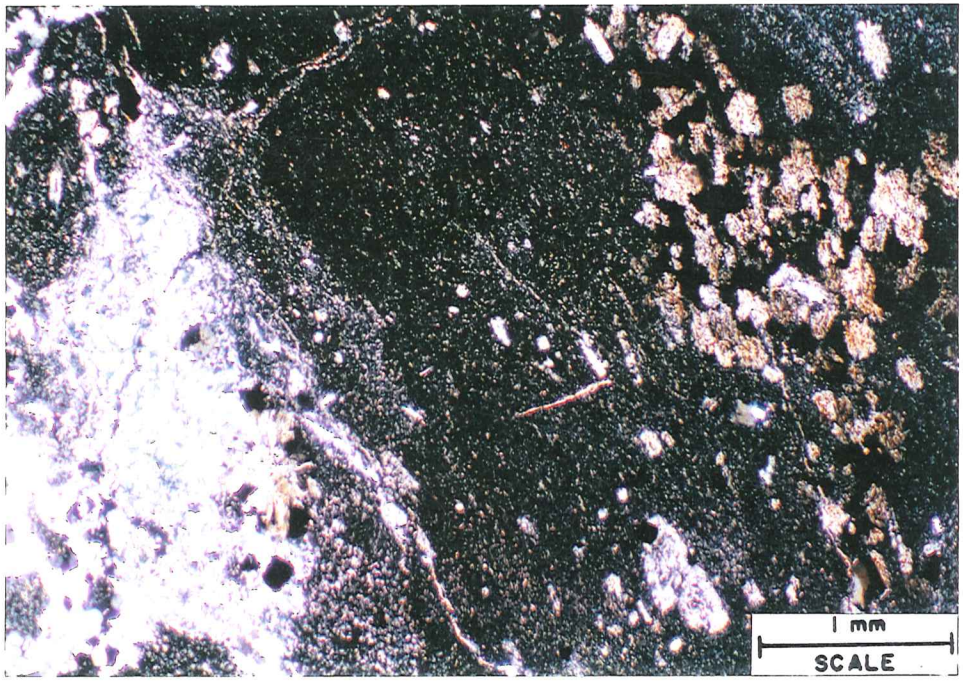
<0.04-0.16mm thick x 2.5-10.0mm long.
Lined with sparse 20% single crystal Q on walls and filled with drab-olive-colored Chl.
These structures are slightly askew to the chains of coarse-crystalline groundmass Q/F which give a general foliation to rock.

a) **RB-C1**, crossed polarized light (xpl). Foliation direction is NW-SE. Chl/chalcedony - filled amygdule at W, micro-crystalline groundmass in center and micro-spherulites at E above scale bar. Groundmass texture is practically structureless.

b) **RB-C2**, plane polarized light (pl). Foliation is E-W. Variegated groundmass suggests ash. Vesicles are lined with colloform chalcedony and empty on W but Chl-filled on E. Q-filled fractures in center of photo.

c) **RB-C3**, pl. Foliation is E-W. Variegated groundmass suggests ash but no conclusive evidence in this photo. Note wall of N amygdule is broken away and has been cemented with Q. Amygdules are lined with tan chalcedony, greenish colloform Chl and filled with colorless Q/clay. N amygdule also contains platy sulfide (Arsenopyrite?).

d) **RB-C4**, pl. Tuff. Volcanic ash fragments are clearly visible by texture variations though fragment boundaries are not visible.



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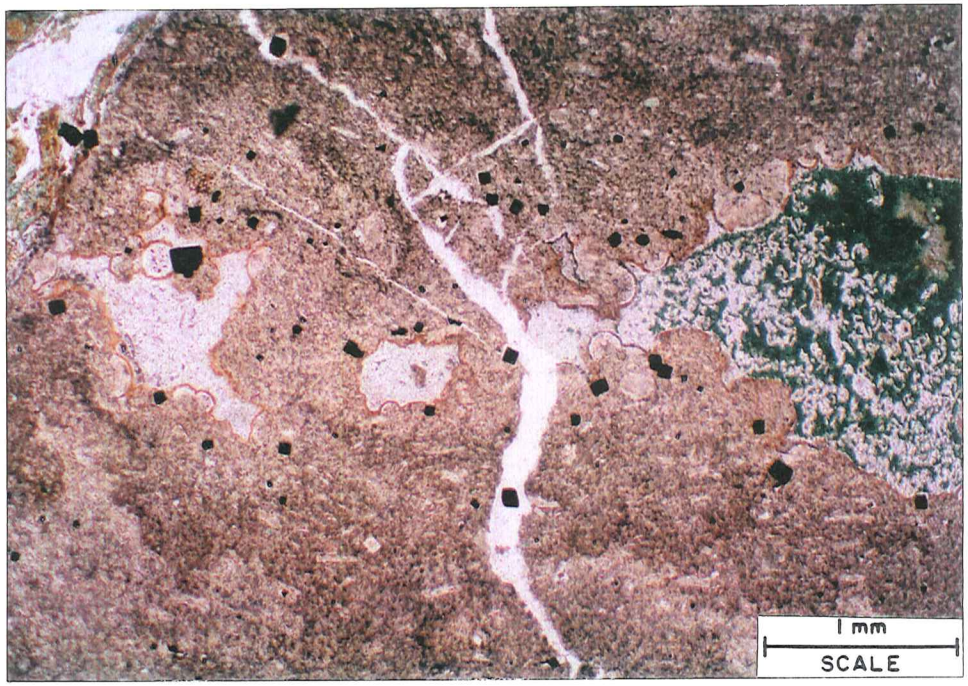

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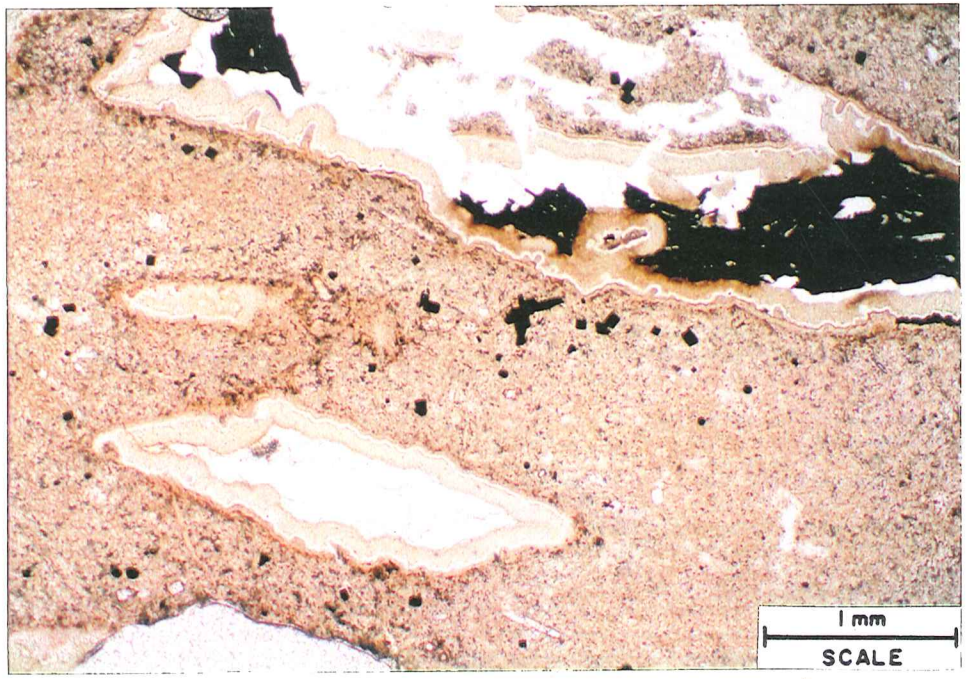

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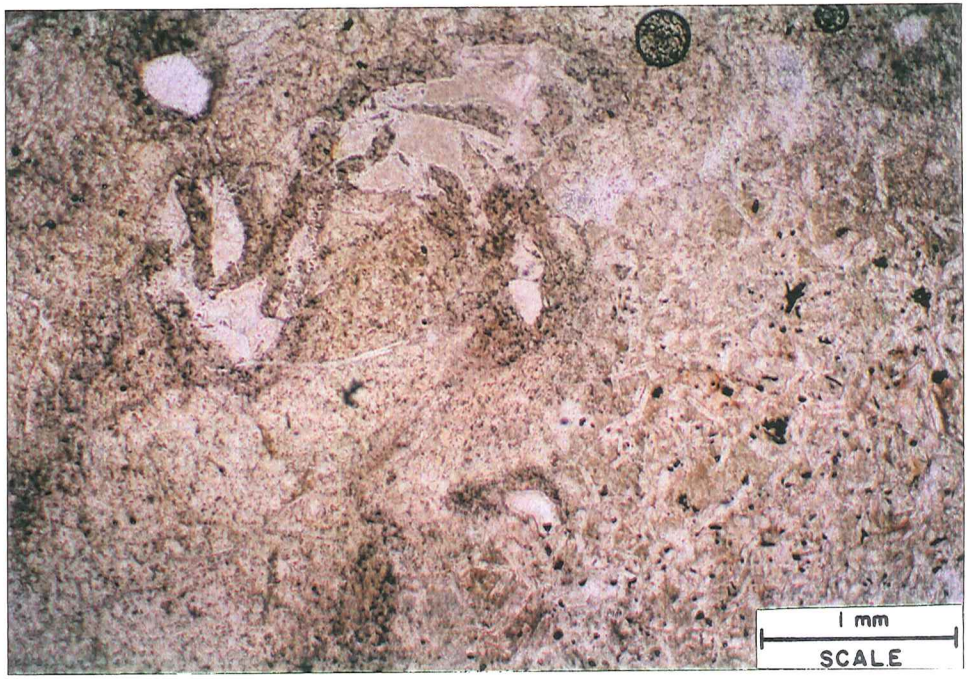
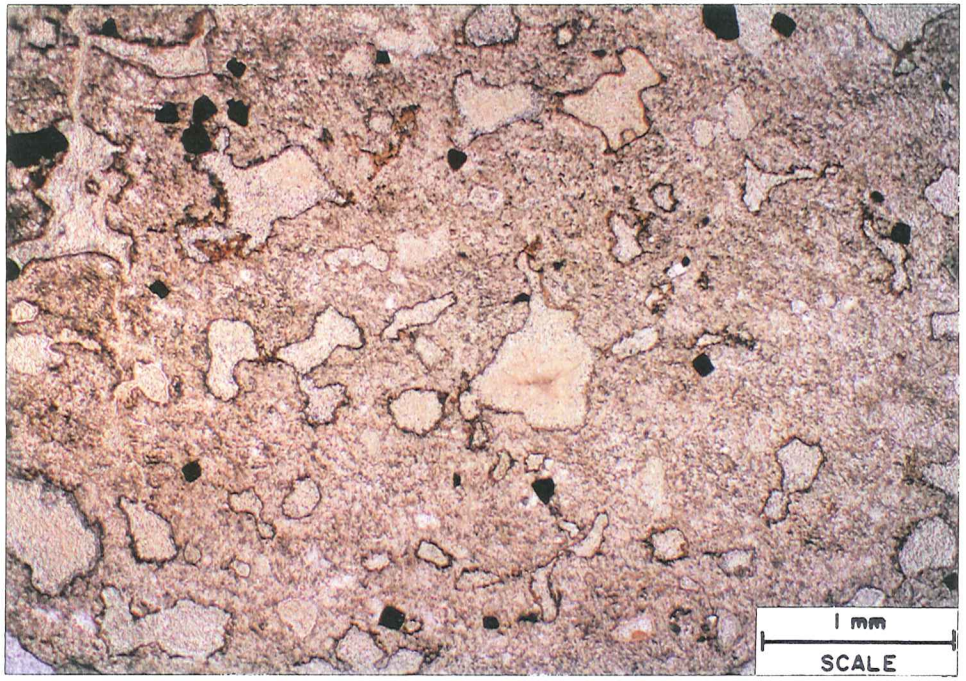


d

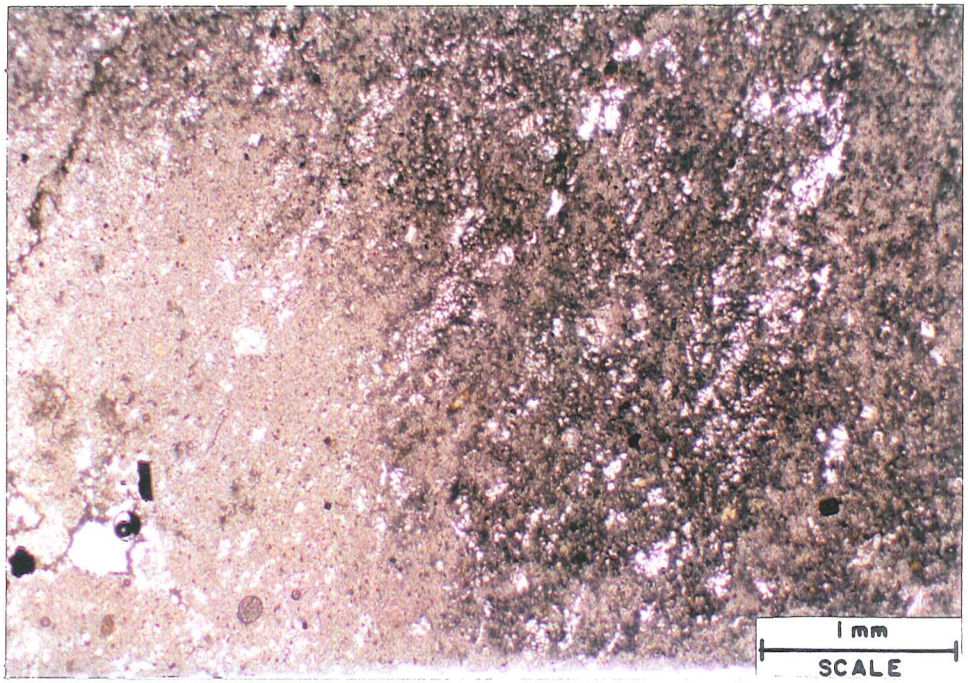
a) **RB-C5**, pl. Argillized tuff. Volcanic ash fragments are vaguely visible in groundmass. Prominent vesicles are filled with Chl.

b) **RB-D4**, pl. NE-SW crystallinity nearly disappears in vesicle halo zone at SW.

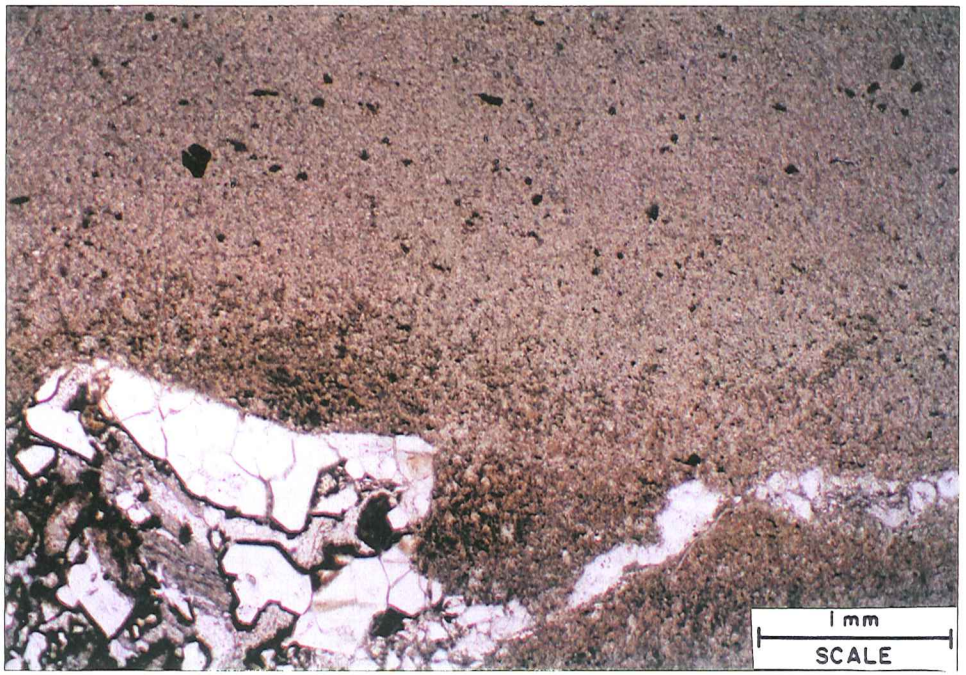
c & d) **RB-D1**, pl in photo c and xpl in photo d. Same view in both photos. Featureless groundmass in plane light shows micro-crystalline structure in photo d. Amygdule contains coarse Q on walls, dark-green Chl lining Q and calcite prisms in clay as filling.



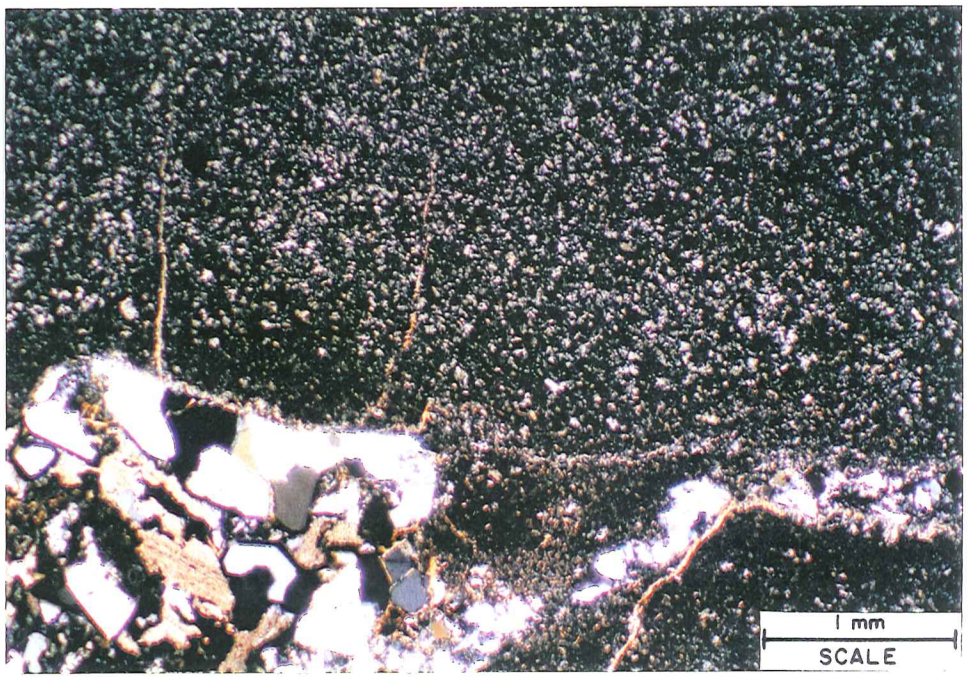
a



b



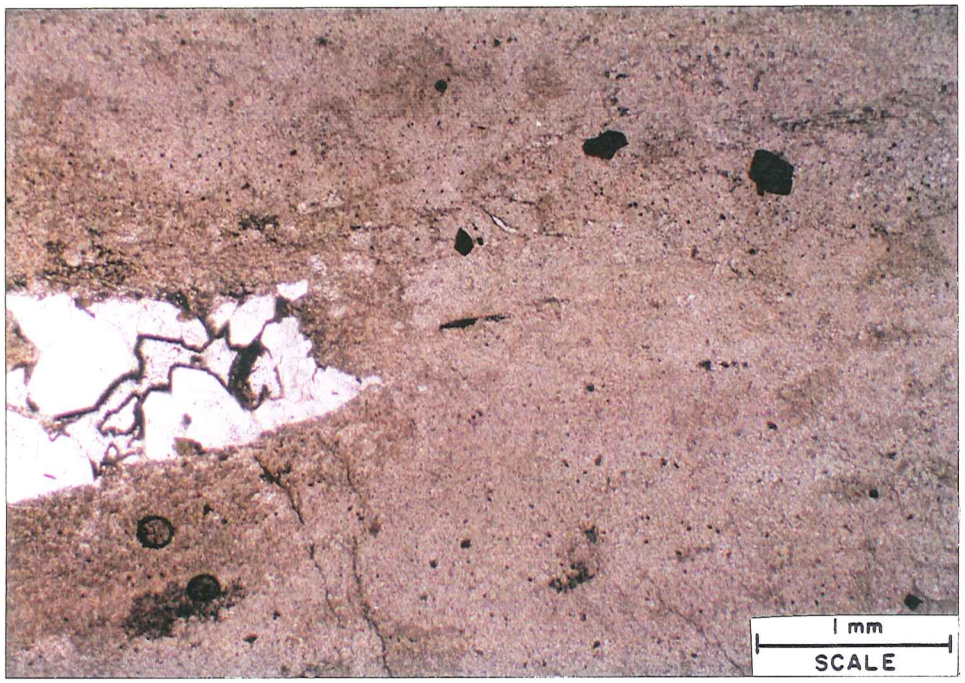
c



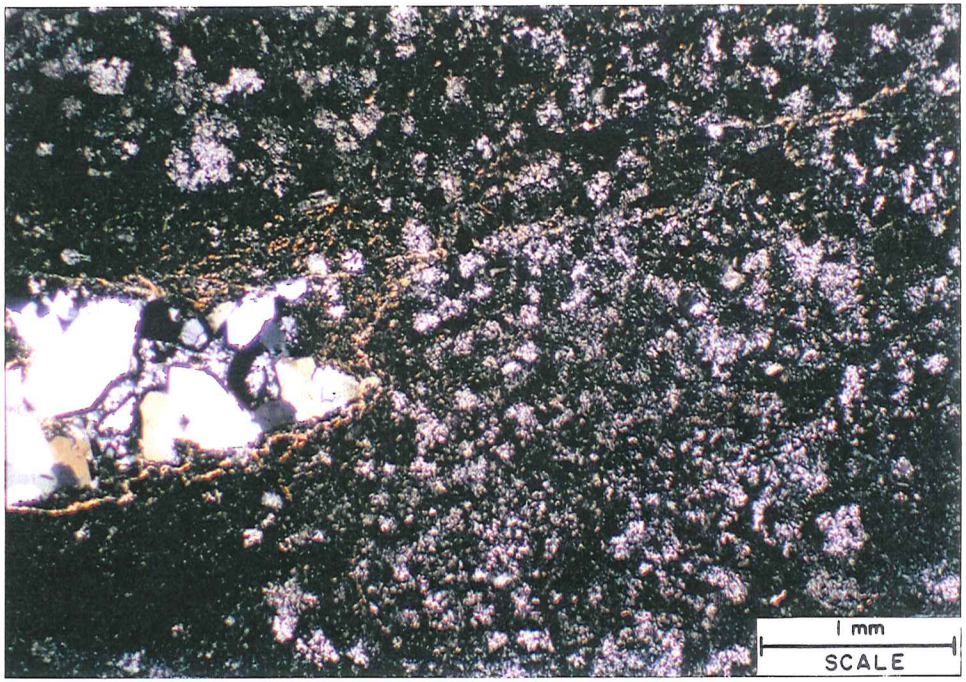
d

a & b) RB-D2, pl in photo a and xpl in photo b. Same view in both photos. Groundmass is featureless in photo a but micro-spherulitic in photo b. Amygdule is lined with coarse Q, dark green Chl on Q and filled with fine-grained Q.

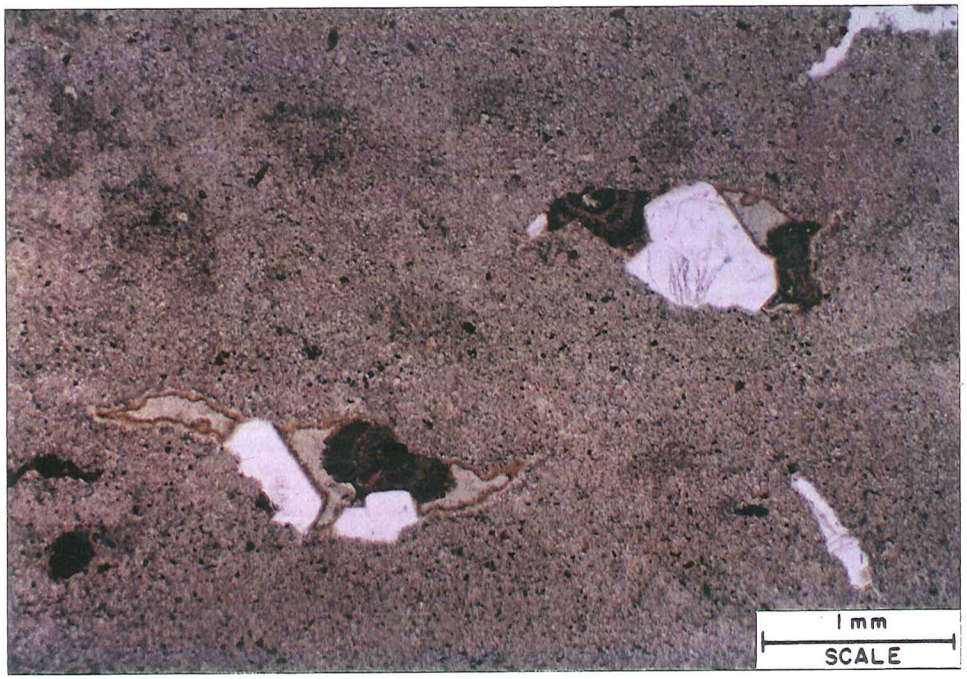
c & d) RB-D3, pl in photo c and xpl in photo d. As in D2, groundmass is featureless in plane light and micro-spherulitic in xpl. Amygdules are sort of s-shaped and aligned to E-W foliation. They contain large crystals on walls and brown Chl linings and spherulites with clay (light tan) fillings.



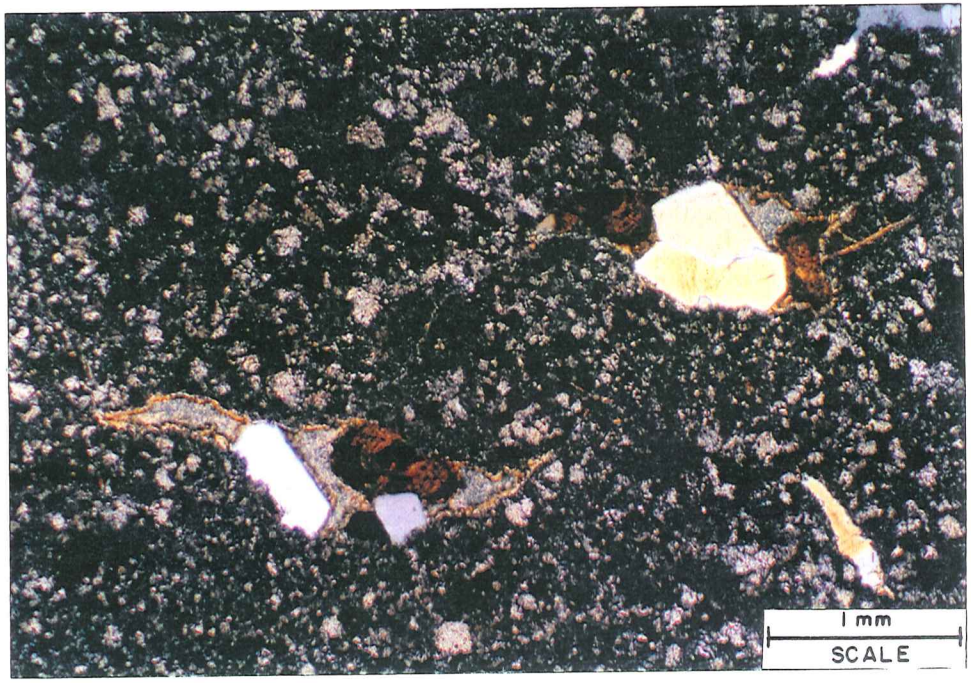
a



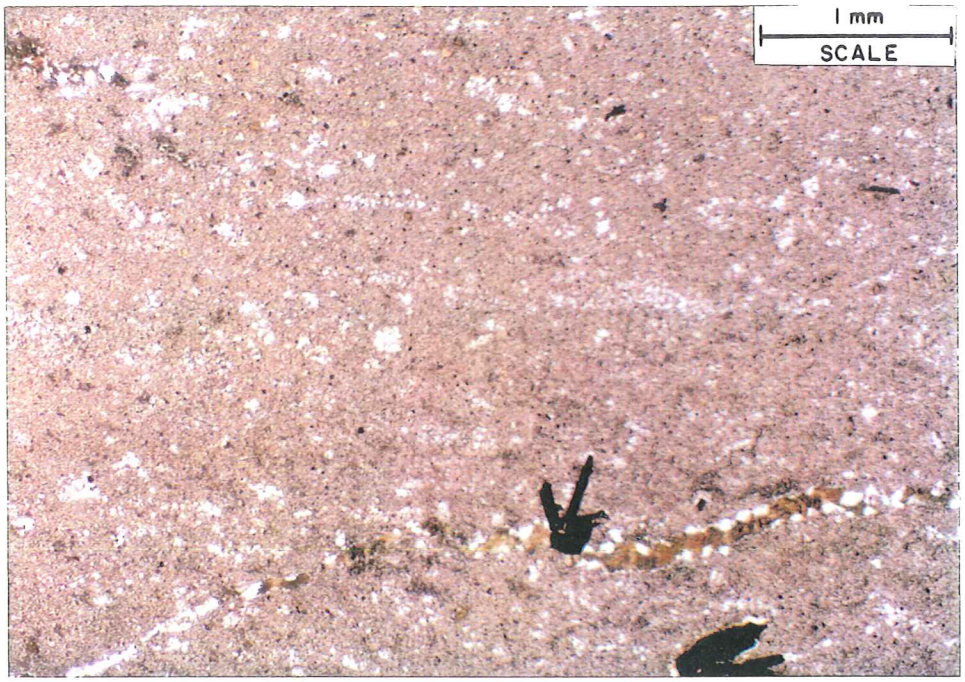
b



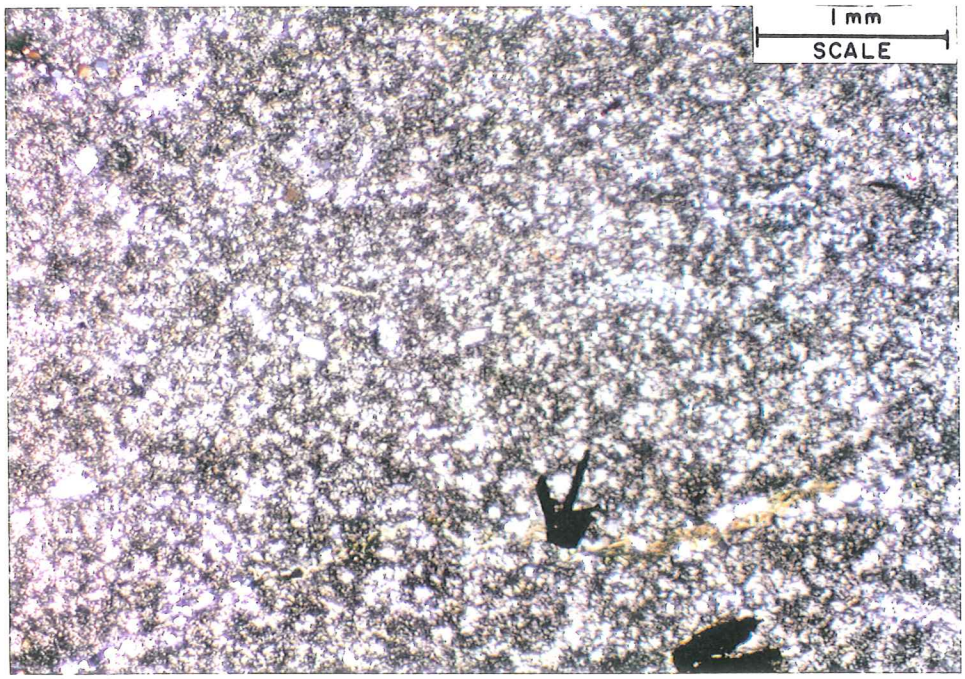
c



d



RB-D4, pl upper photo and xpl lower photo. Same view in both photos. Foliation is E-W. Micro-crystalline groundmass is exceptionally better crystallized in this sample (lower photo) and shows strings of Q > F in E-W foliation.



PETROGRAPHIC ABBREVIATIONS

Ab = albite
Act = actinolite
Ad = adularia
Amph = amphibole
An = anorthite
Ap = apatite
Aspy = arsenopyrite
Ba = barite
Bn = bornite
Bt = biotite
Cal = calcite
Car = carrollite
Carb = carbonate
Ch = chrysocolla
Chl = chlorite
Cv = covellite
Di = diopside
Dm = dumortierite
Dol = dolomite
Ep = epidote
F = feldspar
FM = ferromagnesian
Ga = galena
Gn = gneiss
Gp = graphite
Gr = garnet
Gt = goethite
Hb = hornblende
Ht = hematite
Il = illite
Ilm = ilmenite
K-spar = potassium feldspar
Lm = limonite
Lx = leucoxene
Mo = molybdenite
Mont = montmorillonite
Ms = muscovite
Mt = magnetite
pl = plane polarized light
Pl = plagioclase
Po = pyrrhotite
pts = polished thin section
Px = pyroxene
Py = pyrite
Q = quartz
Rt = rutile
Sp = sphalerite
Sph = sphene
Tm = tourmaline
ts = thin section
u = micron
WM = white mica
xpl = crossed polarized light
Zr = zircon