

PETROGRAPHIC REPORT

10 Rocks from the Mt Jukes
Project, Prince Darwin Prospect,
W Darwin Plateau,
W Tasmania

for

Corona Minerals Ltd.
(attn. Charles Hughes)

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Summary Report

INTRODUCTION

Eleven diamond core samples from three drillholes on Corona's Mt Jukes Project (Prince Lyell prospect) on the western flank of the Darwin Plateau were examined petrographically to determine protolith lithologies and the style and extent of hydrothermal alteration. Five samples with abundant sulfides and magnetite were prepared polished thin sections, and the remainder were prepared as standard (unpolished thin sections). A summary of key petrographic information deriving from the petrographic study of these rocks is provided in Table 1.

PETROGRAPHIC SUMMARY

Hole SDD001 – Protoliths and Affinities

Samples from 123.82m, 133.92m and 138.92m

Six samples were examined from diamond hole SDD001. The first three samples, all strongly hydrothermally altered and mineralized, appear to be derived from protoliths that were quartz-phyric rhyolitic shallow intrusive rocks based on the finely holocrystalline originally quartzofeldspathic groundmasses. From information provided by Corona geological staff, these quartz-phyric rocks have been interpreted as E-dipping sheets intruding into a W-dipping sequence of typical Central Volcanic Complex (CVC) feldspar-phyric, massive felsic lavas.

The quartz-phyric rocks apparently have higher Ti/Zr values than typical felsic CVC lavas (C. Hughes, pers. comm. December 2012) and the question arose as to whether these intrusive rhyolite sheets were best classified as Group 2 rocks in the Mt Read Volcanics lithogeochemical classification scheme of Crawford et al. (1992). In my experience, most Group 2 rocks are andesites and dacites, and rhyolites confidently classified as Group 2 are rare (Fig. 1). Data I have for the quartz-phyric (or quartz+feldspar+biotite-phyric) intrusive rhyolite sheets from north and west of Queenstown show them to be essentially indistinguishable from typical Group 1 felsic lavas for SiO₂ contents between 70 and 77%. (Fig. 1). We have unpublished Nd-Sr isotopic data that indicate that these intrusive rhyolitic sheets are essentially crustal melts, and not derived via prolonged fractionation from andesitic precursors. The plots in Figure 1 may assist in assigning the SDD001 intrusive felsic rocks into the MRV classification scheme, but my prejudice is that they will be correlates of the petrographically similar rocks from N and W of Queenstown, and thus unlikely to be linked with Group 2 magmatism.

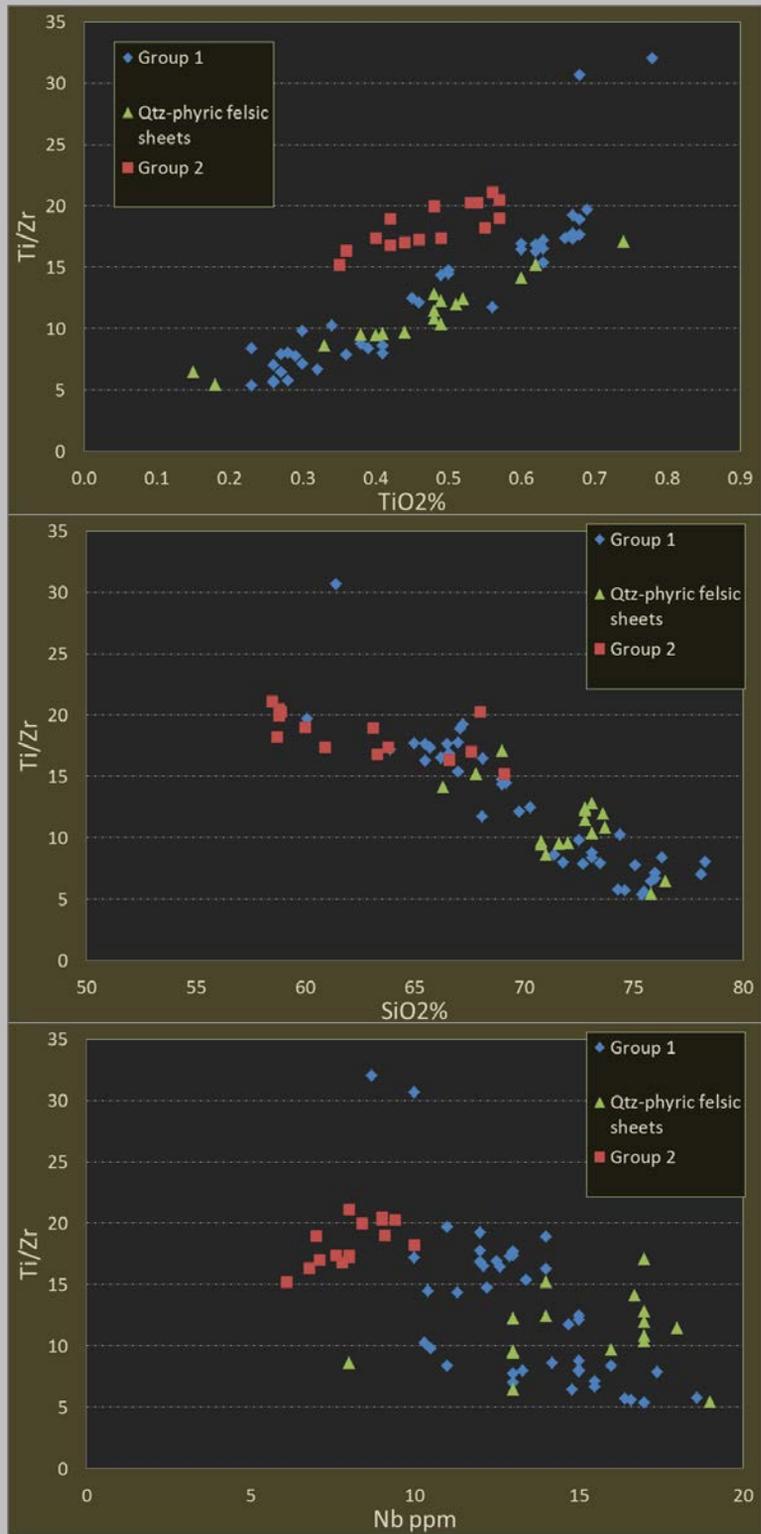


Figure 1: Bivariate plots for felsic rocks from the Central Volcanic Complex Groups 1 and 2, and for intrusive rhyolite sheets from north and west of Queenstown

Summary Report

SDD001 Protoliths (continued)

Samples from 178.89m, 196.98m, 210.20m and 239.84m

The sample from 178.89m has been so intensely hydrothermally altered that no primary textural or mineralogical preservation is preserved to enable diagnosis of the original rock. Similarly that from 196.98m is difficult to diagnose with confidence due to the pervasive intense alteration, but subtle evidence suggests that it may be a volcanoclastic sandstone originally rich in reactive vitric ash and formerly glassy lithic clasts. The rock from 210.20m depth is a better preserved volcanoclastic sandstone and lends some support for the interpretation of that from 196.98m. Detrital components in this rock included quartz phenocryst debris and clasts of originally glassy lava. The deepest sample, from 239.84m depth, was an aphyric felsic lava with a clear micropoikilitic groundmass texture. Although the petrography alone is not diagnostic in correlating this rock, my preference is that it may represent a CVC rhyolite lava.

Hole SDD002 – Protoliths and Affinities

[Samples from 128.26m and 199.71m](#)

Only two samples were examined from diamond hole SDD002. The first (128.26m) appears to be a clast or fragment of brick red, strongly Kspar-altered, Kspar-phyric rhyolite, probably part of the CVC. The sample from 199.71m is another aphyric, micropoikilitic-textured felsic lava, rather similar to that from 239.84m depth in SDD001, and again, it probably represents a CVC massive lava.

Hole SDD003 – Protoliths and Affinities

[Samples from 32.19m and 130.98m](#)

Only two samples were examined from diamond hole SDD003. The first (32.19m depth) is intensely hydrothermally altered with little trace of the protolith texture or mineralogy, but my prejudice is that it was originally a glassy felsic lava. In contrast, the rock from 130.98m depth is very well preserved and is a strongly quartz+feldspar-phyric rhyolitic lava or shallow intrusive rock with an excellent poikilitic groundmass, suggesting that if it is from an intrusive sheet, it was from close to the margin of this cooling unit.

Summary Report

HYDROTHERMAL ALTERATION

SDD001

Irrespective of protolith, samples from SDD001 showed strong to intense hydrothermal alteration, often accompanied by significant brecciation. The main alteration assemblage includes quartz-magnetite-chlorite-pyrite, with variably developed green biotite, apatite, chalcopyrite, green tourmaline and distinctively coarse-grained tan monazite. Not all samples showed all these alteration minerals. Multiple stages of brecciation and veining have occurred, with the thin section- derived evidence suggesting that the early stage alteration involved magnetite, pyrite, chalcopyrite, apatite, monazite and green biotite/chlorite. Overall, tourmaline appears to be generally a later phase, occurring mainly as matrix-infill (even in otherwise unmineralized sample 239.84m) or as veins (cross-cutting magnetite aggregates in sample 138.92m). Comments on individual alteration phases are given below.

A late sericite-carbonate alteration overprints some samples, best shown by sample 196.98m, and in places subtle alteration of the margins of the carbonate produce rusty orange colours suggesting that the carbonate is ankerite or less likely, siderite.

SDD002

The shallower sample from this hole (128.26m) is a felsic lava showing strong and pervasive Kspar alteration, with Kspar (present as veins and patches) producing the distinctive brick red colour that characterizes such alteration south of Mt Lyell. This sample lacks associated magnetite-biotite alteration, but shows a weak to moderate late sericite-carbonate overprint. The deeper sample (199.71m), a massive micropoikilitic textured rhyolite, shows only the late sericite-carbonate alteration.

SDD003

The shallower of the two samples from this hole (32.19m) shows an intense hydrothermal alteration very like that shown by the shallower samples in SDD001 (ie. between 123.82m and 133.92m), with a pervasive quartz-green biotite-apatite-magnetite assemblage, but lacking chalcopyrite. The deeper sample (130.98m) is a well preserved rhyolite with alteration restricted to very weak sericite+chlorite spotting.

Summary Report

HYDROTHERMAL ALTERATION

Hydrothermal Mineralogy

Quartz – Although quartz is common and ubiquitous in these altered felsic rocks, from the samples provided, this alteration system is not particularly quartzose,. Quartz occurs as a granular secondary phase in many samples, but not as robust quartz veins.

Biotite – A very distinctive phyllosilicate with pale green pleochroism not unlike chlorite, but striking high birefringence like muscovite, is common in this alteration system, occurring mainly as a disseminated fairly fine-grained phase. In sample SDD003 32.19m this biotite occurs as a quite coarse-grained typically platy phase to at least 2mm long. This phase is not chlorite, as unambiguous chlorite clearly replaces this phase this phase along cleavages. A more detailed study, including TerraSpec/PIMA and electron probe microanalysis is required to better understand this distinctive phase.

Apatite – Ragged and tatty, rarely well formed grains of apatite to at least 1mm across are common in several samples in the upper section of SDD001 and the shallower rock in SDD003. The apatite occurs embedded within green biotite and magnetite aggregates, and is typically riddled with tiny gaseous and solid micro-inclusions.

Monazite – A striking alteration phase present in a number of rocks showing the intense magnetite-apatite-green biotite alteration is a notably coarse-grained brown monazite, sometime present as crystals and crystal aggregates several mm long. It tends to occur in trails and clots, shows strong compositional zoning in larger crystals, and with apatite will be the major hosts for rare earth elements in these rocks.

Magnetite – Abundant magnetite is a key feature of the more hydrothermally altered rocks in this set, occurring as bands and patches made up of mainly sub-mm, equant, ell formed grains. The magnetite rarely carries inclusions, except for occasional pyrite and chalcopyrite blebs where it abuts local veins and patches of these minerals, suggesting that the magnetite formed at the same time as the sulfides.

Tourmaline – A quite pale green tourmaline occurs in abundance as a void-filling phase in brecciated sample SDD001 239.84m, as veins cutting magnetite in SDD001 138.92m, and as an exceedingly fine-grained aggregate replacing matrix in volcaniclastic sandstone SD001 210.20m.

Summary Report

HYDROTHERMAL ALTERATION

Tiny blue-green tourmaline euhedra occur scattered through SDD001 178.89m, but tourmaline is absent in the samples examined from SDD002 and SDD003.

Chalcopyrite – This usually occurs as an interstitial, anhedral, patchy phase in magnetite aggregates, usually moulded around the margins of magnetite and pyrite crystals, and rarely occurring within magnetite grains in proximity (a mm or so) to chalcopyrite concentrations. It shows no alteration to chalcocite, covellite, or digenite, and no trace of bornite was noted in any sample examined in reflected light. The chalcopyrite is almost certainly a primary phase associated with the magnetite-dominant alteration, but it has been significantly remobilized locally, even into tourmaline aggregates. Not all samples showing the magnetite alteration carry chalcopyrite (e.g., SDD003 32.19m).

Unusual phyllosilicate in SDD001 123.82m – The disseminated and patchy, but abundant fine-grained phyllosilicate in this rock shows a more tabular grain shape than typical ragged, fine-grained sericite/white mica. Although this needs to be checked by TerraSpec/PIMA, it has some significant similarities to fine-grained alunite. However, until this is confirmed (or otherwise), it does not warrant further discussion.

Pyrite – This occurs as trails and short veinlets of slightly reacted grains, usually embedded within magnetite aggregates and closely associated with chalcopyrite concentrations. On the basis of the samples examined, the alteration system is relatively pyrite-poor.

SUMMARY

With little to go on apart from these samples examined petrographically, it appears that the distinctive magnetite-apatite-green biotite-pyrite-chalcopyrite-monazite alteration predates a brecciation event in which fine-grained tourmaline in-filled breccia porosity. The distinctive brick red Kspar alteration, well known in the Darwin Plateau region, is present in only a single sample, and cannot be linked with either style (magnetite-dominated, or tourmaline) from the sample set provided.

Table 1: Summary Descriptions of Prince Lyell drillhole samples

| HOLE ID Depth (m) | Summary Description |
|----------------------|--|
| SDD001 123.82 | An intensely hydrothermally altered quartz-phyric felsic volcanic or shallow intrusive rock with heavy veining and overprinting by patchy, irregular quartz-apatite-sericite-chlorite-coarse monazite assemblages, with abundant pyrite, chalcopyrite and alteration-related magnetite. |
| SDD001 133.92 | A quartz-phyric felsic rock with a holocrystalline groundmass suggesting the protolith was a shallow sill, dyke or plug. Multiple episodes of alteration-brecciation have produced a complex alteration assemblage characterized by quartz-magnetite-white mica-green biotite-monazite, and common pyrite-chalcopyrite, but no apatite. |
| SDD001 138.92 | Protolith was probably a quartz-phyric shallow intrusive unit. It now consists of a mass of fine-grained magnetite cut by common veins of green tourmaline and subordinate quartz, green biotite and chlorite. Occasional pyrite veins and a mesh of chalcopyrite occur throughout the magnetite aggregates. |
| SDD001 178.89 | A multiply brecciated rock with no trace of the protolith texture or mineralogy preserved, now composed of (in order of decreasing modal abundance) quartz, magnetite, green biotite altering to chlorite, brown monazite, microcrystalline epidote(?), minor pyrite, chalcopyrite and late carbonate, and common tiny blue-green tourmaline grains. |
| SDD001 196.98 | This rock is difficult to diagnose with confidence but appears to be a volcanoclastic sandstone rich in vitric ash and formerly glassy felsic lava fragments as well as small detrital quartz phenocryst clasts. The entire rock, including a band of magnetite-chalcopyrite-quartz alteration, is overprinted by intense sericite-carbonate (probably siderite or ankerite) alteration. |
| SDD001 210.20 | A poorly sorted volcanoclastic sandstone in which the detrital fraction is dominated by formerly glassy felsic lava clasts and quartz phenocryst debris. The matrix is strongly altered to dark magnetite-tourmaline-minor sericite+carbonate intergrowths with scattered pyrite (5modal%) but insignificant chalcopyrite. It probably derives from the same protolith as the more strongly altered preceding sample from 178.89m. |
| SDD001 239.84 | A hydrothermal breccia formed by hydraulic fragmentation of an aphyric felsic lava with a micropoikilitic texture. Clasts in this sample are mainly smaller than 1cm, quite angular, unmilled, and the matrix (infill) consists largely of very fine-grained tourmaline and subordinate chlorite. |
| SDD002 128.26 | The contact between a formerly glassy, sparsely Kspar-phyric rhyolitic lava clast(?) and an adjacent sericite+chlorite-dominated matrix domain. The clast shows strong Kspar veining and local recrystallization of the devitrified glassy groundmass to Kspar indicates that Kspar alteration is pervasive despite the fine grain size. Late carbonate veining and small rhombs overprint the Kspar-sericite, and sericite-chlorite alteration. |
| SDD002 199.71 | An aphyric, micropoikilitic-textured felsic lava, probably a rhyolite. Alteration is weak to moderate and dominated by quartz-sericite, with late carbonate veining, and no chlorite, tourmaline or significant magnetite. |
| SDD003 32.19 | The protolith of this rock was probably a glassy felsic lava, but the primary texture and mineralogy have been obliterated by intense, multi-stage alteration that has produced a pervasive quartz - green biotite - apatite - magnetite assemblage, lacking chalcopyrite. |
| SDD003 130.98 | A well preserved, strongly quartz+feldspar-phyric rhyolitic lava or very shallow intrusive rock with an excellent micropoikilitic groundmass. Alteration is limited to sericitization of the feldspar phenocrysts and weak chlorite spotting throughout the rock. |

SAMPLE NUMBER

SDD001 123.82-123.84m

SUMMARY

This is an intensely hydrothermally altered quartz-phyric felsic volcanic or shallow intrusive rock with heavy veining and overprinting by patchy, irregular quartz-apatite-sericite-chlorite-coarse tan monazite assemblages, with abundant pyrite, chalcopyrite and alteration-related magnetite.



SAMPLE NUMBER

SDD001 123.82-123.84m

Thin Section Description

This is an intensely hydrothermally altered and mineralized former quartz-phyric felsic lava or shallow intrusive rock in which the alteration has been totally feldspar-destructive. Occasional but well represented quartz phenocrysts are present in the less mineralized part of this thin section and range up to 2-3mm across, some showing moderate magmatic resorption and rounding. These are set in a medium-grained, holocrystalline groundmass composed almost entirely of quartz and sericite in which the dominant quartz is present as anhedral grains averaging around 0.1mm across, defining a mosaic texture peppered with fine-grained sericite. The paucity of former feldspar sites in this groundmass suggests that it has recrystallized during the pervasive hydrothermal alteration. The fine-grained phyllosilicate(?) throughout this rock is unusual in showing well defined blocky crystal shapes rather than the usual tatty sericite developed during feldspar alteration, and it needs to be checked using XRD or TerraSpec /PIMA for confident identification.

Veining, Alteration, Mineralization: Reflected Light Microscopy

Chalcopyrite-pyrite mineralization is associated with complex, strained quartz veins and abundant intergrown chlorite-sericite-apatite, with occasional clusters of quite robust tan-brown prismatic crystals to about 0.5mm long that are almost certainly unusually coarse monazite. Tatty apatite occurs as anhedral patches to about 0.5mm across, making up about 10-20modal% of the alteration zone in this rock. Patchy late carbonate, probably siderite or ankerite, overprints parts of the alteration assemblage, but is volumetrically insignificant. In reflected light, the abundant sulfides in the alteration assemblage are seen to be dominated by 0.1-1mm-sized pyrite occurring as ragged-edged, rather corroded crystals, commonly fractured, often immersed within irregular pools of chalcopyrite that also invades along fractures in both pyrite and the almost fibre-quartz veinlets. Coexisting with the sulfides is common magnetite, usually present as small, equant, well formed to quite tatty grains, as well as patches and seams of tiny grains. Occasional small blebs of chalcopyrite and pyrite occur within some larger magnetite grains.

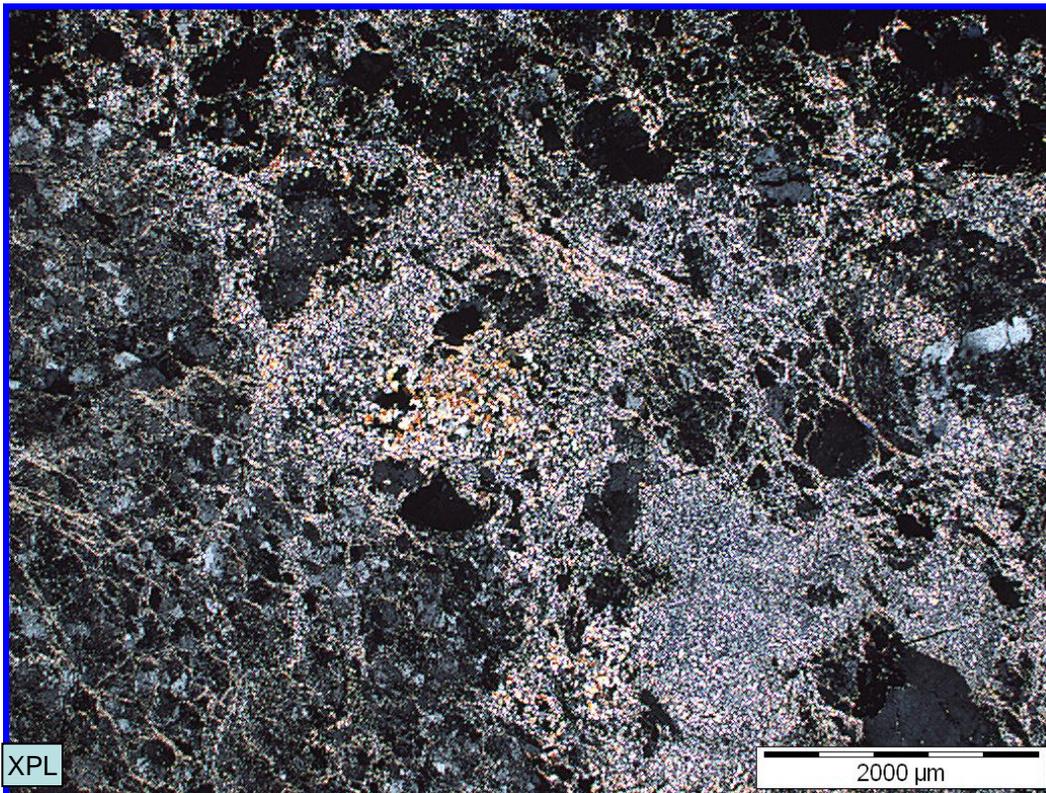
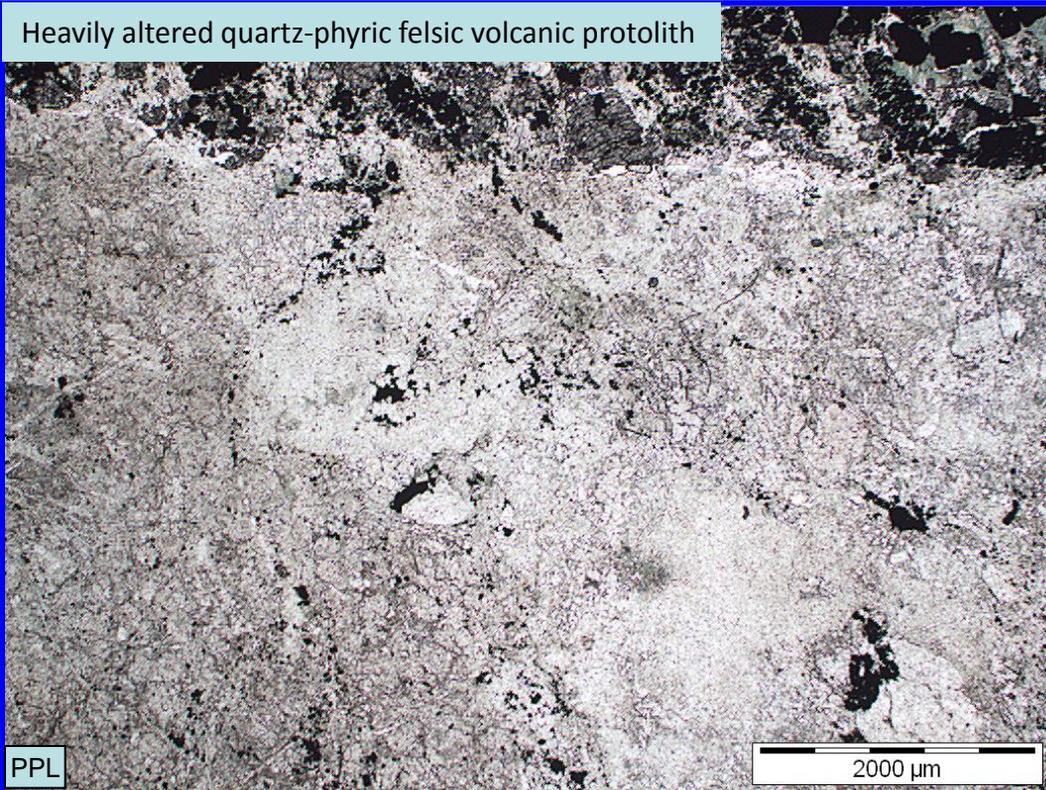
Other Comments

The common quartz phenocrysts in the protolith of this strongly altered rock suggest that it was not part of the Central Volcanic Complex.

SAMPLE NUMBER

SDD001 123.82-123.84m

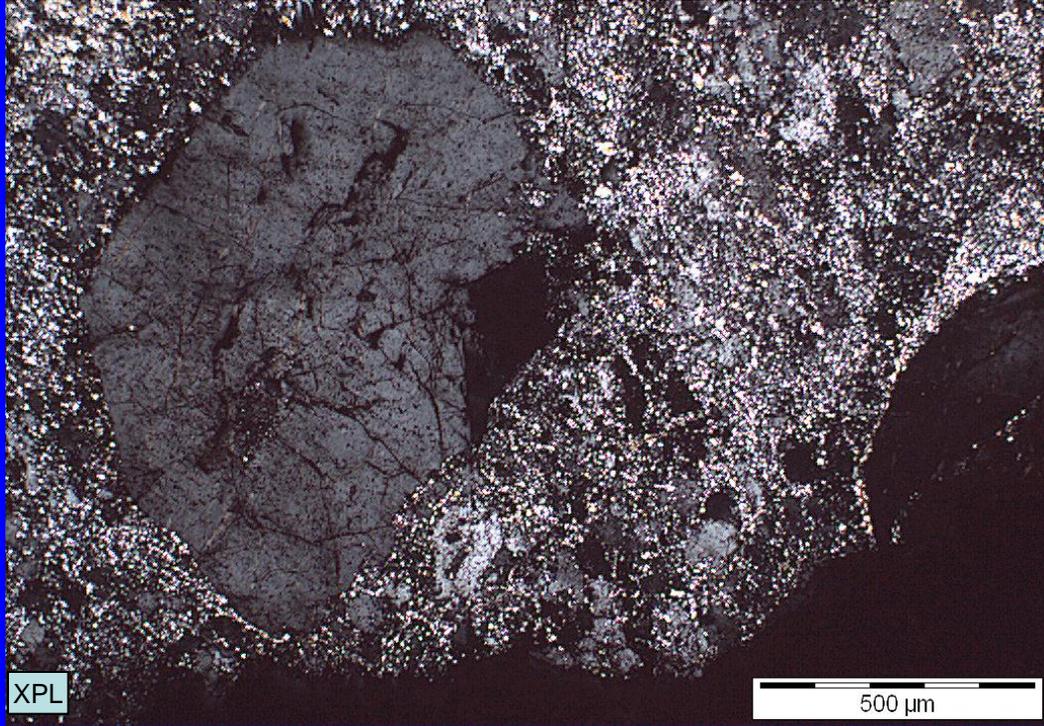
Heavily altered quartz-phyric felsic volcanic protolith



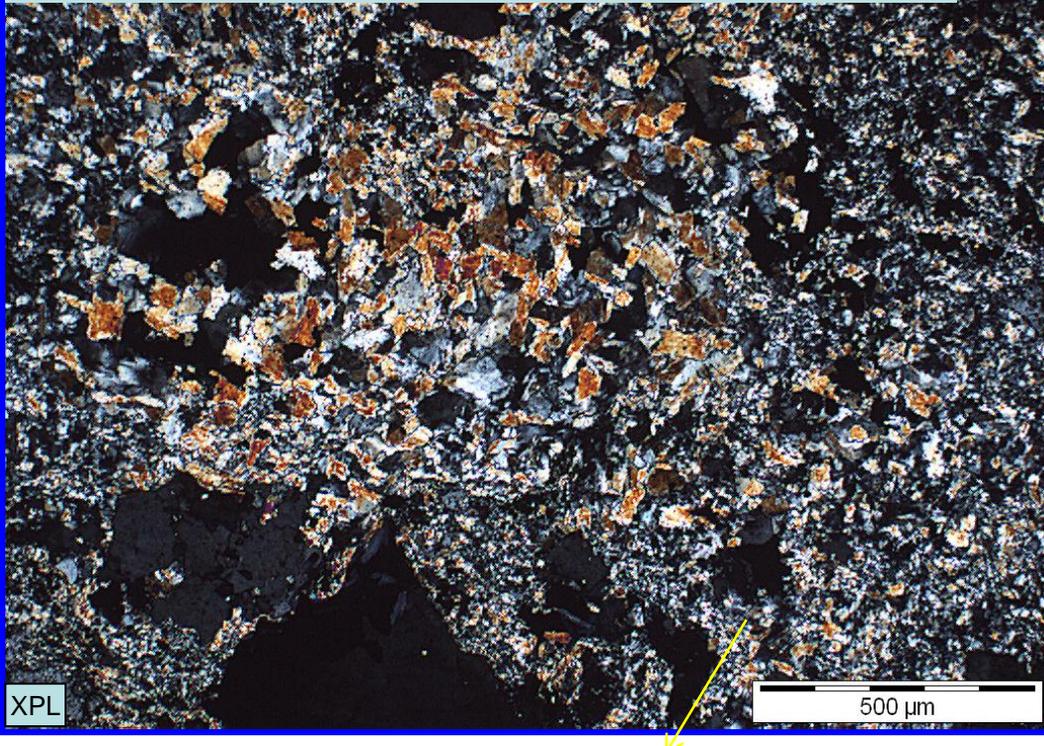
SAMPLE NUMBER

SDD001 123.82-123.84m

Relic quartz phenocryst in quartz-phyric felsic volcanic protolith



Patch of quite coarse phyllosilicate(?) alteration in altered groundmass



SAMPLE NUMBER

SDD001 123.82-123.84m

PPL

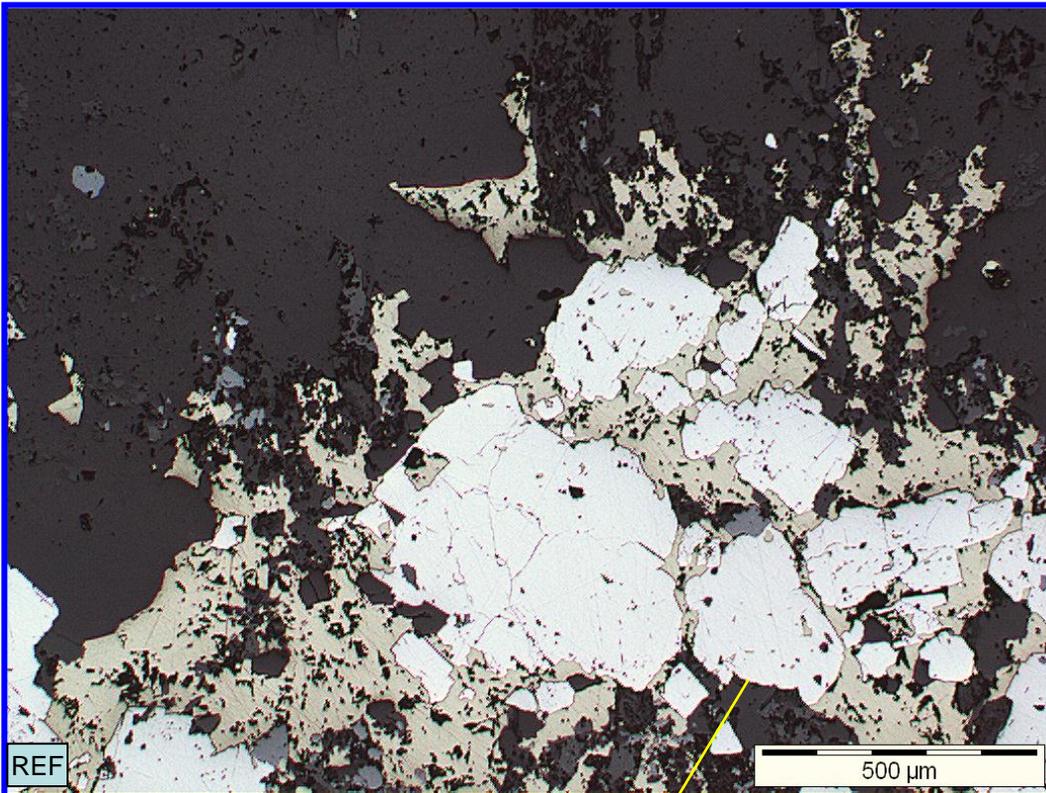
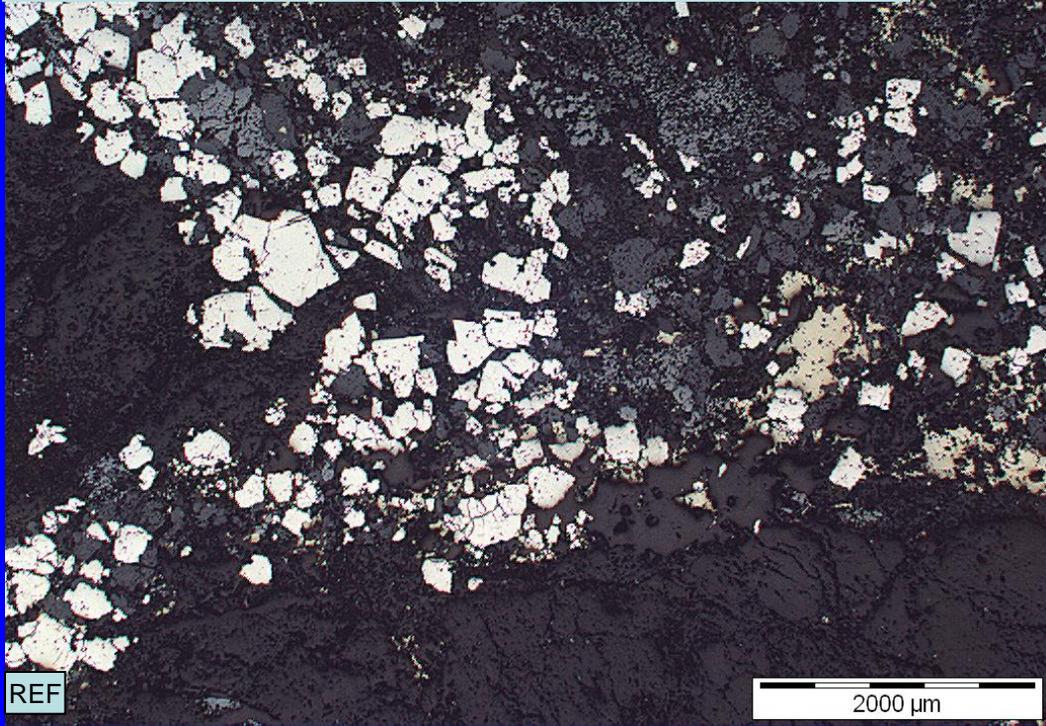
XPL



SAMPLE NUMBER

SDD001 123.82-123.84m

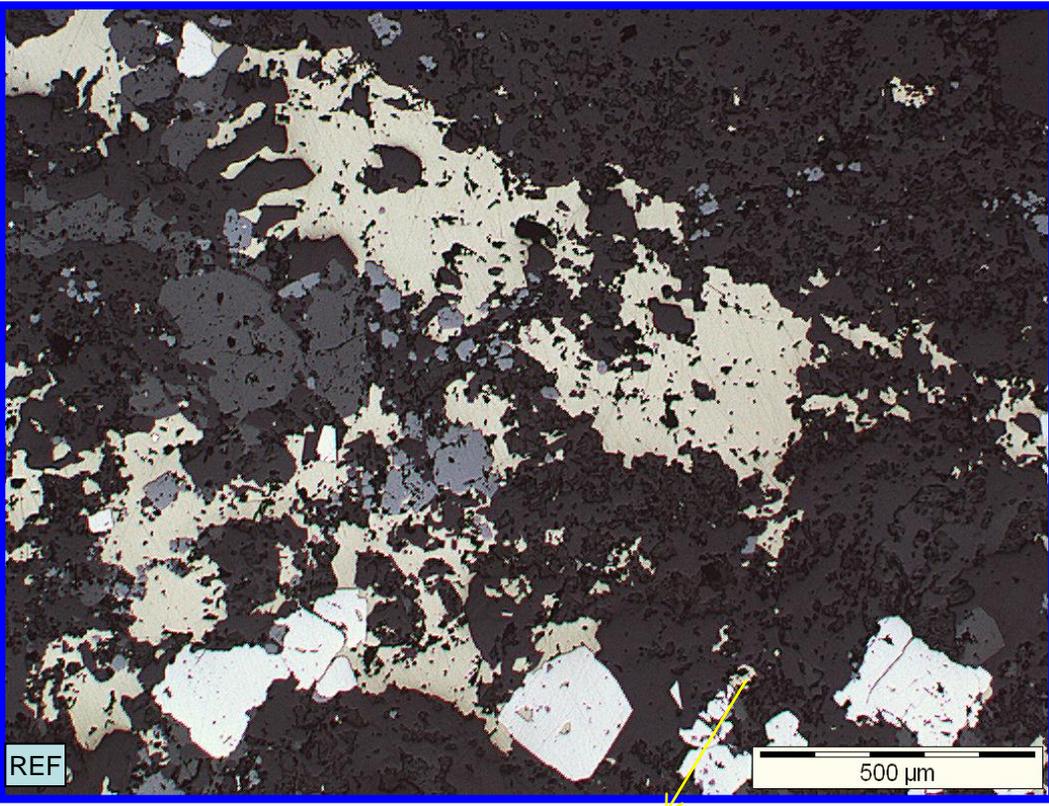
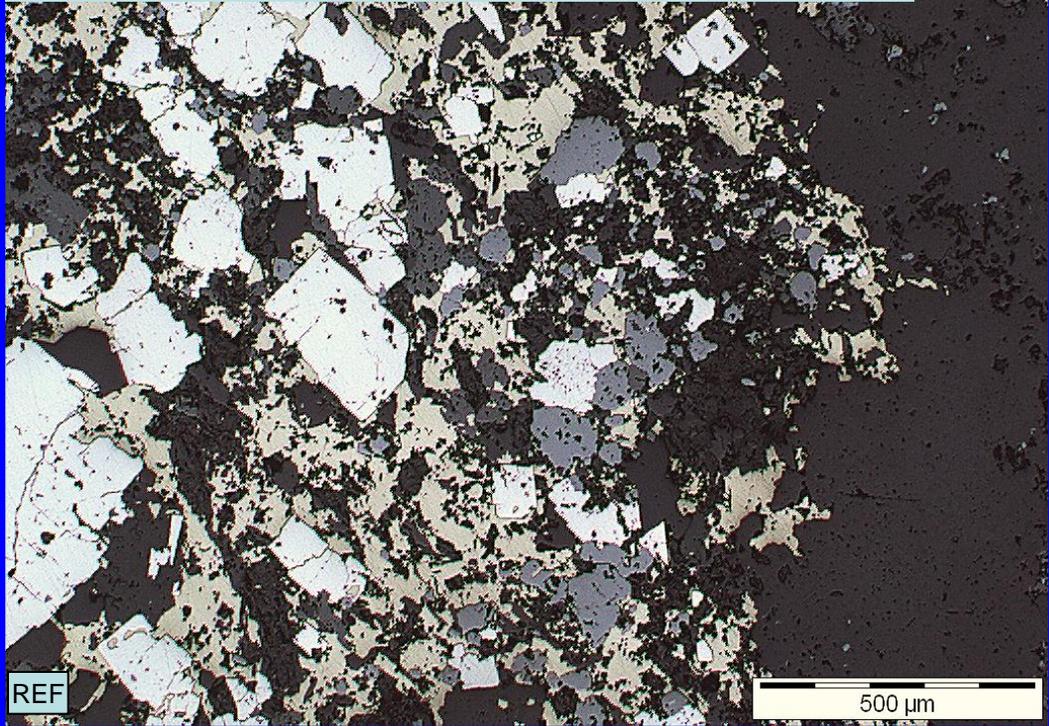
Typical granular fractured pyrite, and patchy interstitial chalcocopyrite



SAMPLE NUMBER

SDD001 123.82-123.84m

Granular pyrite, patchy interstitial chalcocopyrite and grey magnetite



SAMPLE NUMBER

SDD001 133.92-133.94m

SUMMARY

This is another quartz-phyric felsic rock with a holocrystalline groundmass suggesting the protolith was a shallow sill, dyke or plug. Multiple episodes of alteration-brecciation have produced a complex alteration assemblage characterized by quartz-magnetite-white mica-green biotite-tan monazite, and common pyrite-chalcopyrite, but no apatite.



SAMPLE NUMBER

SDD001 133.92-133.94m

Thin Section Description

This is another heavily hydrothermally altered and mineralized rock, but like the preceding sample preserving large unambiguous quartz phenocrysts in a strongly altered and recrystallized groundmass. Some of the rather resorbed quartz phenocrysts are up to 4mm long, and most are strongly strained and fractured. The holocrystalline quartzo-feldspathic groundmass appears to retain the primary texture, suggesting this rock was a shallow intrusive rather than a lava, although fine-grained sericite replaces much of the former feldspars.

Veining, Alteration, Mineralization: Reflected Light Microscopy

Most of this section consists of strong, patchy alteration dominated by quartz and sulfides, but with common quite coarse-grained white mica, a green phyllosilicate with high birefringence suggesting that it is biotite rather than chlorite, and common patches of stout crystals of tan monazite. Other alteration phases include murky microcrystalline epidote(?) and patches of pale carbonate (ankerite) intergrown with quartz and magnetite in late, cross-cutting veinlets. The texture of this rock indicates multiple episodes of local brecciation and veining, In reflected light, the three main opaque phases are pyrite, chalcopyrite and abundant magnetite, the latter occurring as trails and patches of small, equant, often very well formed crystals. Pyrite-chalcopyrite veinlets clearly transect some early magnetite veinlets. Pyrite occurs as ragged-edged, often reacted and resorbed crystals to about 1mm across but usually much smaller, making up probably <5modal% of this rock. Chalcopyrite forms irregular patches and sprays often surrounding, and filling fractures, in pyrite grains. Magnetite is widely developed as small disseminated crystals through the altered groundmass of this rock, but neither sulfides occur in this paragenesis.

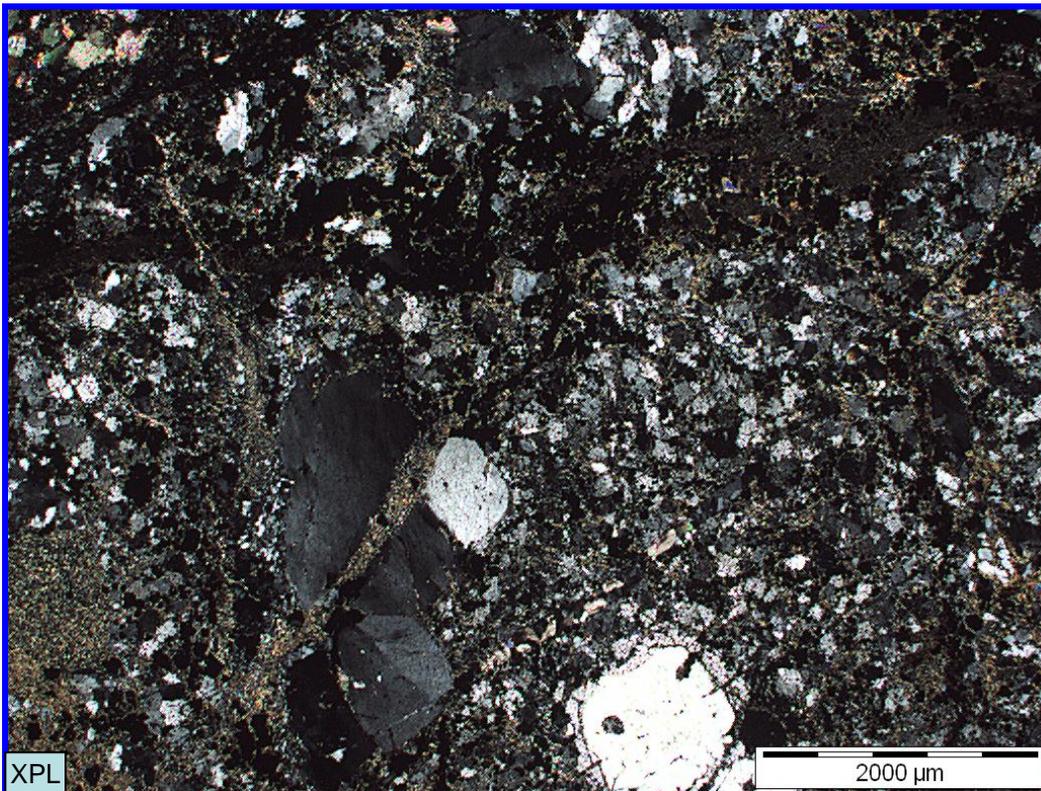
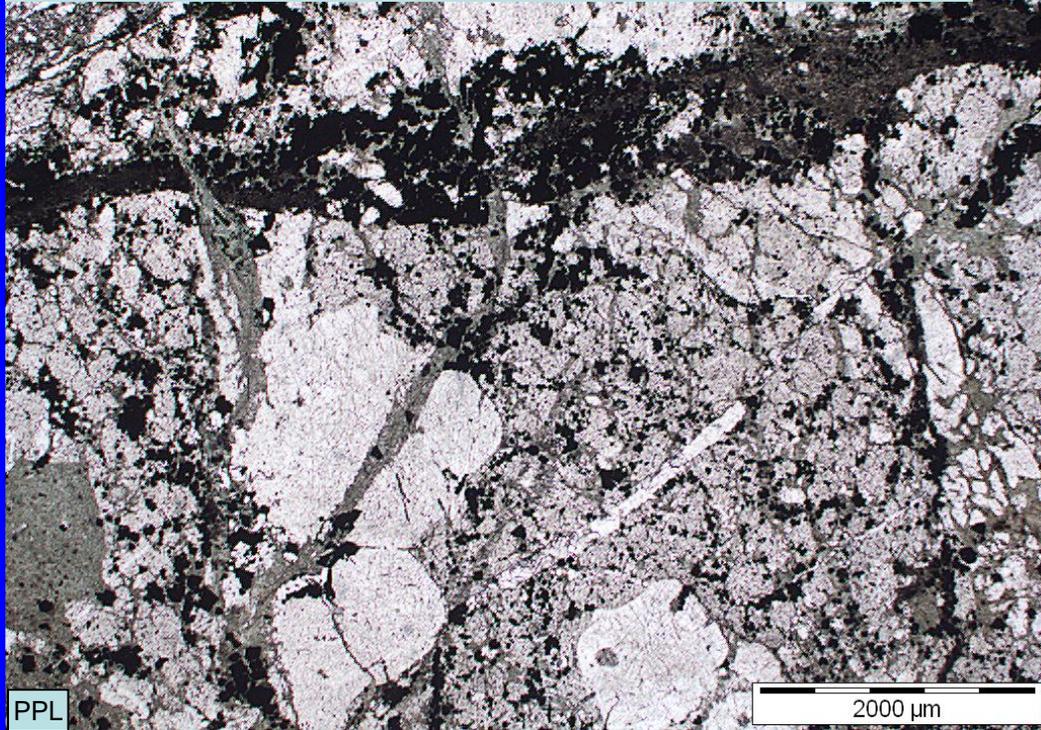
Other Comments

In terms of protolith and alteration style, the only significant differences between this rock and the preceding sample from 10m higher in this drillhole is that this sample lacks the common apatite in SDD001 123.82m, and carries significant green biotite whereas the minor green phyllosilicate in the rock from 123.82m is clearly chlorite. The better preserved groundmass in this sample suggests the protolith may have been a shallow intrusive sill/plug rather than a lava (see discussion in Summary Report).

SAMPLE NUMBER

SDD001 133.92-133.94m

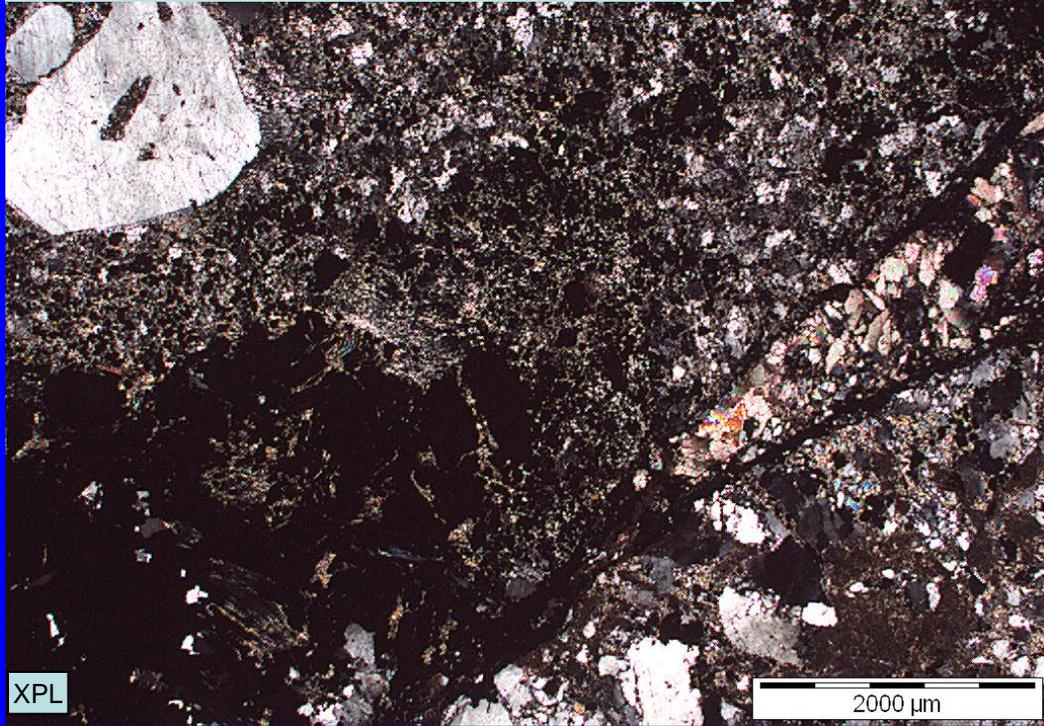
Broken quartz phenocrysts in finely holocrystalline, altered groundmass



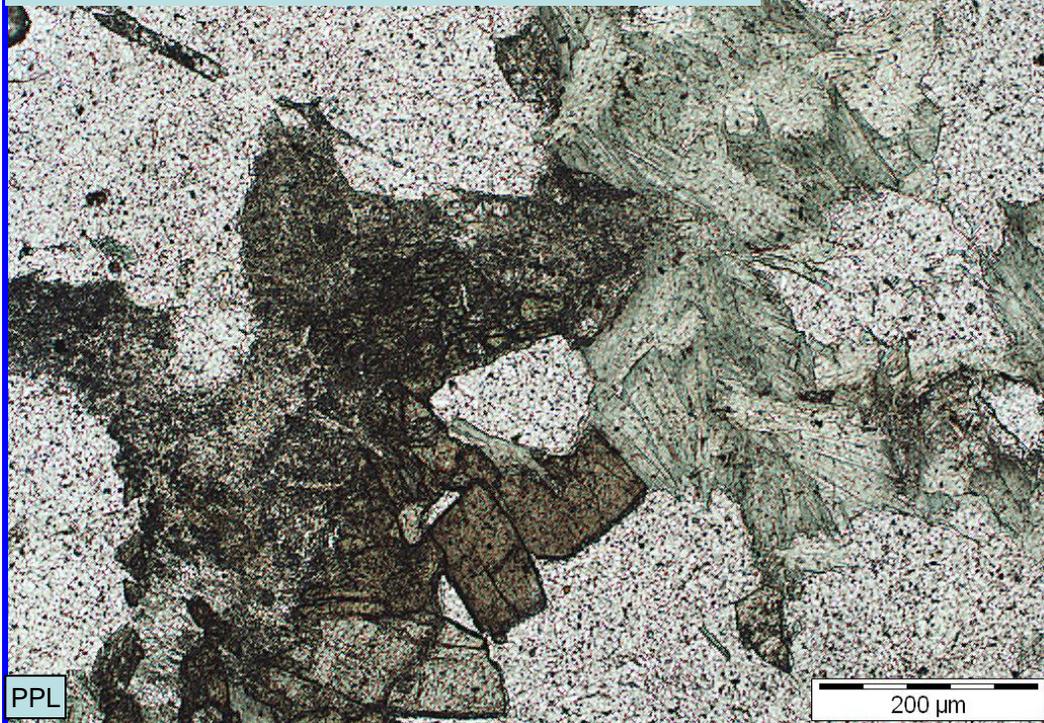
SAMPLE NUMBER

SDD001 133.92-133.94m

Quartz phenocryst in brecciated, altered groundmass



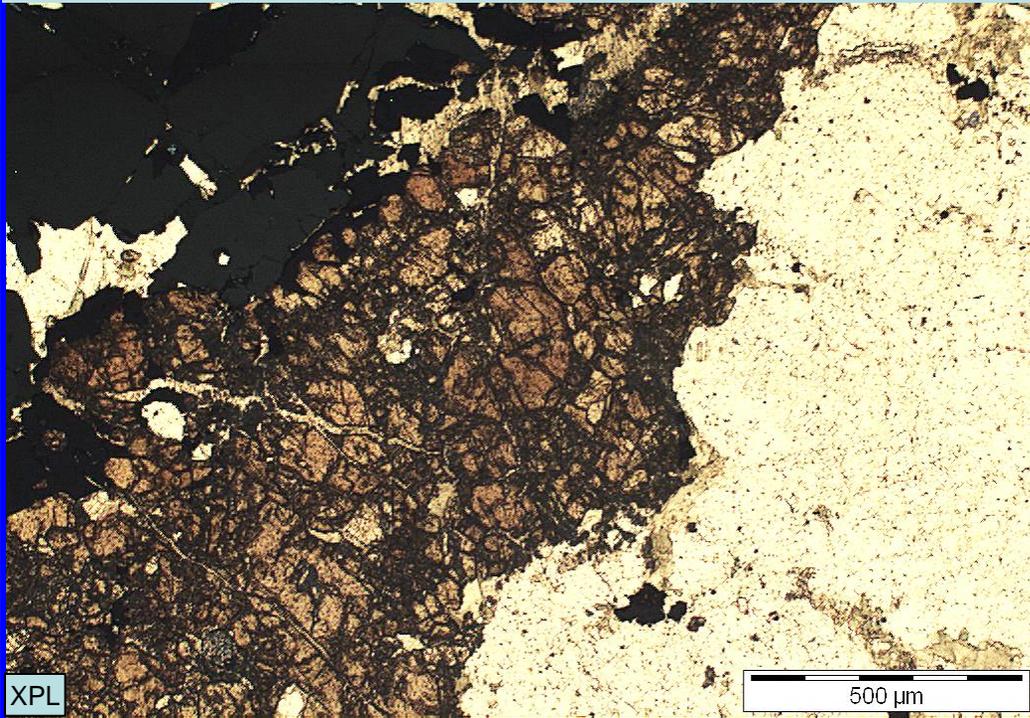
Green biotite and robust tan monazite crystals in quartz



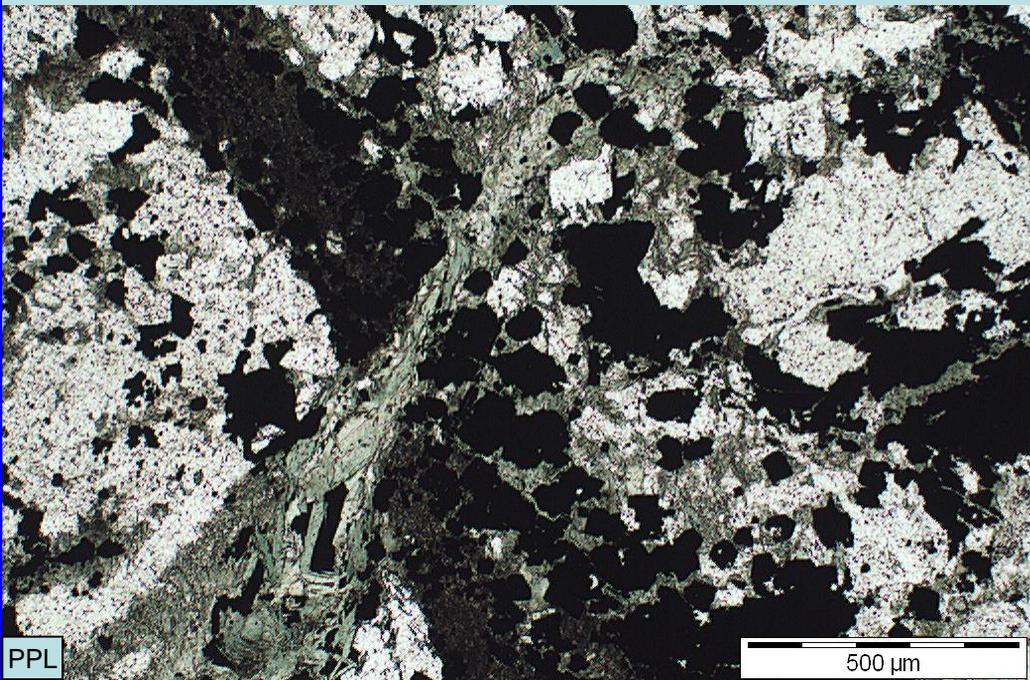
SAMPLE NUMBER

SDD001 133.92-133.94m

Cluster of tan monazite grains between quartz and pyrite-chalcocopyrite (black)



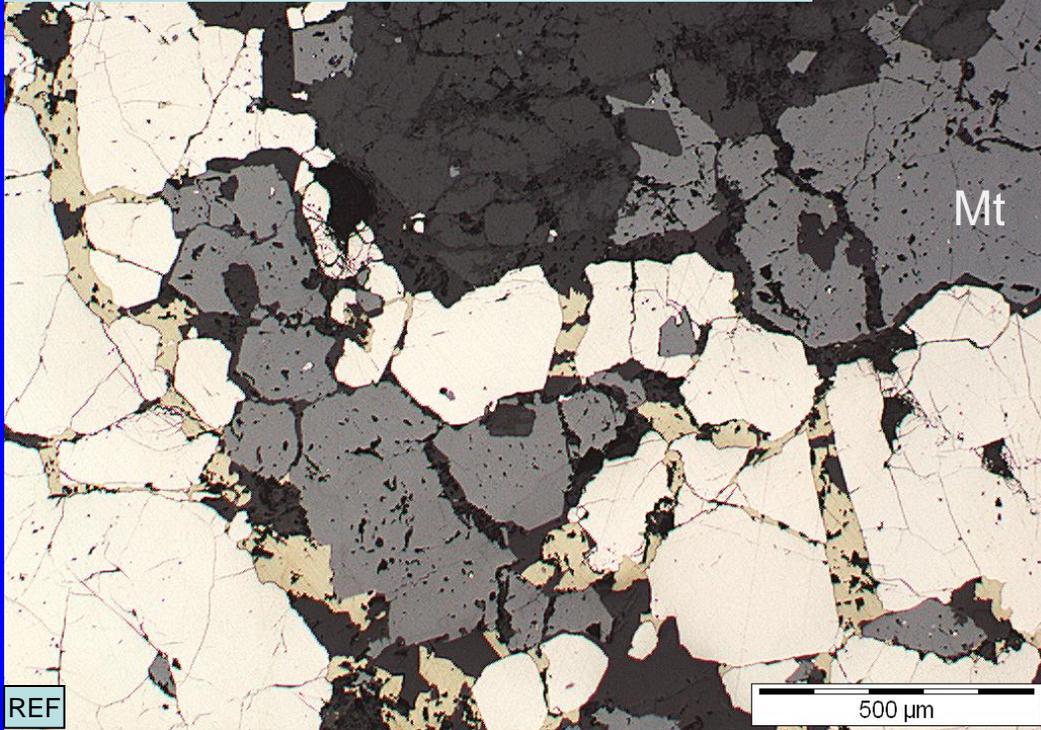
Green biotite veinlet cutting vein composed of very fine-grained magnetite and quartz



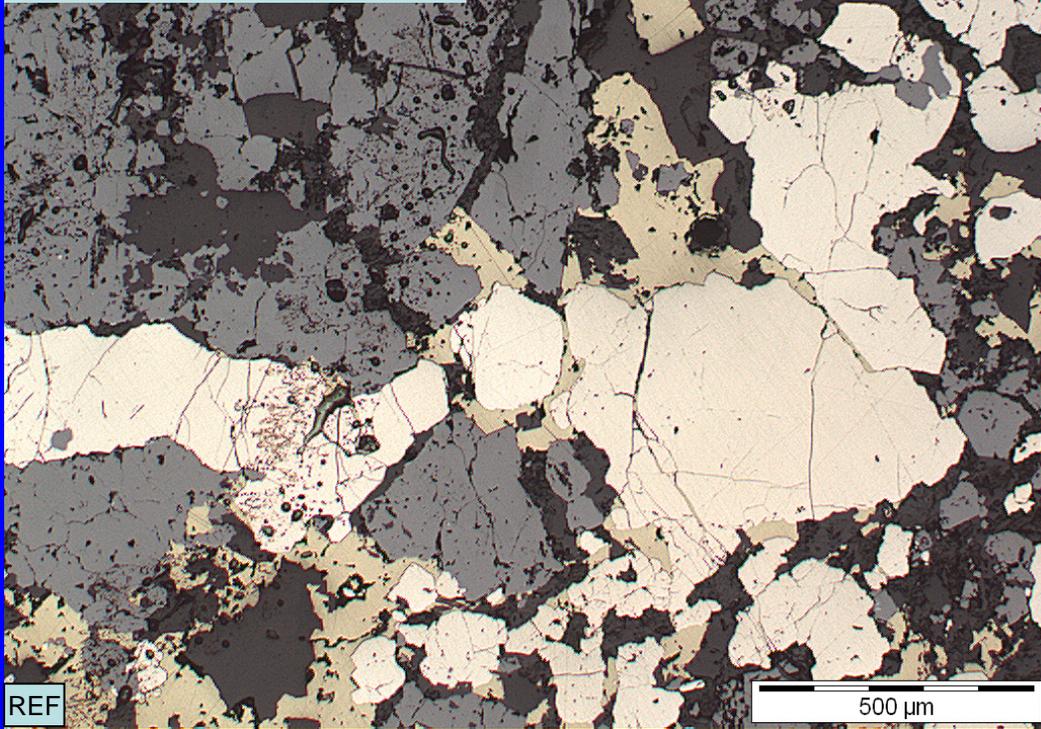
SAMPLE NUMBER

SDD001 133.92-133.94m

Pyrite, chalcopyrite and magnetite in strongly altered patch



Anhedrally pyrite and chalcopyrite



SAMPLE NUMBER

SDD001 138.92-133.94m

SUMMARY

The protolith of this rock was probably a quartz-phyric shallow intrusive unit. It now consists of a mass of fine-grained magnetite cut by common veins consisting of green tourmaline and subordinate quartz, green biotite and chlorite. Occasional pyrite veins and a mesh of chalcopyrite occur throughout the magnetite aggregates. Some chalcopyrite has been mobilized into the tourmaline veins/breccia infill.



SAMPLE NUMBER

SDD001 138.08-138.10m

Thin Section Description

This sample retains only a few vague traces of the protolith texture, and consists almost entirely of locally brecciated aggregates of sulfides and magnetite, between which are irregular masses and veins composed (1) almost entirely of intergrown pale green, fine-grained, prismatic tourmaline, and (2) texturally- and grainsize variable quartz with minor green biotite and chlorite. Both silicate phases are peppered by tiny magnetite grains. A few of the cores of silicate material show quartz-phyric textures, suggesting the protolith was a felsic volcanic like those described from shallower levels in this drillholes at 123.82m and 133.92m depth.

Veining, Alteration, Mineralization: Reflected Light Microscopy

Almost this entire thin section consists of alteration phases. In reflected light, the dominant opaque is masses of fine-grained magnetite impregnated by a patchy network of interstitial chalcopyrite and occasional discontinuous trails of pyrite. The latter shows a grain size around 1mm and common chalcopyrite-filled fractures. Away from the adjacent sulfides, the magnetite forming the mainly fine-grained aggregates lacks sulfide inclusions, whereas within a few mm of the sulfides, magnetite with identical textural detail includes common tiny sulfide inclusions (chalcopyrite, pyrite). Overall, pyrite makes up only 2-3modal% of this rock, and chalcopyrite about 5-10modal%, with the remainder dominated by magnetite, and the cross-cutting fractures filled by tourmaline aggregates and quartz. Late, narrow carbonate veinlets and occasional overprinting patches are present, but not significant modally.

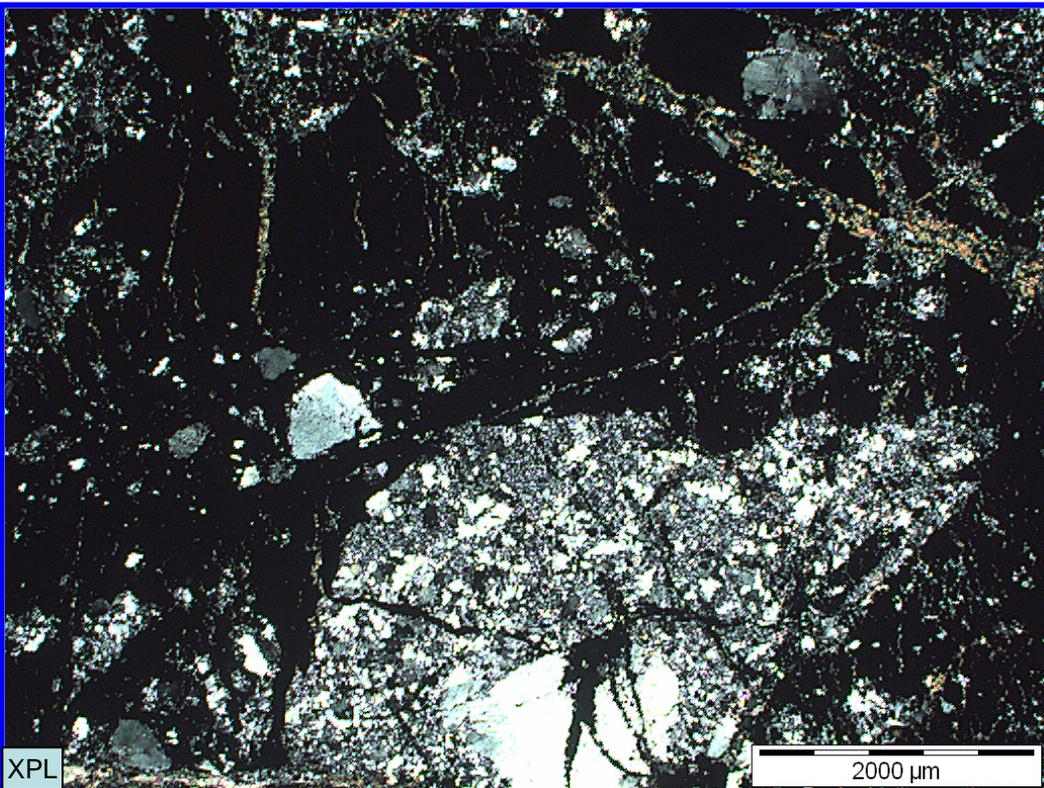
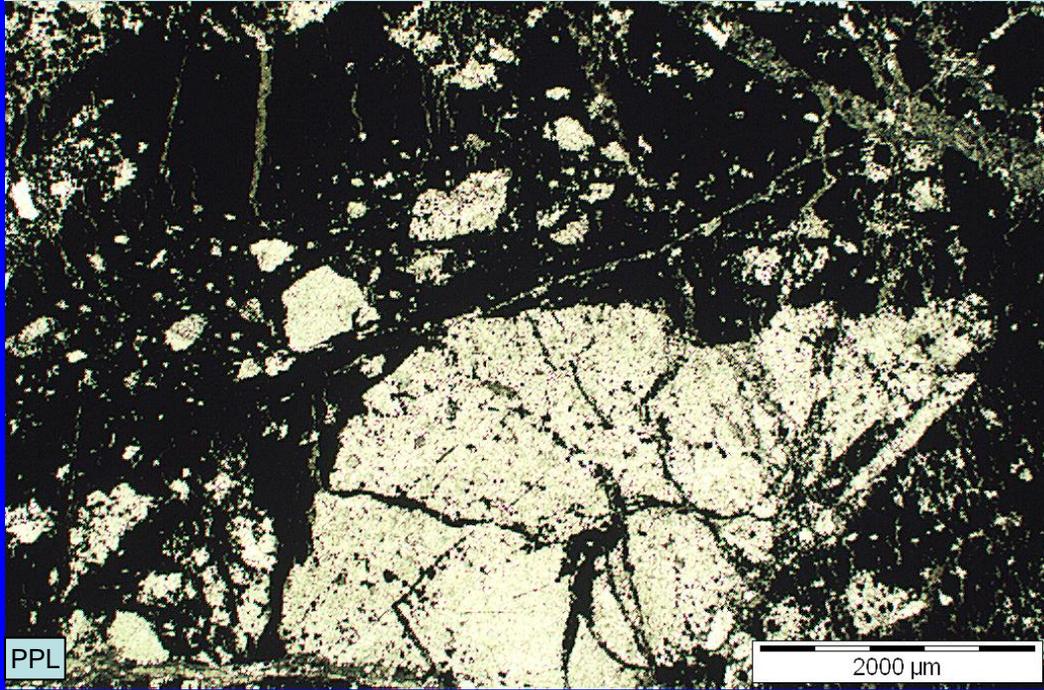
Other Comments

The few cores of unbrecciated and veined/replaced protolith in this rock indicate that it was probably a quartz-phyric felsic shallow intrusive rock like those from higher in this drillhole. Both the chalcopyrite-pyrite and tourmaline-dominant alteration clearly transect and thus post-date the magnetite alteration.

SAMPLE NUMBER

SDD001 138.08-138.10m

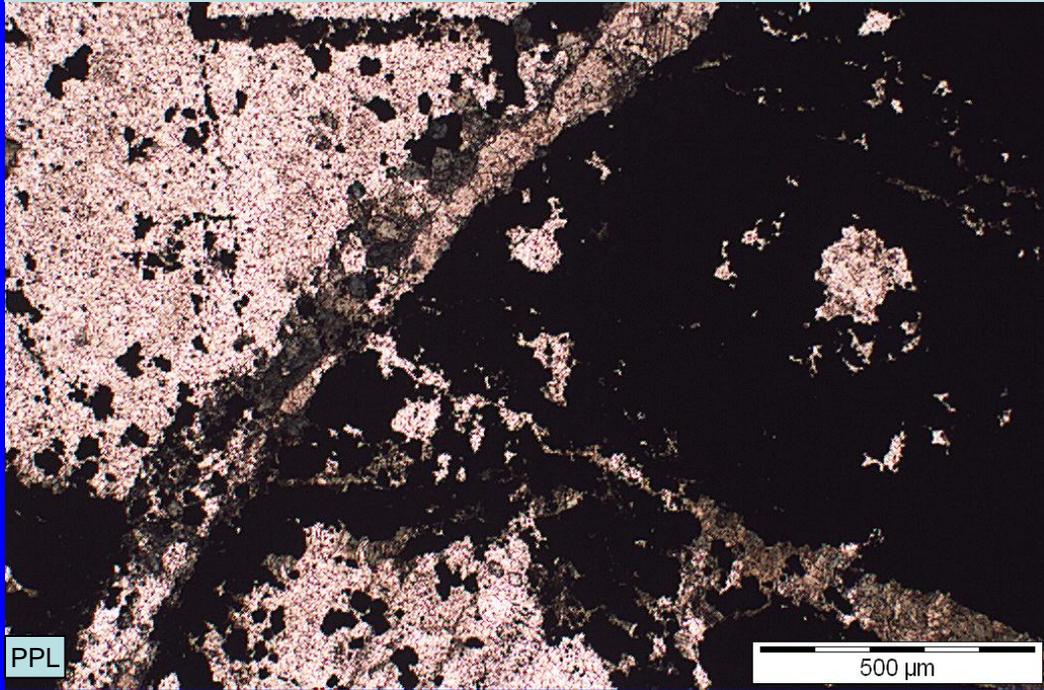
Core of protolith showing quartz phenocryst in altered groundmass, set in intensely magnetite-altered matrix cut by very fine-grained tourmaline veins



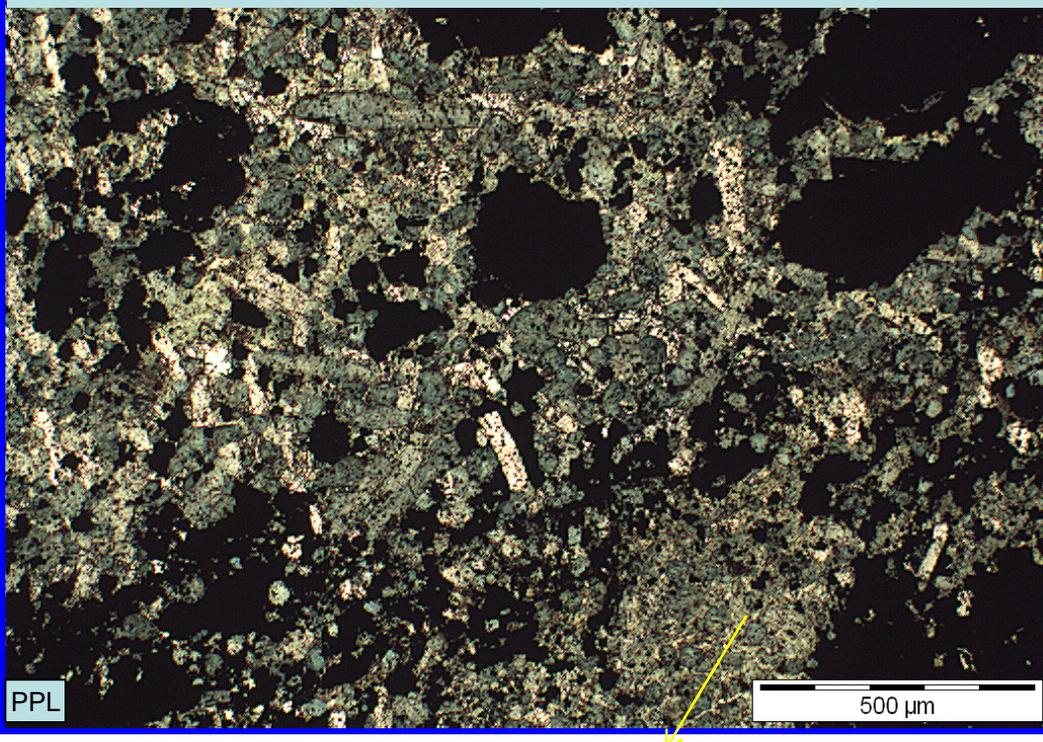
SAMPLE NUMBER

SDD001 138.08-138.10m

Quartzose protolith domain and magnetite domains cut by narrow tourmaline-quartz veins



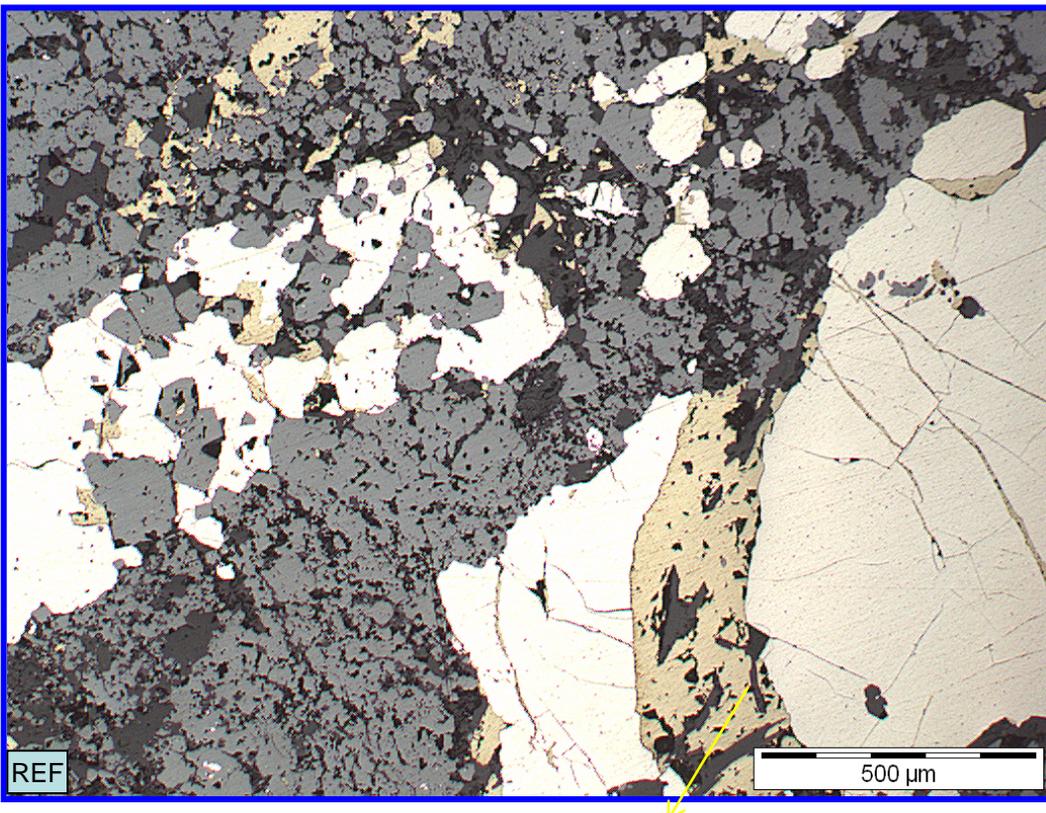
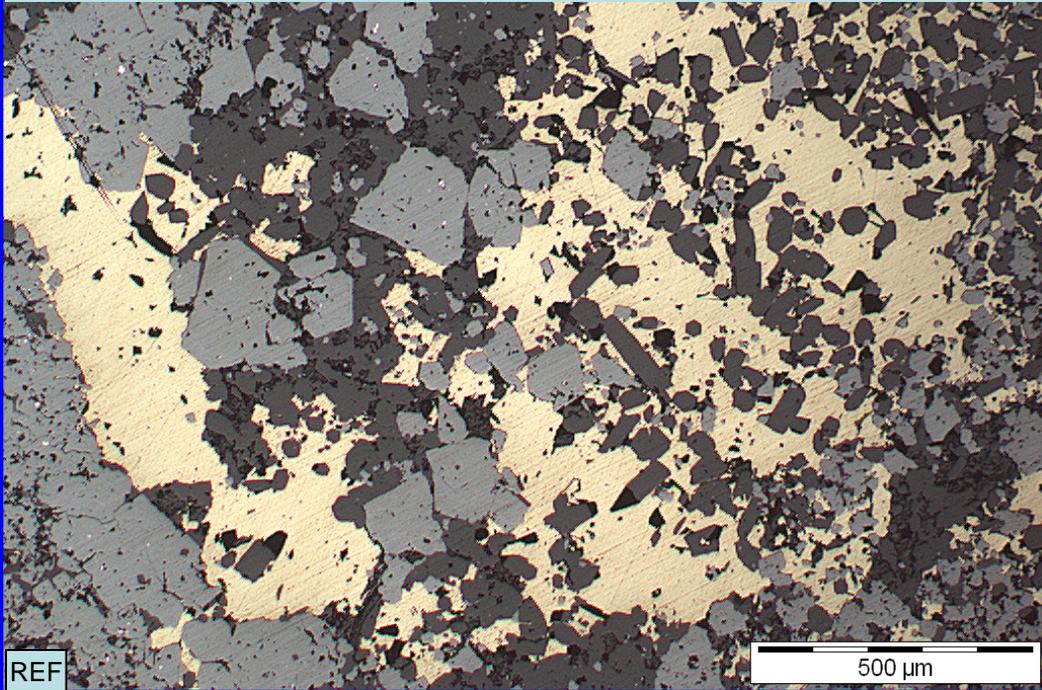
Typical prismatic tourmaline-dominated infill zone with scattered magnetite



SAMPLE NUMBER

SDD001 138.08-138.10m

Granular magnetite aggregates with patchy chalcopyrite (top) and pyrite-chalcopyrite impregnation/veining.



SAMPLE NUMBER

SDD001 178.89-178.91m

SUMMARY

This is a multiply brecciated rock with no trace of the protolith texture or mineralogy preserved, now composed of (in order of decreasing modal abundance) quartz, magnetite, green biotite altering to chlorite, brown/tan monazite, microcrystalline epidote(?), minor pyrite, chalcopyrite and late carbonate, and common tiny blue-green tourmaline grains.



SAMPLE NUMBER

SDD001 178.89-178.91m

Thin Section Description

This is another intensely magnetite-altered, quite brecciated rock which retains no trace of the protolith texture. It consists of a complex intergrowth of disrupted and disaggregated quartz veins with abundant, mainly fine-grained magnetite that varies from disseminated small crystals to more massive aggregates. Intergrown with the quartz and magnetite are irregular patches of coarsely to finely crystalline green biotite often partly altered to chlorite, brown monazite as aggregates of crystals from <0.2mm to almost 1mm across, and turbid patches of microcrystalline epidote. Small blue to green pleochroic, perfectly formed tourmaline prisms are common, mainly embedded within biotite aggregates. The coarser quartz grains are riddled with trails of tiny gaseous and magnetite inclusions.

Veining, Alteration, Mineralization: Reflected Light Microscopy

In reflected light, the dominant opaque phase in this rock by far is magnetite, occurring as cracked aggregates and disseminated smaller crystals. Hosted within the magnetite aggregates are occasional clusters and short trails of sub-mm, rather rounded and reacted pyrite grains, some of which show chalcopyrite along fractures or occur moulded against the crystals. Pyrite grains often host small magnetite crystals, and rare, tiny inclusions of either a sulfosalt or pyrrhotite. Chalcopyrite is much less abundant in this rock than in the preceding samples, and is limited to occasional aggregates of angular splashes filling interstices within biotite crystal aggregates. Minor spots of late pale carbonate are also present.

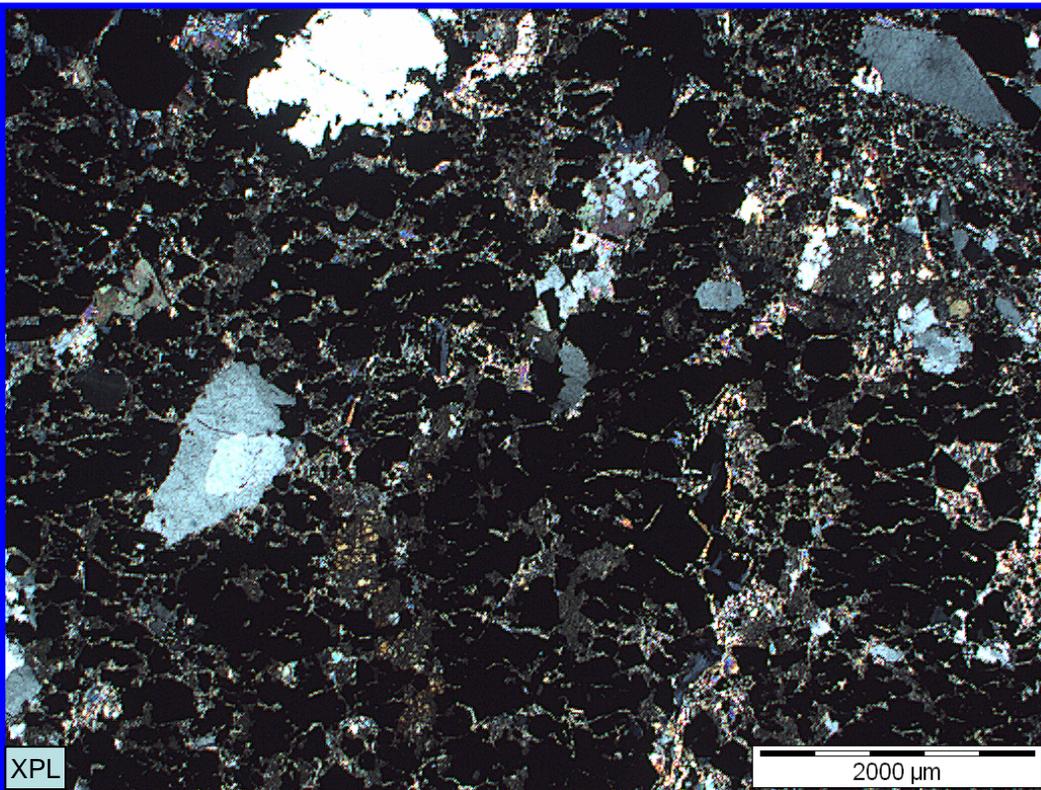
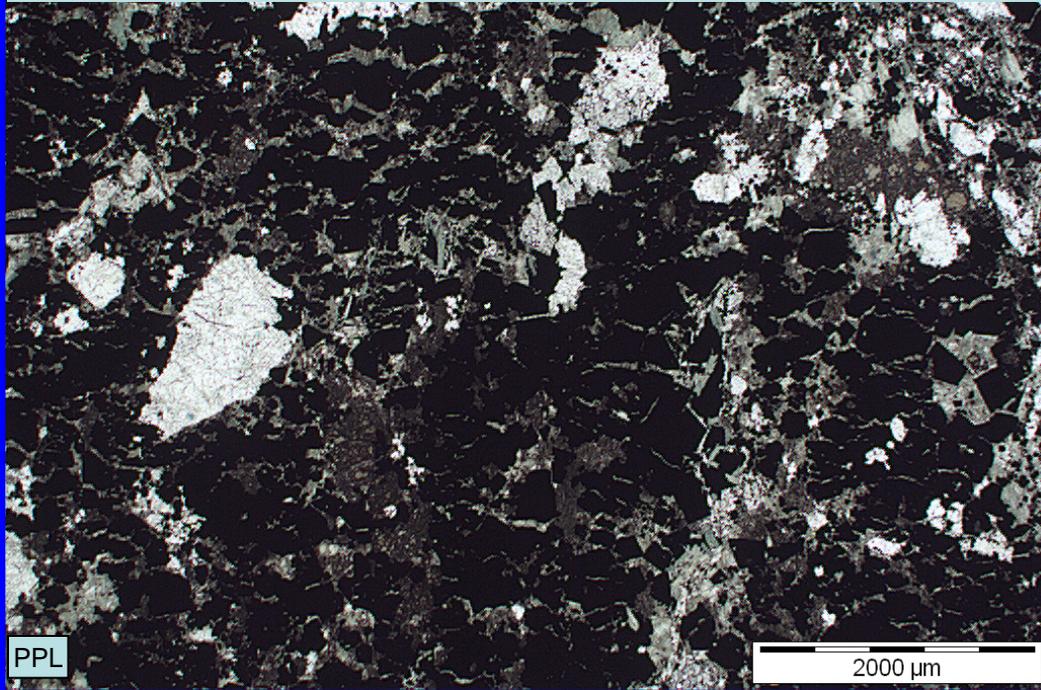
Other Comments

No trace of the protolith is preserved in this quite finely brecciated rock, but the alteration assemblage and style is essentially identical to the sample from 138.08m depth in this hole, lacking apatite, but with abundant magnetite, quartz, green biotite and microcrystalline epidote, and pyrite and chalcopyrite as the sulfide assemblage.

SAMPLE NUMBER

SDD001 178.89-178.91m

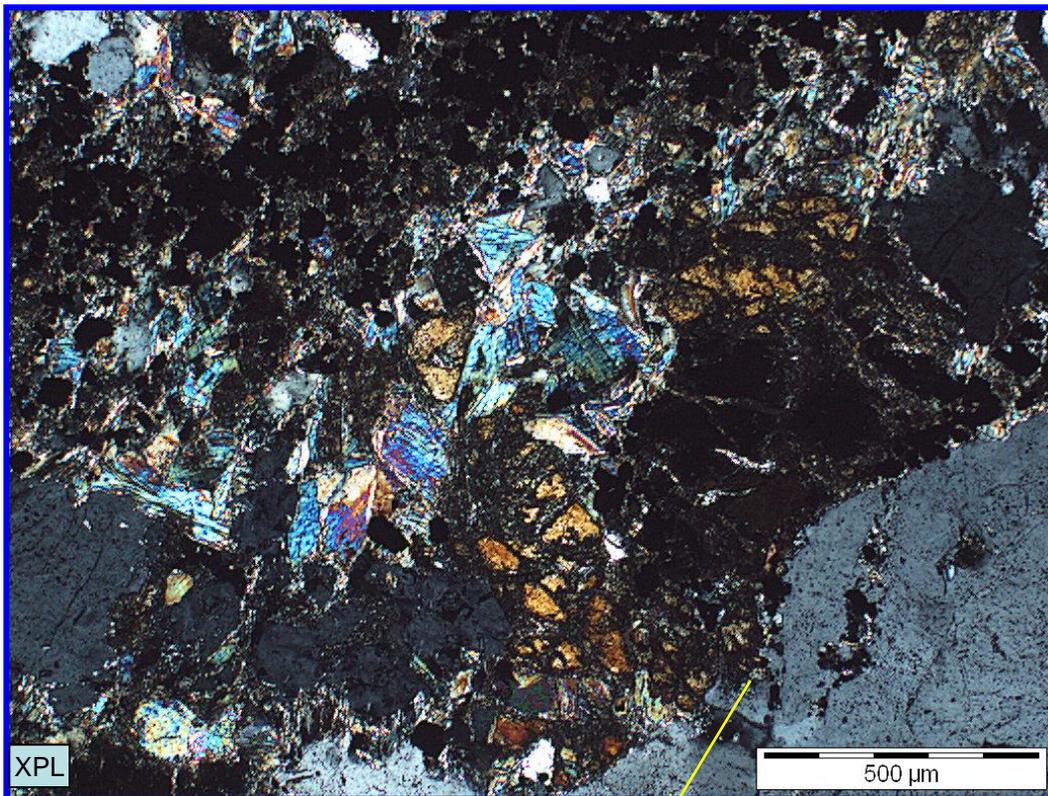
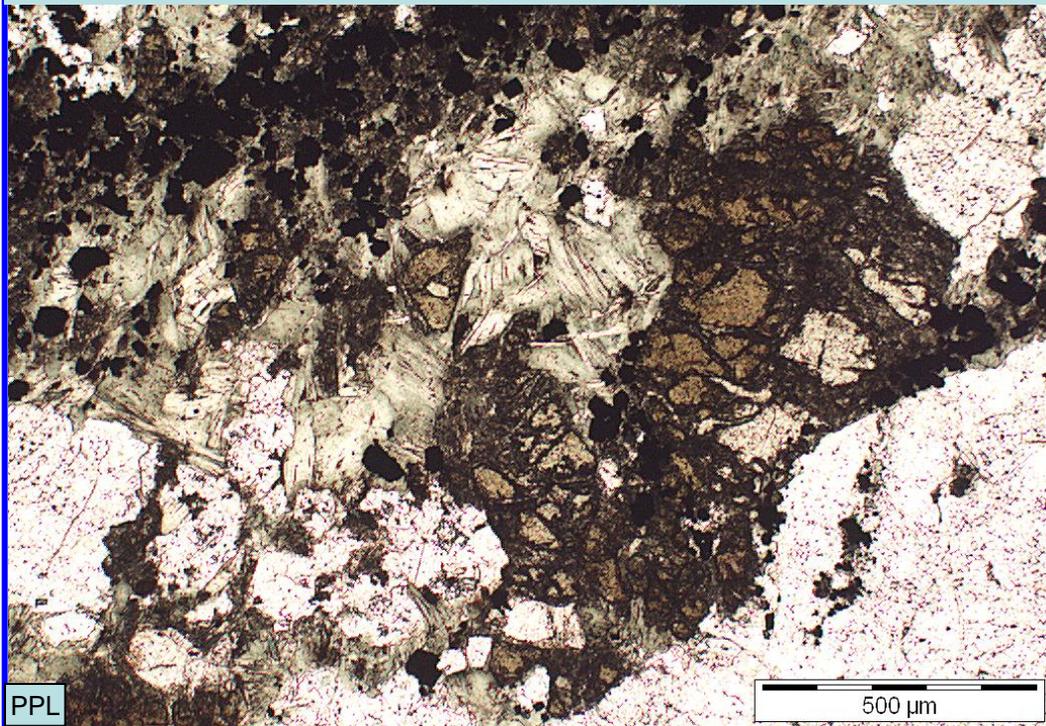
Mesh of fine-grained, cracked magnetite with texturally variable broken quartz and green biotite-chlorite on some fractures



SAMPLE NUMBER

SDD001 178.89-178.91m

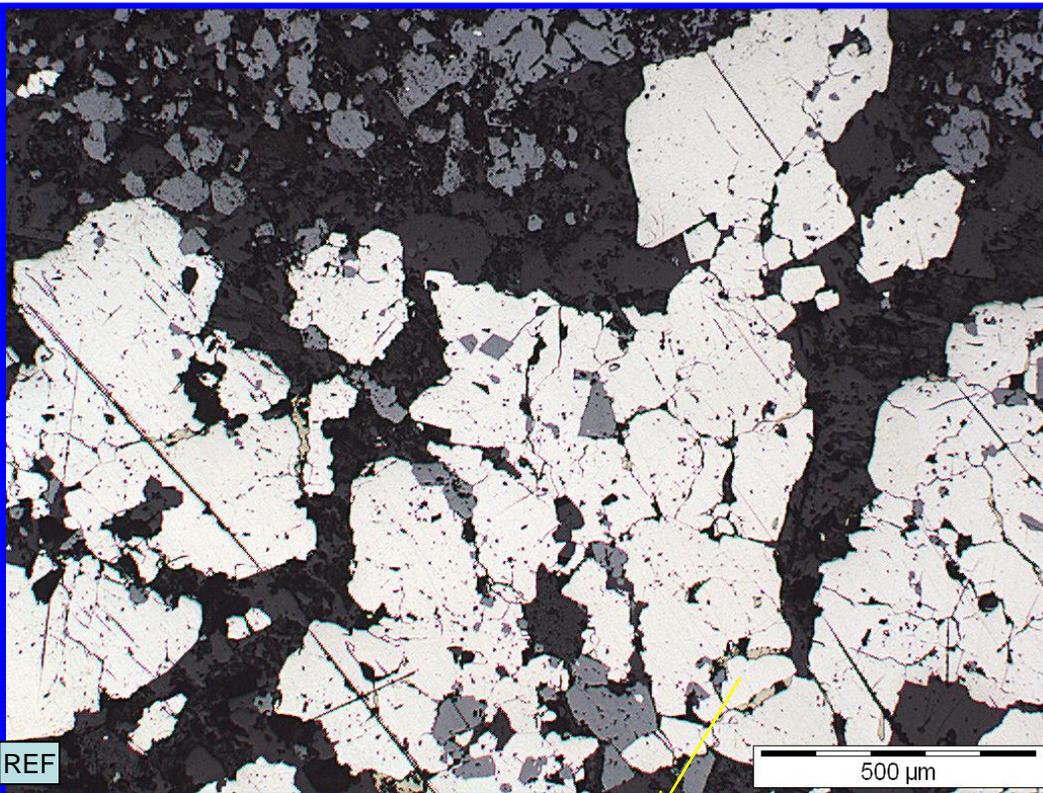
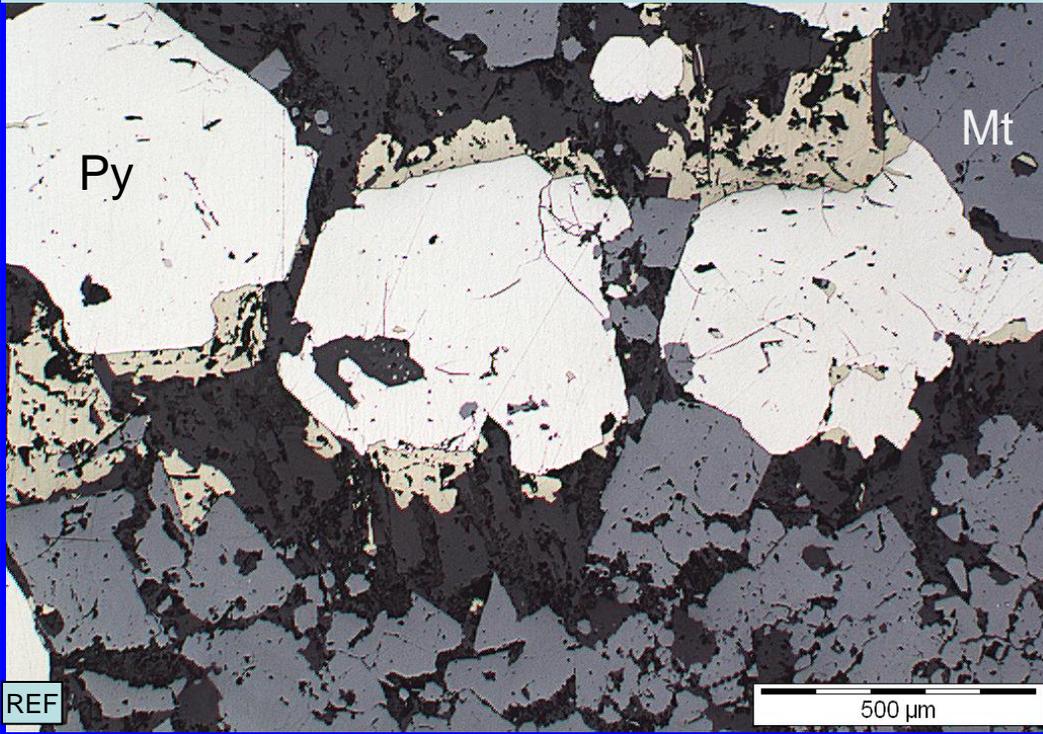
Green biotite and brown kaersutite with quartz (white)



SAMPLE NUMBER

SDD001 178.89-178.91m

Pyrite trail in magnetite with marginal chalcopyrite



SAMPLE NUMBER

SDD001 196.98-196.99m

SUMMARY

This rock is difficult to diagnose with confidence but appears to be a volcanoclastic sandstone rich in vitric ash and formerly glassy felsic lava fragments as well as small detrital quartz phenocryst clasts. The entire rock, including a band of magnetite-chalcopyrite-quartz alteration, is overprinted by intense sericite-carbonate (probably siderite or ankerite) alteration.



SAMPLE NUMBER

SDD001 196.98-196.99m

Thin Section Description

This is a strongly hydrothermally altered felsic volcanoclastic rock with quite poor textural preservation. Scattered small areas with less intense alteration show textures that range from almost snowflake-textured, quartzo-feldspathic intergrowths after formerly glassy aphyric felsic lava, to more clastic textures resembling matrix-supported volcanoclastic sandstone. Identification of bedding features in the diamond core section around this sample may help better diagnose the nature of the protolith.

Veining, Alteration, Mineralization

The strong hydrothermal alteration throughout this rock varies from an intense sericite-carbonate overprint with abundant 0.5mm-sized ovoid to rhombic porphyroblasts of rather dark (sideritic or ankeritic?) carbonate, to more quartzose patches that vary from relative coarse-grained crystalline to fine-grained, mottled and almost chalcedonic silica, both peppered with dark carbonate that in places shows a rusty orange colour indicating a significant Fe component. The coarser-grained quartzose patches carry about 2-5modal% of disseminated, fairly fine-grained pyrite.

A dark band at least 1.4cm wide cuts the rock and using a hand-held LED light on this unpolished sample, the opaque minerals are seen to be fine-grained magnetite with scattered chalcopyrite. Interstitial within the magnetite-dominated dark band are common ragged, anhedral quartz grains and patches, and spotty fine-grained carbonate, but essentially no sericite nor chlorite. Although evidence is not unambiguous, it appears that the sericite-carbonate alteration overprints the magnetite-dominant alteration assemblage.

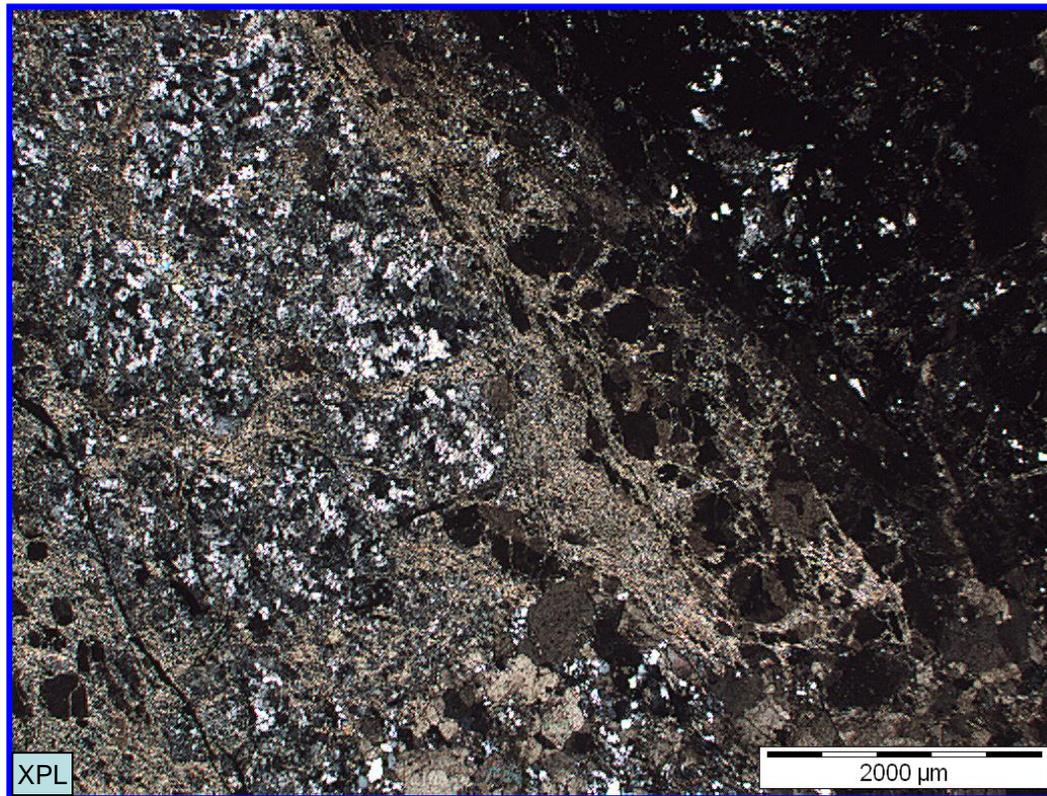
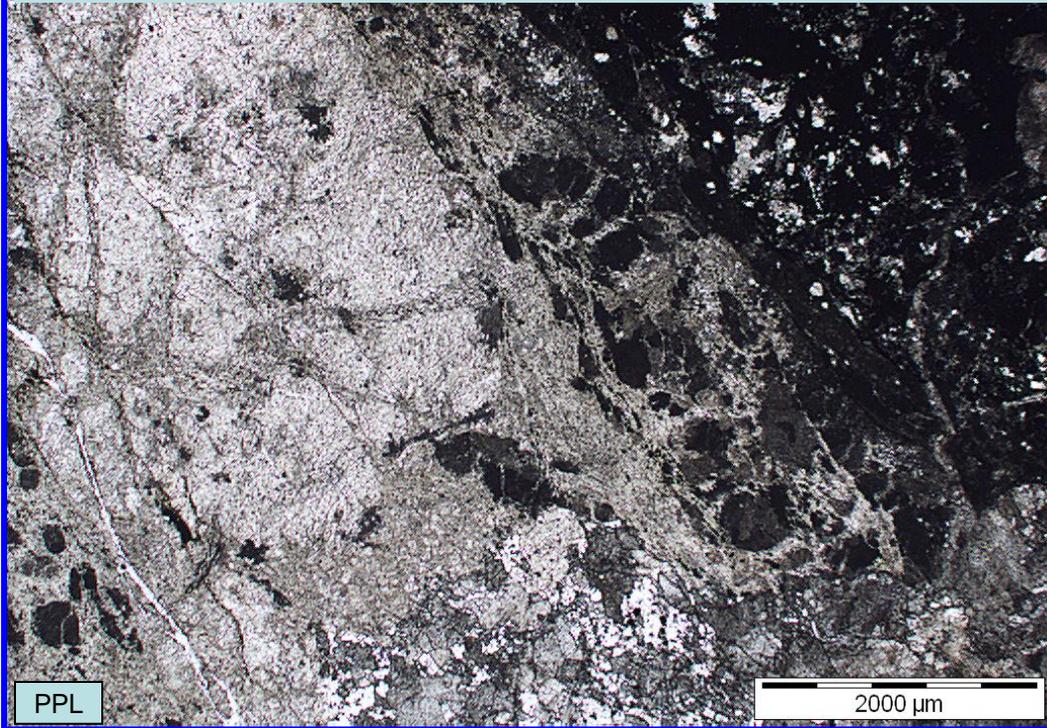
Other Comments

This protolith of this sample is quite difficult to diagnose with confidence although my best guess is that it was a volcanoclastic sandstone rich in reactive vitric ash and vitric lithic clasts of felsic lava. The intense sericite-carbonate alteration lacks the widespread green biotite-chlorite noted in the preceding samples, and appears to post-date and overprint the magnetite-rich alteration.

SAMPLE NUMBER

SDD001 196.98-196.99m

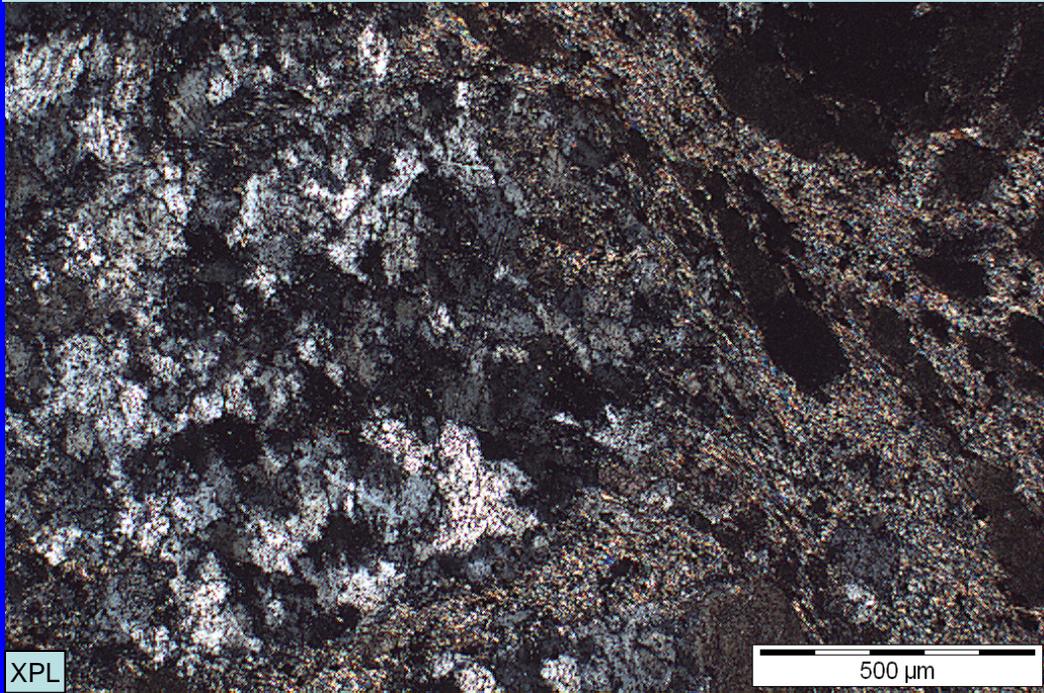
Contact between magnetite-quartz and sericite-carbonate alteration



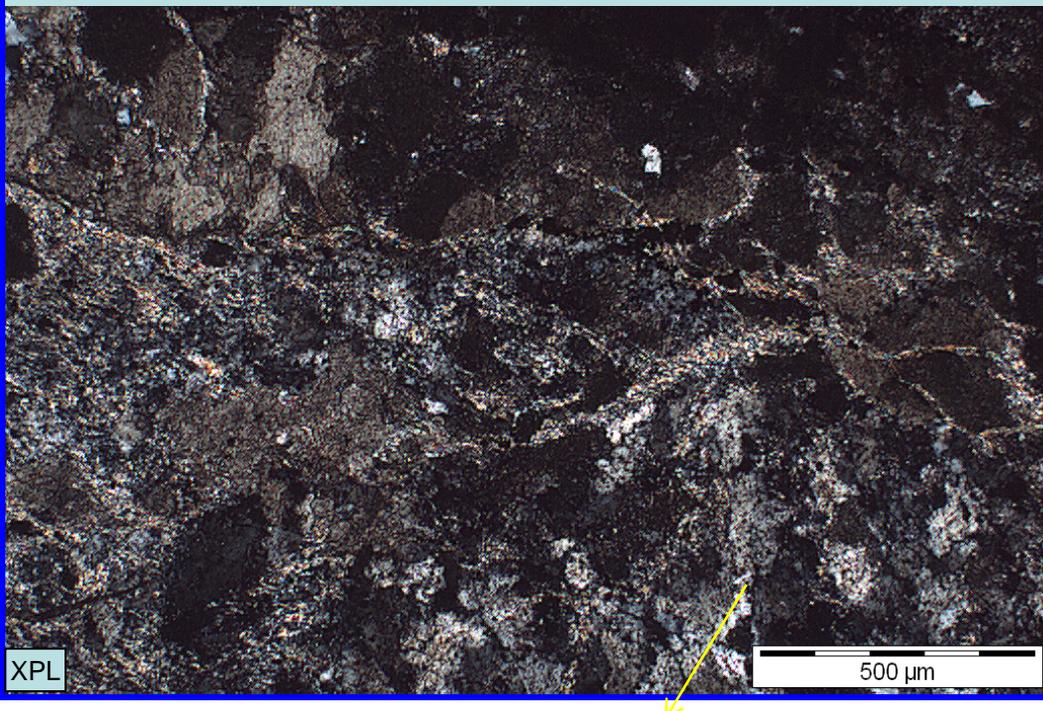
SAMPLE NUMBER

SDD001 196.98-196.99m

Lithic clast of formerly glassy felsic lava now devitrified to a mosaic quartzo-feldspathic intergrowth



Mosaic-textured quartzo-feldspathic intergrowth after glass overprinted by dark carbonate and subordinate sericite



SAMPLE NUMBER

SDD001 210.20-210.22m

SUMMARY

This rock is a poorly sorted volcanoclastic sandstone in which the detrital fraction is dominated by formerly glassy felsic lava clasts and quartz phenocryst debris. The matrix is strongly altered to dark magnetite-tourmaline-minor sericite+carbonate intergrowths with scattered pyrite (5modal%) but insignificant chalcopyrite. It probably derives from the same protolith as the more strongly altered preceding sample from 178.89m.



SAMPLE NUMBER

SDD001 210.20-210.22m

Thin Section Description

Despite strong hydrothermal alteration-mineralization, this rock preserves clearly textural evidence indicating unambiguously that it was a volcanoclastic fine sandstone with interbedded siltstone laminae, with the detritus derived entirely from a felsic, quartz-phyric volcanic terrain. The sandstone was matrix-supported and very poorly sorted, with clasts rarely larger than 1.5mm across. Most readily identified are detrital quartz phenocrysts and phenocryst fragments, which are sometimes subhedral and sometimes quite ovoid or rounded due to magmatic resorption. Harder to pick in many instances are subangular to subrounded lithic fragments, almost all of which are former glassy felsic lavas now represented by mosaic-textured quartzo-feldspathic intergrowths. The matrix of this sandstone is intensely hydrothermally altered, varying from turbid fine-grained carbonate-sericite in places, to darker domains in which the matrix contains abundant fine-grained magnetite, common small prisms of blue-green tourmaline, and variable amounts of fine-grained sericite and dark carbonate.

Veining, Alteration, Mineralization: Reflected Light Microscopy

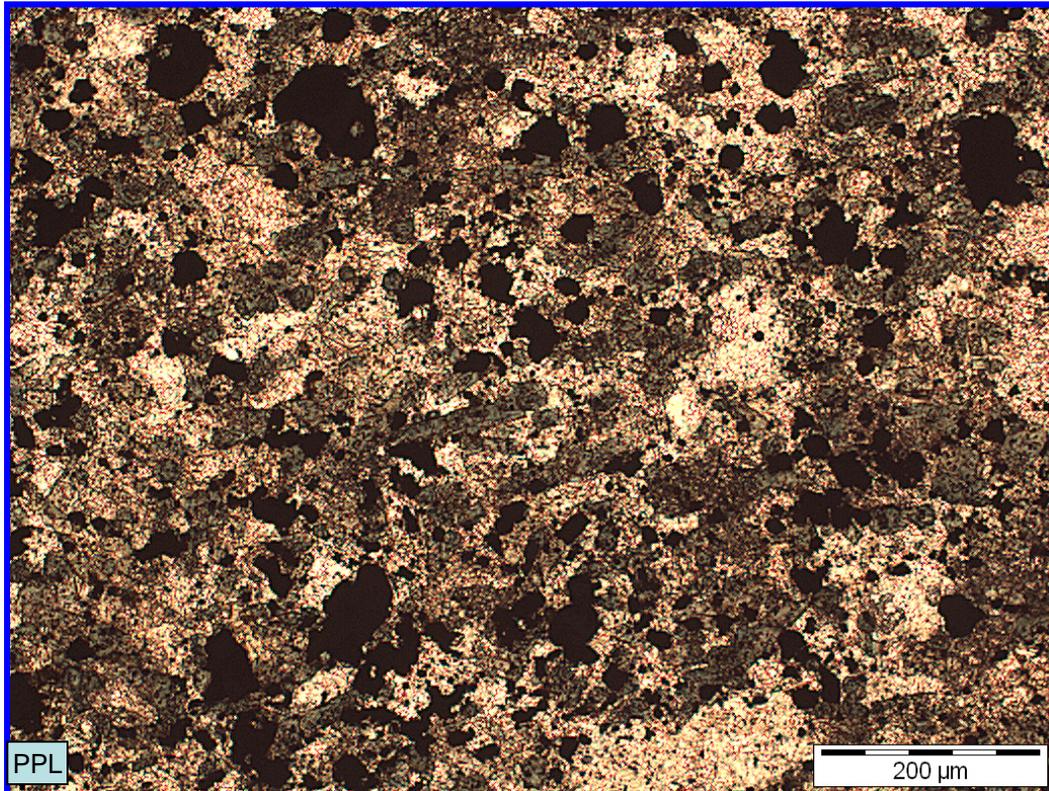
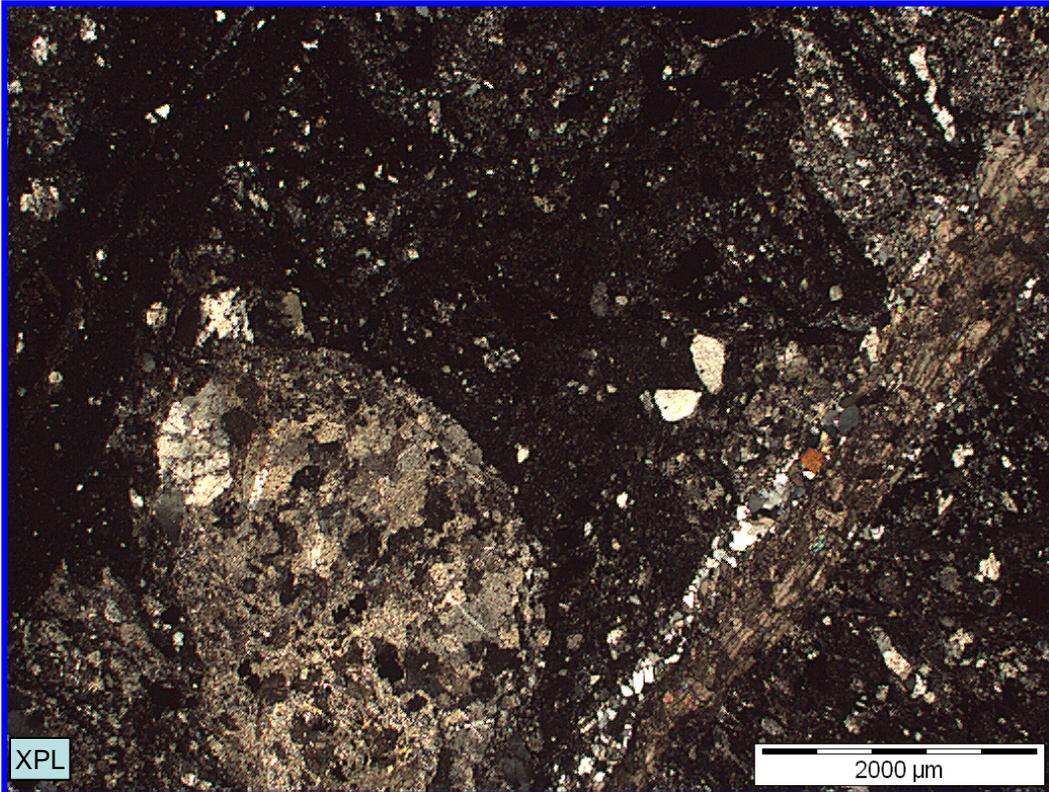
Reflected light shows the fine-grained, equant magnetite crystals scattered through the matrix of this rock. Locally, these form short trails and less commonly they cluster into larger aggregates that are speckled with tiny anhedral pyrite grains. Developed throughout the slide as small, scattered grains and occasional trails and streaks of anhedral, ragged pyrite grains mainly smaller than 1.5mm across, and occasionally containing small chalcopyrite inclusions, especially filling fractures. Many pyrite grains have a reacted margin, with 'nibbled' edges indicating significant dissolution. Chalcopyrite is modally insignificant in this rock, occurring as rare splashes in the matrix and making up <<1modal% of the sample.

Other Comments

This rock is likely to be derived from the same protolith as the preceding, much more altered sample from 196.98m depth in this drillhole. It lacks the intense sericite-carbonate overprint of the latter sample, suggesting that the carbonate-sericite alteration may be structurally controlled.

SAMPLE NUMBER

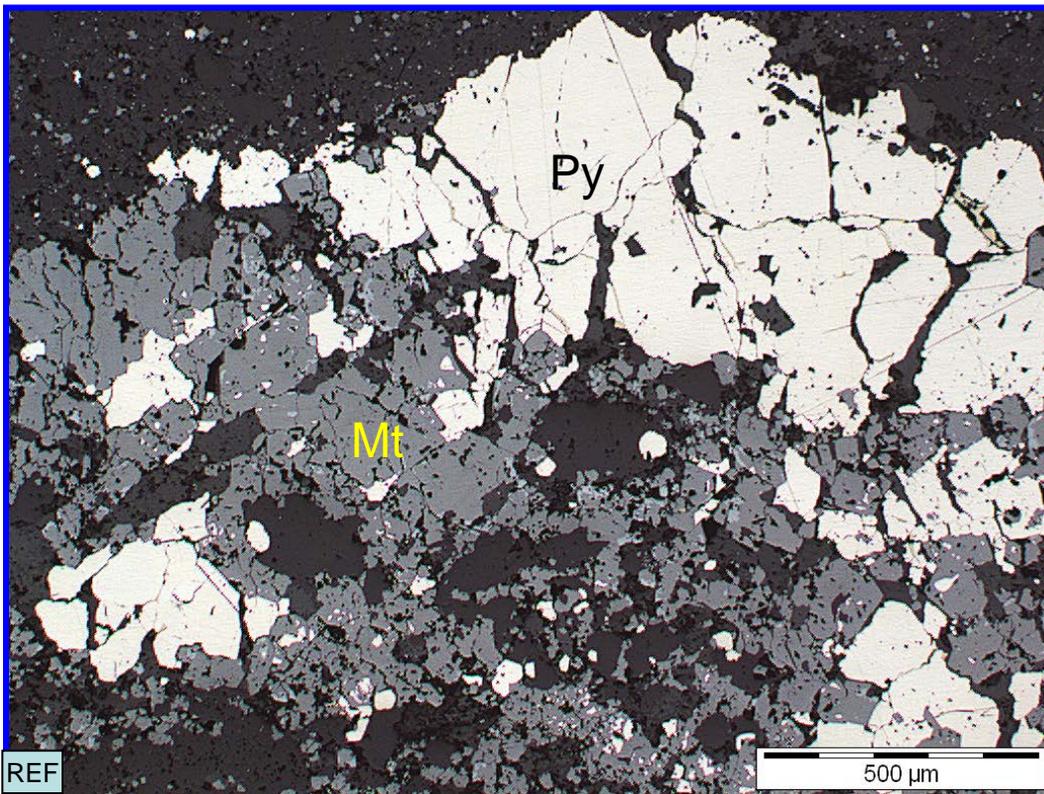
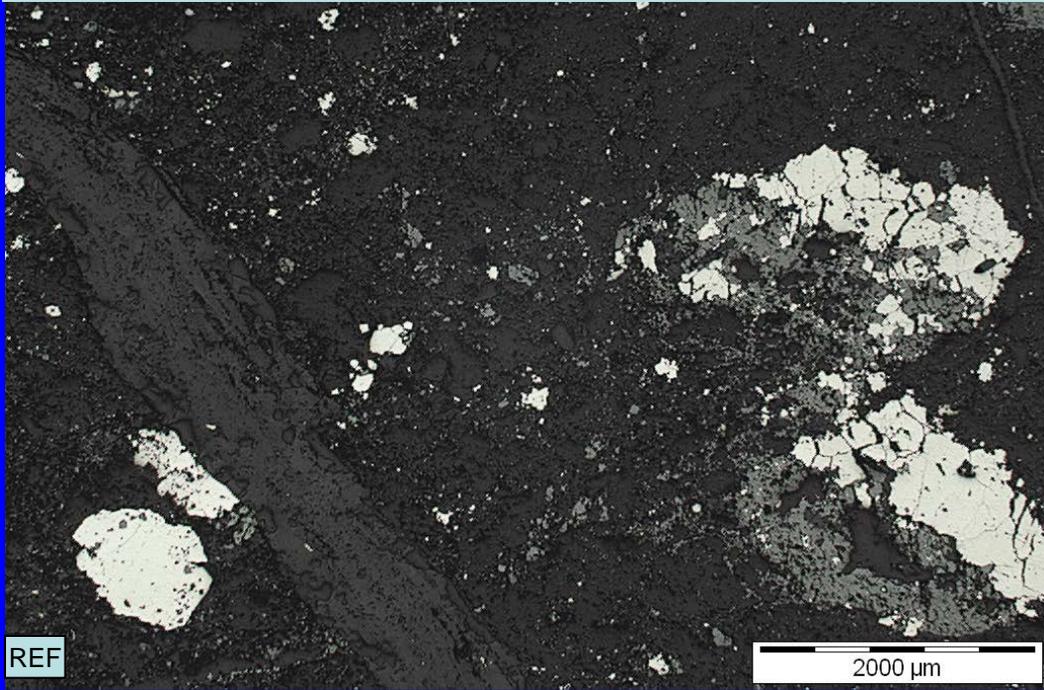
SDD001 210.20-210.22m



SAMPLE NUMBER

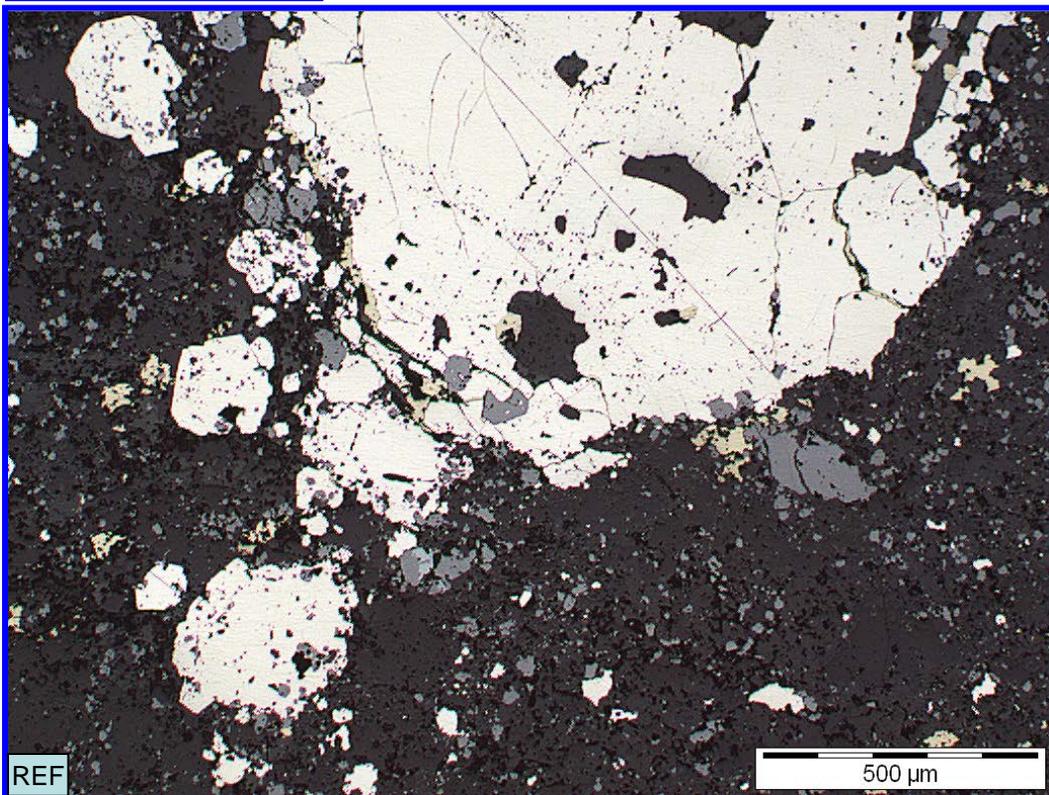
SDD001 210.20-210.22m

Scattered ragged pyrite grains and aggregates and associated fine-grained magnetite, and narrow carbonate veinlet on left.

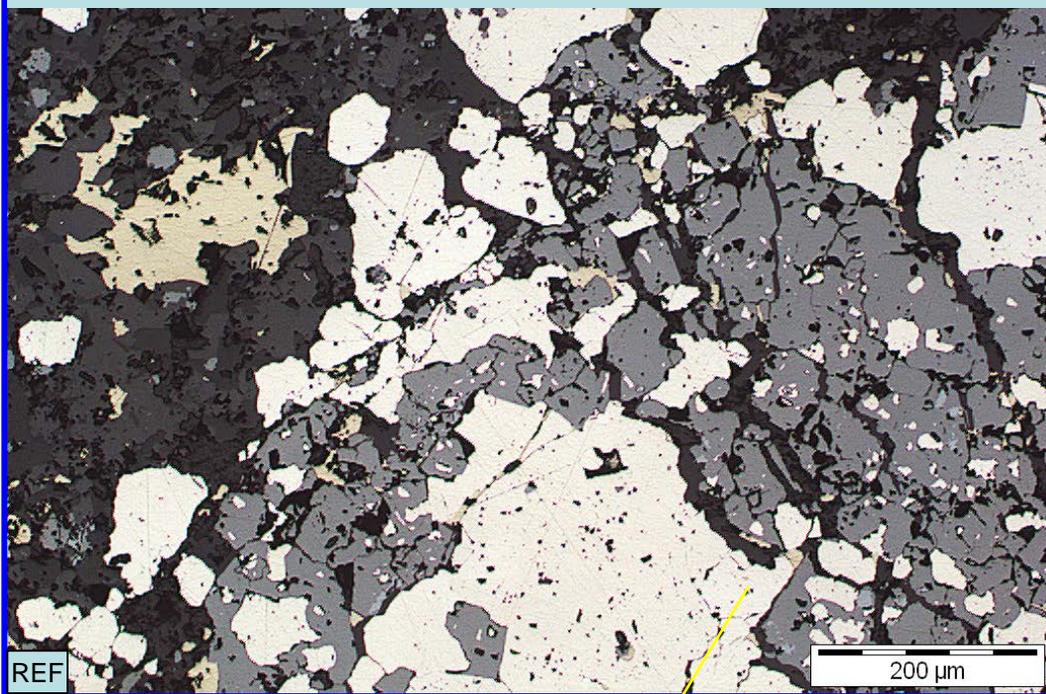


SAMPLE NUMBER

SDD001 210.20-210.22m



Typical occurrence of interstitial chalcopyrite with more abundant and robust pyrite and magnetite

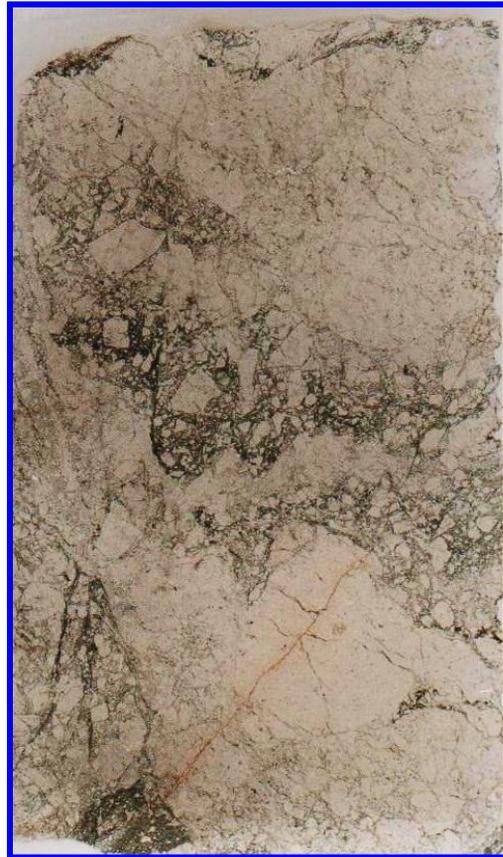
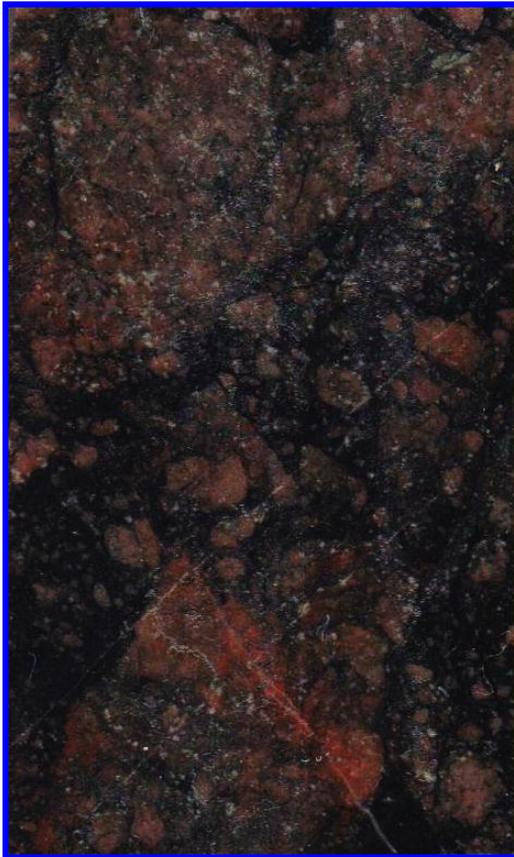


SAMPLE NUMBER

SDD001 239.84-239.86m

SUMMARY

This rock is a hydrothermal breccia formed by hydraulic fragmentation of an aphyric felsic lava with a micropoikilitic texture. Clasts in this sample are mainly smaller than 1cm, quite angular, unmilled, and the matrix (infill) consists largely of very fine-grained tourmaline and subordinate chlorite.



SAMPLE NUMBER

SDD001 239.84-239.86m

Thin Section Description

This is a strongly and quite finely brecciated, mainly clast-supported aphyric felsic lava in which fragments are petrographically identical, mainly smaller than 1cm across, notably angular, and generally touching. However, over much of the slide, the clasts do not show 'jigsaw fit' internal organization, and have clearly undergone some degree of rotation and disruption. All clasts show the same well developed micropoikilitic quartzo-feldspathic texture. The feldspathic component is lightly to moderately sericite-altered, and narrow veinlets of murky chlorite-carbonate intergrowths are common in most clasts. The breccia matrix is an extremely fine-grained, turbid aggregate that is dominated by abundant, exceedingly fine-grained tourmaline.

Veining, Alteration and Mineralization

Alteration in this rock is largely restricted to the murky matrix areas (breccia infill) between paler clasts, and as noted above, appears to be dominantly very fine-grained tourmaline. Less abundant but not uncommon in the matrix areas are patches of green chlorite and occasional late, well formed rhombs of pale carbonate. Tiny equant magnetite crystals are scattered through both the clasts and the matrix in similar amounts, although making up only a tiny modal proportion of this rock.

Other Comments

This is probably a hydrothermal breccia formed by hydraulic brecciation of a previously massive or weakly autoclastic felsic lava. The distinctive micropoikilitic texture of this aphyric rhyolite or rhyodacite is characteristic of rapidly cooled felsic lavas in which quenching was not rapid enough to form glass. The variable brecciation, angular clasts lacking obvious milling and rounding, and absence of reaction margins on clasts, suggest that this breccia formed by hydraulic brecciation driven by hydrothermal fluids responsible for the precipitation of the abundant fine-grained matrix tourmaline. Better understanding of the nature of this alteration requires drillcore/outcrop information to define the geometry of the breccia and spatial variation in its mineralogy.

SAMPLE NUMBER

SDD001 239.84-239.86m

PPL

PPL

SAMPLE NUMBER

SDD001 239.84-239.86m

PPL

XPL



SAMPLE NUMBER

SDD002 128.26-128.3m

SUMMARY

This section samples the contact between a formerly glassy, sparsely Kspar-phyric rhyolitic lava clast(?) and an adjacent sericite+chlorite-dominated matrix domain. The clast shows strong Kspar veining, and local recrystallization of the devitrified glassy groundmass to Kspar indicates that Kspar alteration is pervasive despite the fine grainsize. Late carbonate veining and scattered rhombs overprint the Kspar+sericite, and sericite+chlorite alteration.



SAMPLE NUMBER

SDD002 128.26-128.3m

Thin Section Description

This thin section samples the contact between a red felsic volcanic clast(?) at least 3cm across, and dark matrix. In thin section, the red volcanic clast is seen to be a sparsely Kspar-phyric rhyolitic lava with an exceedingly fine-grained groundmass presumably developed from devitrification of glass, and heavily peppered with very fine-grained sericite. The rare mm-sized blocky Kspar phenocrysts are lightly sericitized. The passage from the clast margin to the dark matrix is marked by a sharp increase in the intensity of sericite development, with streaks of chlorite occurring commonly within the dense sericite intergrowths.

Veining, Alteration and Mineralization

This lava clast is transected by numerous narrow Kspar veinlets and localized spots that are locally intense enough to brecciate the lava and generate small-scale jigsaw-fit textures. Where this small-scale brecciation is best developed, the adjacent host rock has recrystallized to patchy, coarser-grained Kspar aggregates. There is no sign of tourmaline in this rock, but small, often drawn-out patches of fine-grained pyrite and one pyrite aggregate ~2mm across are present. Small pale carbonate rhombs and narrow veinlets of the same phase cut and overprint the earlier alteration.

Other Comments

Without a detailed log of the immediately surrounding drill core it is difficult to know the exact geological context of this sample, but it appears to be a lava clast from a zone of either structural dislocation or brecciation. The alteration assemblage is dominated by Kspar and marked by the distinctive brick red colour of the altered clast in this thin section. The alteration assemblage lacks the common tourmaline that was present in a number of the preceding samples, and a feature of the hydrothermally brecciated samples.

SAMPLE NUMBER

SDD002 128.26-128.3m

XPL

XPL

SAMPLE NUMBER

SDD002 128.26-128.3m

XPL

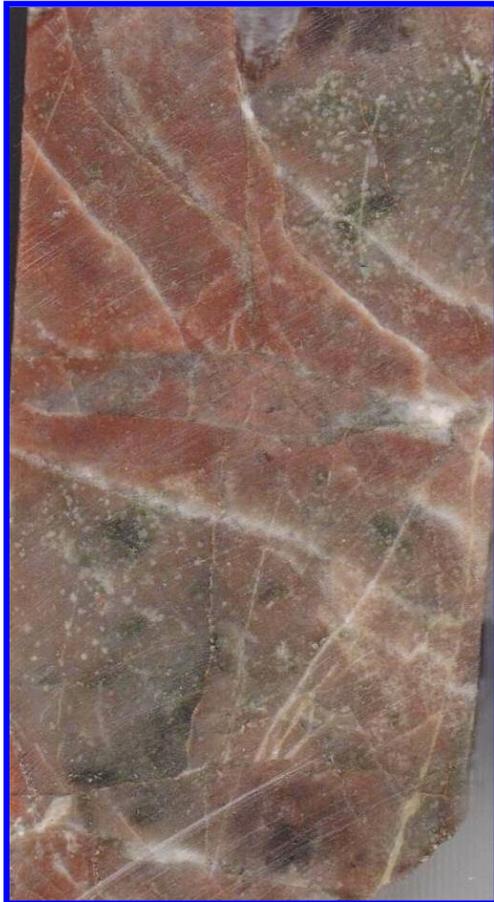
XPL

SAMPLE NUMBER

SDD002 199.71-199.73m

SUMMARY

This rock is an aphyric, micropoikilitic-textured felsic lava, probably a rhyolite. Alteration is weak to moderate and dominated by quartz-sericite, with late carbonate veining, and no chlorite, tourmaline or significant magnetite.



SAMPLE NUMBER

SDD002 199.71-199.73m

Thin Section Description

In the less altered and recrystallized parts of this slide, this rock is an aphyric felsic lava, probably a rhyolite, with a well developed micropoikilitic texture. The latter is defined by individual sub-0.1mm 'cells' in which a small quartz core is surrounded by mottled, almost granophyric quartzo-feldspathic intergrowths that merge with their neighbours. Changes in the grain size of this quartzo-feldspathic intergrowth mainly reflect the extent of post-solidification recrystallization, which is expressed as common anhedral patches of polycrystalline quartz, producing an almost 'snowflake' texture.

Veining, Alteration and Mineralization

This sample is less altered than the preceding samples, with alteration limited to patchy but widespread, very fine-grained sericite overprinting the feldspathic component of the quartzo-feldspathic intergrowths, and in places, forming patches to 4-5mm across. Late, narrow carbonate veinlets, and a few more robust quartz-carbonate veinlets, are common throughout the sample, which lacks both chlorite and tourmaline. Magnetite is present in insignificant amounts as tiny crystals in a few small clusters in the altered groundmass.

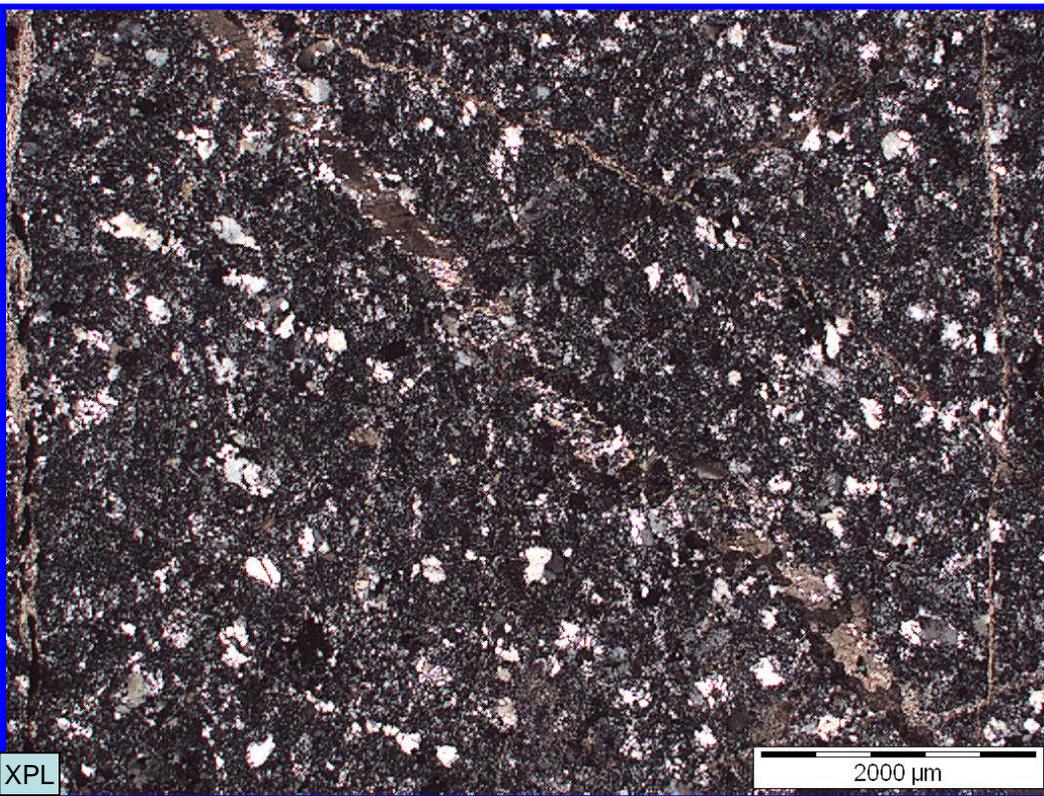
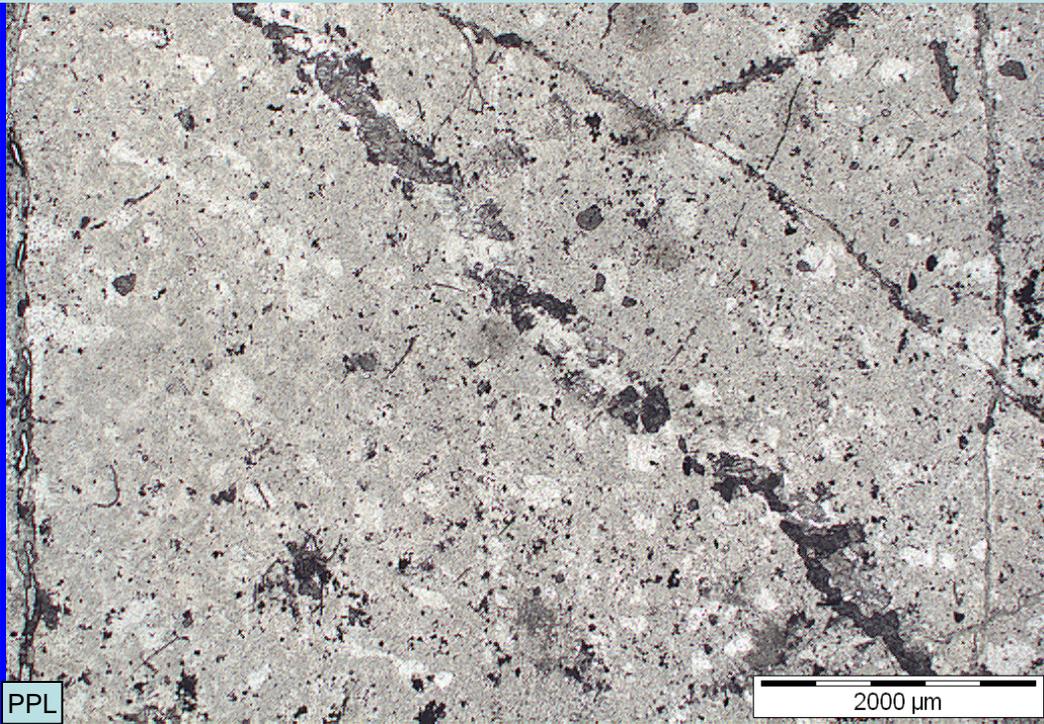
Other Comments

The alteration in this sample (quartz-sericite-late carbonate) is less intense than the Kspar-dominant alteration in the lava clast from previous sample from this hole, and far less intense than in the samples from SDD001.

SAMPLE NUMBER

SDD002 199.71-199.73m

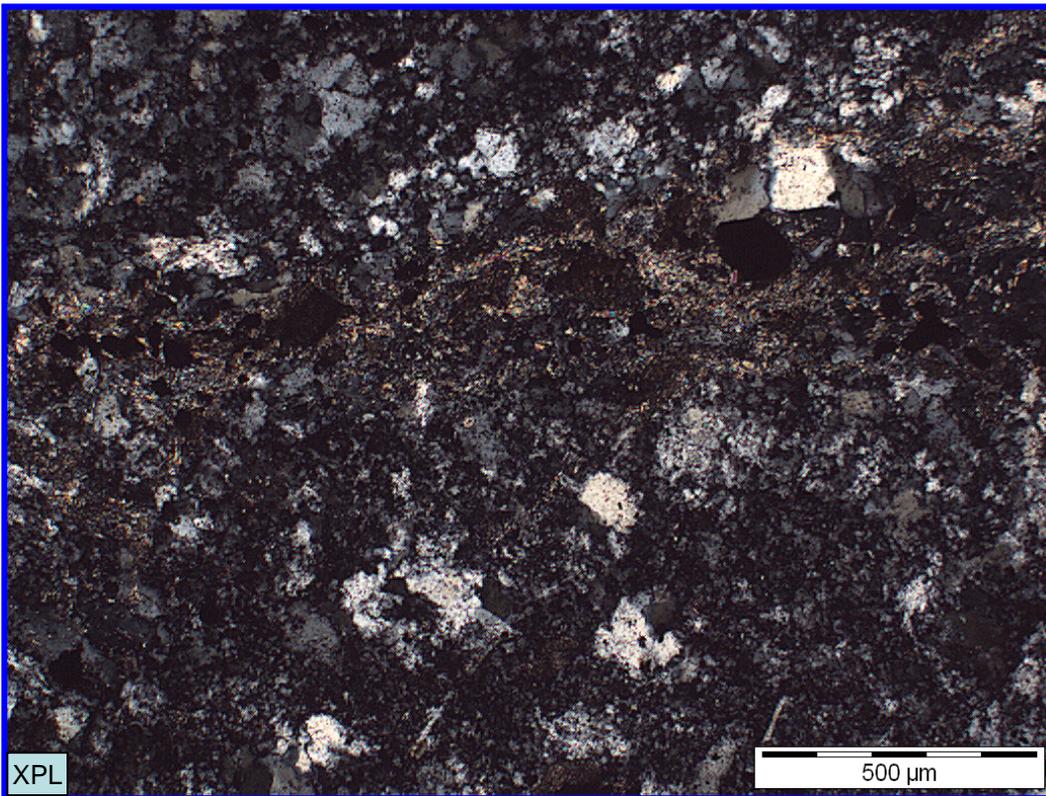
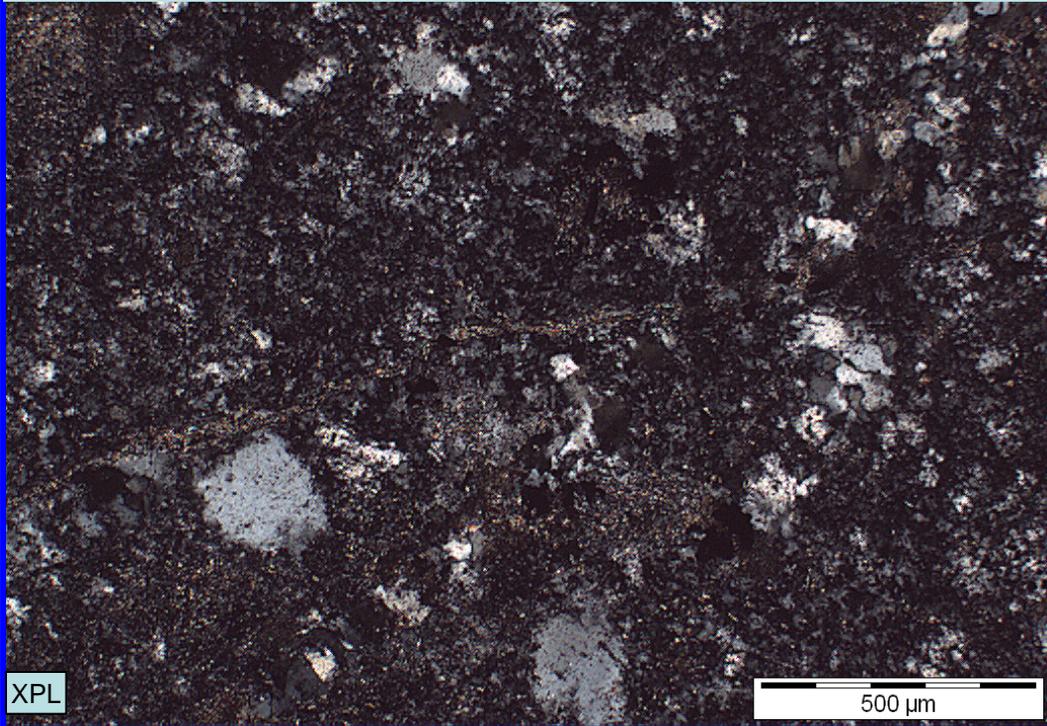
Micropoikilitic-textured groundmass with late carbonate-quartz vein



SAMPLE NUMBER

SDD002 199.71-199.73m

Detail of micropoikilitic-textured groundmass



SAMPLE NUMBER

SDD003 32.19-32.21m

SUMMARY

The protolith of this rock was probably a glassy felsic lava, but the primary texture and mineralogy has been obliterated by intense, multi-stage alteration that has produced a pervasive quartz - green biotite – apatite – magnetite assemblage, lacking chalcopyrite.



SAMPLE NUMBER

SDD003 32.19-32.21m

Thin Section Description

This intensely hydrothermally altered rock has undergone multi-stage brecciation and alteration, and preserves few clues as to the nature of the protolith. Vague suggestions of a former quartzo-feldspathic texture like that in recrystallized, devitrified glassy felsic lavas suggest that the protolith may have been a glassy felsic lava, but no obvious quartz phenocrysts or altered feldspar phenocrysts can be discerned. The rock consists of a complex and texturally variable intergrowth of quite coarsely crystalline quartz, elongate ragged-edged apatite crystals and abundant very fine-grained magnetite, surrounded by or immersed in rather coarse-grained green biotite. Abruptly terminated quartz veins, sharp textural changes, and sharp changes in the alteration mineralogy all suggest that this rock has been repeatedly brecciated and veined.

Veining, Alteration and Mineralization

The dominant alteration minerals in this rock are:

- 1: abundant green biotite, which varies enormously in grain size from very fine-grained aggregates to intergrowths of 1-2mm-sized crystals,
- 2: fine-grained magnetite that occurs in sharply defined patches, as well as trails and veinlets in the biotite, its distribution providing a good visual record of the repeated fine-scale brecciation of this rock. Fractures between dense magnetite intergrowths are filled by fine-grained green biotite, minor quartz and trails of extremely fine-grained magnetite.
- 3: apatite, present as rather ragged prismatic crystals to 2mm long, making up perhaps 10modal% of this rock, usually embedded within the green biotite.

Occasional bands comprising tan-brown monazite aggregates and associated turbid, fine-grained amorphous aggregates of the same phase are present in places but are not common. Examination of this unpolished slide with a hand-held LED light suggests there is no chalcopyrite associated with the abundant fine-grained magnetite in this rock.

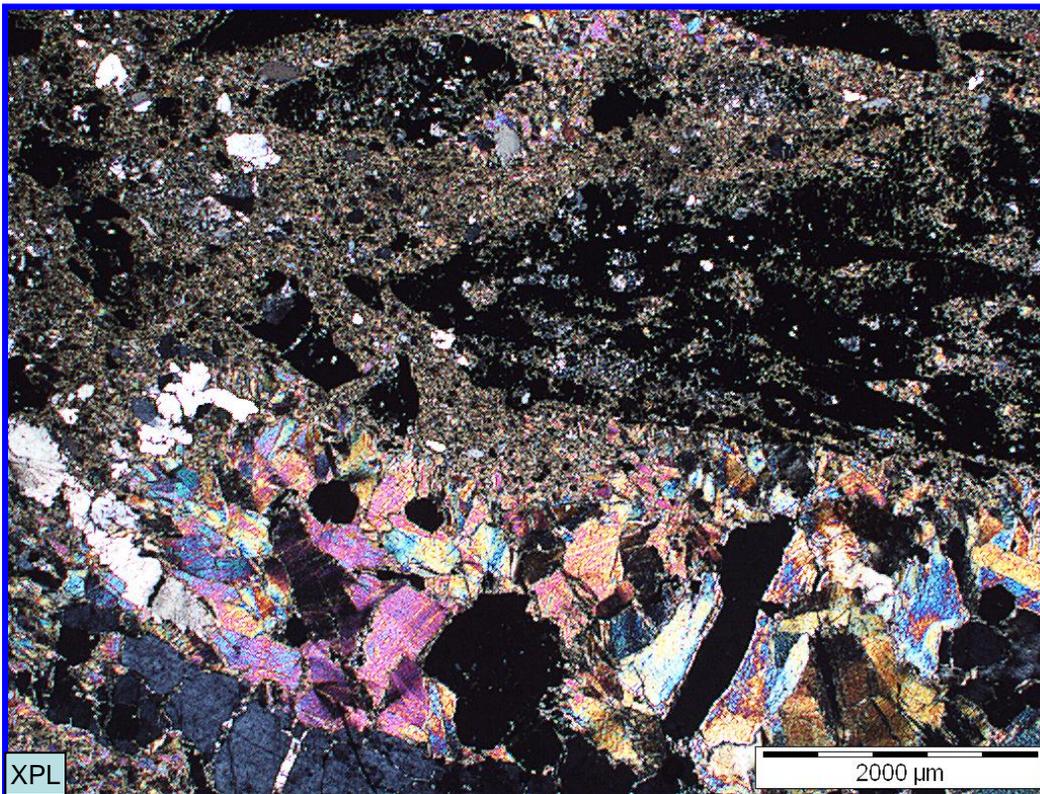
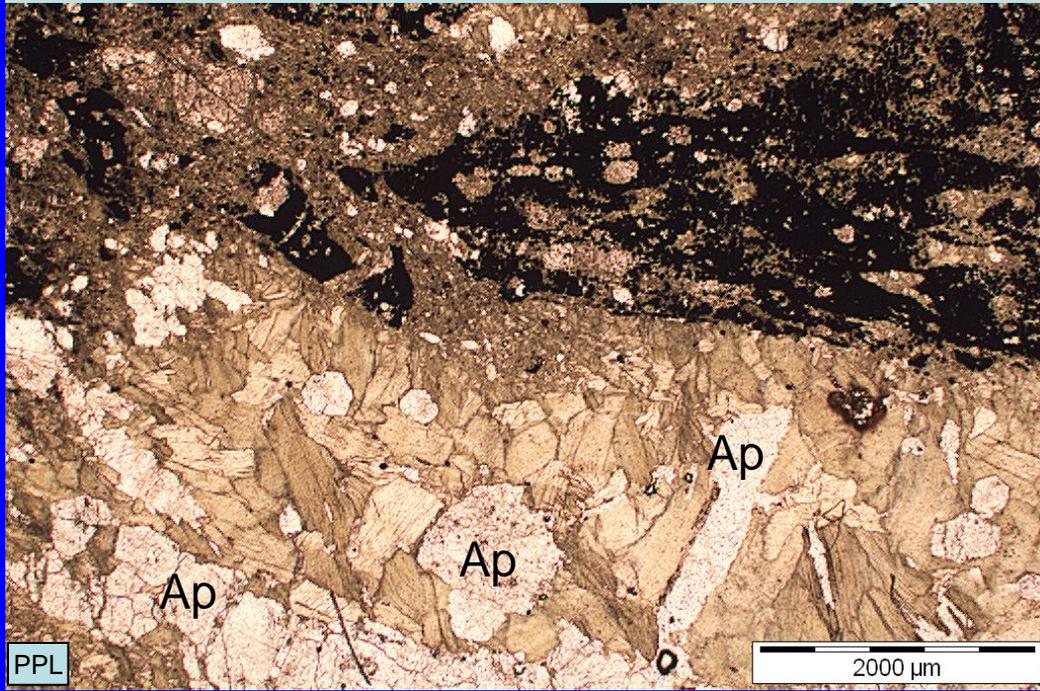
Other Comments

This apatite-biotite-magnetite-monazite alteration assemblage in this rock is well developed, and similar to that in SDD001 123.82-123.84m, although green biotite is more abundant and chalcopyrite absent in this sample.

SAMPLE NUMBER

SDD003 32.19-32.21m

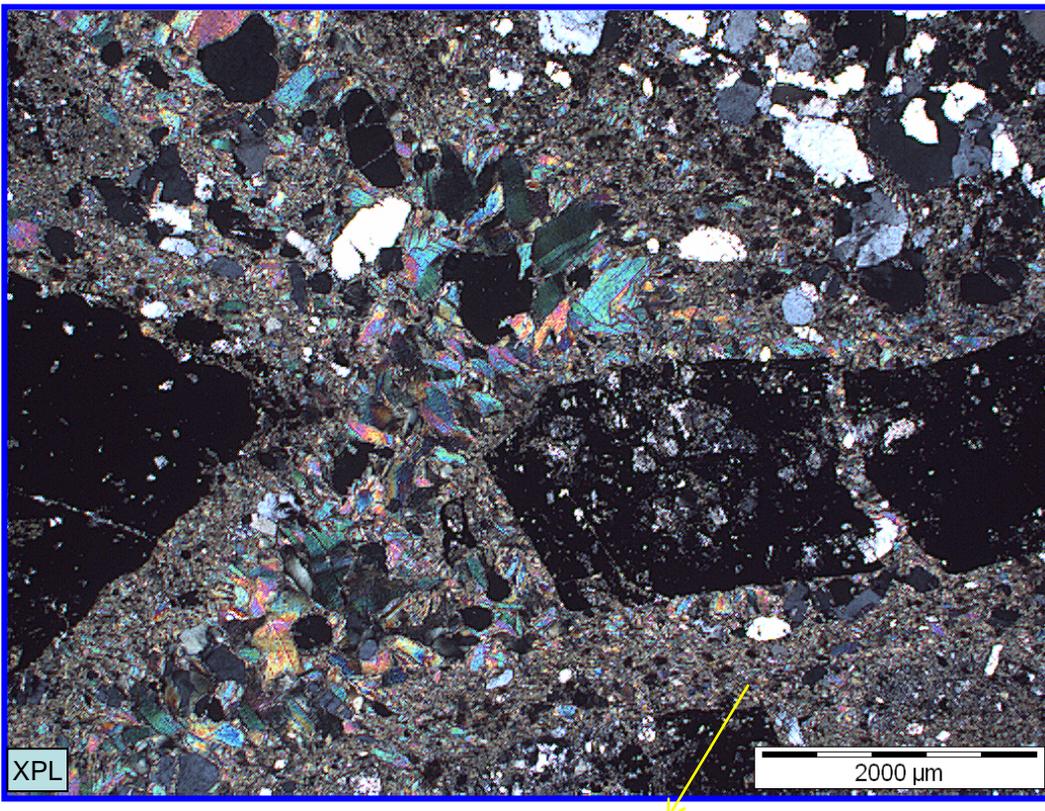
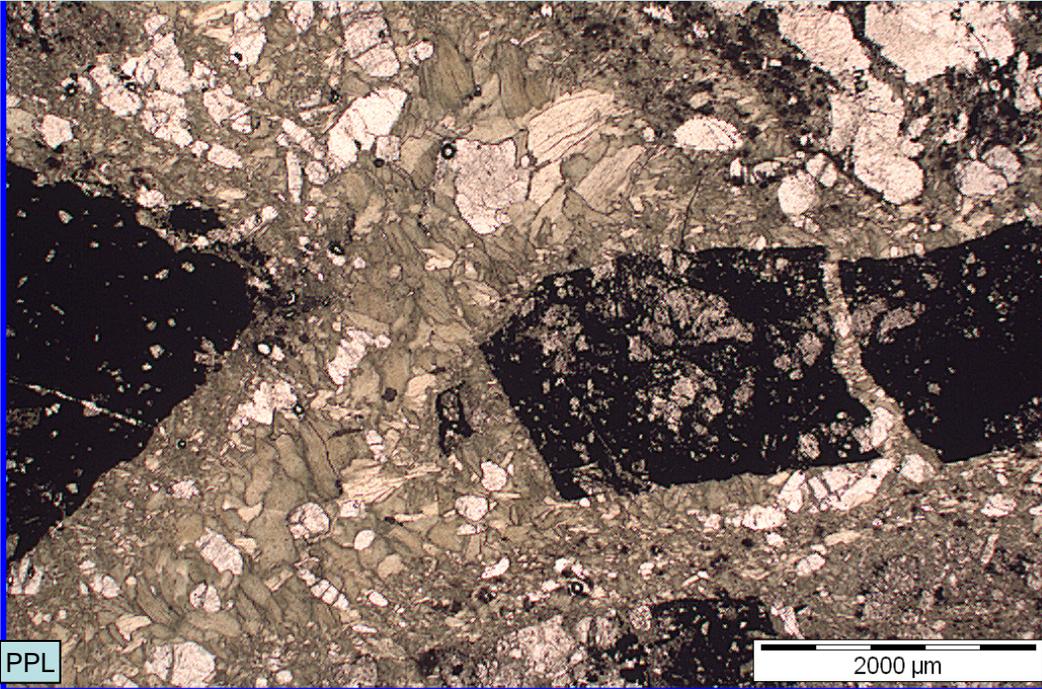
Repeatedly brecciated and veined magnetite-apatite-green biotite alteration assemblage



SAMPLE NUMBER

SDD003 32.19-32.21m

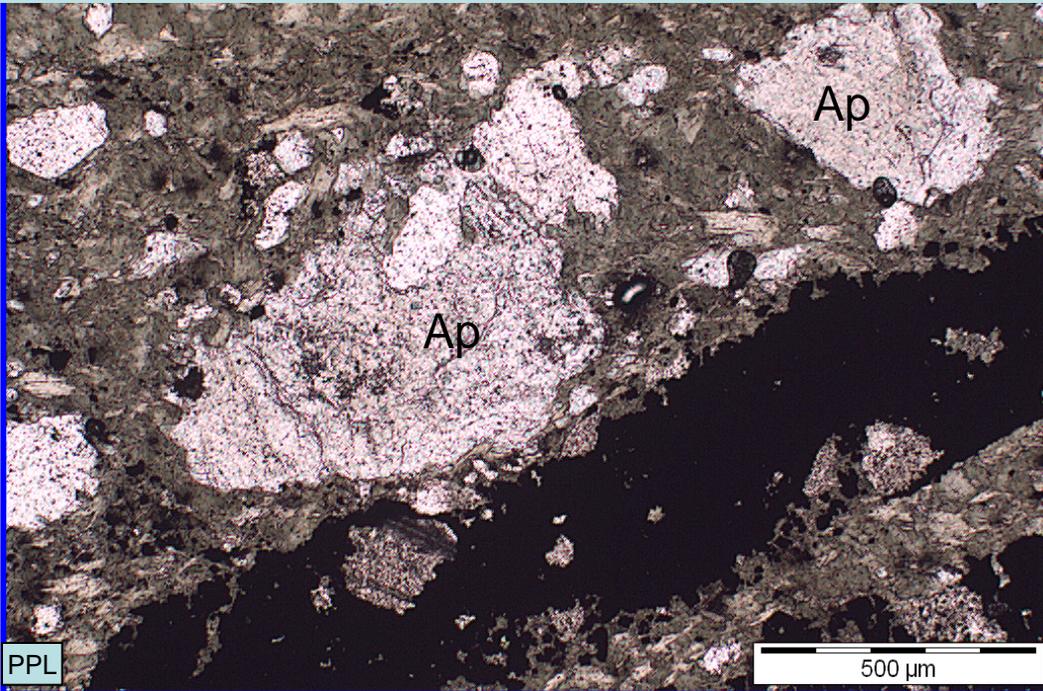
Repeatedly brecciated and veined magnetite-apatite-green biotite alteration assemblage



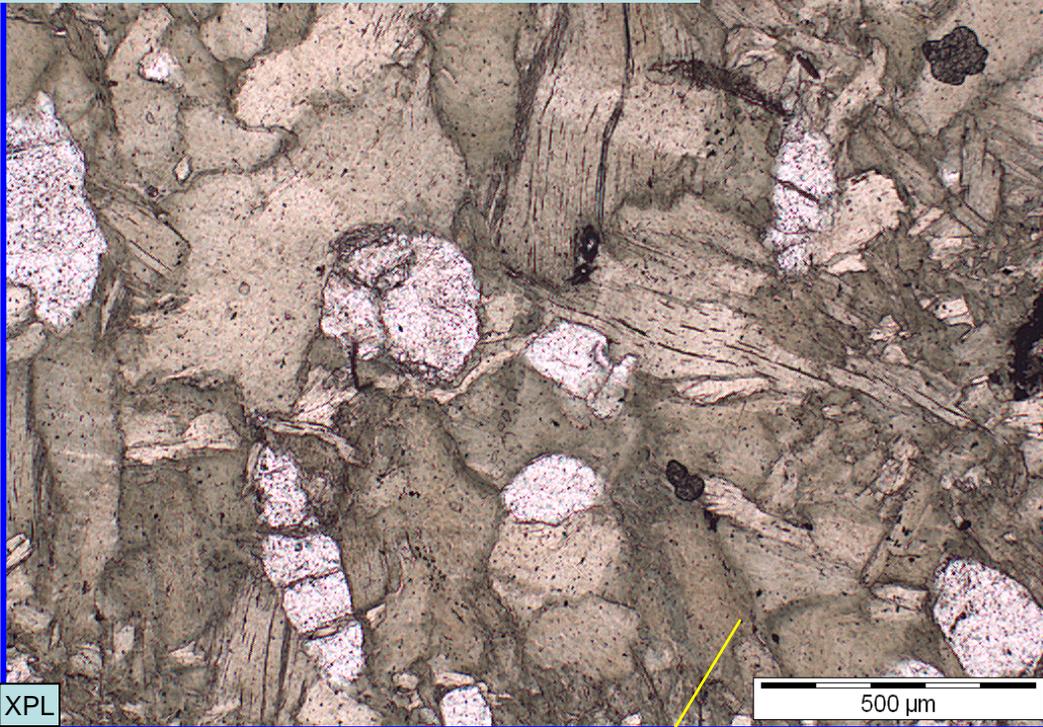
SAMPLE NUMBER

SDD003 32.19-32.21m

Coarse, ragged apatite prisms, fine-grained green biotite and aggregates of fine-grained magnetite



Coarse-grained green biotite and apatite prisms



SAMPLE NUMBER

SDD003 130.98-131.00m

SUMMARY

This is a well preserved, strongly quartz+feldspar-phyric rhyolitic lava or very shallow intrusive rock with an excellent micropoikilitic groundmass.

Alteration is limited to sericitization of the feldspar phenocrysts and weak chlorite spotting throughout the rock.



SAMPLE NUMBER

SDD003 130.98-131.00m

Thin Section Description

This is a texturally very well preserved, weakly altered, strongly quartz+feldspar-phyric felsic lava with an excellent micropoikilitic groundmass. Quartz phenocrysts constitute 15-20 modal% of the sample and are present as well formed to slightly magmatically resorbed prisms to around 5mm long. Slightly less abundant but well represented are 1-4mm-sized blocky feldspar phenocrysts now totally replaced by fine-grained sericite, so that it is not possible to determine whether they were plagioclase, Kspar or both. A few former biotite phenocrysts are replaced by green chlorite and tiny spots of titanite/leucoxene, and scattered small, equant former FeTi oxides are replaced by leucoxene. These phenocrysts are set in a textbook example beautifully preserved micropoikilitic textured, quartzo-feldspathic groundmass with weak sericite alteration and spotty secondary green chlorite.

A number of well formed quite large zircons were also noted.

Veining, Alteration and Mineralization

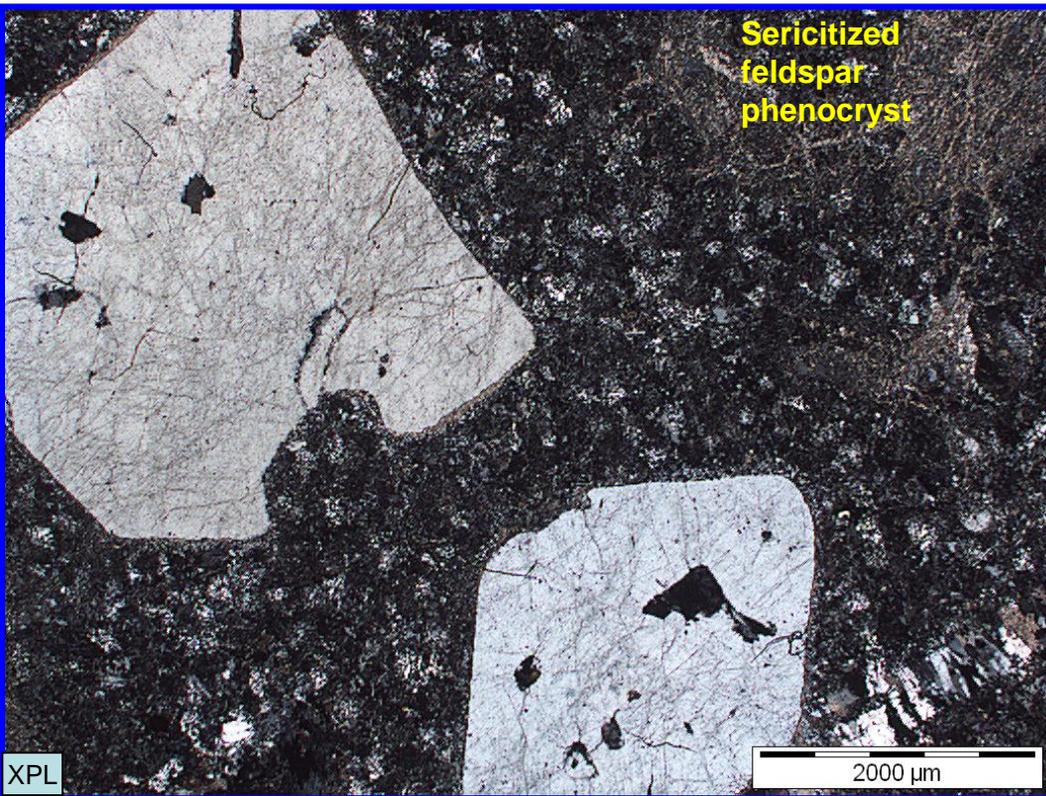
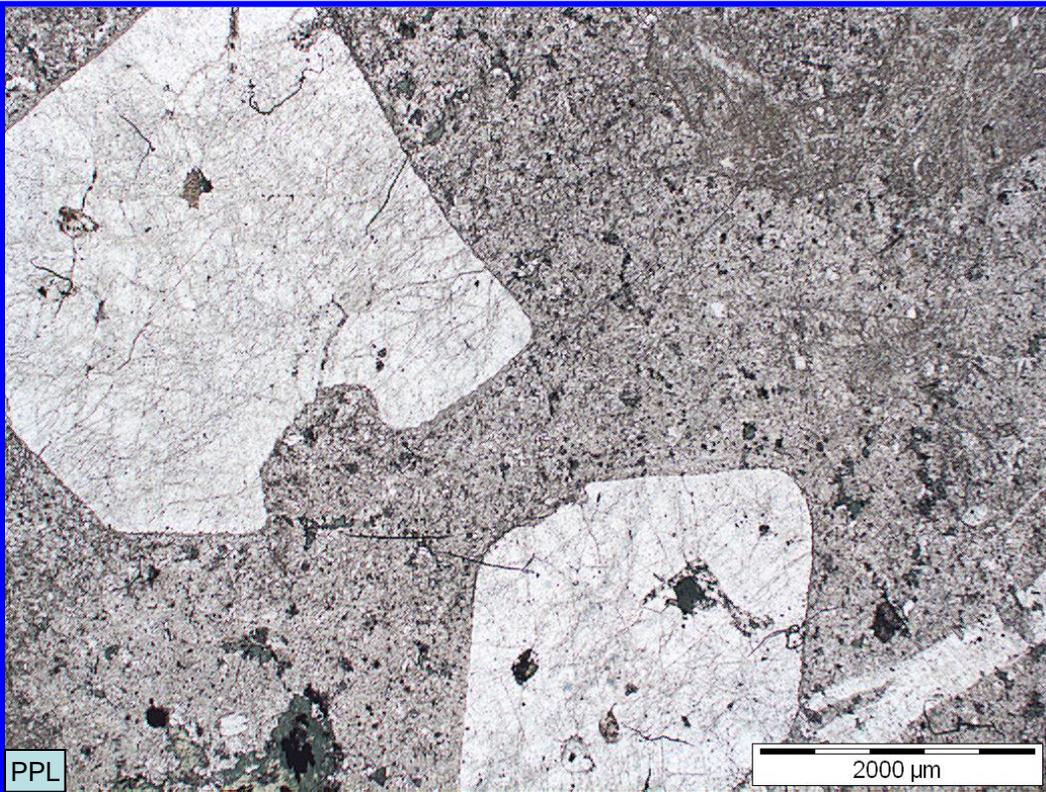
Apart from the sericite alteration of feldspar phenocrysts and light sericite speckling of the groundmass, and the dispersed but not uncommon green chlorite spots, the only other alteration of this rock is common small, carbonate rhombs scattered through much of the sample. A few 1mm-wide quartz veinlets cut the rock.

Other Comments

This rock could be either a lava (likely) or from just inside the margins of a volcanic dome or narrow sill. The alteration is insignificant relative to that higher in this drillhole and in SDD001.

SAMPLE NUMBER

SDD003 130.98-131.00m



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