

**Capricorn Copper**

**Petrology report on thirty-three samples from the  
around the Capricorn Copper Mine, NW QLD.**

**November 2019**

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**Mintex report number:** 411119



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## Introduction

This report details the results of transmitted and reflected light microscopy observations on 33 hand samples submitted by Matt Price of Capricorn Copper Ltd. Darren Richardson of Ingham Petrographics prepared polished thin sections from the samples. Petrographic descriptions of each sample were then undertaken and photomicrographs and observations for each sample are listed below. The mineralogy is listed in order of abundance. No company descriptions were given.

## Summary

Thirteen of these 33 samples are altered igneous rocks and the remaining 20 samples are sedimentary rocks.

Eight of the igneous samples are propylitically altered (chlorite-epidote-carbonate) metabasalt and two that are amygdaloidal have copper sulphides as part of the infill vug assemblage along with carbonate, epidote, quartz and chlorite (163040 and 163193). One altered dolerite sample (163050) has minor disseminated chalcopyrite and pyrite. Opaques in all other samples are iron/titanium oxides, and these may be secondary as they appear to partially replace feldspar in several samples. Samples 162972 and 162984 are feldspar porphyries that are strongly chlorite-carbonate altered.

Sediments in this set of samples are all siliciclastic and generally hematite altered to some degree. Many are also sericitised and a few are weakly chloritised. Sample 163291 is anomalous in that it is a strongly epidote altered siltstone. Meta-siltstones are the most common type and are generally grain supported with subangular to subrounded grains. They are generally well to moderately well sorted. Many are foliated, some with two foliations visible, but all are only weakly metamorphosed. Sample 163415 has preserved sedimentary structures that can define way up. Of the four quartzite samples, one is brecciated, and this is probably a fault breccia (sample 163177).

The petrography of the samples is summarised below in Table 1.

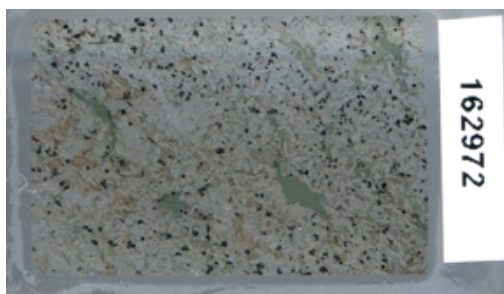
**Table 1 Summary of Petrological Observations**

Sample ID	Petrology summary
162972	Chlorite-carbonate-magnetite altered andesite porphyry with 60 to 70% plagioclase phenocrysts.
162984	Chlorite-carbonate-magnetite altered crowded feldspar-porphyry with no obvious remaining ferromagnesian phases and abundant carbonate and chloride alteration.
163001	Chlorite-epidote-actinolite-carbonate altered fine grained meta-amygdaloidal basalt.
163007	Iron altered mildly deformed quartzite.
163022	Highly hematite-chlorite altered basalt?
163040	Chlorite-carbonate-actinolite altered fine-medium grained basalt with chalcedony-quartz-carbonate-chalcopyrite-bornite infilled amygdales.
163050	Chlorite-epidote-carbonate altered dolerite with minor pyrite and chalcopyrite mineralisation.
163060	Sparsely porphyritic chlorite-epidote-carbonate altered meta-basalt.
163071	Strongly hematized fine-grained feldspathic sandstone with quartz veining.
163072	Strongly iron-oxide altered laminated fine-grained quartz-feldspar sandstone-with minor muscovite defining a weak schistosity.
163101	Variably hematized quartz-feldspar-muscovite sandstone.
163112	Hematized and mildly chloritized quartz-feldspar-muscovite laminated siltstone.
163129	Hematite altered feldspathic sandstone (arkose) showing patchy alteration and strong alteration fronts.
163142	Very fine-grained granular grain supported quartz-feldspar-muscovite siltstone.
163159	Coarse-grained quartz-feldspar sandstone (arkose) with patchy hematite alteration and veining.
163177	Brecciated quartzite- possible fault breccia.
163185	Chlorite-epidote-carbonate altered sparsely plagioclase-phyric amygdaloidal meta-basalt.
163193	Chlorite-carbonate-epidote altered sparsely phyric amygdaloidal meta-basalt with copper sulphides in carbonate amygdales.
163207	Very fine-grained rock variably hematized laminated quartzo-feldspathic meta-siltstone with a weak schistosity at a high angle to sedimentary laminations.
163219	Sericite-pyrite-quartz-chlorite altered possible igneous feldspar porphyritic rock?
163232	Sericite-clay altered laminated quartzo-feldspathic meta-siltstone with secondary albite veining.
163256	Pervasively chlorite-carbonate altered possible meta-basalt?
163271	Epidote-chlorite-carbonate scarcely porphyritic propylitically altered amygdaloidal meta-basalt.
163281	Chlorite-epidote altered meta-basalt.
163291	Epidote-carbonate altered fine-grained quartz siltstone with quartz and quartz-epidote veining.
163299	Fine-grained quartzite.
163322	Sub-arkosic meta-sandstone/ fine grained quartzite.

163343	Foliated sericite-chlorite altered meta-siltstone.
163366	Sericite-hematite altered, foliated, laminated quartz meta-siltstone.
163394	Sericitised and weakly chlorite altered meta-siltstone with late hematite alteration.
163415	Very fine-grained, laminated, sericitised siltstone with way up indicators
163451	Quartzite with mild hematite alteration.
163462	Variably hematized, foliated and laminated quartz-feldspar-sericite meta-siltstone.



## **Sample Descriptions**

**162972****Thin section and offcut of sample 162972**

**Mineralogy:** Plagioclase feldspar, chlorite, carbonate, magnetite, hematite.

The hand specimen is a pinky grey green rock with abundant disseminated opaque phases and occasional thin white veinlets. The thin section shows a colourless rock with brown and green patches and ca. 25% disseminated opaques.

Microscopically, this sample is a feldspar porphyry with no obvious remaining ferromagnesian phases and abundant carbonate and chlorite alteration. It can be described as a crowded feldspar porphyry with 60 to 70% phenocrysts.

Plagioclase feldspars have an average grain size of 0.5mm long, are commonly subhedral and display polysynthetic twinning with extinction angles that suggest oligoclase composition. Carbonate alteration/replacement of feldspars is common.

The groundmass is now strongly chlorite-carbonate altered with abundant regularly disseminated opaques. Green chlorite often occurs in patches suggesting replacement of ex-ferromagnesian phases?

Magnetite is common and is the only opaque phase and shows incipient alteration to haematite. Grains are subhedral, occasionally ragged and range in size between 0.2-0.5 mm. Partial replacement by carbonate was observed indicating that carbonate alteration was paragenetically late. Occasionally magnetite is seen partially replacing feldspar suggesting it may be secondary.

**Summary:** Chlorite-carbonate-magnetite altered andesite porphyry with 60 to 70% plagioclase phenocrysts.

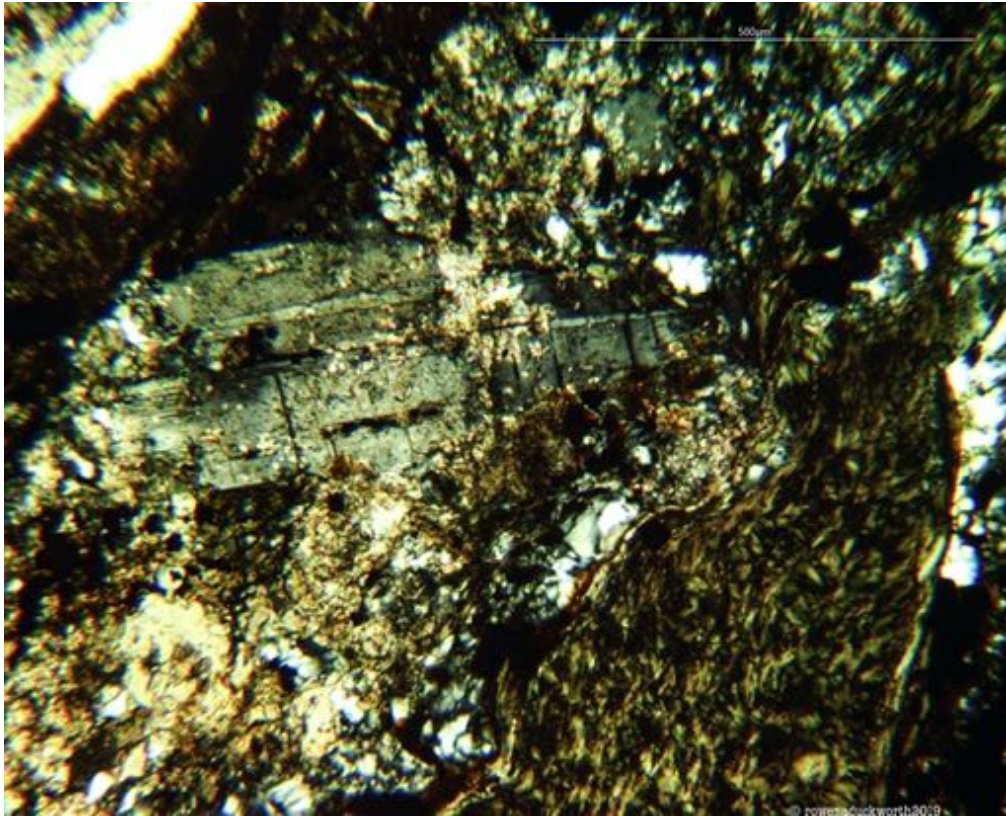


**Plane polarised light photomicrograph of sample 162972 (x4) illustrating the texture with feldspar laths and green chlorite and brown carbonate alteration.**

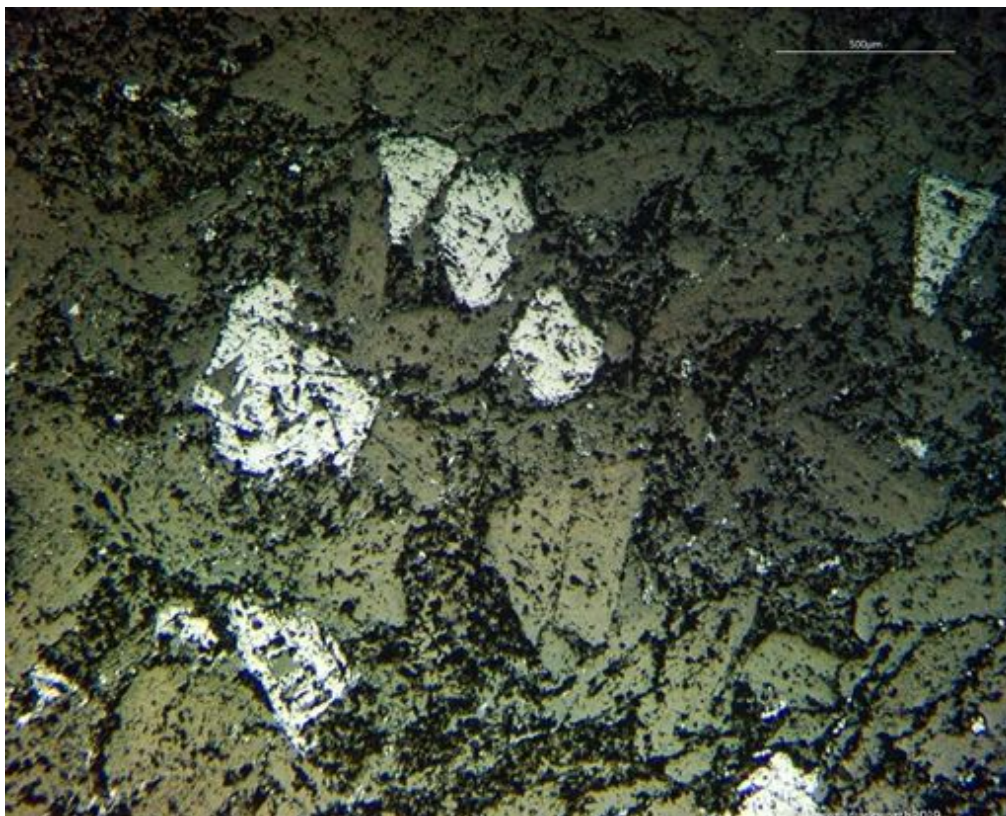


**Cross polarised light photomicrograph of sample 162972 (x4) showing the plagioclase-phyric texture of the sample in chlorite-carbonate altered groundmass. Note incipient carbonate alteration of feldspar.**





**Cross polarised light photomicrograph of sample 162972 (x10) showing carbonate and chlorite alteration of primary plagioclase.**



**Reflected light photomicrograph of sample 162972 (x4) illustrating disseminated magnetite.**

**162984****Thin section and offcut of sample 162984**

**Mineralogy:** Plagioclase feldspar, chlorite, magnetite, carbonate, hematite.

The hand specimen is a pale grey-green rock with scattered white patches and occasional dark blebs. The thin section shows a colourless and green mottled sample with 10-15% disseminated opaques.

Microscopically, this sample is a plagioclase-rich altered igneous rock with a porphyritic texture and an irregularly distributed and variably sized crystals (from 0.5-1mm) and occasional glomerocrysts up to 3mm across.

Plagioclase feldspar grains have an average grain size of 0.5mm, are commonly subhedral and display polysynthetic twinning with extinction angles that indicates an oligoclase to andesine composition. Plagioclase phenocrysts are incipiently carbonate and chlorite altered.

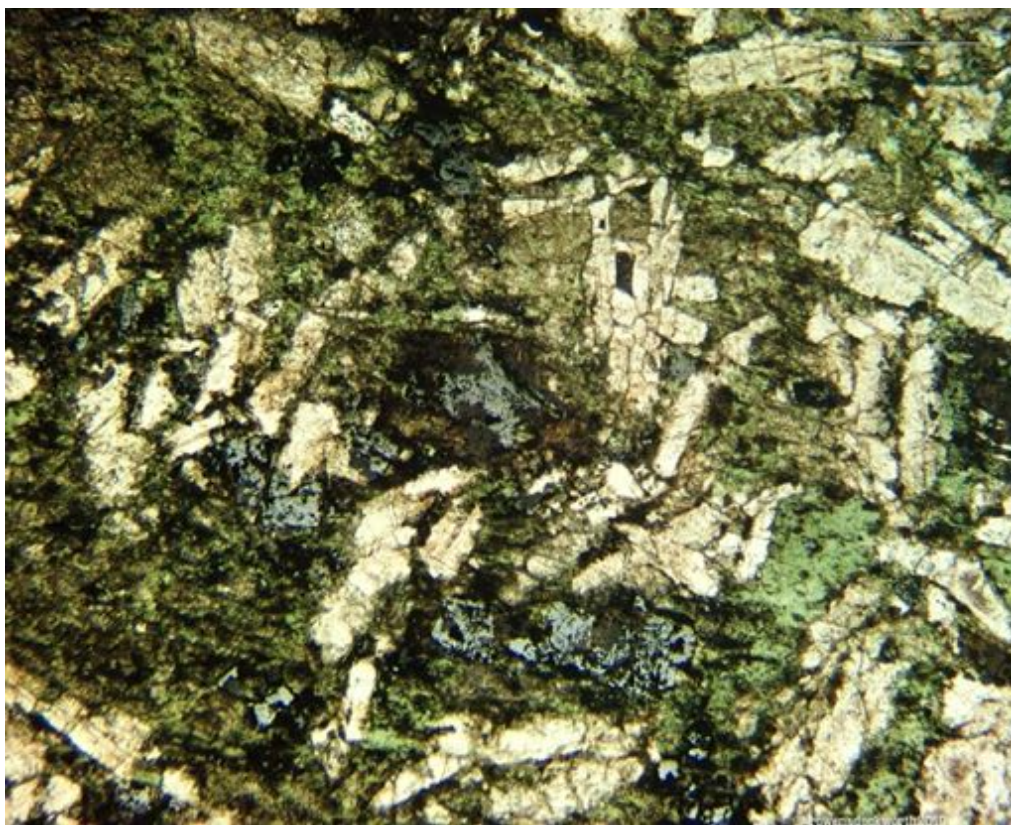
Opaques are common and are all magnetite which has formed as 0.1-0.3mm crystals that are now sub-anhedral and incipiently altered to hematite. Magnetite appears to replace feldspar and is spatially and possibly paragenetically associated with green chlorite. Magnetite may be secondary alteration rather than a primary igneous phase?

The groundmass shows pervasive alteration to chlorite and carbonate, and no primary ferromagnesian phases were observed. Green chlorite often occurs in patches though that may be replacement of ex-ferromagnesian phases?

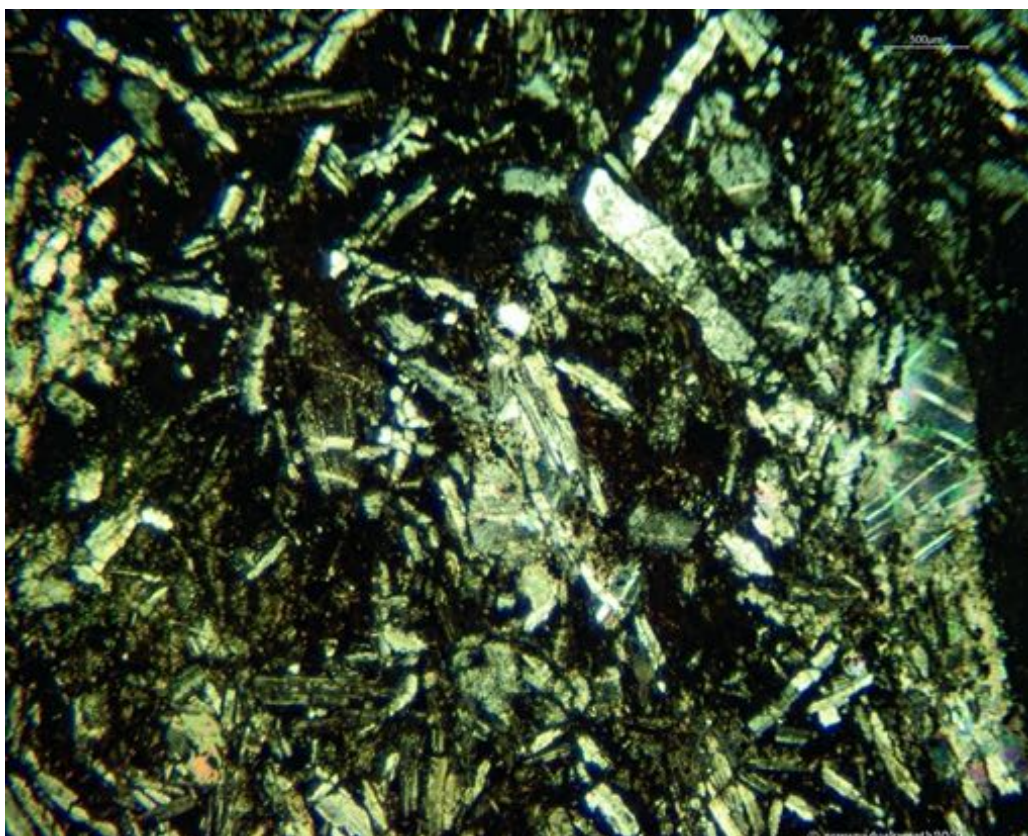
Magnetite is common in the groundmass and is the only opaque phase and shows incipient alteration to haematite. Grains are subhedral, occasionally ragged and range in size between 0.2-0.5 mm. Partial replacement by carbonate was observed indicating that carbonate alteration was paragenetically late. Occasionally magnetite is seen partially replacing feldspar.

**Summary:** Chlorite-carbonate-magnetite altered crowded feldspar-porphyry with no obvious remaining ferromagnesian phases and abundant carbonate and chloride alteration.



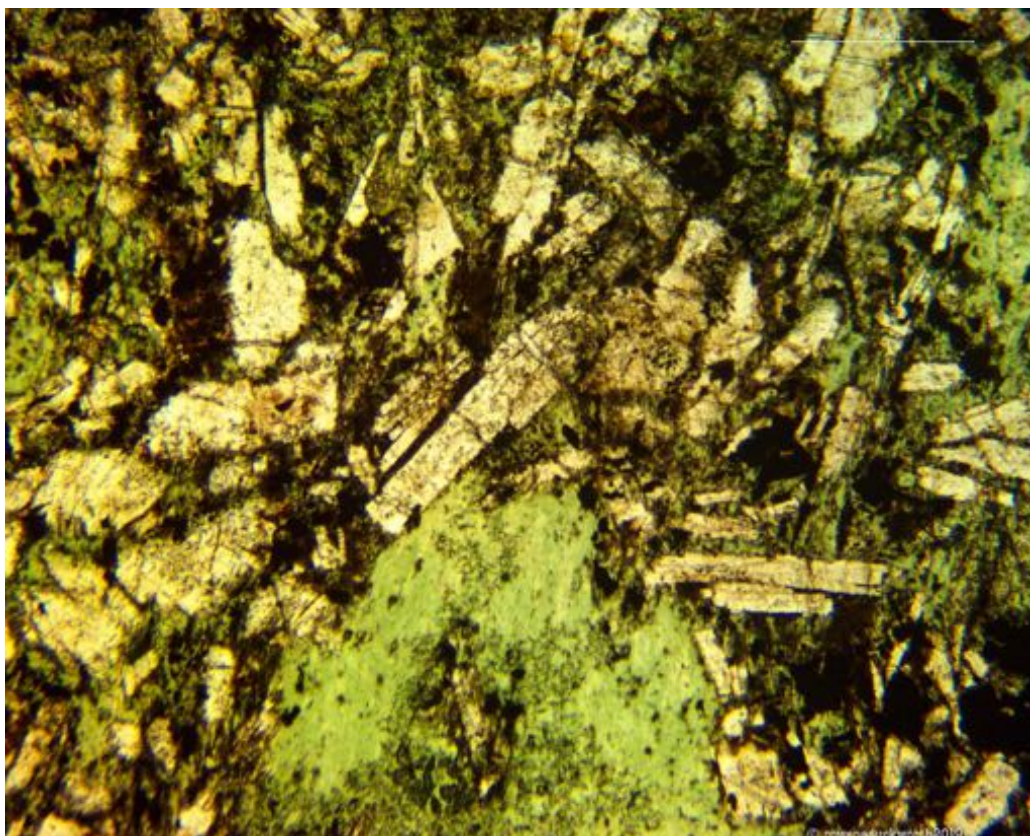


**Plane polarised and reflected light photomicrograph of sample 162984 (x4) illustrating the texture with feldspar phenocryst, ragged grey magnetite and green chlorite.**

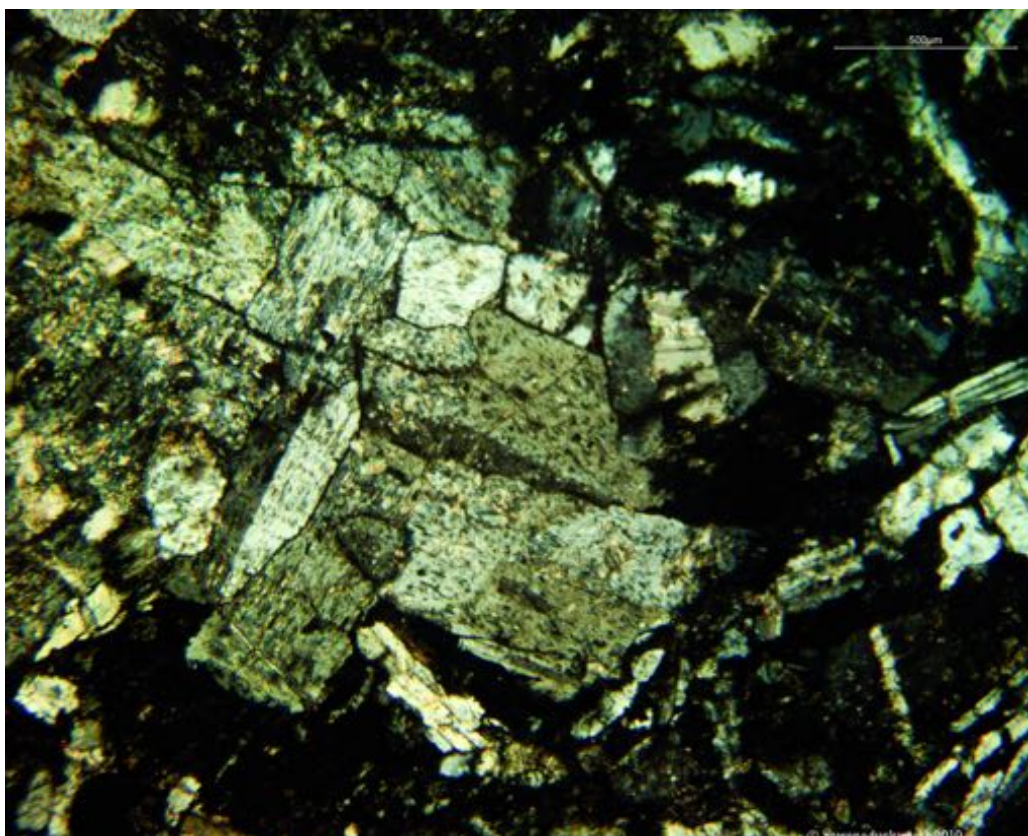


**Cross polarised light photomicrograph of sample 162984 (x2) illustrating the texture with strong dark chlorite alteration and twinned calcite.**

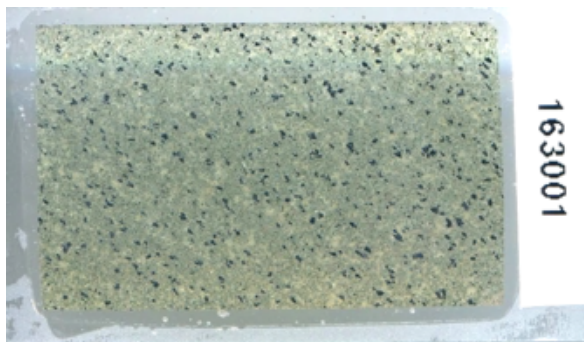




**Plane polarised light photomicrograph of sample 162984 (x4) illustrating the texture with late chlorite replacing possible primary ferromagnesian phase?**



**Cross polarised light photomicrograph of sample 162984 (x4) illustrating speckled carbonate alteration of plagioclase glomerocryst.**

**163001****Thin section and offcut of sample 163001**

**Mineralogy:** Chlorite, amphibole, magnetite, epidote, titanite, hematite, ilmenite, carbonate.

The hand specimen is a grey fine-grained rock with pale green and white patches. The thin section shows a yellowish-green sample with abundant disseminated opaques (20-25%).

Microscopically, this sample is a very altered fine-grained igneous rock with pervasive chlorite alteration and clusters of high relief cracked pale green-yellow secondary epidote crystals. Less common secondary titanite and amphibole (actinolite) occur and the actinolite forms as 0.2-0.4mm laths and this appears to replace primary plagioclase feldspar.

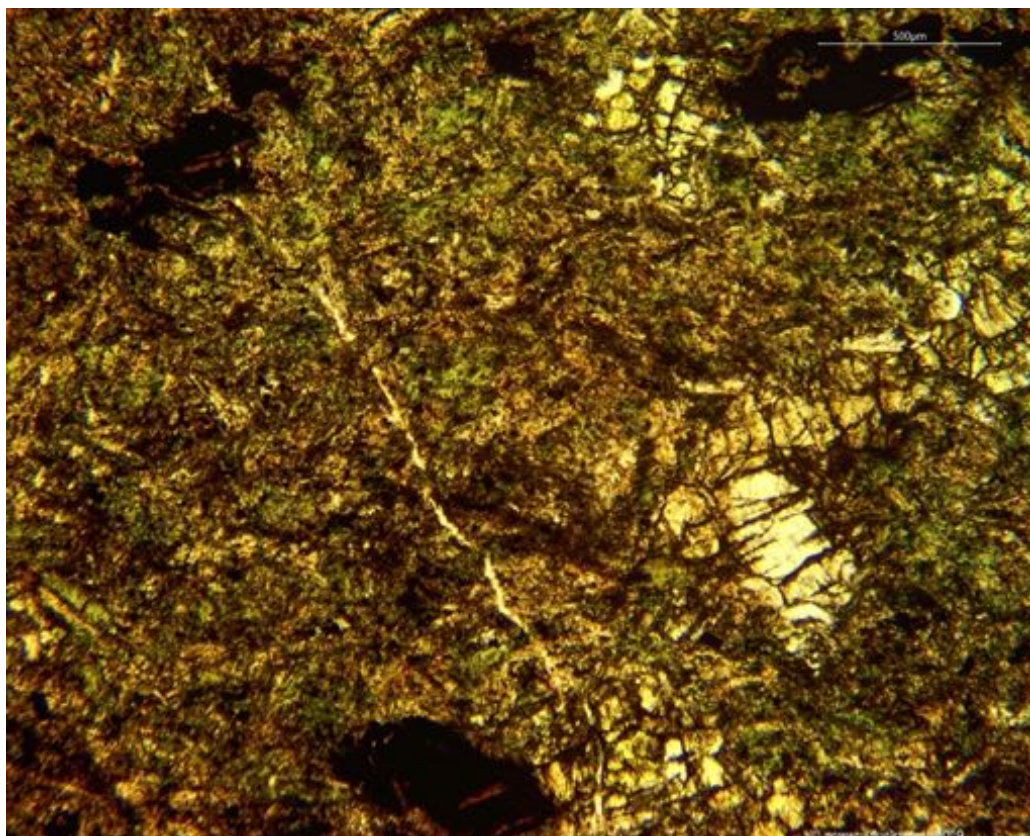
The plagioclase occurs as 0.2-0.4mm laths that form a microlitic texture groundmass. They are commonly replaced by chlorite, epidote and actinolite. Epidote occurs as vug infill-amygdales- and may also replace primary clinopyroxene?

The common opaques display a striped texture with translucent stripes of rutile and these are probably altered titanite-magnetite grains with crystallographically controlled alteration to rutile and ilmenite. Titanite also occurs as an alteration phase indicating some titanium mobility in these samples.

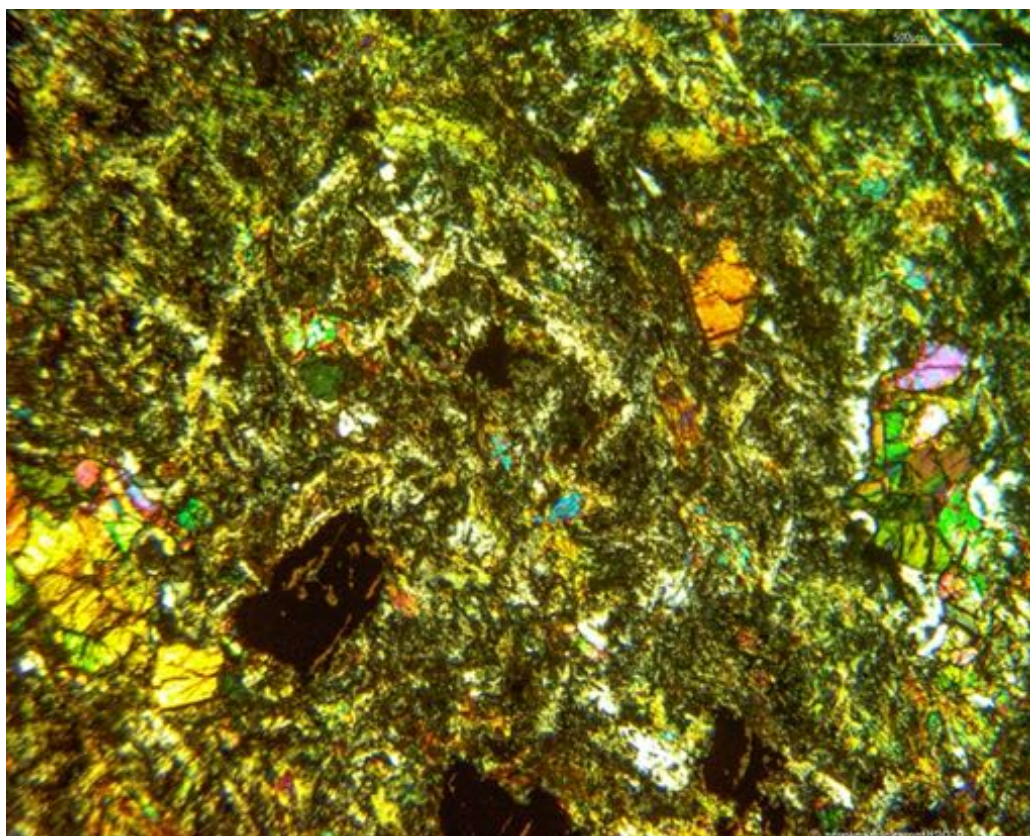
Thin late carbonate veins crosscut the sample and are paragenetically late.

**Summary:** Chlorite-epidote-actinolite-carbonate altered fine grained meta-amygdaloidal basalt.



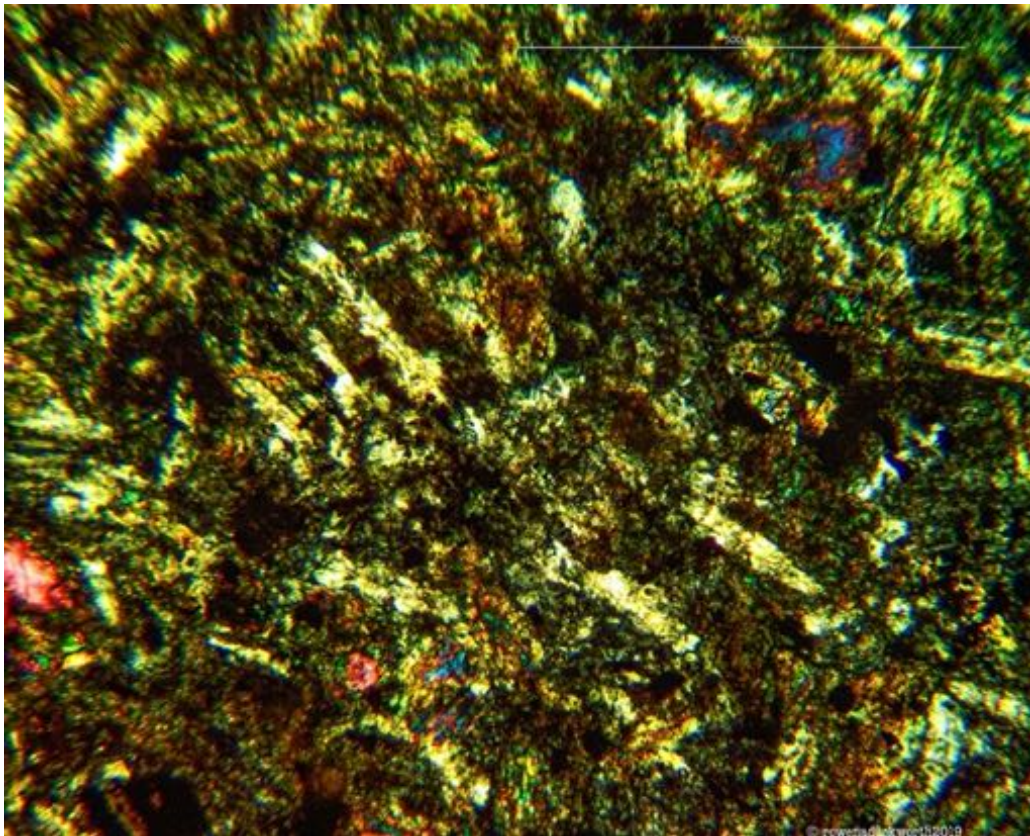


**Plane polarised light photomicrograph of sample 163001 (x4) illustrating altered texture with chlorite, carbonate, titanite and high relief pale epidote.**

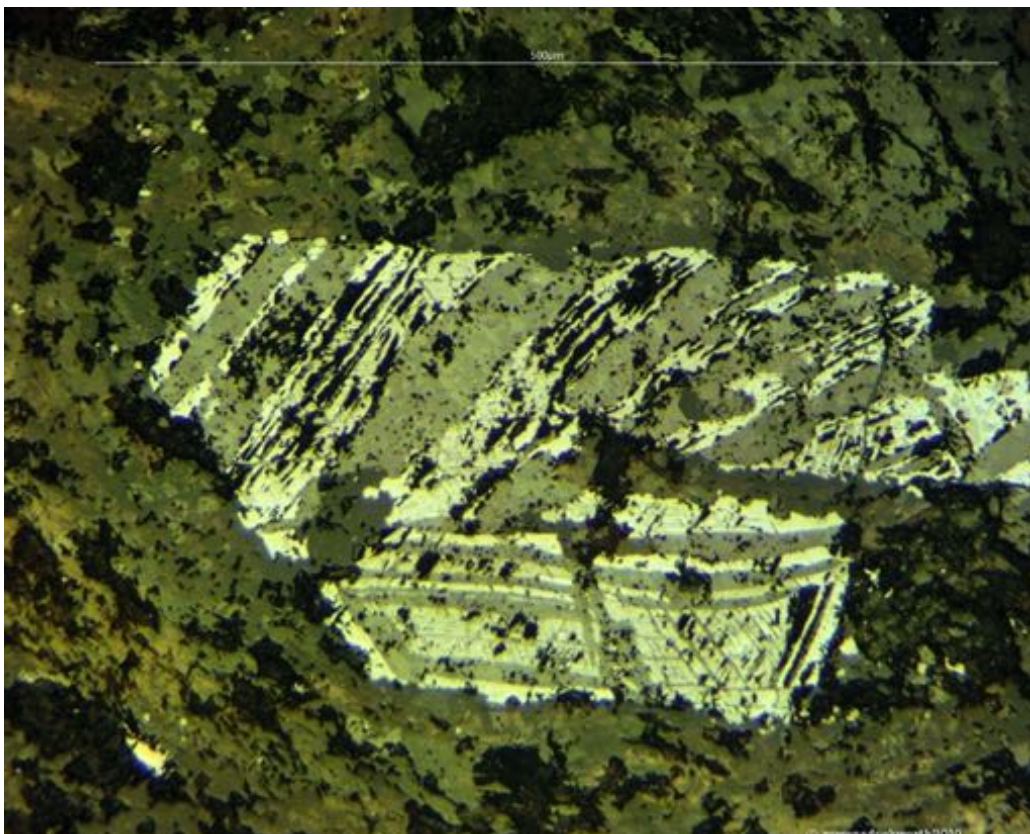


**Cross polarised light photomicrograph of sample 163001 (x4) illustrating altered texture with anhedral high birefringence epidote with chlorite, actinolite, titanite and opaques.**

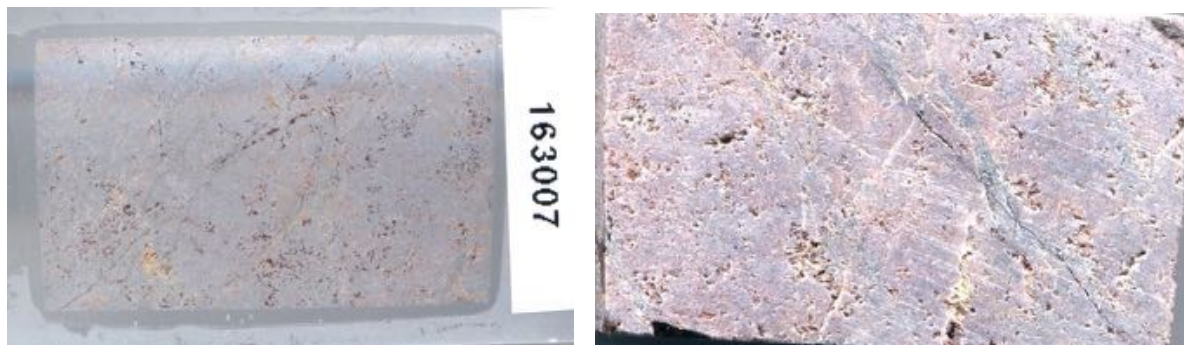




**Cross polarised light photomicrograph of sample 163001 (x10) illustrating epidote-chlorite-carbonate-titanite alteration and primary feldspar laths.**



**Reflected light photomicrograph of sample 163001 (x10) showing altered magnetite crystal altered to hematite and non-reflective grey rutile.**

**163007****Thin section and offcut of sample 163007**

**Mineralogy:** Quartz, hematite, goethite.

The hand specimen is a porous patchy grey-pink rock with pale and grey veins. The thin section is a pale-colourless rock with opaques in patches and in veins-around 20% opaques.

Microscopically, this is a granular textured quartz rich rock with no obvious matrix.

The quartz grain size ranges between 0.1 and 0.5 mm and the grains are anhedral, oval to subrounded/subangular, and display mild undulose extinction with incipient re-crystallisation. Careous grain boundaries are common indicative of pressure solution.

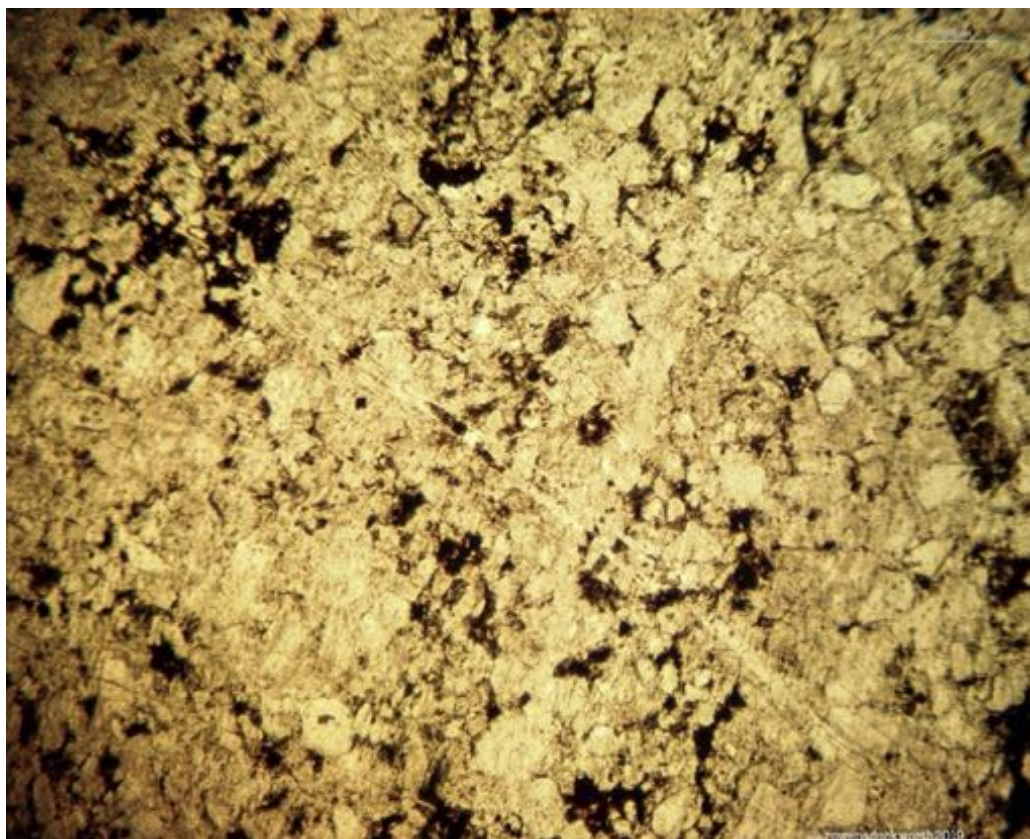
Mild shearing textures are evident and one micro-breccia pipe was observed in this section. The poorly defined banding in this section is therefore tectonic in origin.

Scattered opaques (around 20%) occur in veins and wrapped around quartz grains. Commonly these are earthy hematite with only occasional small ragged specular hematite and goethite grains.

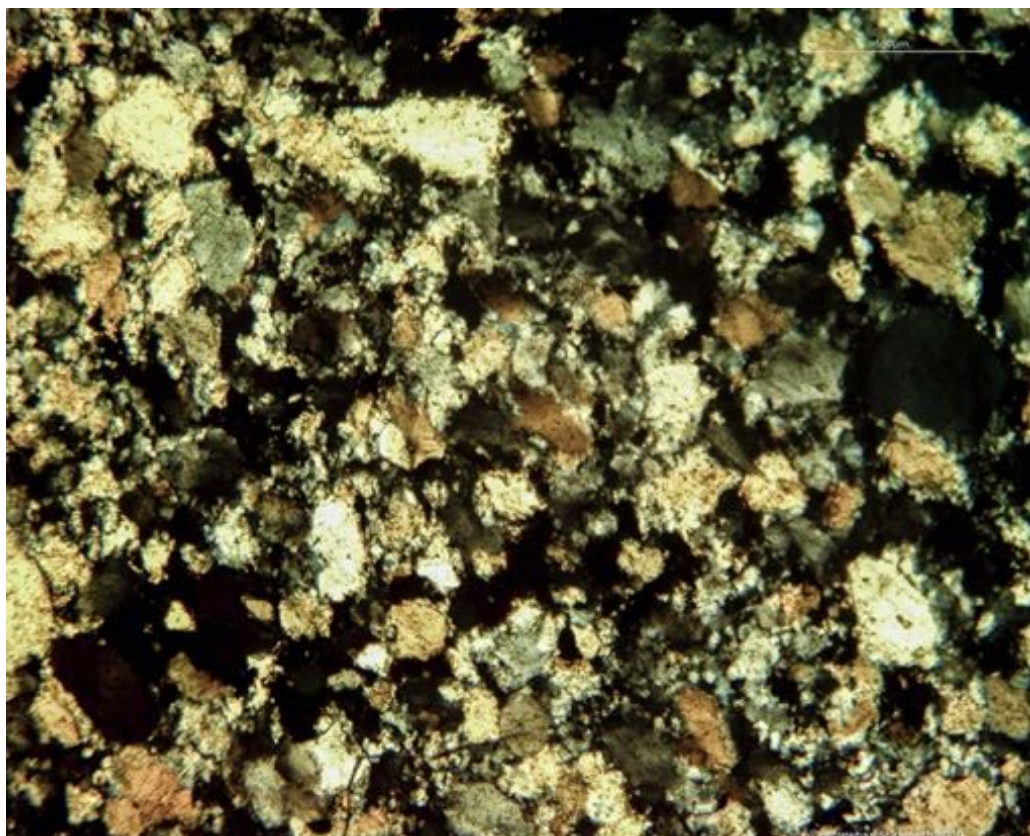
Skinny quartz veins and hematitic veins cut the sample and are paragenetically late.

**Summary:** Iron altered mildly deformed quartzite.



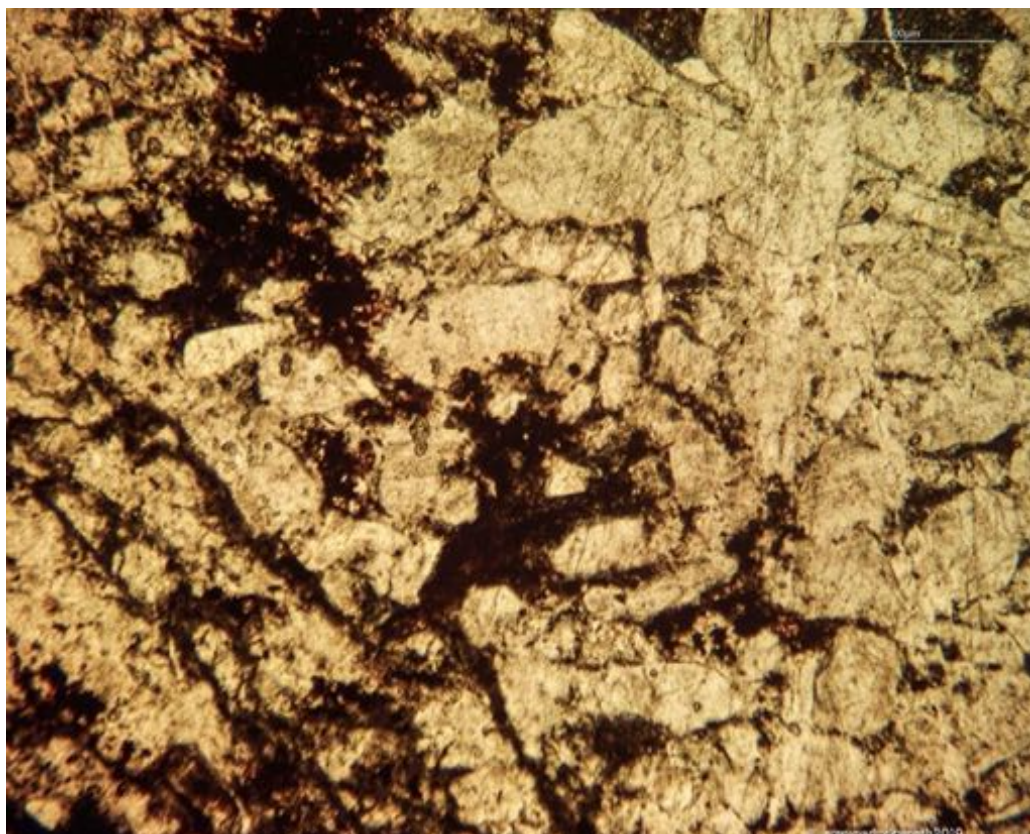


**Plane polarised light photomicrograph of sample 163007 (x2) illustrating quartz grains and opaques with late thin colourless quartz veins.**

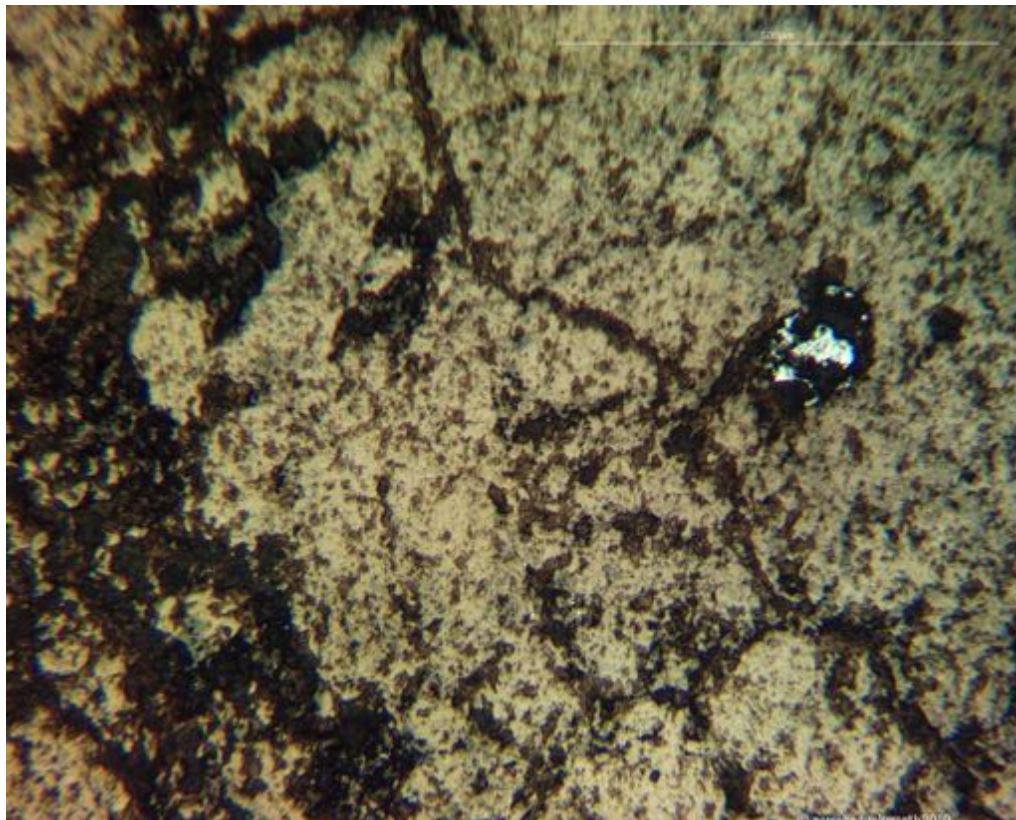


**Cross polarised light photomicrograph of sample 163007 (x4) illustrating texture with careous, undulose quartz grains and opaques.**

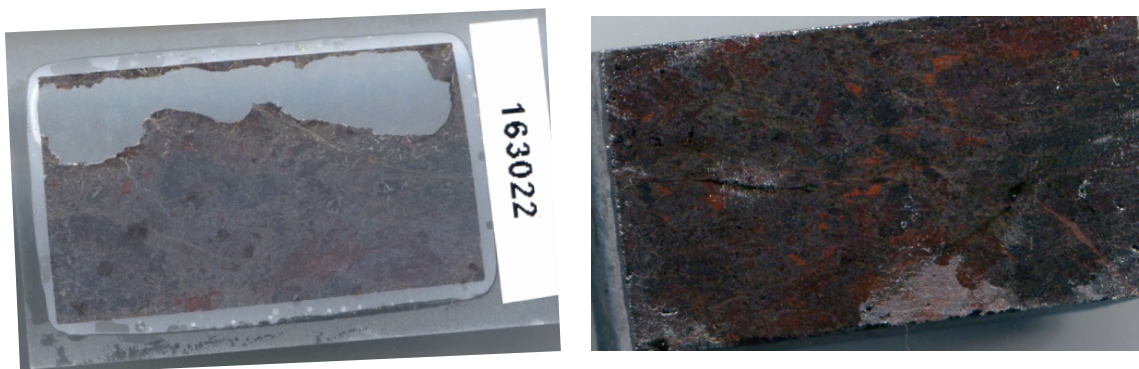




**Plane polarised light photomicrograph of sample 163007 (x4) illustrating texture with late opaque phases after deformed quartz.**



**Reflected and plane polarised light photomicrograph of sample 163007 (x10) illustrating occasional bright specular hematite grains.**

**163022****Thin section and offcut of sample 163022**

**Mineralogy:** Earthy hematite, rutile, chlorite, amphibole, quartz, hematite

The hand specimen is a very dark red black fine-grained sample. The thin section was exceedingly difficult to prepare and kept peeling but shows a rock with a grey-red mottled texture.

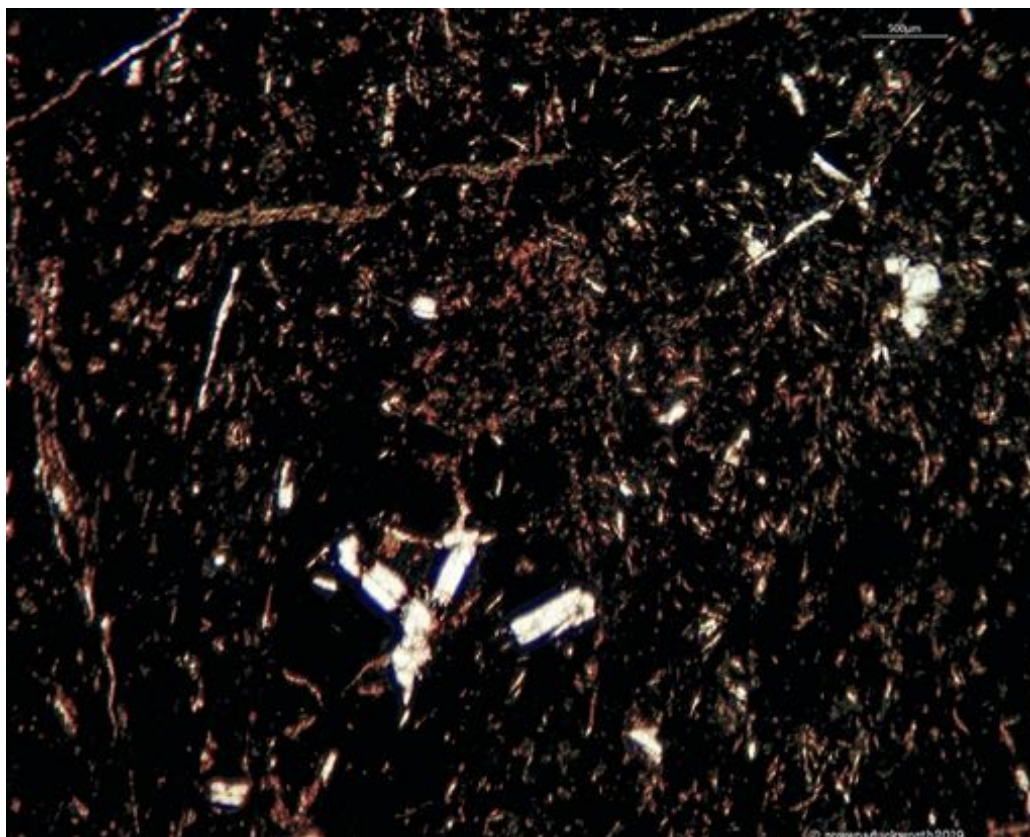
Microscopically, this sample is very altered with possible altered feldspar laths in highly iron-altered matrix. In places, the laths form a microlitic texture suggesting that this may be an altered basalt? These laths are no longer feldspar. but are commonly now amphibole with low second order interference colours and/or chlorite.

Opaque phases are dominantly non-reflective earthy hematite and semi-translucent rutile with only occasional specular hematite.

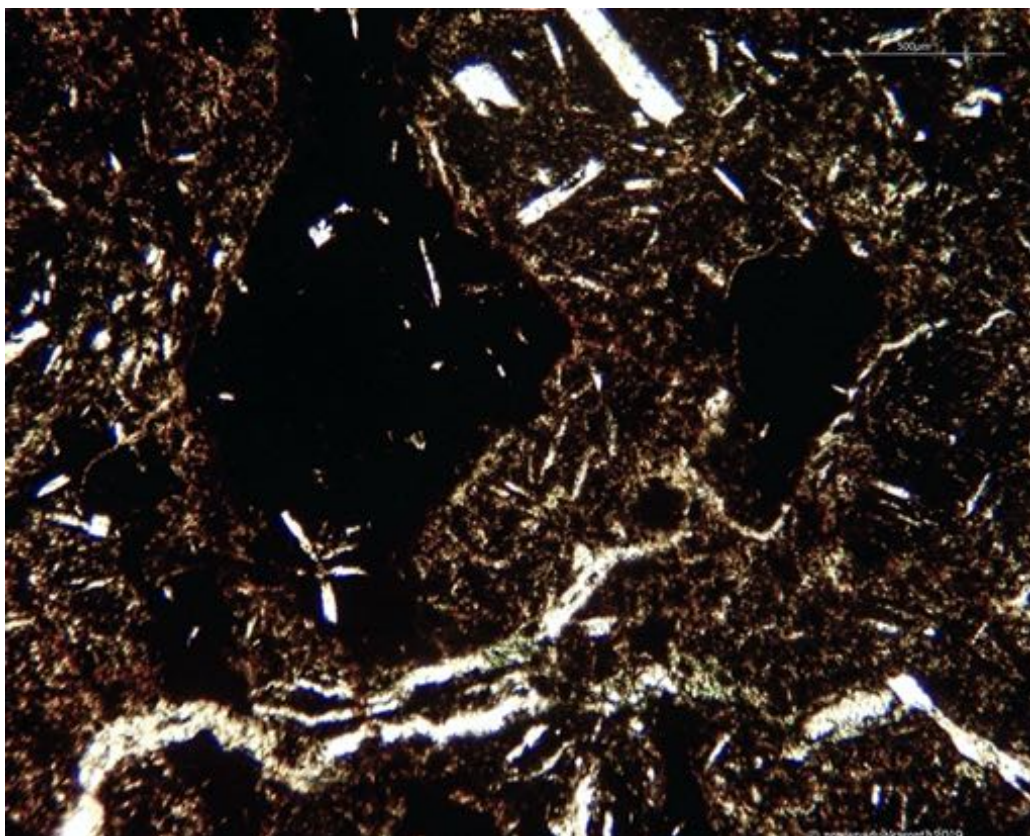
Chlorite patches are evident, and chlorite occasionally rims opaque grains indicating that the chlorite is paragenetically later than the iron oxides. Chlorite also occurs in paragenetically late quartz veins,

**Summary:** Highly hematite-chlorite altered basalt?



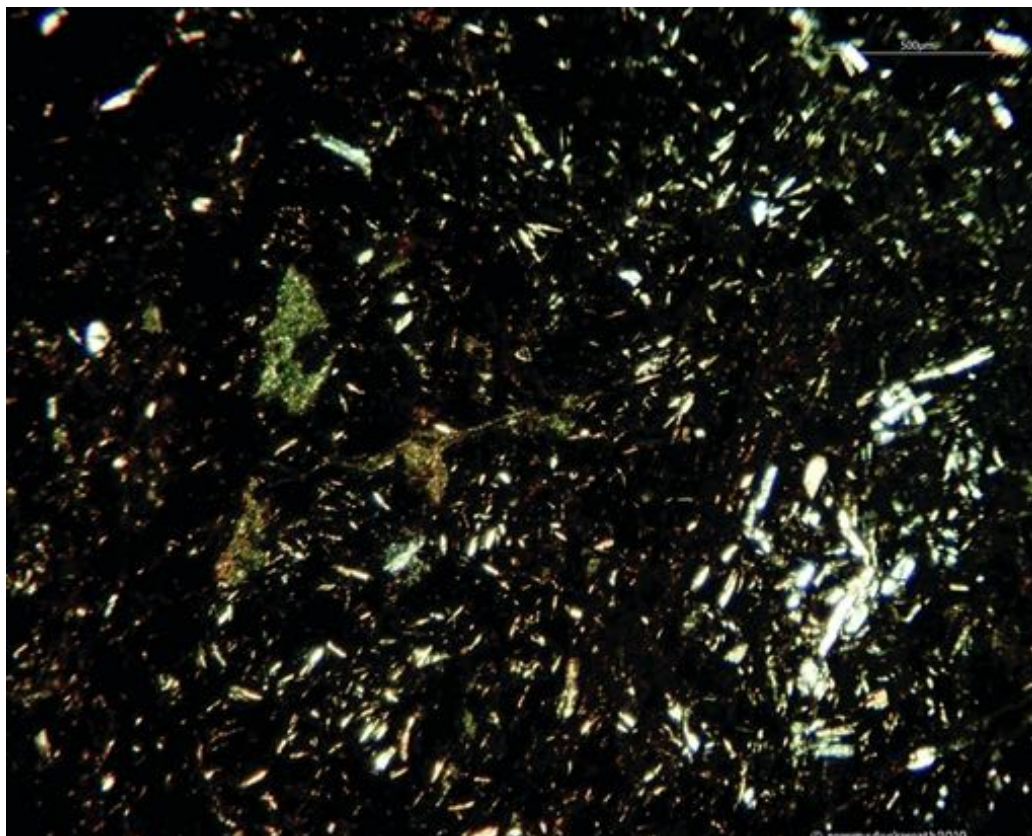


Plane polarised light photomicrograph of sample 163022 (x2) illustrating the very dark red-black iron rich sample with pale laths that may be altered feldspars.

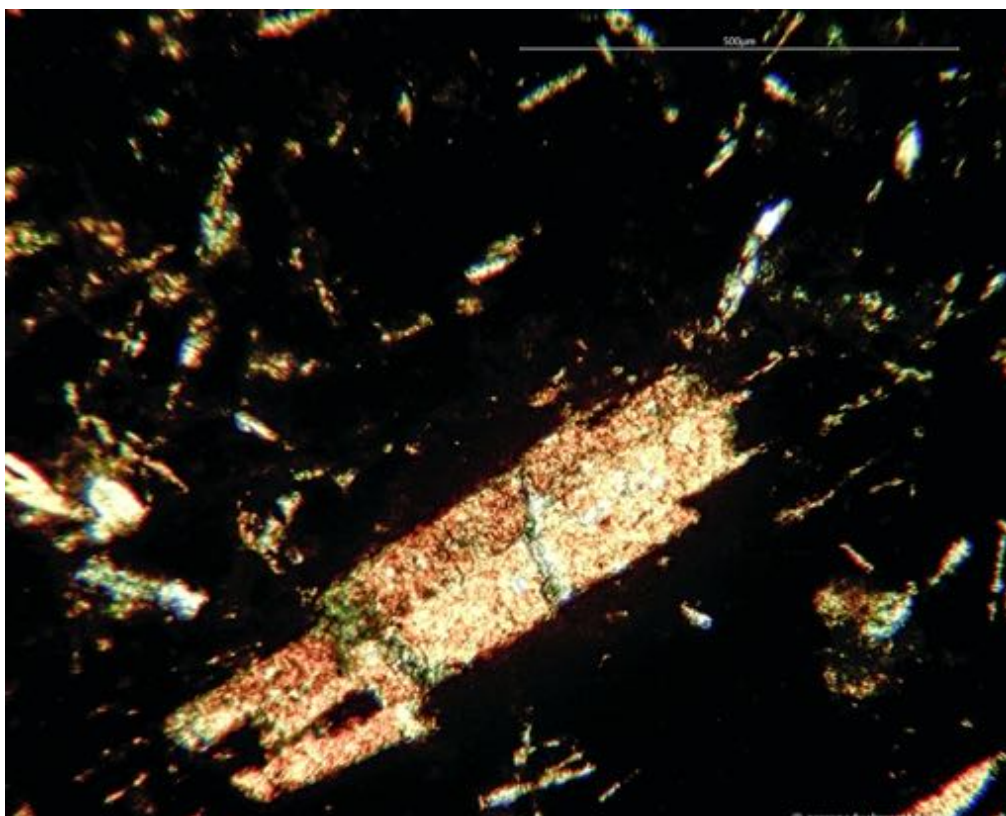


Plane polarised light photomicrograph of sample 163022 (x4) illustrating quartz-chlorite veins and green chlorite rims around opaques.



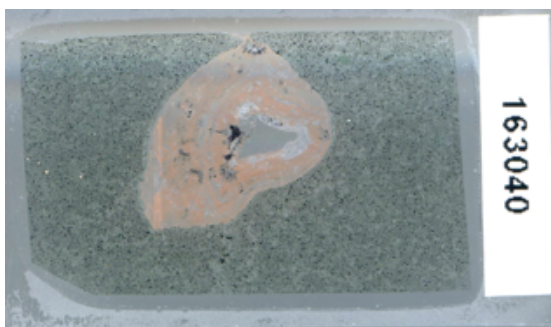


**Plane polarised light photomicrograph of sample 163022 (x4) illustrating ex feldspars laths and green chlorite alteration in iron altered matrix.**



**Cross polarised light photomicrograph of sample 163022 (x10) illustrating amphibole-chlorite alteration of ex-plagioclase?**



**163040****Thin section and offcut of sample 163040**

**Mineralogy:** Plagioclase, chlorite, carbonate, quartz, actinolite, magnetite, chalcedony, hematite, chalcopyrite, bornite, chalcocite, covellite.

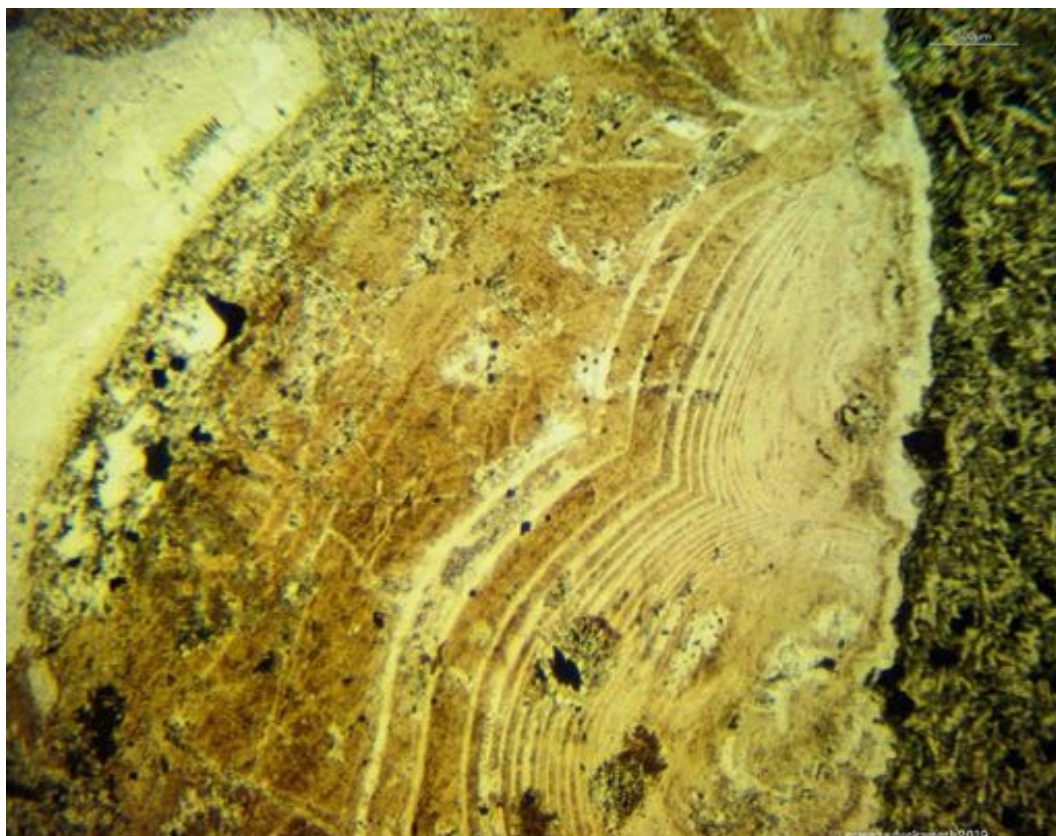
The hand specimen is a dark grey fine-grained rock with two large subrounded pink and white infilled vugs. The thin section shows a green and colourless fine-grained rock with 15-20% disseminated opaques and a large pinky-white infilled vug.

Microscopically, this sample is a feldspar-rich igneous rock with abundant fine-grained scattered opaques and pervasive chlorite-carbonate alteration with quartz and carbonate infilled amygdaloids.

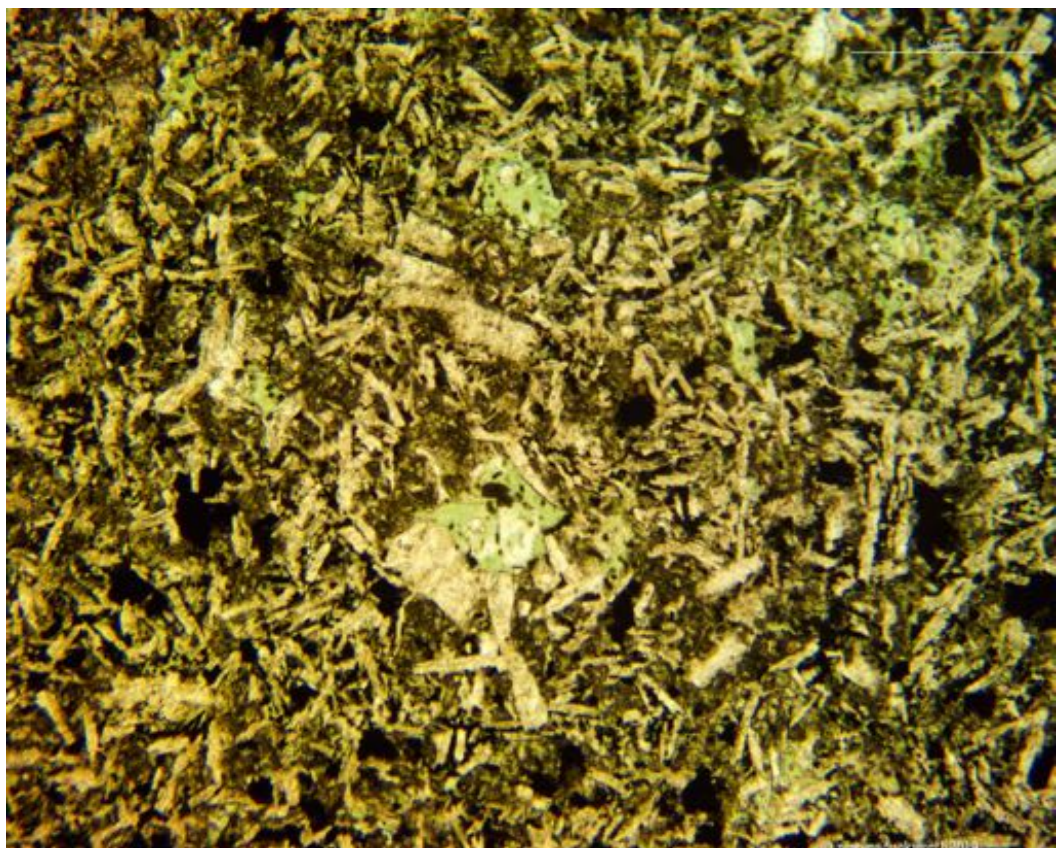
The host rock is a fine-grained feldspar-rich basalt with a microlitic texture and common chlorite, actinolite and carbonate alteration. Plagioclase laths are subhedral and commonly around 0.2mm long. Fine grained disseminated opaques in the host rock are all magnetite which are anhedral to subhedral with incipient hematite alteration.

The amygdaloids are infilled by chalcedony and granular quartz and the chalcedony is strongly overprinted by carbonate. The pink colour of the vug in hand specimen may indicate manganese carbonate? The opaques associated with the granular quartz in the centre of the vugs are chalcopyrite and bornite that show incipient alteration to grey chalcocite and blue covellite.

**Summary:** Chlorite-carbonate-actinolite altered fine-medium grained basalt with chalcedony-quartz-carbonate-chalcopyrite-bornite infilled amygdaloids.

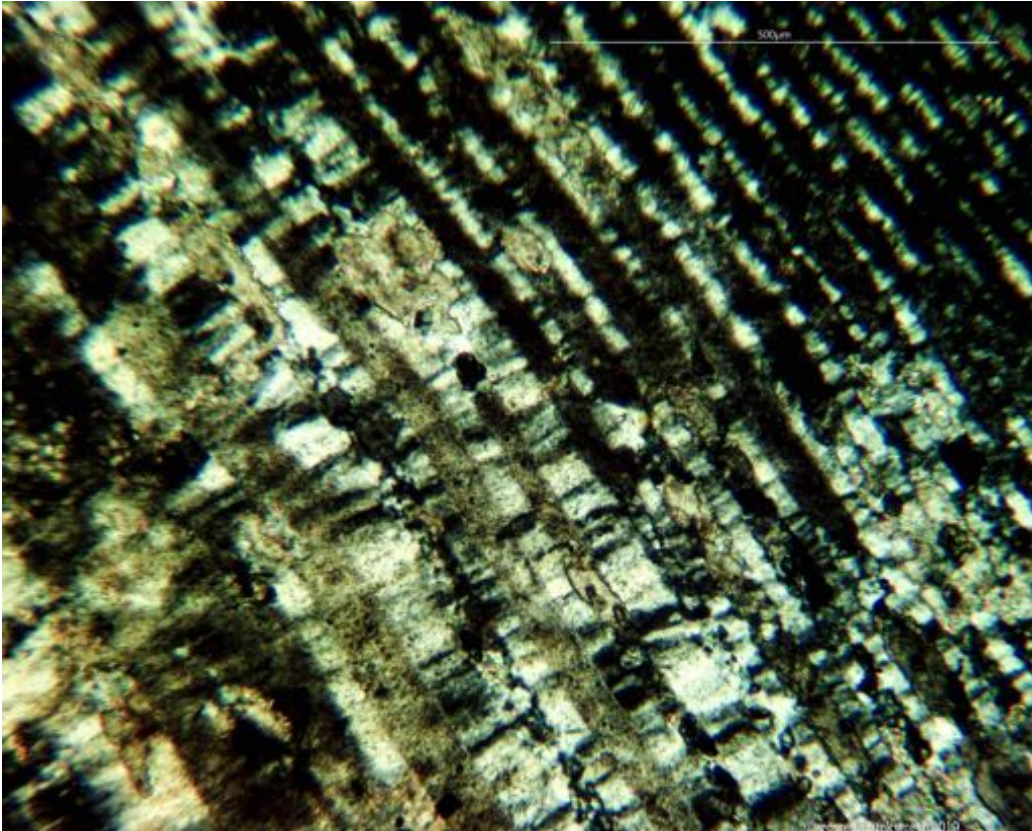


**Plane polarised light photomicrograph of sample 163040 (x2) illustrating texture of amygdale with chalcedony, quartz, carbonate and opaques; host rock to the right.**

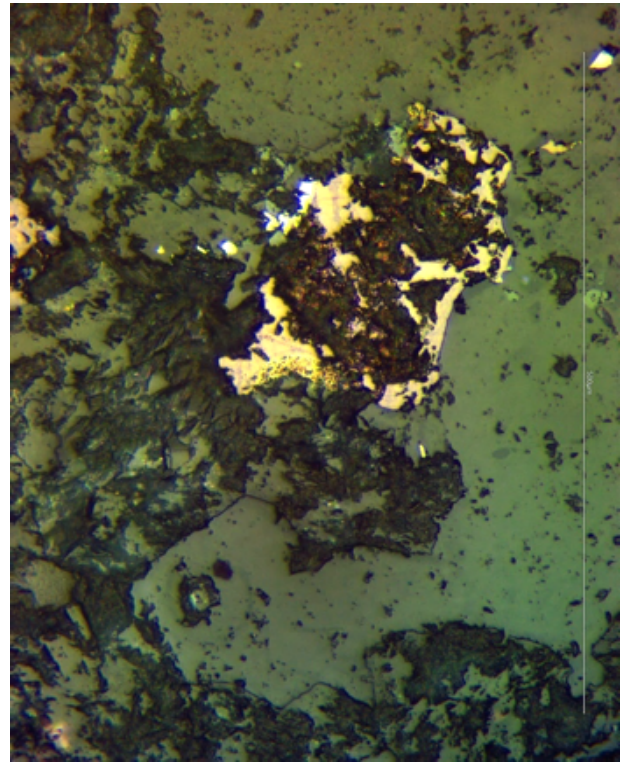
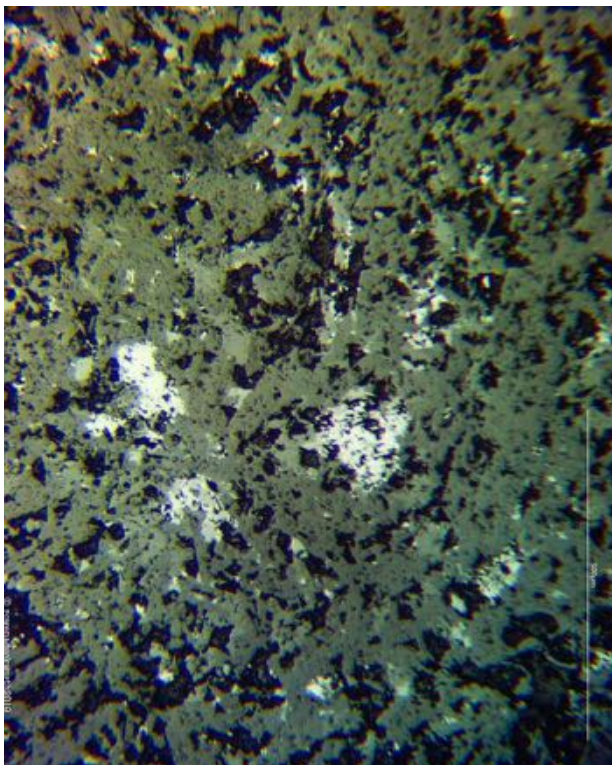


**Plane polarised light photomicrograph of sample 163040 (x4) illustrating texture of the feldspar-rich basalt with green chlorite alteration.**

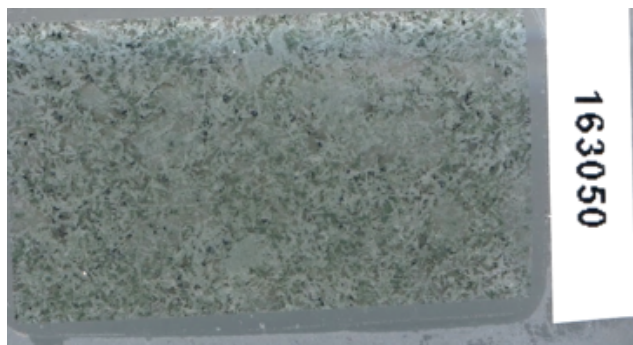




**Cross polarised light photomicrograph of sample 163040 (x10) illustrating chalcidony layering in vug with secondary carbonate alteration.**



**Reflected light photomicrographs of sample 163040 (x10 left and x20 right) illustrating right- common disseminated sub-anhedral magnetite grains with incipient hematite alteration and left-rare bornite + chalcopyrite in vugs.**

**163050****Thin section and offcut of sample 163050**

**Mineralogy:** Clinopyroxene, carbonate, chlorite, epidote, plagioclase feldspar, titanite, actinolite, pyrite, chalcopyrite.

The hand specimen is a pale grey medium grained rock and the thin section shows a texture with coarse pale coloured blocky crystals in a green groundmass with finer grained pale laths. Scattered opaques form approximately 10% of the sample.

Microscopically, this sample is a medium-grained igneous rock with altered clinopyroxene phenocrysts in a finer-grained chlorite-epidote-carbonate altered feldspathic groundmass. Minor titanite also occurs as 0.2-0.4 mm sub-euhedral grains.

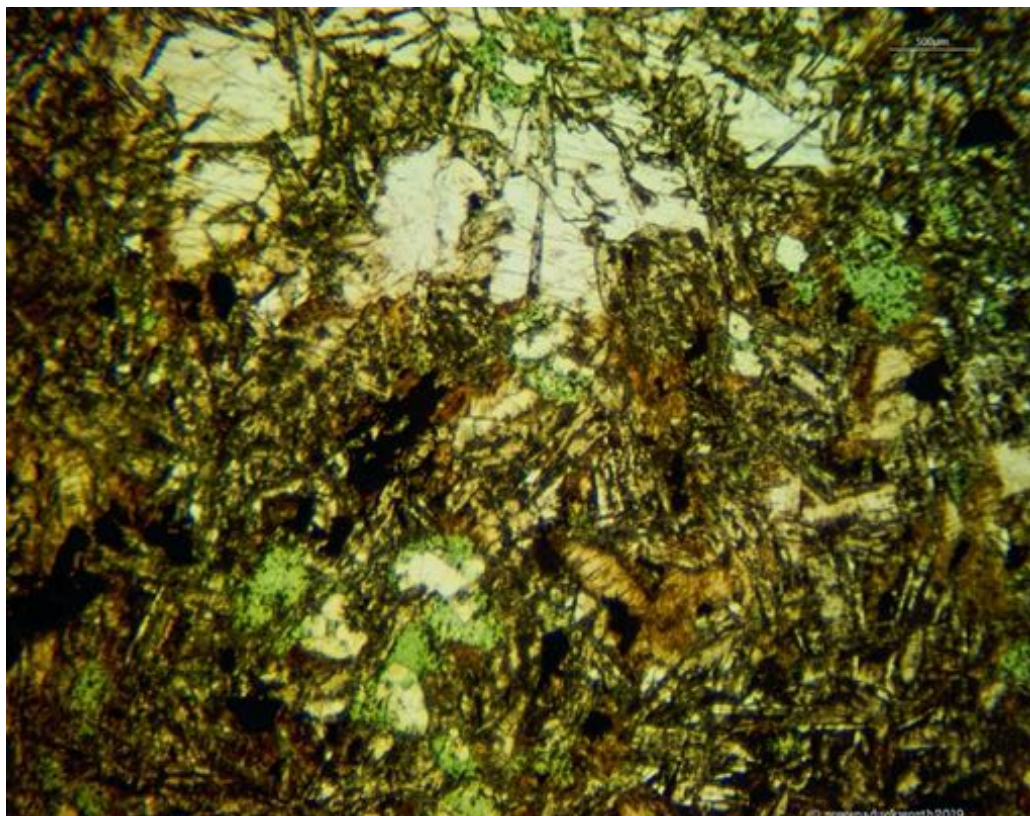
Clinopyroxene grains are ragged, commonly clustered, generally around 1-2mm long, though the exact size is hard to define due to the partial replacement by carbonate that alters the groundmass. Occasional actinolite alteration of the clinopyroxene occurs.

Plagioclase laths are subhedral, twinned, around 0.5-1mm long and partially altered by carbonate, epidote and chlorite. The composition cannot be reliably determined due to the pervasive propylitic alteration, but maybe andesine.

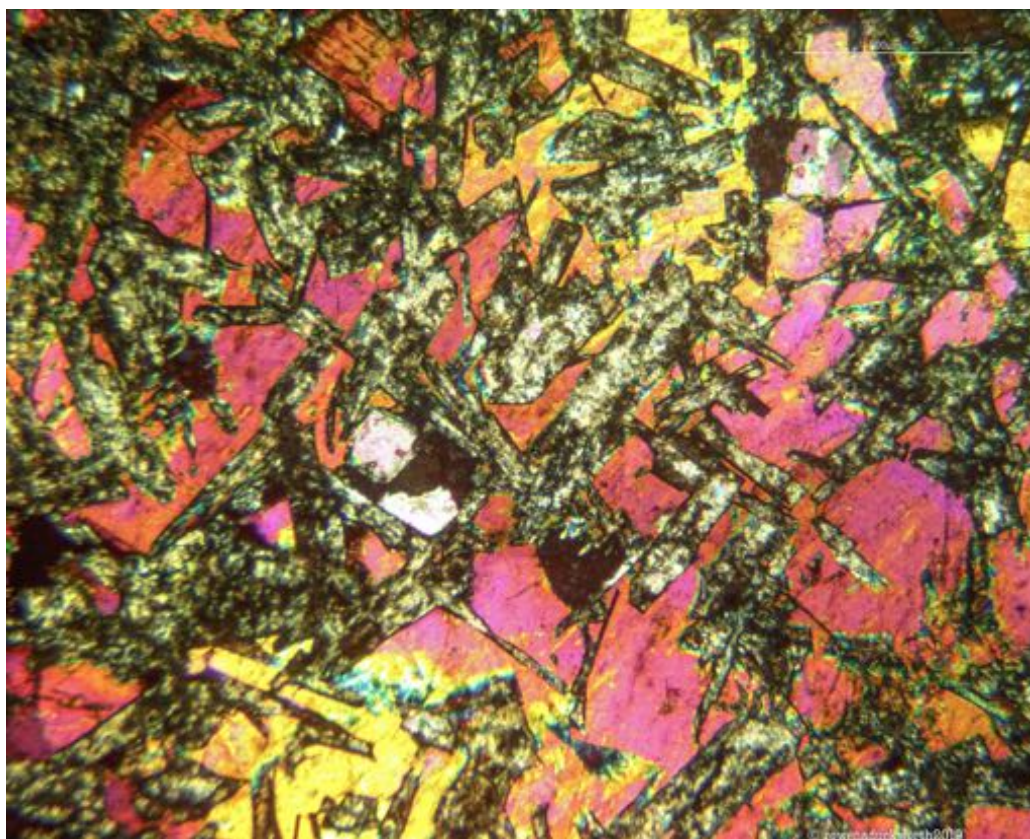
Opaques in this sample are pyrite and less common chalcopyrite which are paragenetically associated with the carbonate alteration.

**Summary:** Chlorite-epidote-carbonate altered dolerite with minor pyrite and chalcopyrite mineralisation.



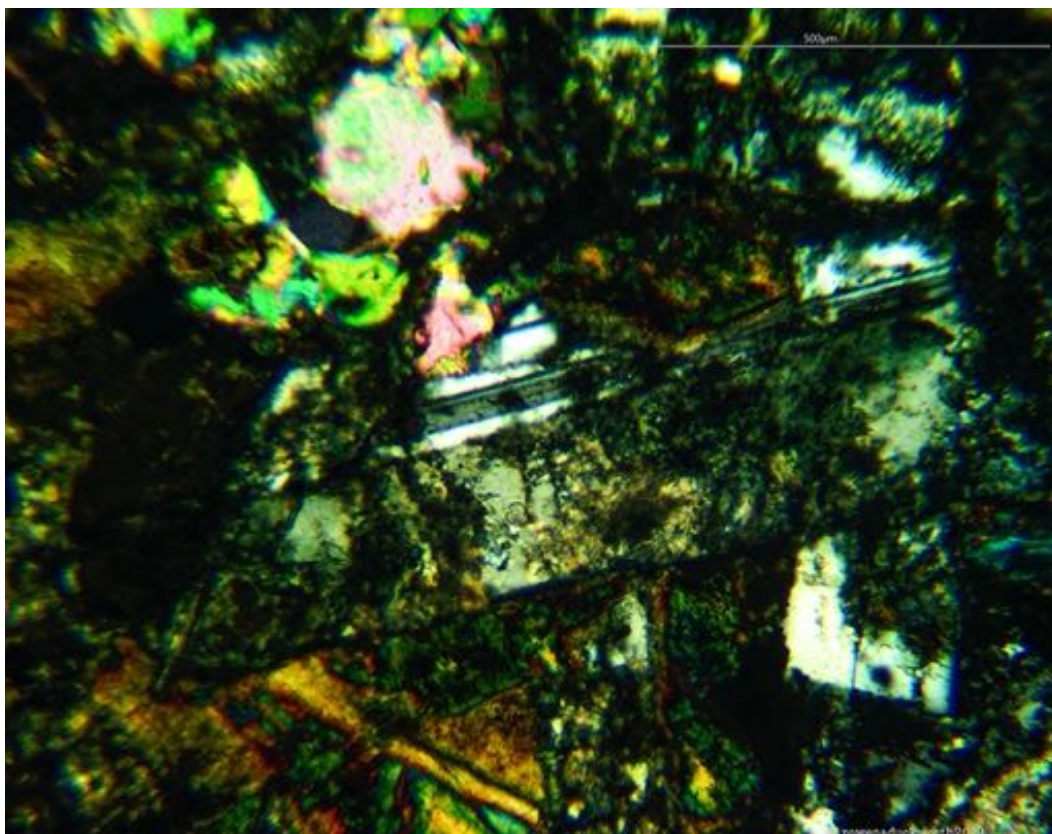


**Plane polarised light photomicrograph of sample 163050 (x2) illustrating the texture with large pale clinopyroxene, altered feldspar, titanite, epidote, green chlorite and opaques.**

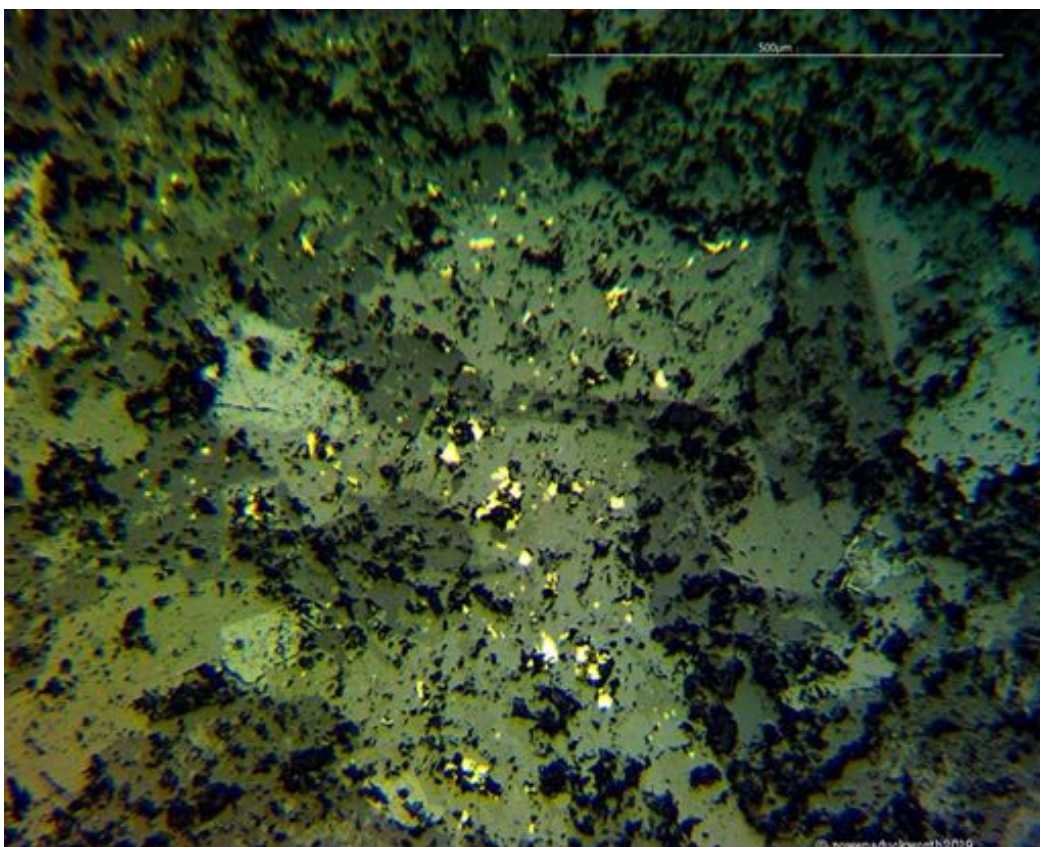


**Cross polarised light photomicrograph of sample 163050 (x4) illustrating the alteration of coarse-grained clinopyroxene.**

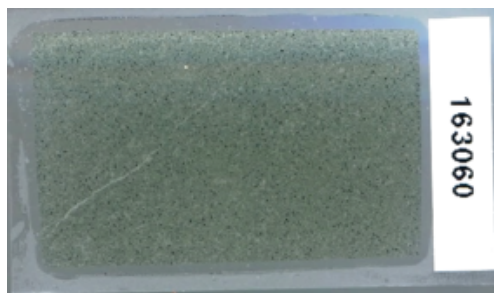




**Cross polarised light photomicrograph of sample 163050 (x10) illustrating texture of groundmass with plagioclase partially replaced by pervasive chlorite, epidote and carbonate alteration.**



**Reflected light photomicrograph of sample 163050 (x4) illustrating pyrite and chalcopyrite associated with carbonate alteration.**

**163060****Thin section and offcut of sample 163060**

**Mineralogy:** Clinopyroxene, carbonate, chlorite, epidote, plagioclase feldspar, titanite, actinolite, hematite.

The hand specimen is a pale to medium grey fine-grained rock and the thin section shows a green groundmass with finer grained pale laths and fine grained disseminated opaques form approximately 10% of the sample. One pale vein cuts the sample.

Microscopically, this sample is fine grained with occasional 1mm epidote grains that may be altered clinopyroxene phenocrysts as they have a pentagonal outline. Occasional 1mm subhedral plagioclase phenocrysts also occur.

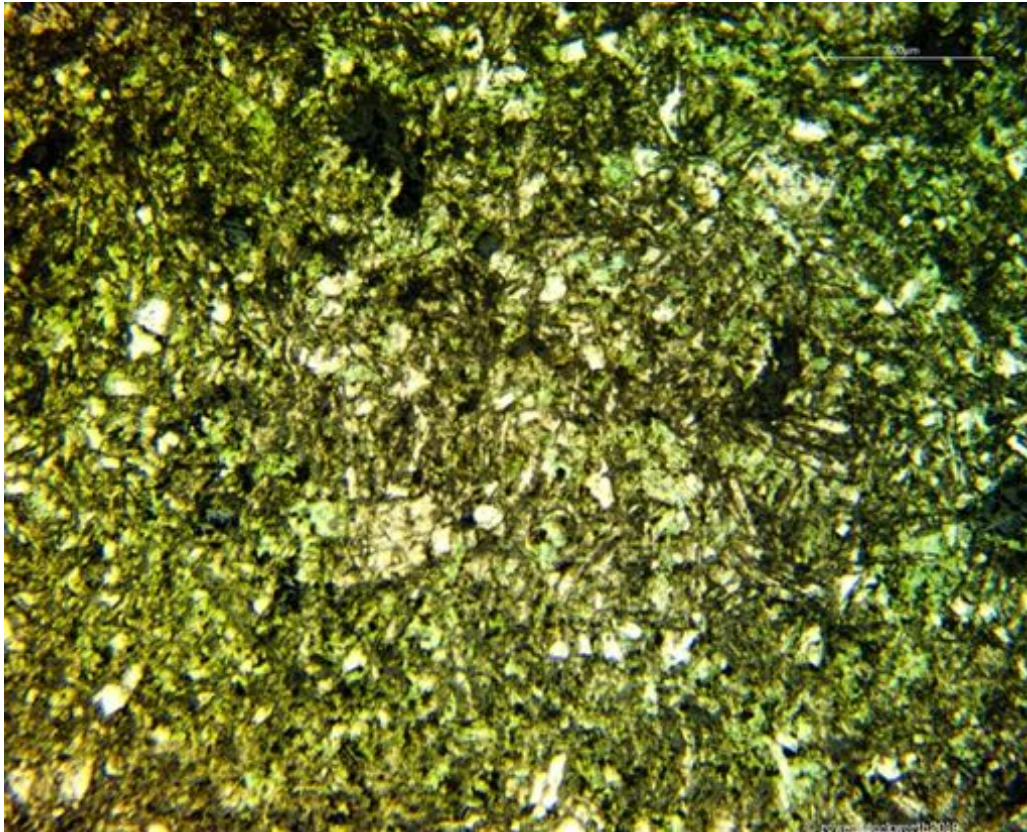
The groundmass is strongly chlorite and epidote altered with lesser carbonate and minor titanite. Plagioclase laths in the groundmass are strongly altered, around 0.4mm long and partially altered to clay, carbonate, epidote and chlorite. The composition cannot be reliably determined due to the pervasive propylitic alteration.

Opaques in this sample are all ragged hematite after magnetite that show partial carbonate alteration.

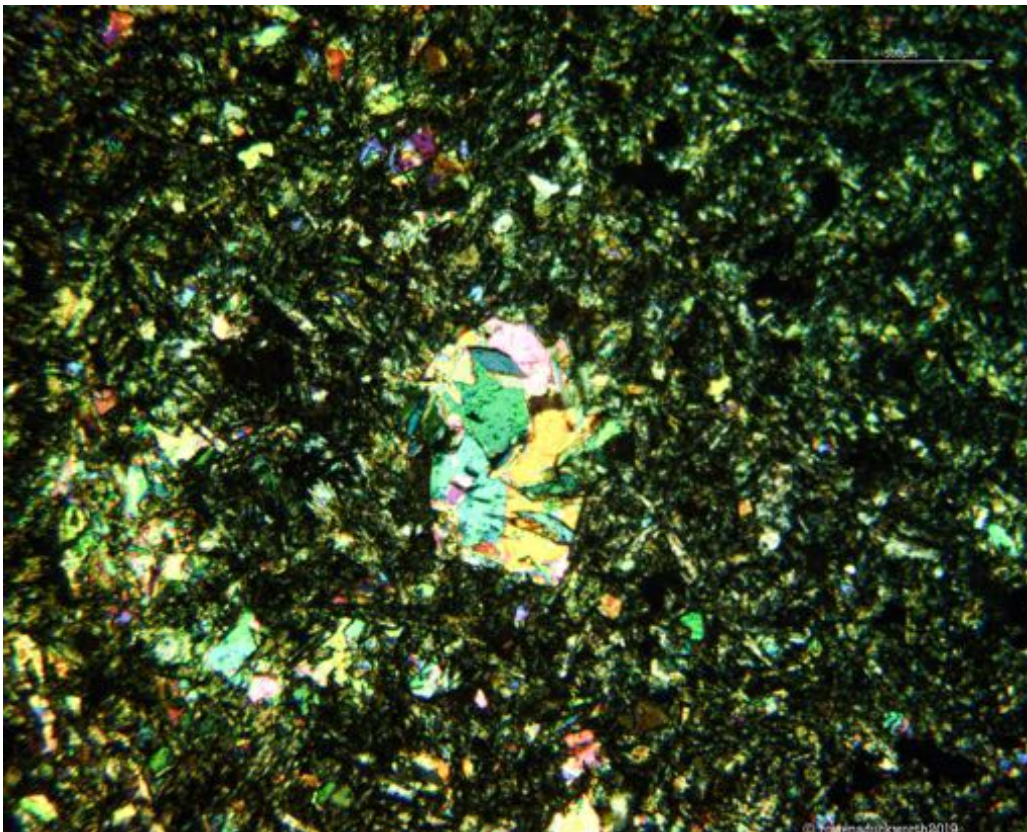
Late thin veins are carbonate. Carbonate is therefore paragenetically late.

**Summary:** Sparsely porphyritic chlorite-epidote-carbonate altered meta-basalt.



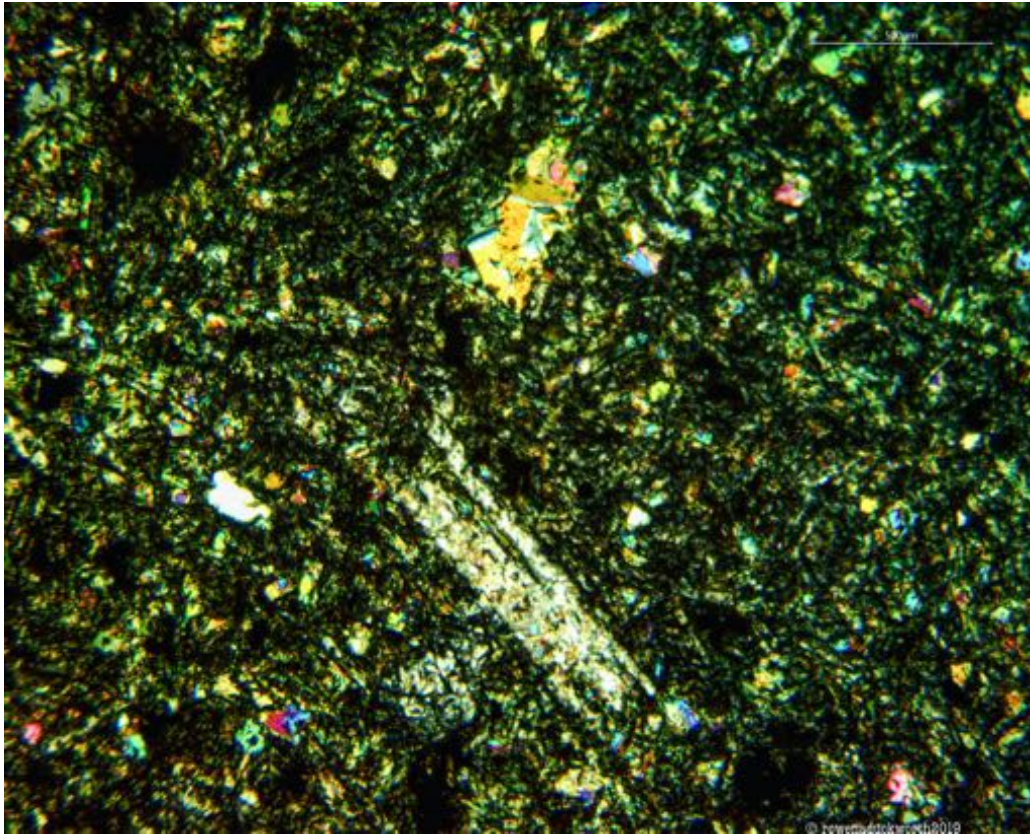


**Reflected and plane polarised light photomicrograph of sample 163060 (x4) illustrating the texture with pervasive green chlorite alteration and disseminated grey magnetite.**

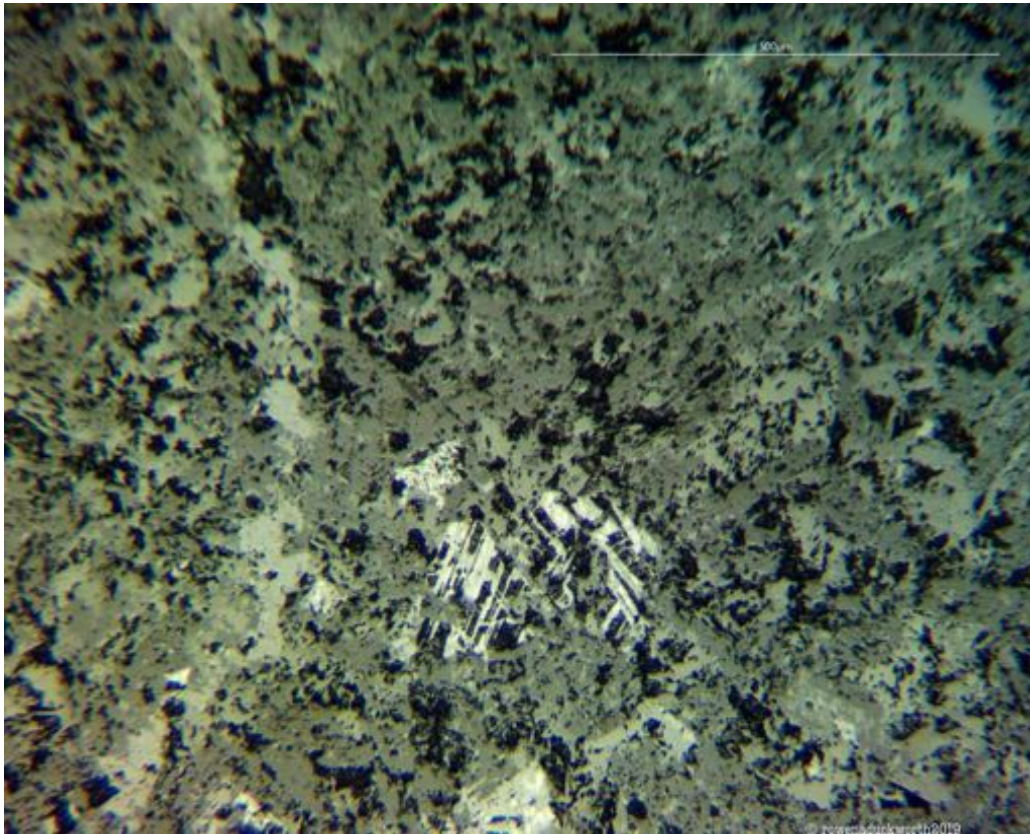


**Cross polarised light photomicrograph of sample 163060 (x4) illustrating chlorite-epidote fine grained groundmass with occasional larger epidote grains.**





**Cross polarised light photomicrograph of sample 163060 (x4) illustrating occasional plagioclase phenocryst in chlorite-feldspar-epidote groundmass.**



**Reflected light photomicrograph of sample 163060 (x10) illustrating ragged partially hematite altered magnetite grain partially replaced by non-reflective grey carbonate.**

**163071****Thin section and offcut of sample 163071**

**Mineralogy:** Hematite, Kspar, quartz, goethite.

The hand specimen shows a red-grey mottled fine-grained rock. The thin section shows a red rock with a well-defined darker band cut by a pale vein at the end away from the label.

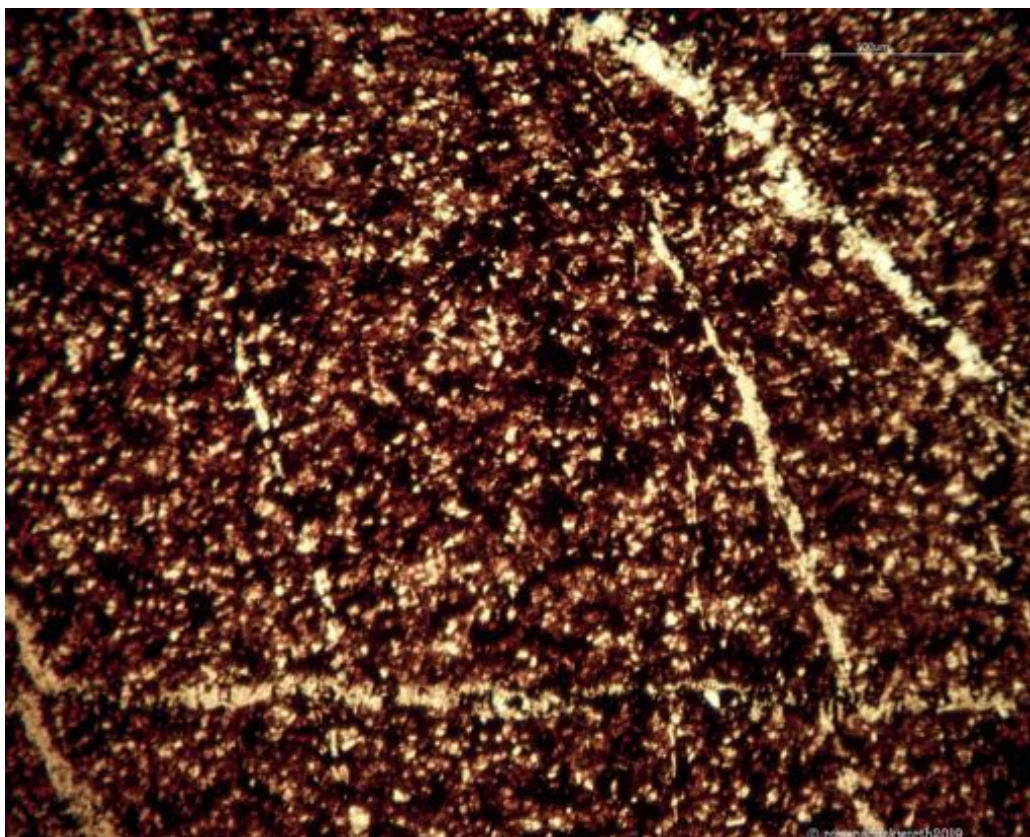
Microscopically, this sample is a strongly hematized fine-grained rock composed dominantly of quartz and altered feldspar. Altered potassic (?) feldspar is probably slightly more abundant than quartz but the hematitic alteration makes absolute abundances hard to determine. Grain size of both the quartz and hematized feldspar is around 0.1mm.

The darker layer at one end of the section is more strongly iron altered, and the quartz veins that cut this sample, are occasionally overprinted by iron oxides indicating that the iron alteration is paragenetically late.

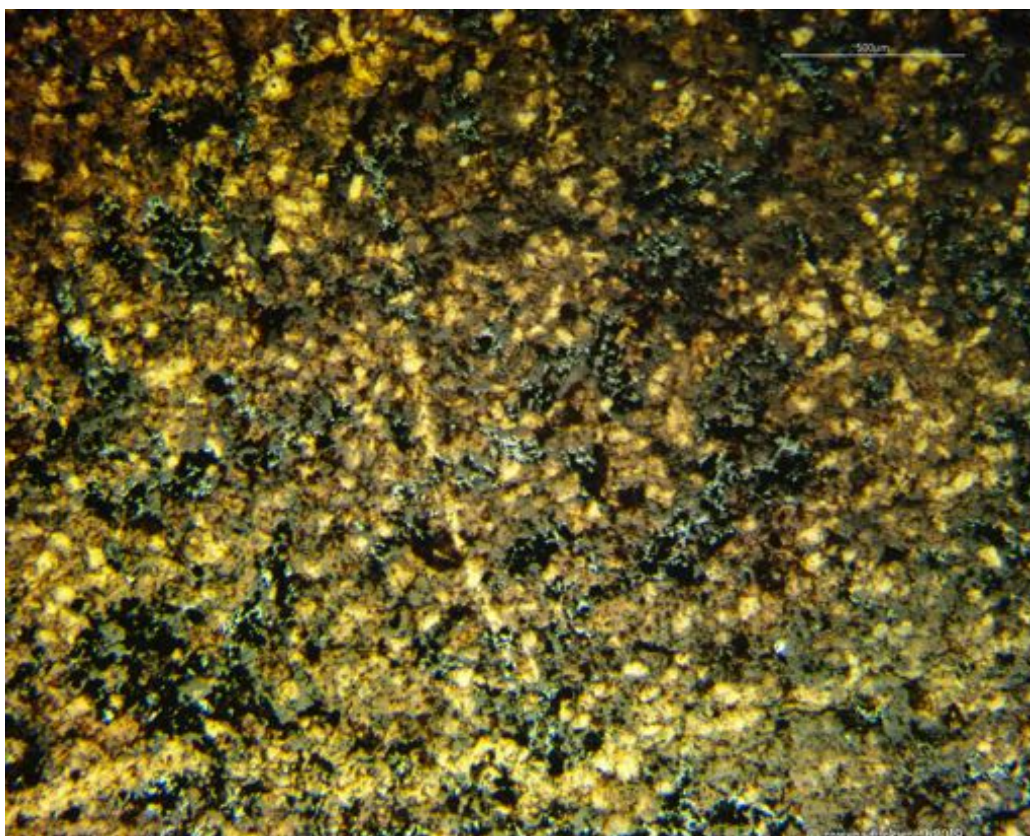
Hematite is commonly earthy hematite with more specular hematite and goethite.

**Summary:** Strongly hematized fine-grained feldspathic sandstone with quartz veining.



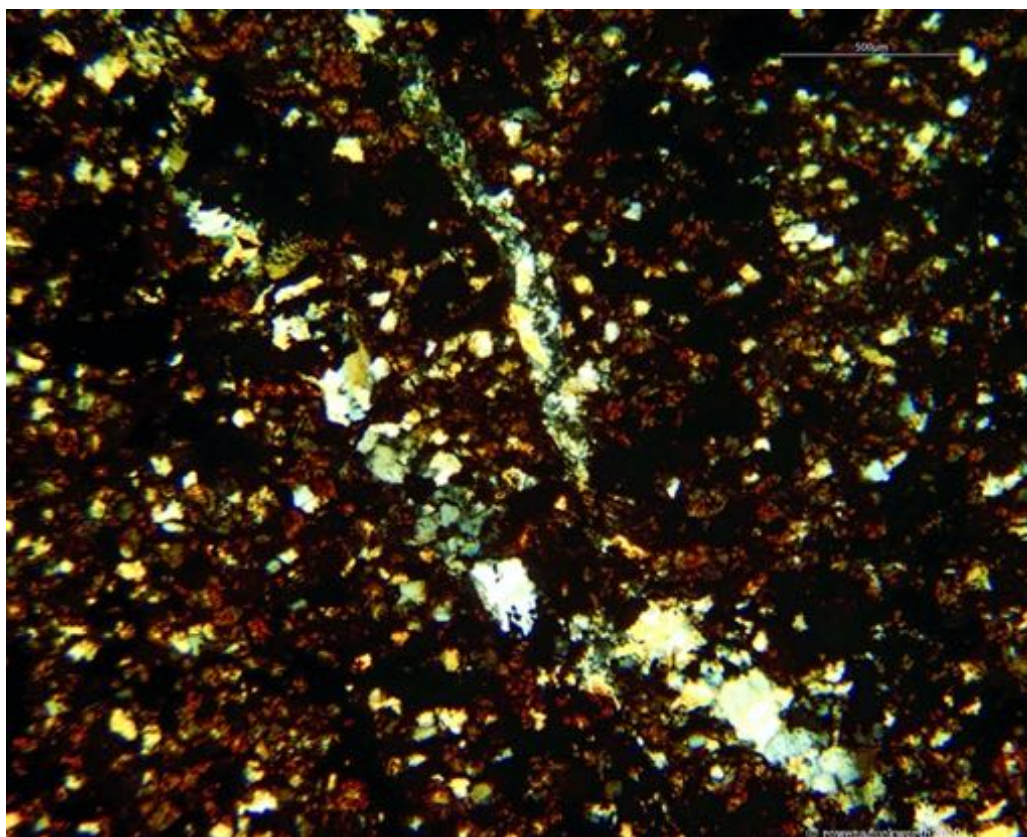


**Plane polarised light photomicrograph of sample 163071 (x2) illustrating the iron oxide altered and veined fine-grained sediment.**

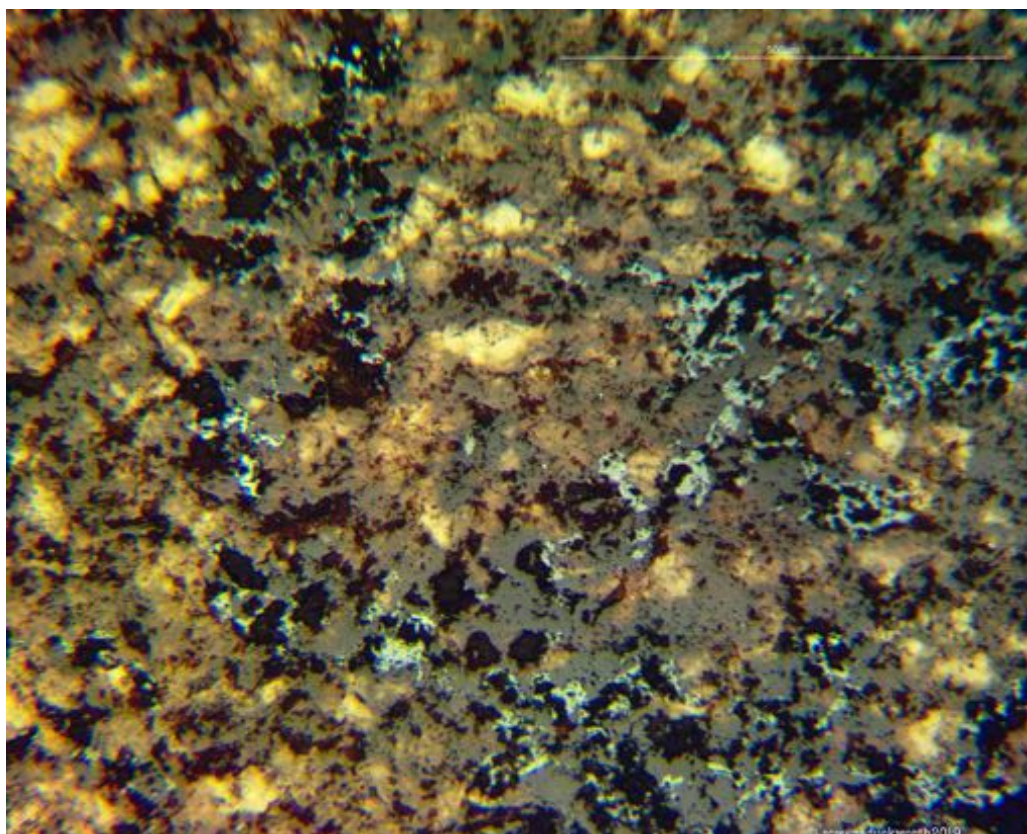


**Reflected and plane polarised light photomicrograph of sample 163071 (x4) illustrating extensive hematite and alteration.**





**Cross polarised light photomicrograph of sample 163071 (x4) illustrating red hematite alteration of feldspar + quartz and quartz veins also partially Fe-replaced.**



**Reflected and plane polarised light photomicrograph of sample 163071 (x10) illustrating hematite and goethite alteration of feldspar and quartz.**

**163072****Thin section and offcut of sample 163072**

**Mineralogy:** Earthy hematite, quartz, altered feldspar, goethite, muscovite.

The hand specimen shows a fairly homogenous orange coloured fine grained rock. The thin section shows a reddish-brown sample with a finely laminated texture.

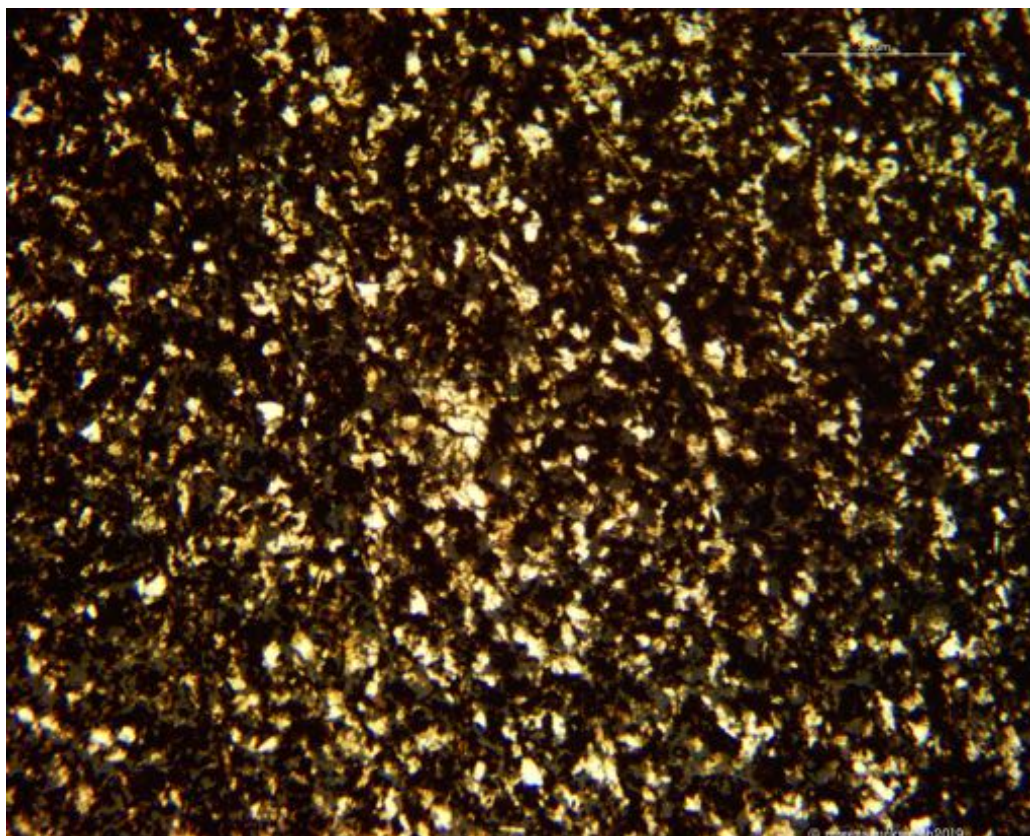
Microscopically, this sample is a strongly iron-altered fine-grained rock composed dominantly of quartz with lesser altered feldspar and uncommon white mica

Altered potassic (?) feldspar is strongly hematite-altered and the hematitic alteration makes absolute abundances hard to determine. Grain size of both the quartz and hematised feldspar is around 0.1mm.

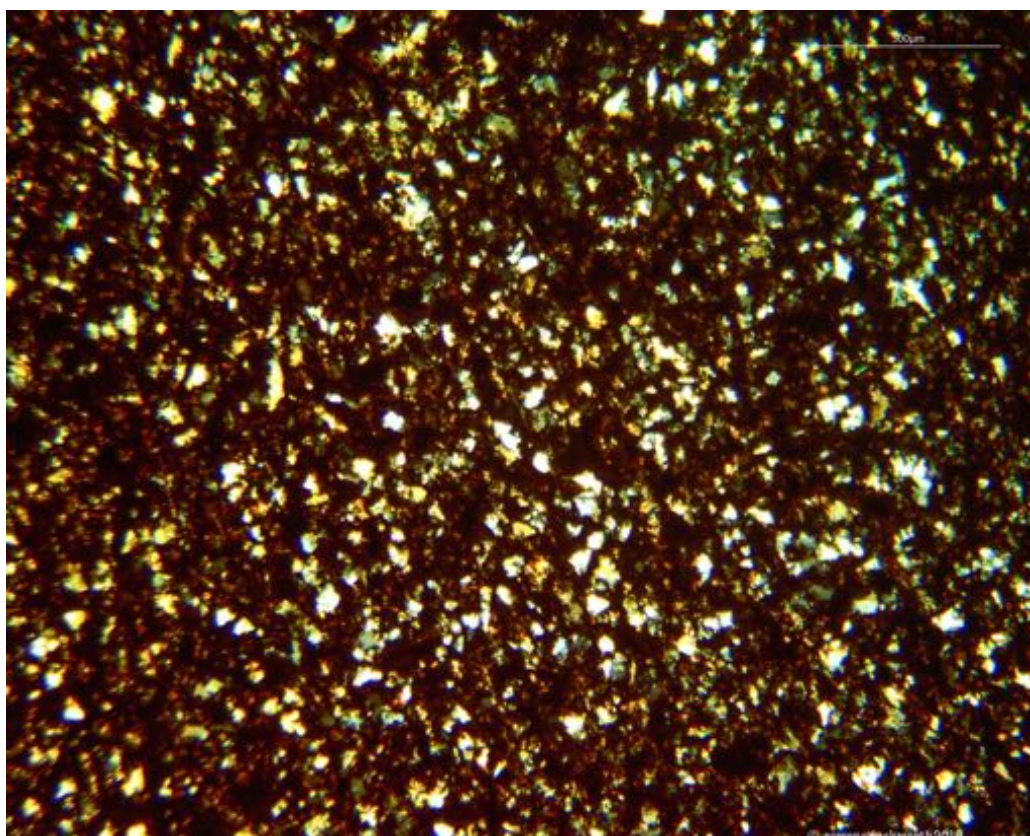
Minor 0.1-0.2mm long muscovite flakes show a preferred alignment and define w weak schistosity parallel to the fine laminations in the sample.

**Summary:** Strongly iron-oxide altered laminated fine-grained quartz-feldspar sandstone- with minor muscovite defining a weak schistosity.



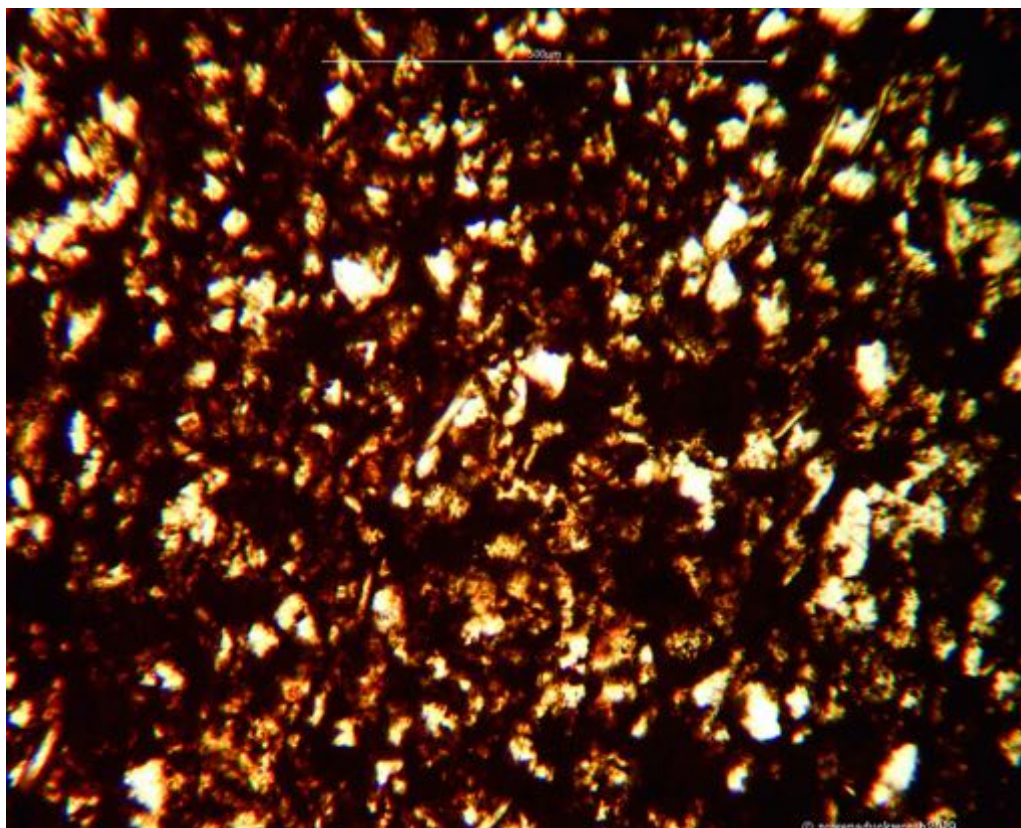


**Plane polarised light photomicrograph of sample 163072 (x2) illustrating the fine grained quartz rich texture with pervasive iron oxide alteration.**

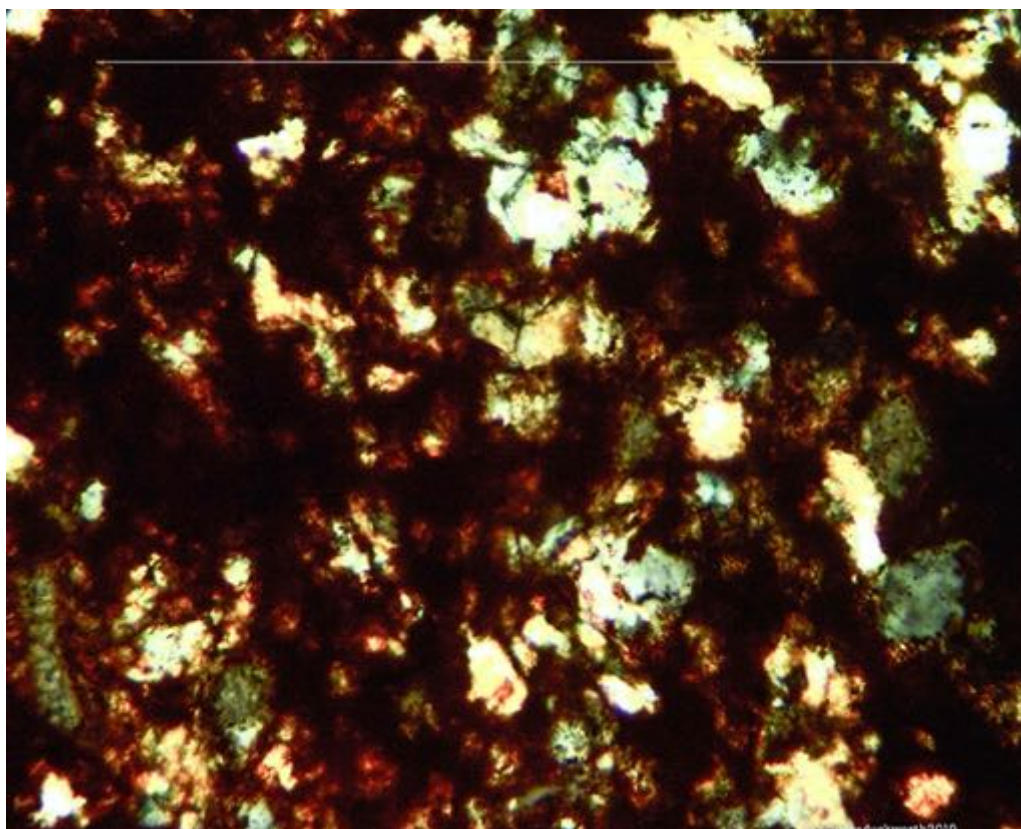


**Cross polarised light photomicrograph of sample 163072 (x4) illustrating texture of fine grained quartzo-feldspathic rock with extensive iron oxide alteration.**

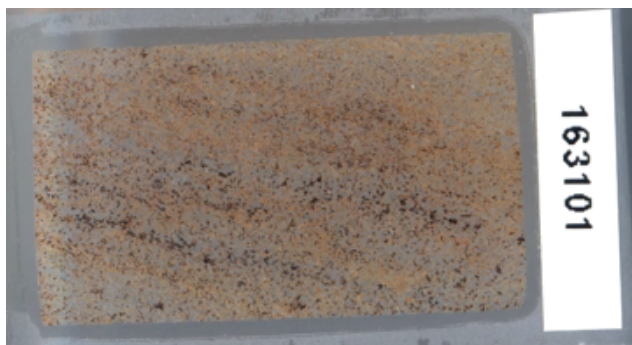




**Plane polarised light photomicrograph of sample 163072 (x10) illustrating the occurrence of minor muscovite flakes defining a very weak schistosity.**



**Cross polarised light photomicrograph of sample 163072 (x10) illustrating hematite altered feldspar and less altered quartz grains.**

**163101****Thin section and offcut of sample 163101**

**Mineralogy:** Quartz, hematite, Kspar, muscovite, rutile.

The hand specimen shows a porous, granular texture pinky-brown-grey rock with a rough layering. The thin section shows a layered colourless-orange rock with 7-10% opaques defining layers.

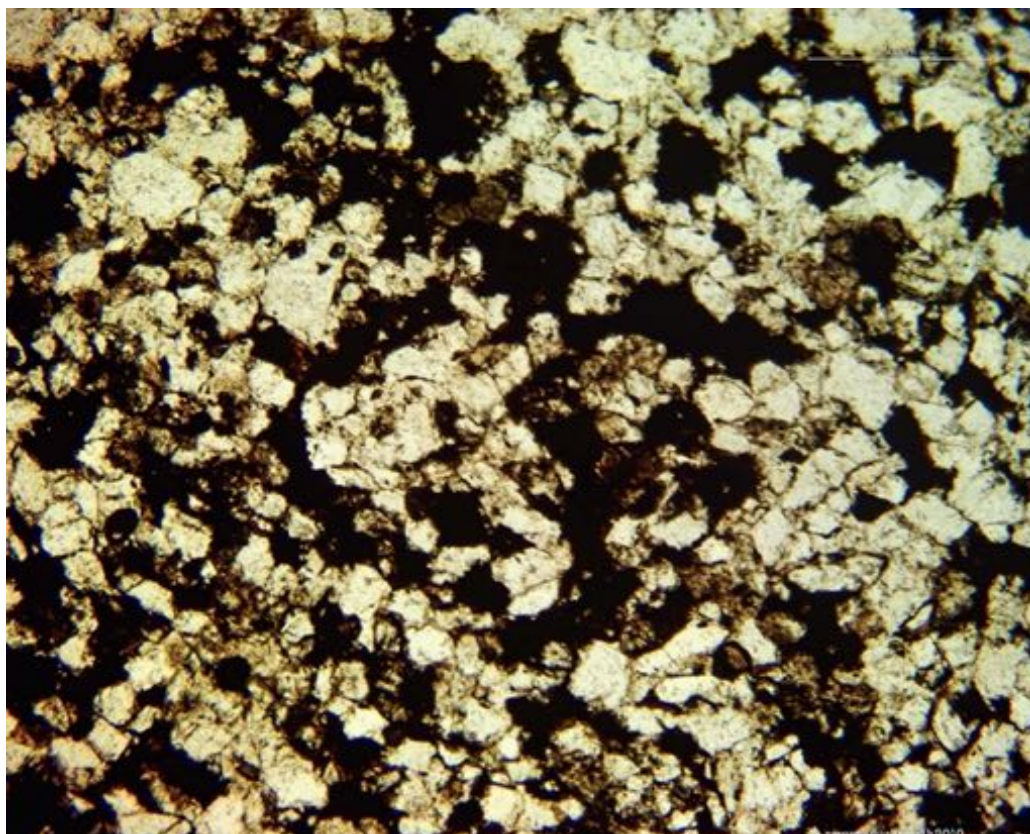
Microscopically, this sample is a bedded quartz-feldspar sandstone with hematite alteration. Darker layers are more strongly hematite altered and these may have been more feldspathic?

Quartz grains are anhedral, between 0.2-0.4mm and feldspars are hematite altered and commonly a little coarser-grained, with a grain size range from 0.2-0.5mm. Occasional 0.5-0.6mm microcline grains were observed indicative of an igneous source rock. Overall there is less than 20% feldspar in this sample.

Minor muscovite flakes are 0.1-0.2mm long and these are randomly distributed with no alignment. Minor rutile was observed.

**Summary:** Variably hematized quartz-feldspar-muscovite bedded sandstone.



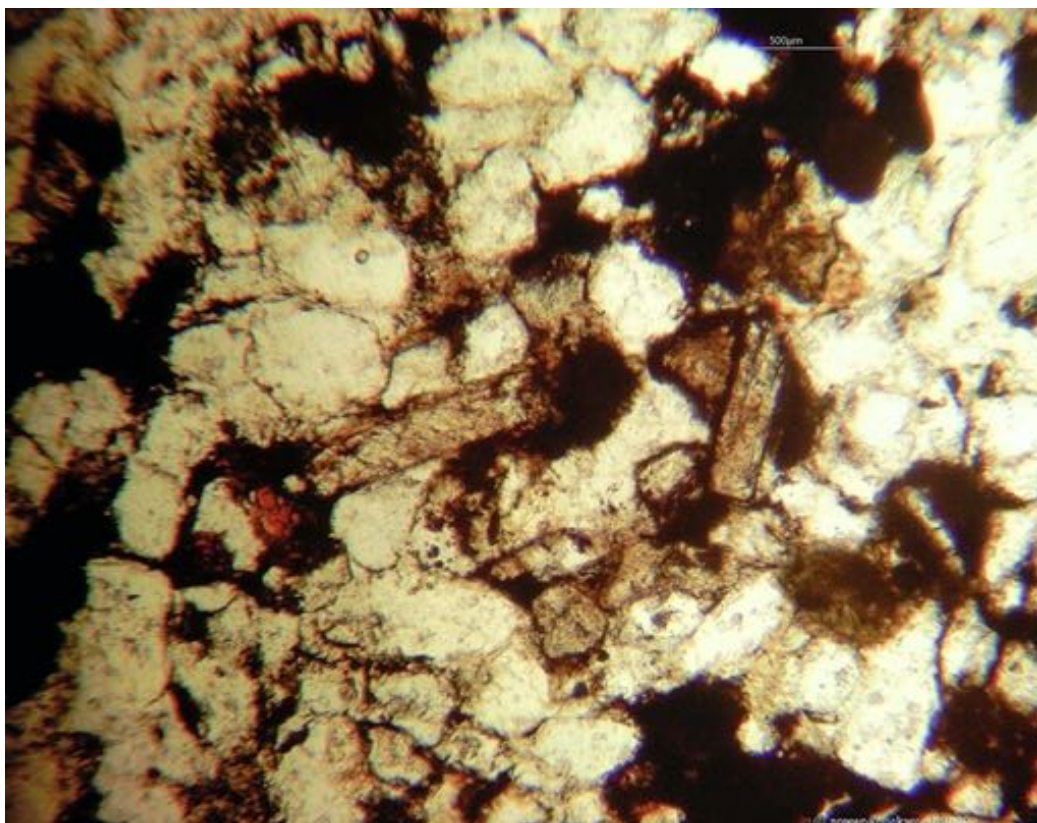


**Plane polarised light photomicrograph of sample 163101 (x4) illustrating the iron oxide altered granular sandstone texture.**

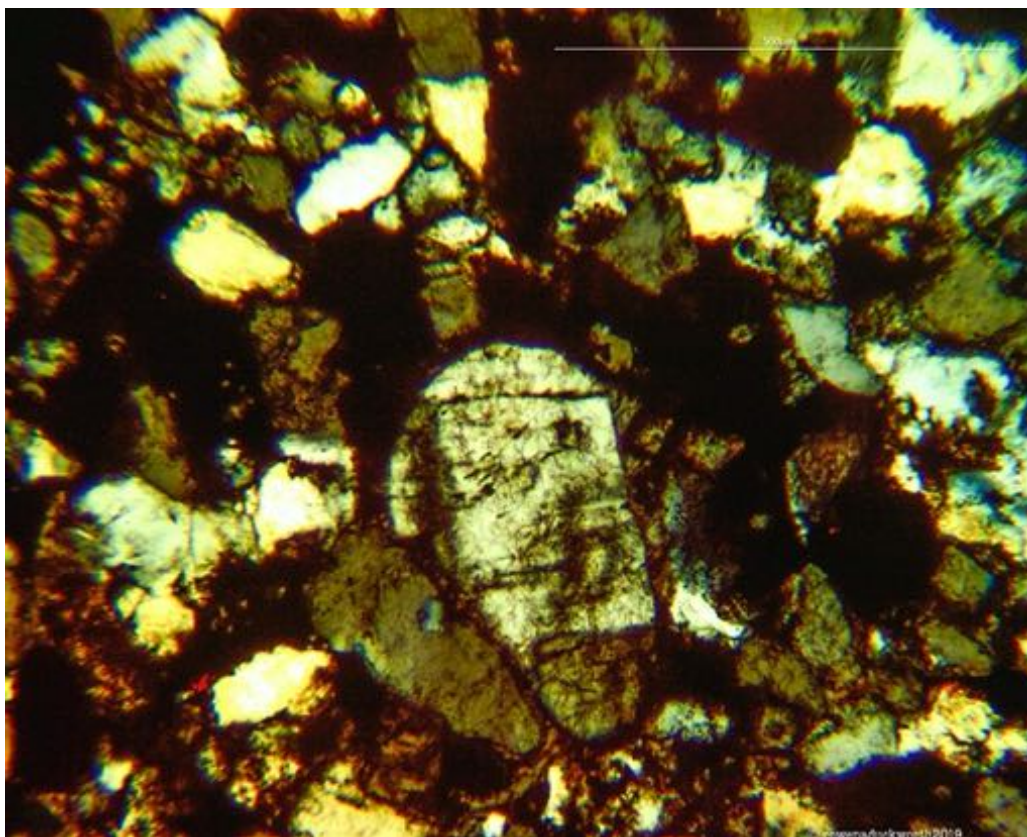


**Cross polarised light photomicrograph of sample 163101 (x4) illustrating the texture with anhedronal quartz grains and opaques.**





**Plane polarised light photomicrograph of sample 163101 (x10) illustrating minor muscovite and golden-brown rutile.**



**Cross polarised light photomicrograph of sample 163101 (x10) illustrating occasional rounded microcline grain that is partially hematized.**



**163112****Thin section and offcut of sample 163112**

**Mineralogy:** Quartz, hematite, feldspar, muscovite, chlorite, apatite.

The hand specimen is a laminated pale red and white sample with an area of darker red alteration near one edge. The thin section shows a finely laminated reddish rock with patches of deeper red alteration.

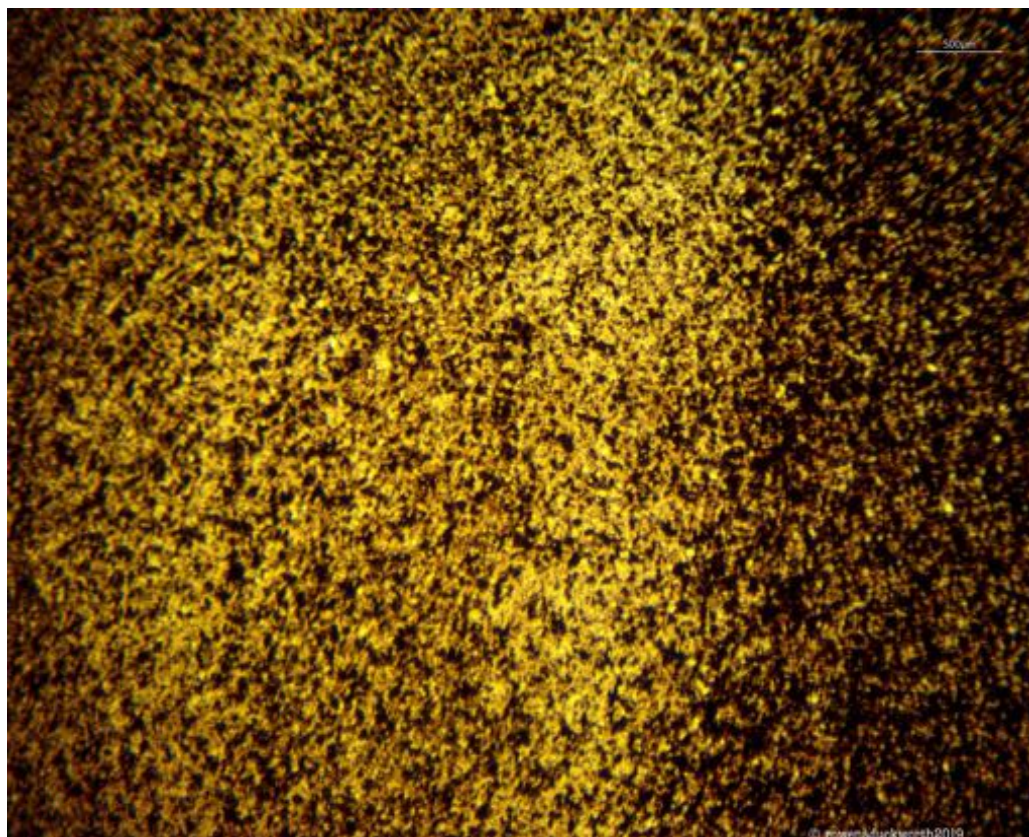
Microscopically, this sample is very fine grained with an average grain size of less than 0.1mm. Grains have very blurry altered grain boundaries and all grain are anhedral.

Mineralogically, quartz is the dominant phase, with lesser hematized and chloritized feldspar and minor muscovite and rare apatite. The texture is granular with no visible matrix.

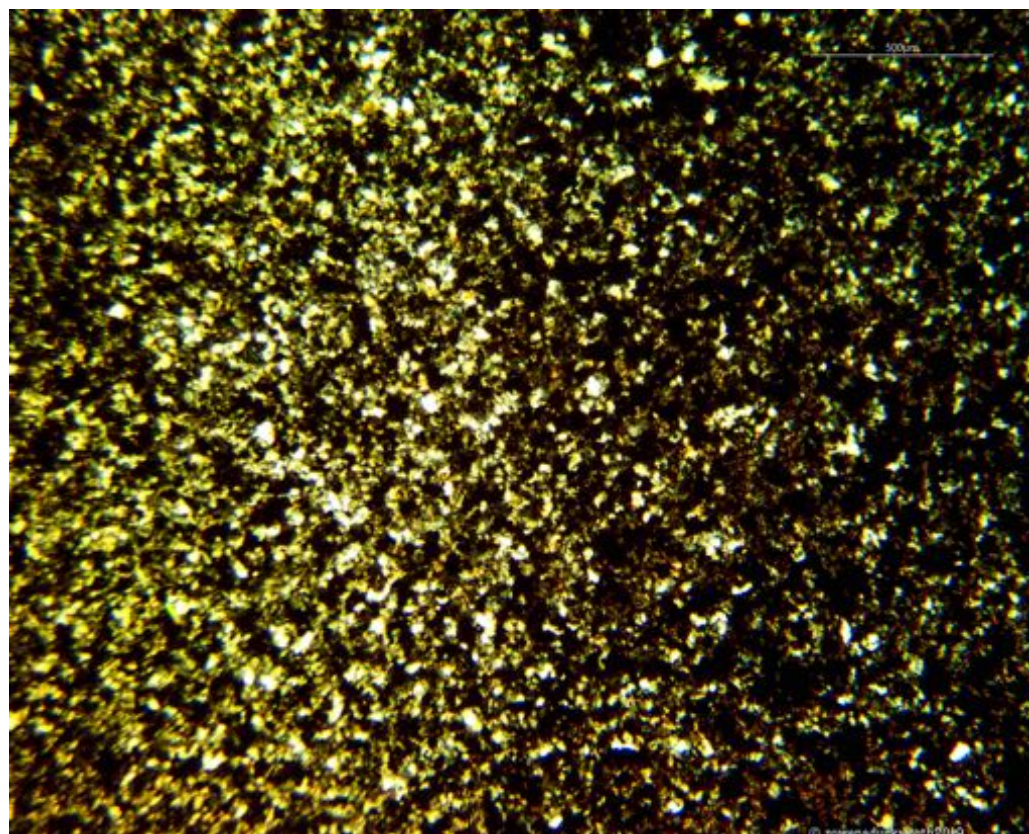
Laminations in the sample are defined by grain size and alteration and the deeper red layers that are more strongly hematized may have originally been more feldspathic? Paler less hematized layers are slightly coarser grained and more quartz rich. Muscovite flakes are approximately 0.1mm long.

Earthy hematite is the dominant as the alteration phase (with occasional grains of specular hematite), but pale green chlorite alteration of feldspar is also evident. The chlorite appears to be paragenetically earlier than the hematite.

**Summary:** Hematized and mildly chloritized quartz-feldspar-muscovite laminated siltstone.

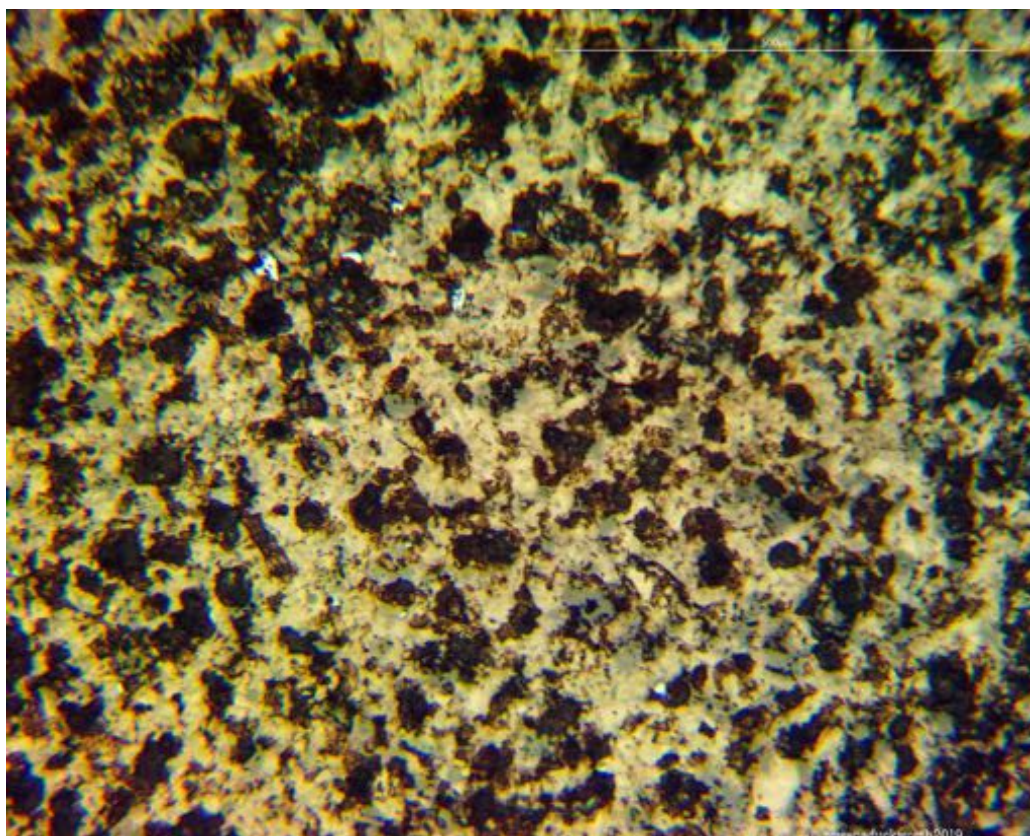


**Plane polarised light photomicrograph of sample 163112 (x4) illustrating the texture with darker and layered lighter layers.**

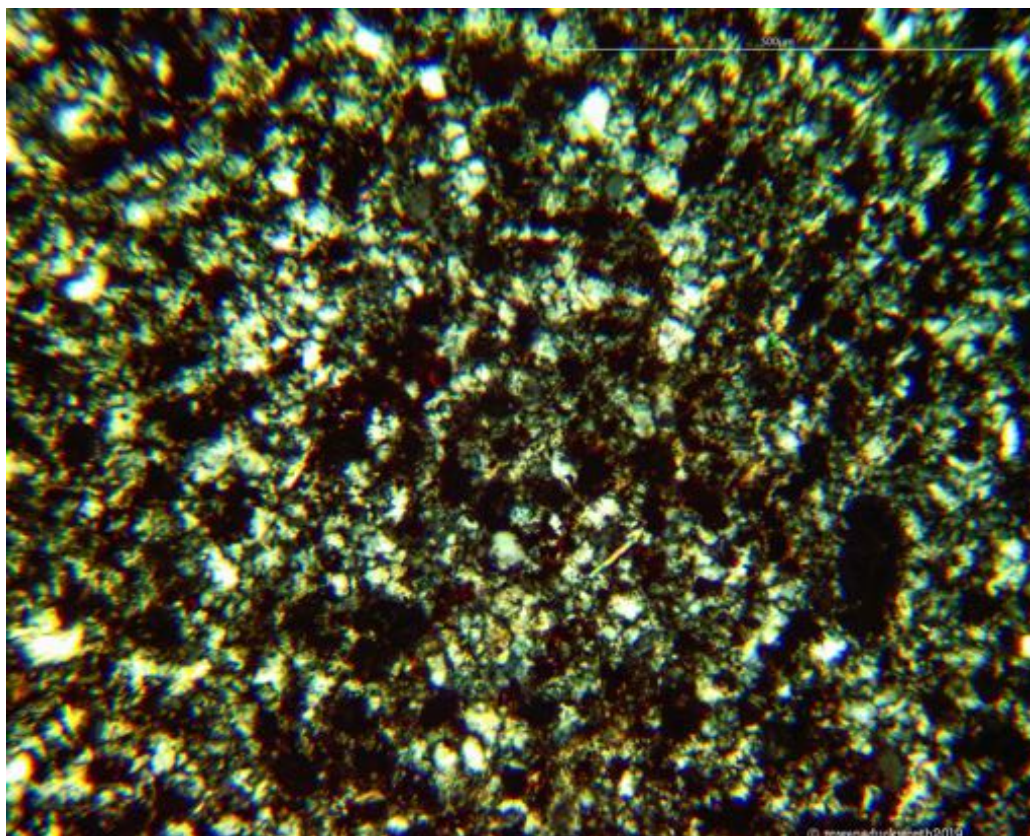


**Cross polarised light photomicrograph of sample 163112 (x4) showing the variation in iron oxide alteration in the fine-grained sediment.**

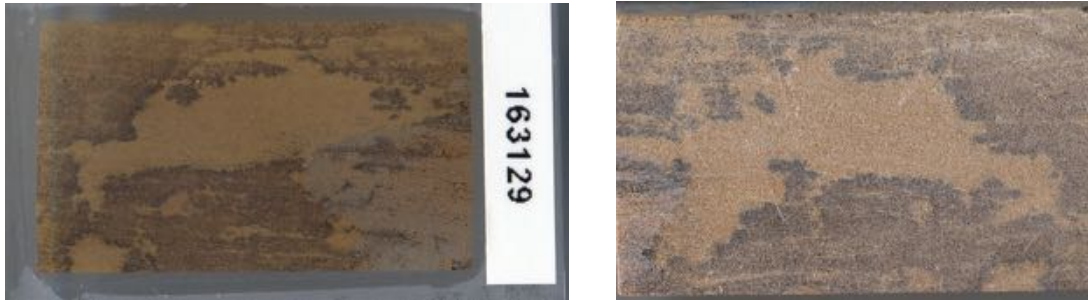




**Reflected and plane polarised light photomicrograph of sample 1163112 (x10) showing occasional specular hematite and more common grey non-reflective earthy hematite.**



**Cross polarised light photomicrograph of sample 163112 (x10) illustrating occasional high birefringence muscovite laths.**

**163129****Thin section and offcut of sample 163129**

**Mineralogy:** Feldspar, quartz, iron oxides, muscovite,

The hand specimen is a very mottled variably altered orange-red fine-grained rock and the thin section shows patchy darker brown red alteration along an orange layered rock with some sharp alteration fronts.

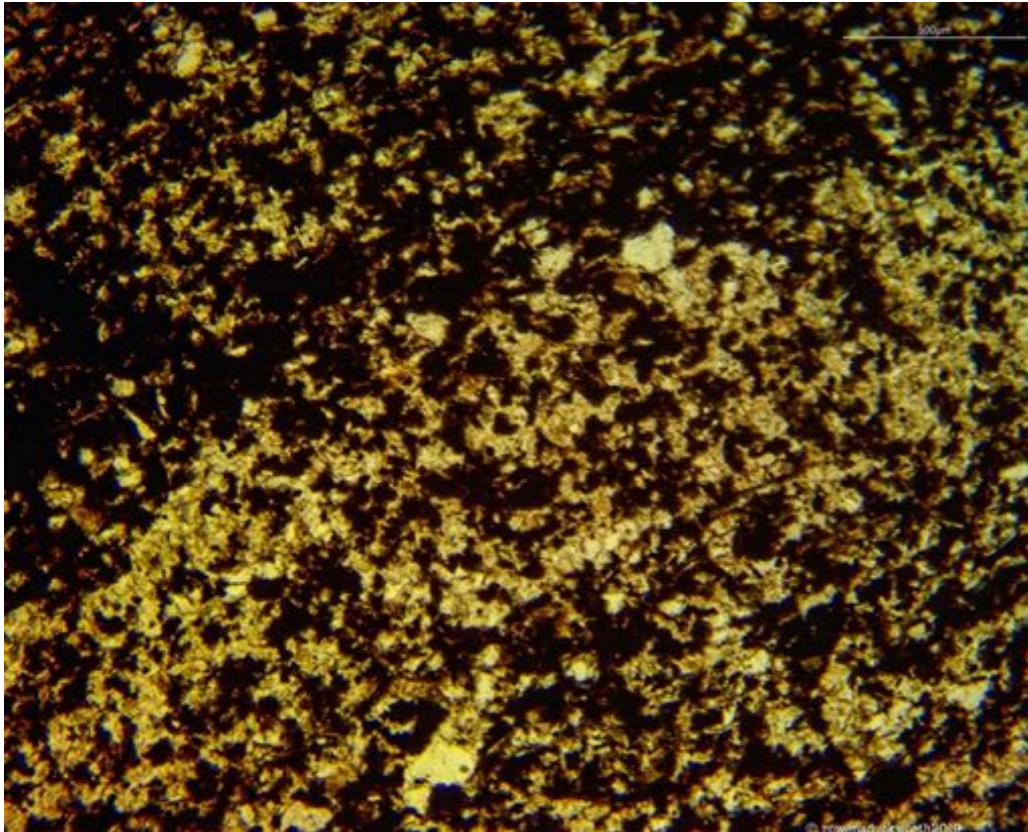
Microscopically, this sample is an altered feldspathic sandstone with anhedral feldspar and quartz grains forming a granular grain supported texture. The feldspars are quite strongly altered to earthy hematite, especially in the darker zones. The more heavily iron altered darker zones may be more feldspathic?

Grain size is generally between 0.1-0.2mm, but the roughly aligned muscovite grains are up to 0.3mm.

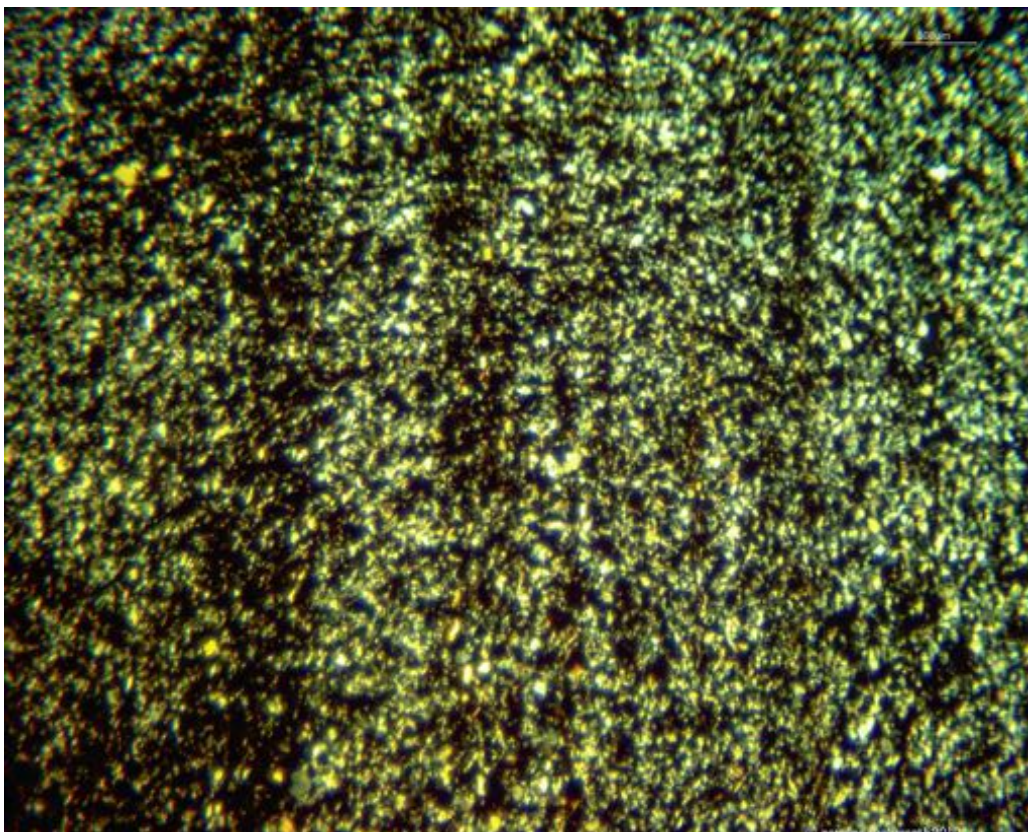
The sharp alteration fronts may reflect sharp redox changes or simply mineralogical variations.

**Summary:** Hematite altered feldspathic sandstone (arkose) showing patchy alteration and strong alteration fronts.



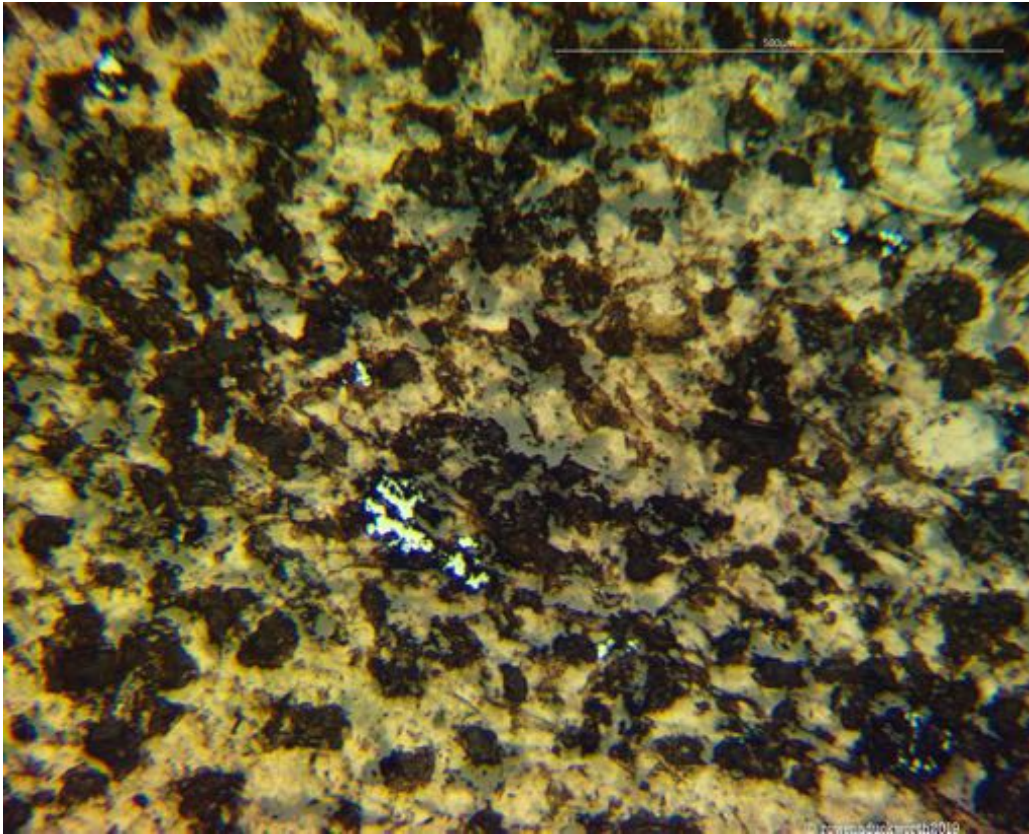


**Plane polarised light photomicrograph of sample 163129 (x4) illustrating the pervasive iron oxide (opaque) alteration and the fine grain size.**

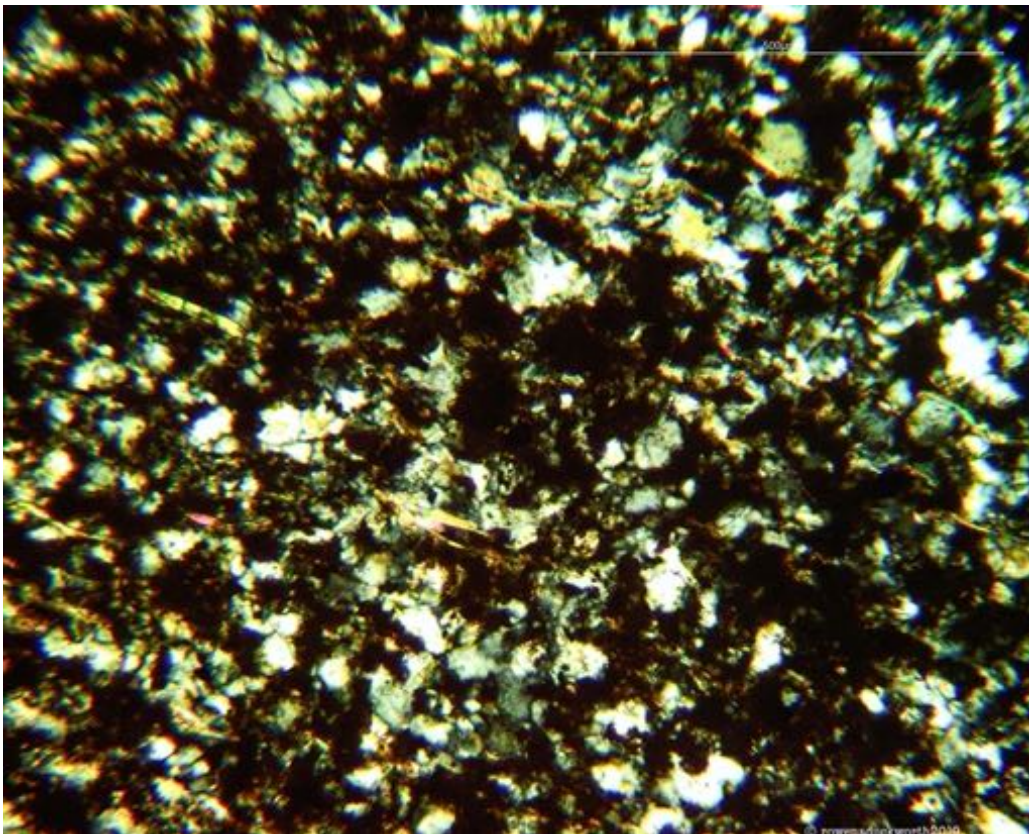


**Cross polarised light photomicrograph of sample 163129 (x2) illustrating the texture with some layers more iron oxide altered.**



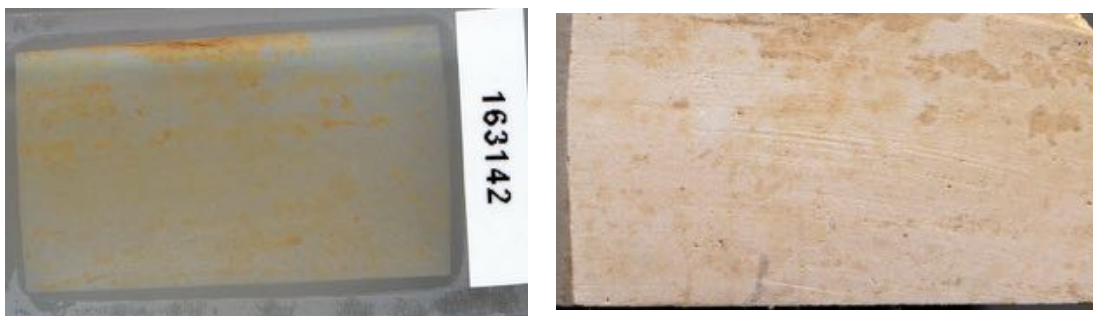


**Reflected and plane polarised light photomicrograph of sample 163129 (x10) illustrating the texture with occasional specular hematite and more common grey non-reflective earthy hematite.**



**Cross polarised light photomicrograph of sample 163129 (x10) illustrating quartz, feldspar and muscovite mineral assemblage with strong opaque iron oxide overprint.**



**163142****Thin section and offcut of sample 163142**

**Mineralogy:** Quartz, feldspar, muscovite, iron hydroxyoxides, apatite, rutile, hematite.

The hand specimen shows a bleached pale rock with splotchy darker brown alteration. The thin section shows a pale rock with variable yellow-orange staining.

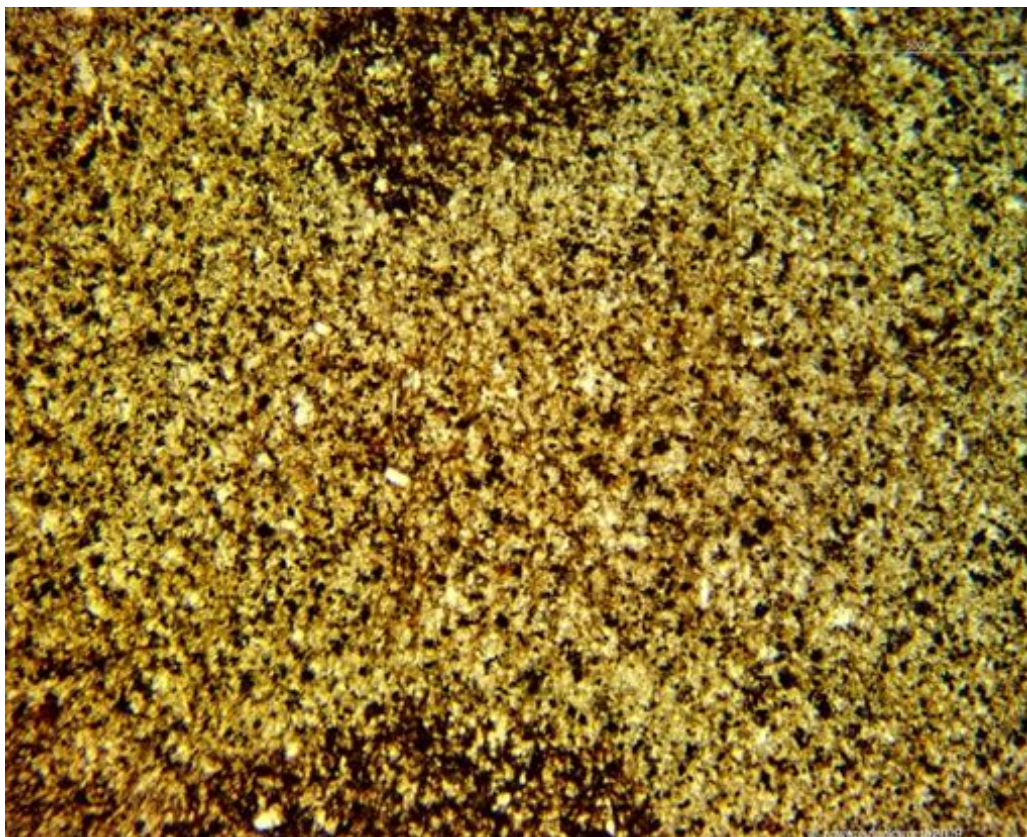
Microscopically, this is a very fine-grained quartz-feldspar-muscovite siltstone with patchy limonite alteration.

Generally, the grain size is between 0.05-0.1mm but some grains are finer than this. Occasional quartz grains are up to 0.2mm.

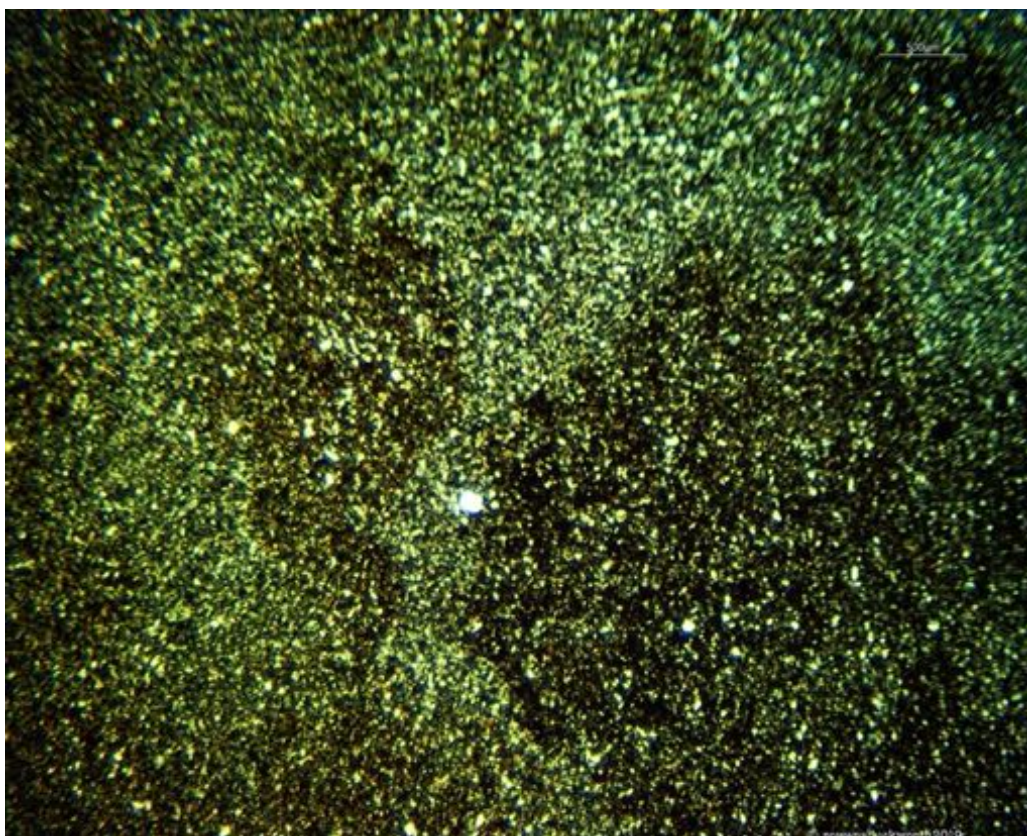
Feldspar grains are variably iron altered and muscovite grains are scattered throughout and show a weak alignment. Minor apatite and rutile were observed.

The iron alteration is patchy and doesn't follow primary sedimentary layering.

**Summary:** Very fine-grained granular, grain-supported, quartz-feldspar-muscovite siltstone, patchily iron stained.

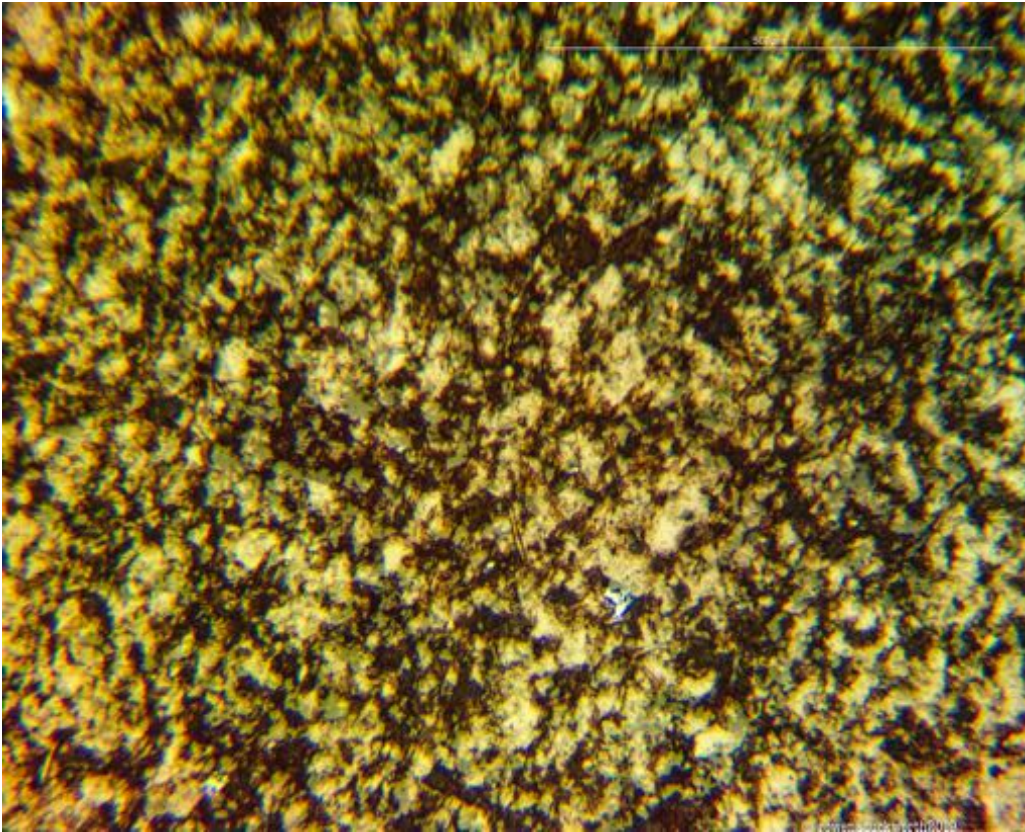


**Plane polarised light photomicrograph of sample 163142 (x4) illustrating fine grained granular texture with finely disseminated and patchy iron oxide alteration.**

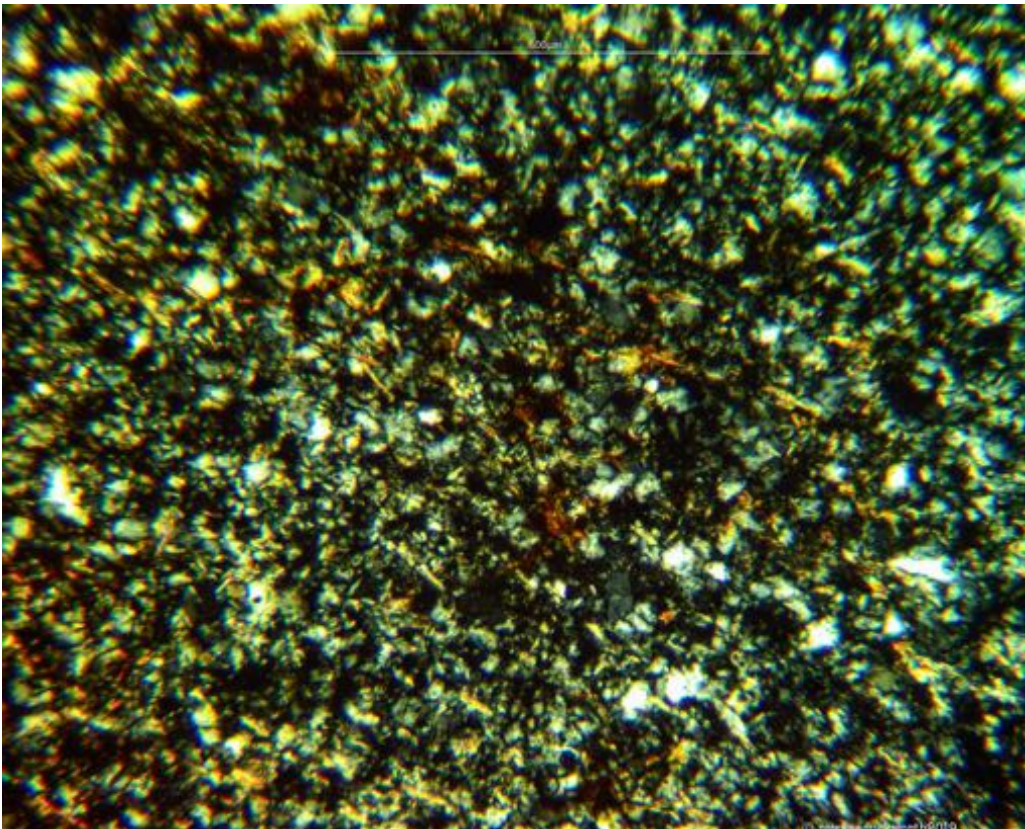


**Cross polarised light photomicrograph of sample 163142 (x2) illustrating patchily altered quartzo-feldspathic texture.**

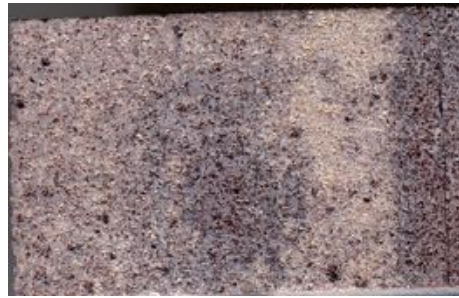
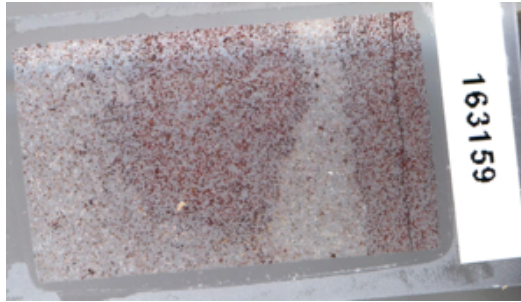




**Reflected and plane polarised light photomicrograph of sample 163142 (x10) illustrating pervasive goethite alteration and rare bright hematite (bottom left).**



**Cross polarised light photomicrograph of sample 163142 (x10) showing texture with wee anhedral quartz + feldspar grains and aligned muscovite needles.**

**163159****Thin section and offcut of sample 163159**

**Mineralogy:** Quartz, feldspar, hematite, chlorite, rutile, apatite.

The hand specimen is a porous, pale rock with patchy red alteration and disseminated dark patches. The thin section shows a colourless-pale rock with patchy red-grey alteration and one dark veinlet at the label end. Around 20% opaques.

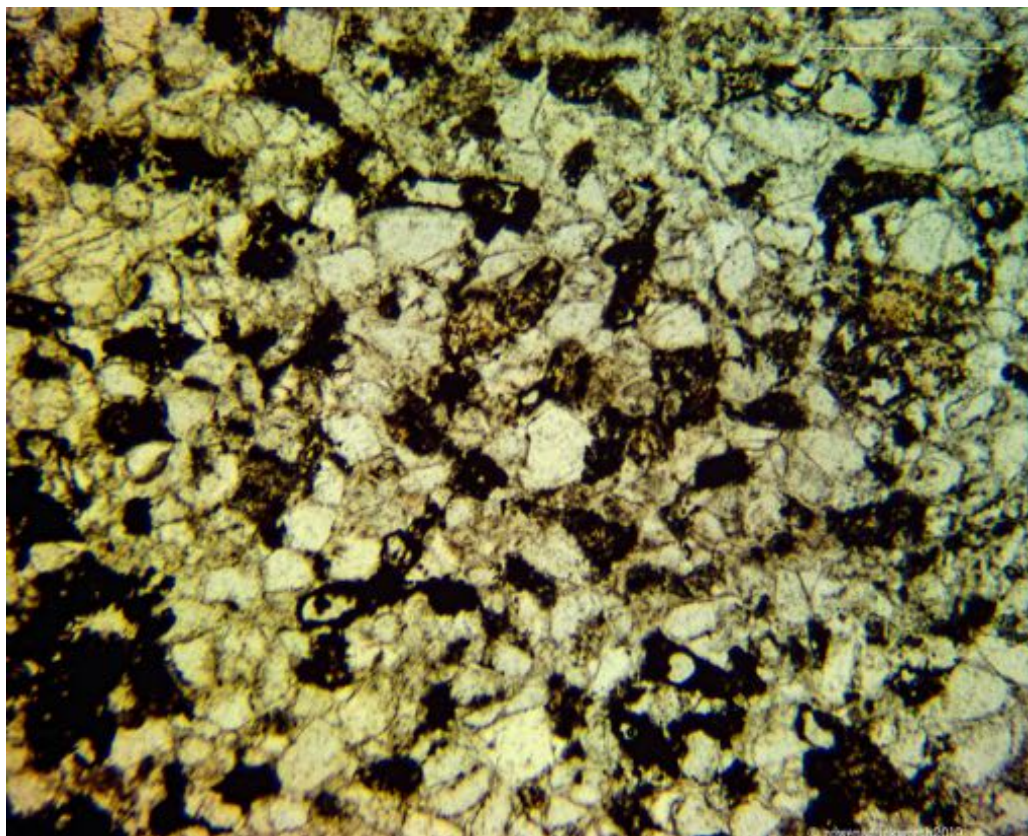
Microscopically, this is a granular porous rock with an average grain size of 0.2-0.5mm and is composed dominantly of quartz and feldspar.

Quartz grains are anhedral and form around 50-60% of the rock. Identifiable feldspar forms around 20% of the rock with the rest composed of hematite which may be after feldspar. Minor chlorite, rutile and apatite make up less than 5% of the sample.

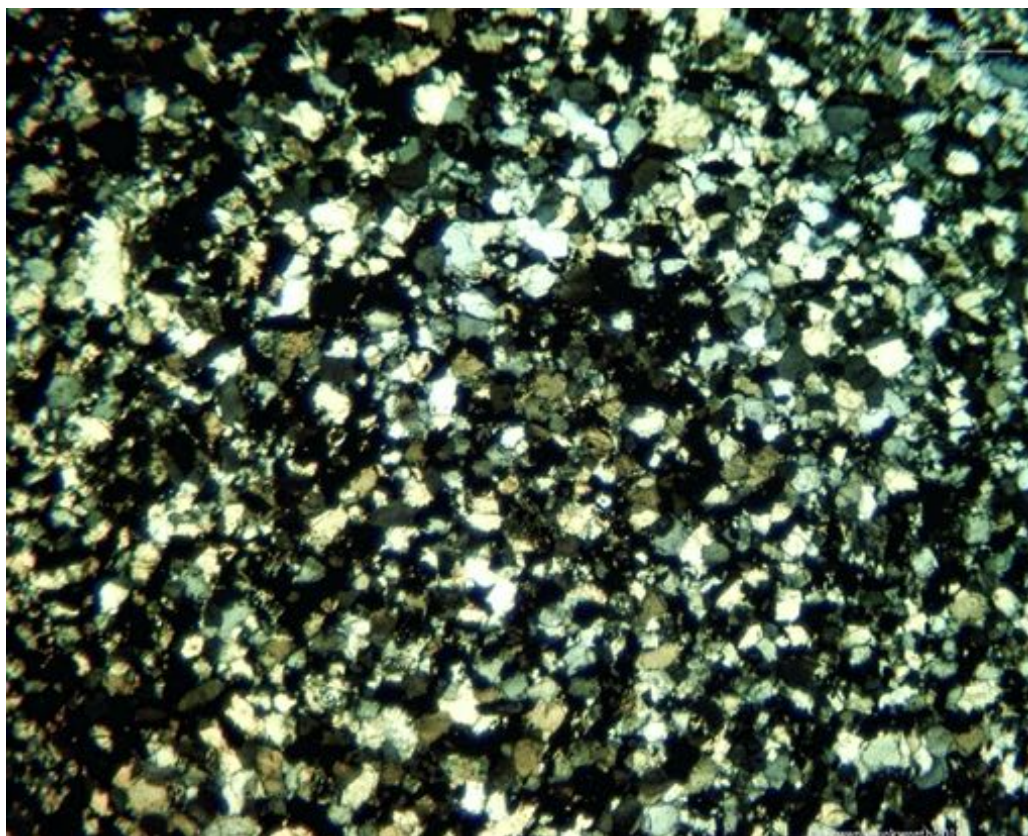
Earthy hematite is paragenetically late and wraps around quartz grains as well as partially replacing feldspars. The patchy nature of the alteration may be a result of the permeability and porosity of this sandstone. The alteration is probably associated with the hematite veining.

**Summary:** Coarse-grained quartz-feldspar sandstone (arkose) with patchy hematite alteration and veining.



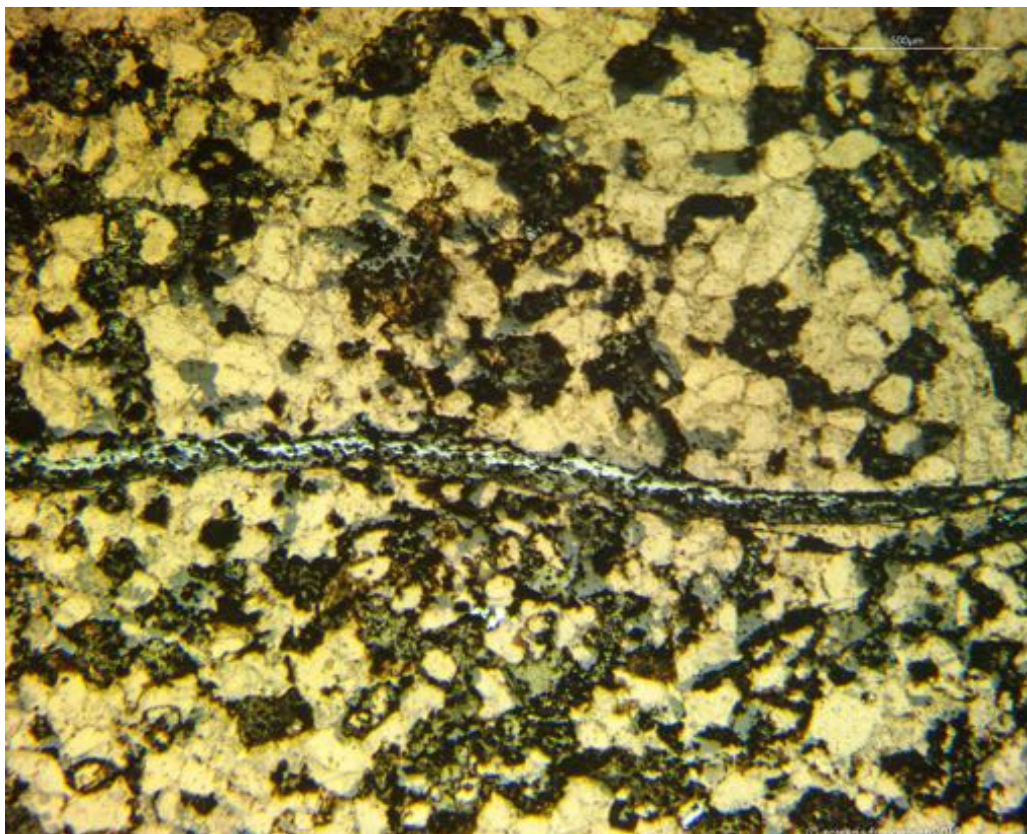


**Plane polarised light photomicrograph of sample 163159 (x4) illustrating quartz grains, dusty feldspars and opaques.**

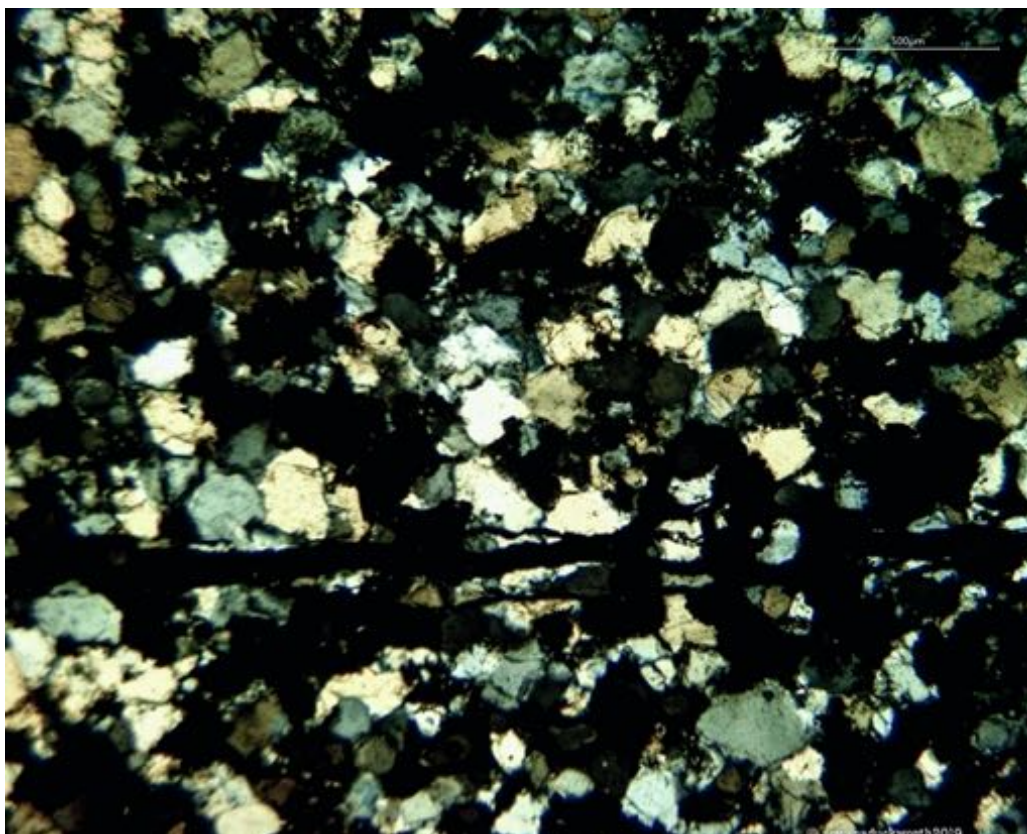


**Cross polarised light photomicrograph of sample 163159 (x2) illustrating texture with scattered partially replacing opaque iron oxides.**





**Reflected and plane polarised light photomicrograph of sample 163159 (x4) illustrating texture with hematite veinlet and disseminated non-reflective earthy hematite.**



**Cross polarised light photomicrograph of sample 163159 (x10) illustrating occasional hematite veinlets and alteration in granular quartz rich arkose.**



**163177****Thin section and offcut of sample 163177**

**Mineralogy:** Quartz, clays, hematite.

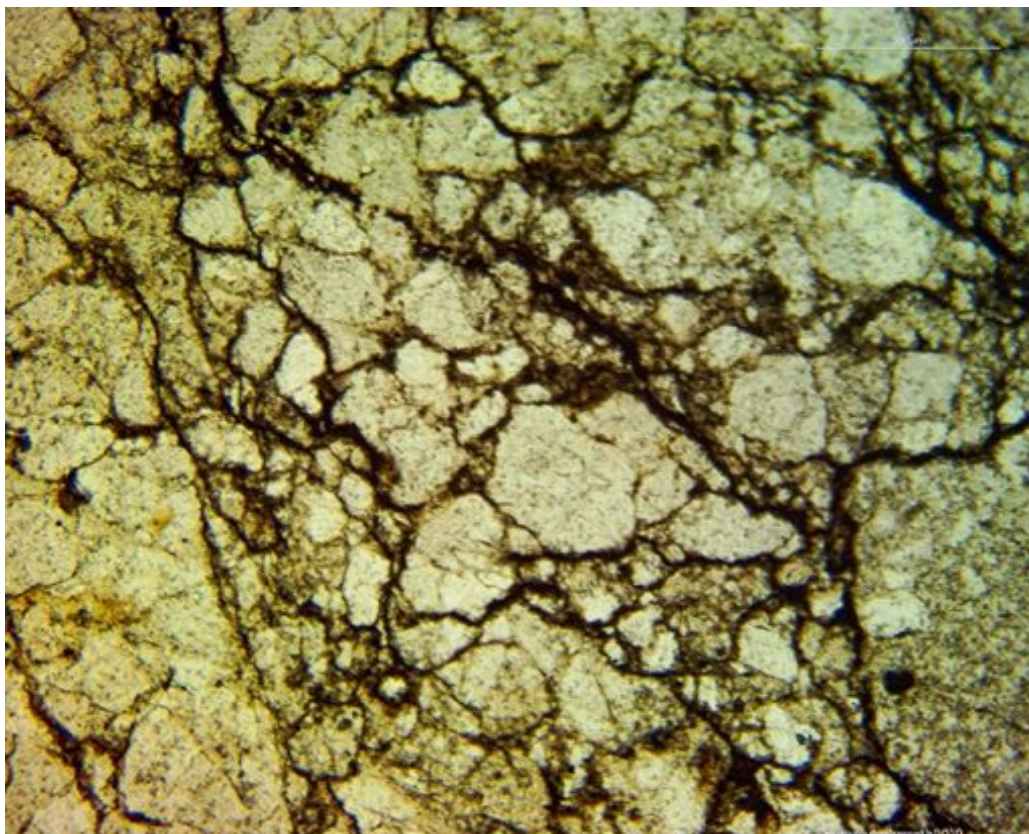
The hand specimen is a pinkish clastic rock with pale curvilinear veining. The thin section shows a brecciated rock that is dominantly colourless.

Microscopically, this sample is a brecciated quartzite. Quartz grains have a variable size range from 0.2-1.5mm and are commonly subrounded to subangular and form an interlocking granular texture. No undulose extinction was observed indicating no ductile deformation.

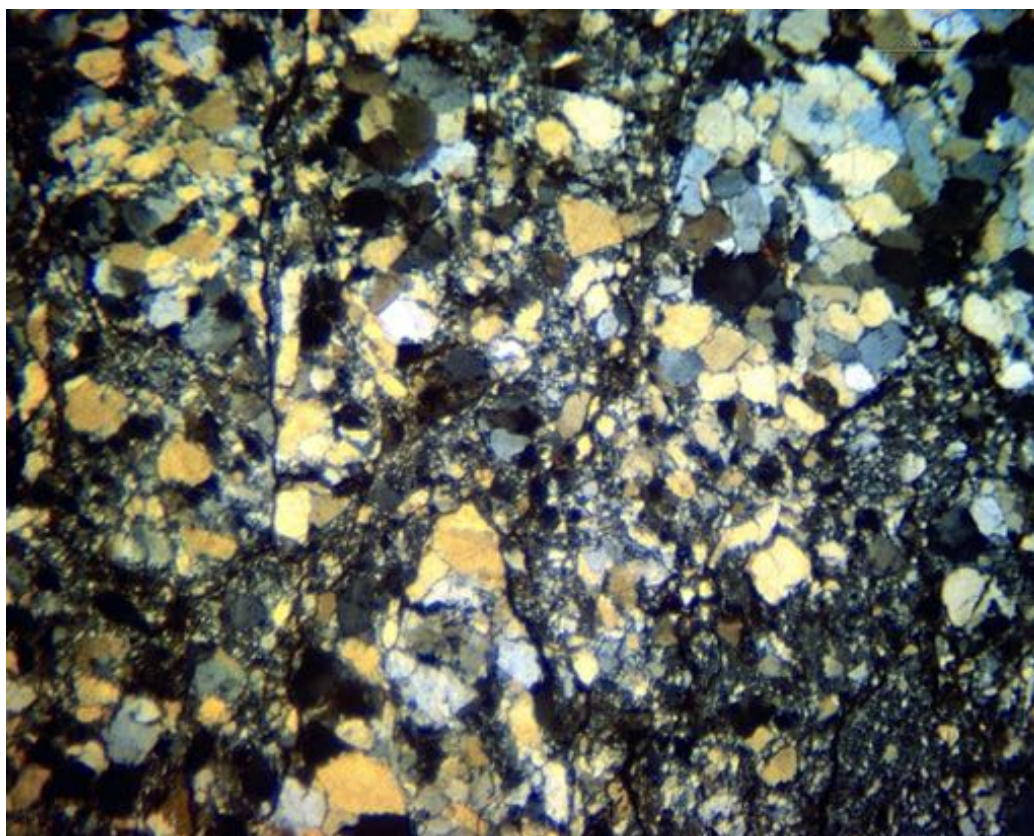
The quartzite has been brecciated into clasts that range in size from single quartz grains through to 1-2cm quartzite fragments. Some areas of very fine-grained matrix quartz may represent milling, and this could be a fault breccia. Occasional clay phases occur in these matrix areas.

Dark semi-opaque to opaque hematite veinlets cut clast and matrix and therefore post-date the brecciation.

**Summary:** Brecciated quartzite- possible fault breccia.

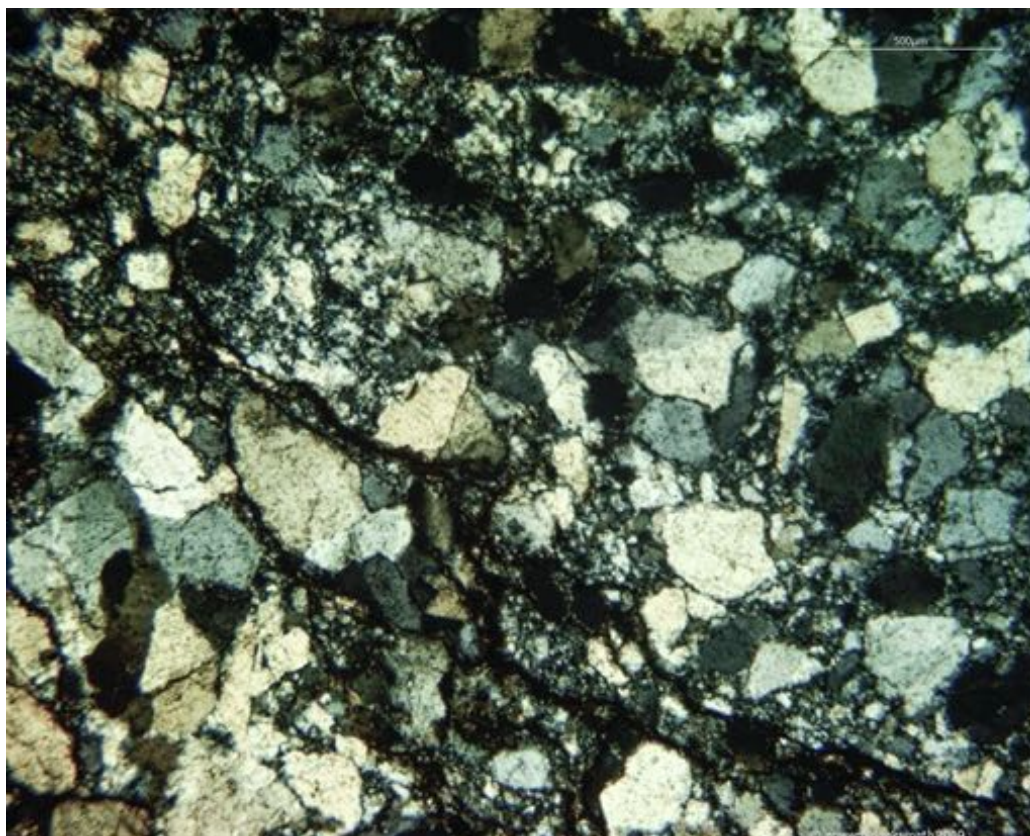


**Plane polarised light photomicrograph of sample 163177 (x2) illustrating the brecciated texture with iron oxide veining.**

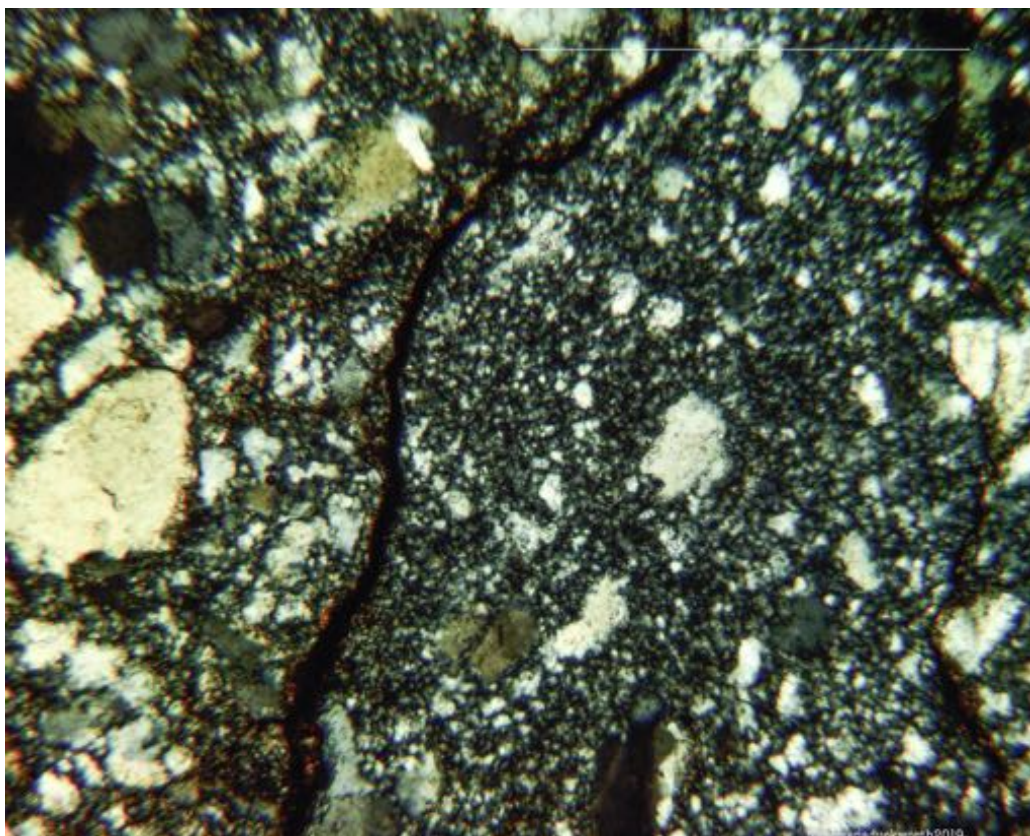


**Cross polarised light photomicrograph of sample 163177 (x4) illustrating granular quartzite clasts in fine grained quartz rich matrix.**

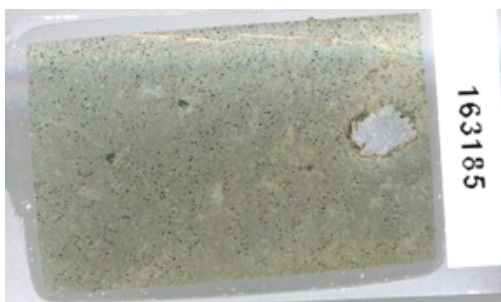




**Cross polarised light photomicrograph of sample 163177 (x4) illustrating texture of the probable fault breccia with paragenetically late opaque veinlets.**



**Cross polarised light photomicrograph of sample 163177 (x10) illustrating fine grained nature of the matrix with quartz grains of various sizes, all anhedral and angular.**

**163185****Thin section and offcut of sample 163185**

**Mineralogy:** Plagioclase feldspar, chlorite, epidote, carbonate, hematite, magnetite.

The hand specimen is a dark grey fine-grained rock. The thin section shows a dominantly green fine-grained rock with colourless vugs and 5-10% disseminated opaques.

Microscopically, this sample is a chlorite-epidote feldspar-rich igneous rock with chlorite-epidote and carbonate amygdales.

The groundmass shows pervasive chlorite and epidote alteration with a partially preserved microlitic texture with 0.1-0.3mm feldspar laths.

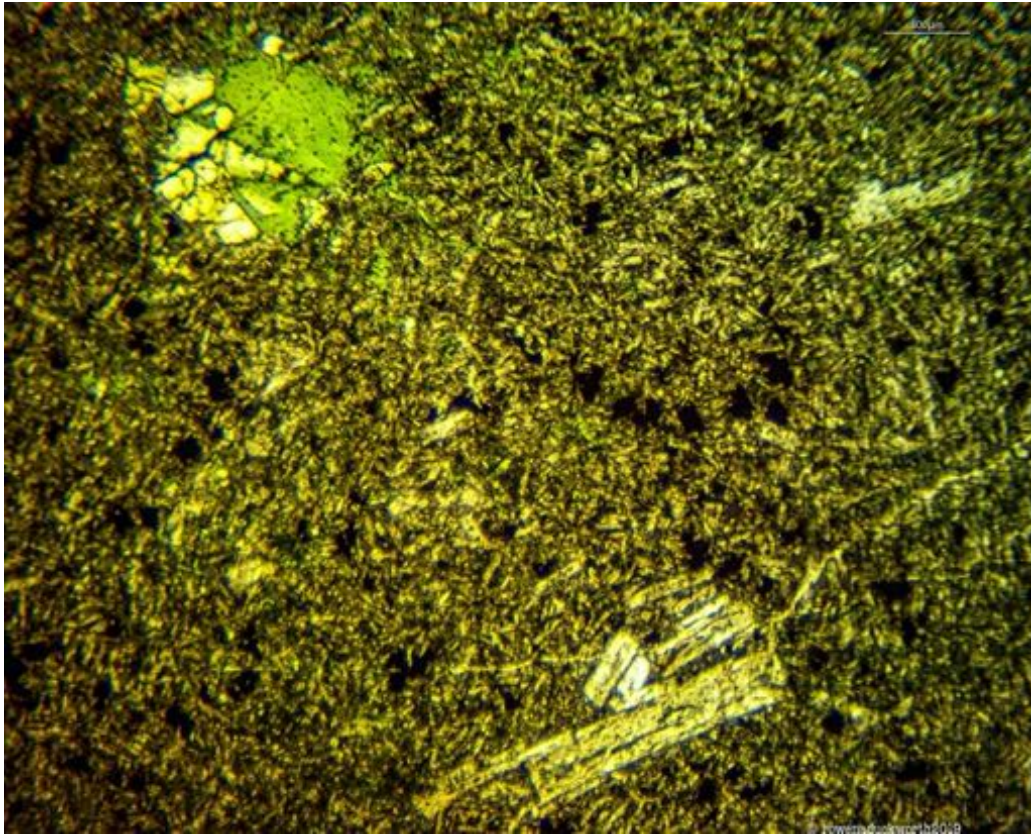
Occasional 0.5- 2mm plagioclase phenocrysts (andesine) occur and these are commonly partially chlorite-epidote and carbonate altered. Possibly the rock was originally more phenocryst-rich, but alteration has obliterated many of these? No primary ferromagnesian phases were seen, presumably these have all been totally altered.

Fine-grained disseminated anhedral to subhedral magnetite with strong hematite alteration is the only opaque phase in this sample.

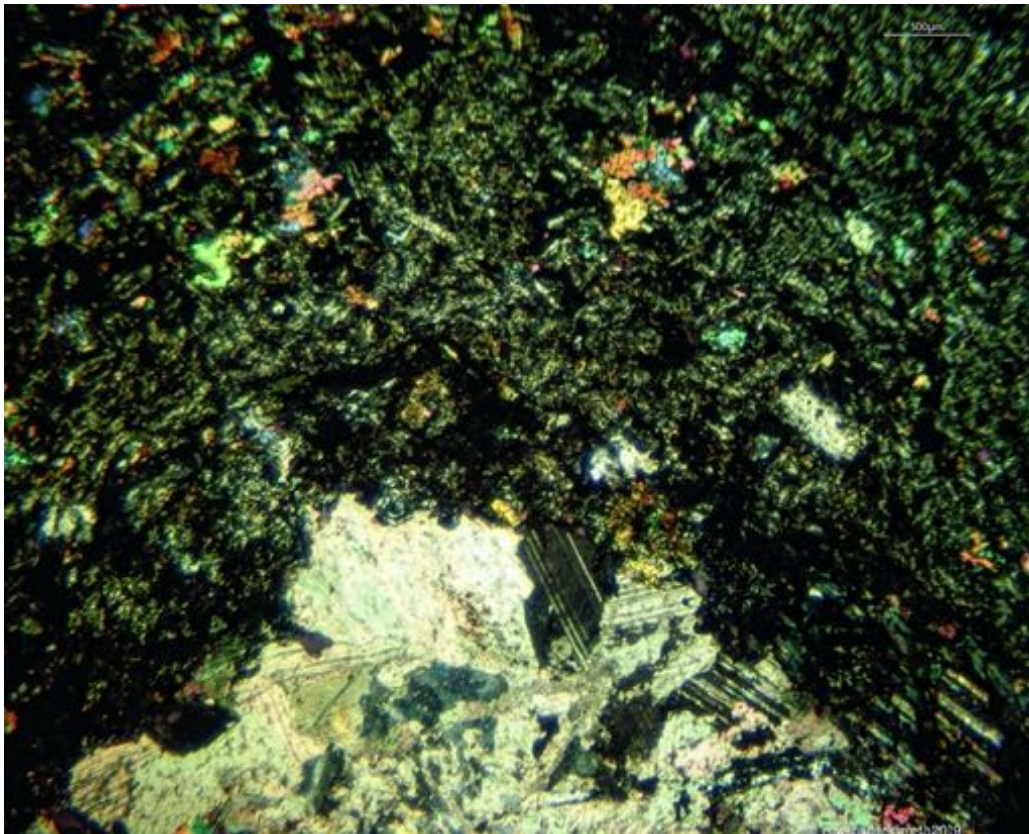
Amygdales are 1mm-1cm across and are infilled with chlorite-epidote and carbonate. No sulphides were observed in these- unlike sample 163040.

**Summary:** Chlorite-epidote-carbonate altered sparsely plagioclase-phyric amygdaloidal meta-basalt.



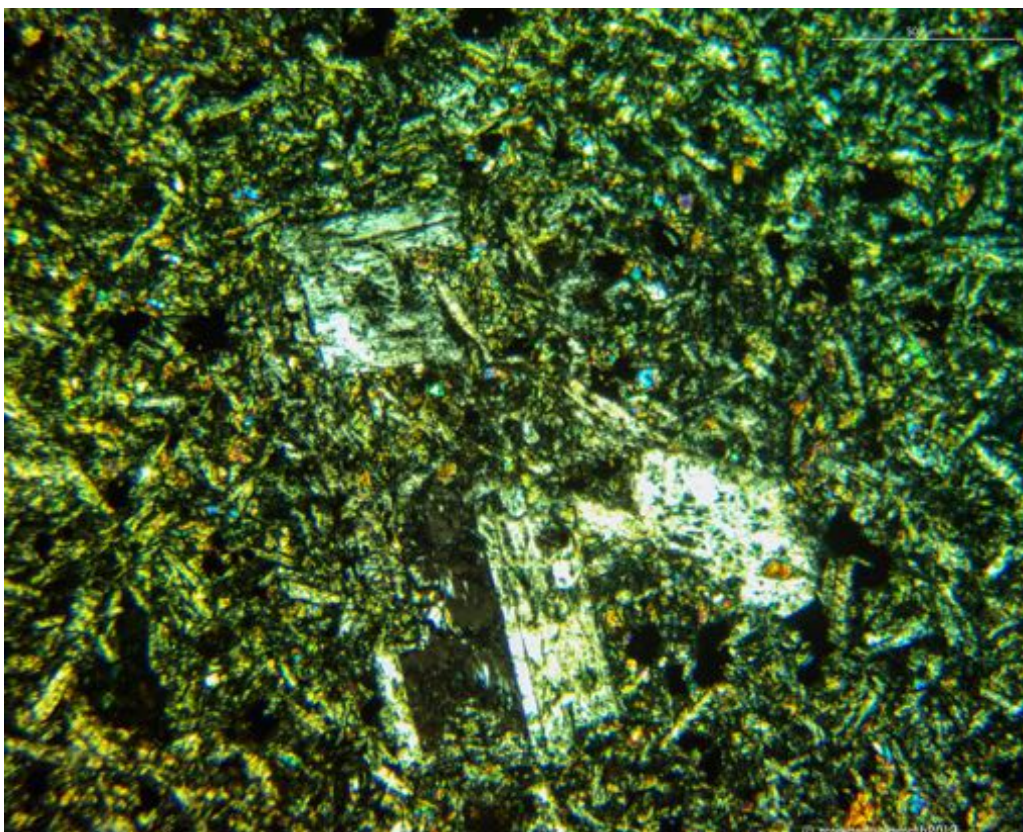


**Plane polarised light photomicrograph of sample 163185 (x2) illustrating texture of rock with feldspars and chlorite-epidote amygdales and pervasive chlorite alteration.**

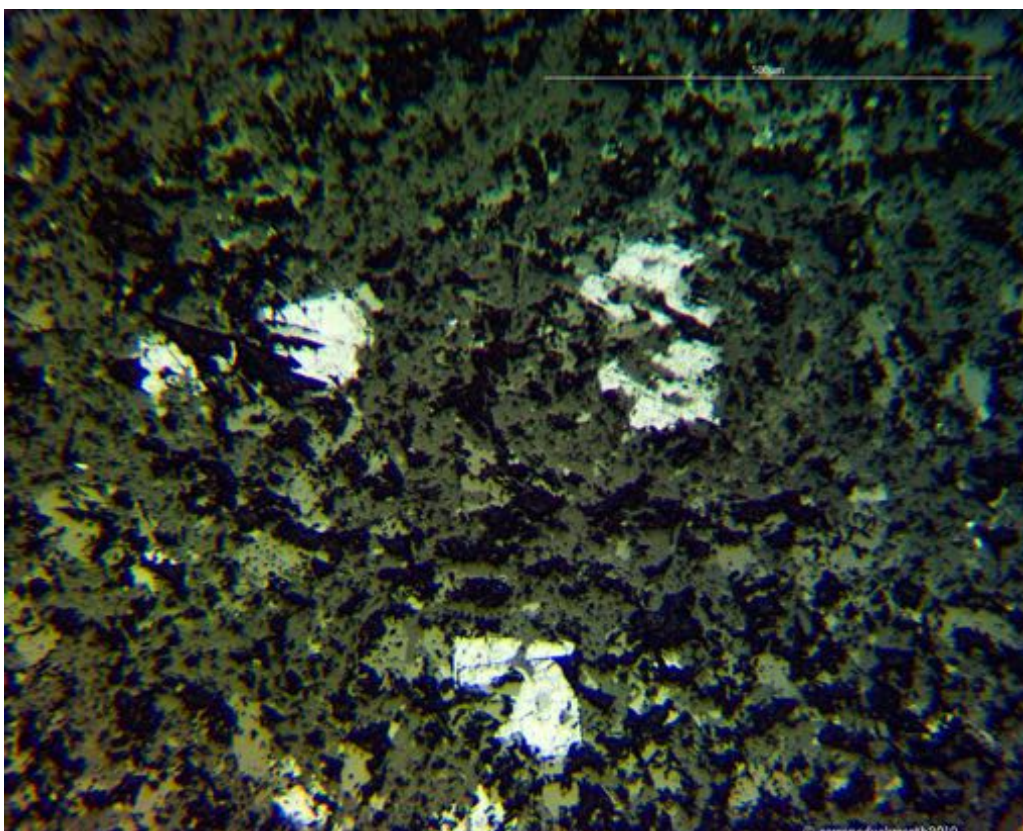


**Cross polarised light photomicrograph of sample 163185 (x4) illustrating texture of host rock with carbonate amygdale and pervasive chlorite -epidote alteration.**





**Cross polarised light photomicrograph of sample 163185 (x4) illustrating microlitic groundmass and partially altered and replaced plagioclase phenocrysts.**



**Reflected light photomicrograph of sample 163185 (x10) illustrating disseminated ragged magnetite grains with strong hematite alteration.**



**163193****Thin section and offcut of sample 163193**

**Mineralogy:** Plagioclase feldspar, chlorite, carbonate, actinolite, epidote, quartz, hematite, bornite, chalcopyrite, covellite.

The hand specimen is a dark grey fine-grained rock with pale and dark green blebs. The thin section shows a dominantly green fine-grained rock with colourless and dark blobs and 20% disseminated opaques.

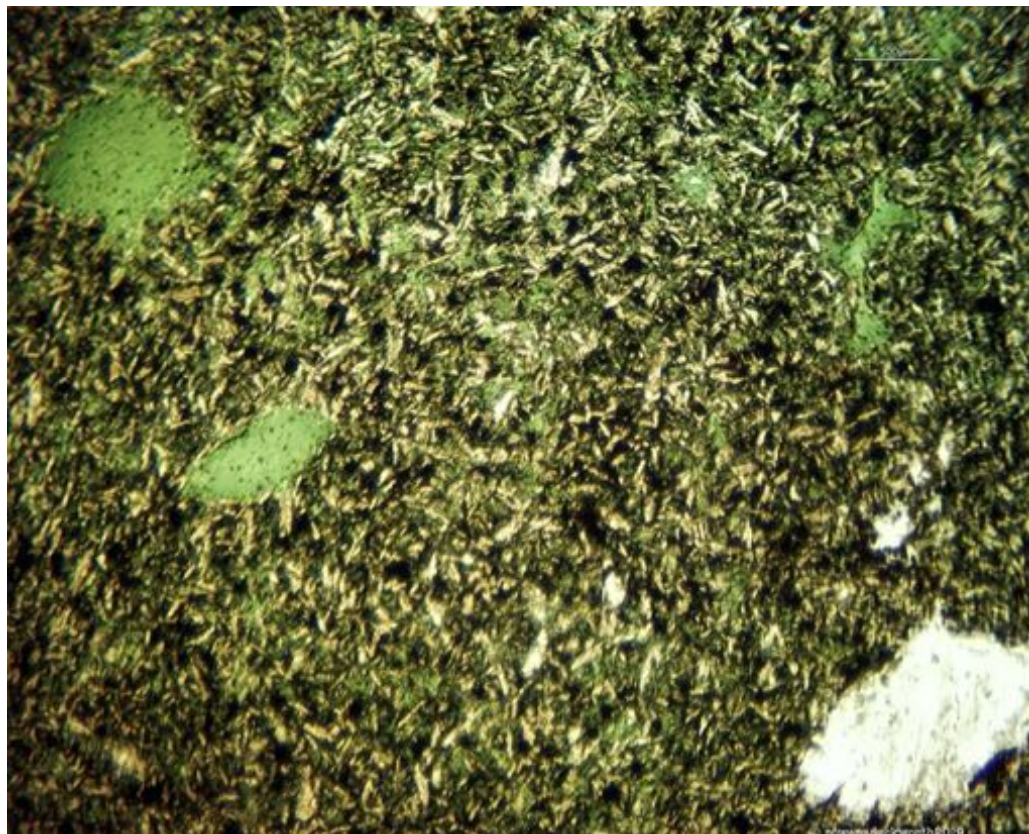
Microscopically, this sample is a chlorite-carbonate-epidote altered feldspar-rich igneous rock with chlorite-epidote-carbonate-sulphide filled amygdales.

The groundmass shows pervasive chlorite-carbonate-epidote alteration with a partially preserved microlitic texture with 0.2-0.3mm feldspar laths (microlites). 1mm-2mm green chlorite spots may be altered ferromagnesian phenocryst phases? Only rare 0.5mm plagioclase phenocrysts were seen in this section. Possibly the rock was originally more phenocryst-rich, but alteration has obliterated many of these?

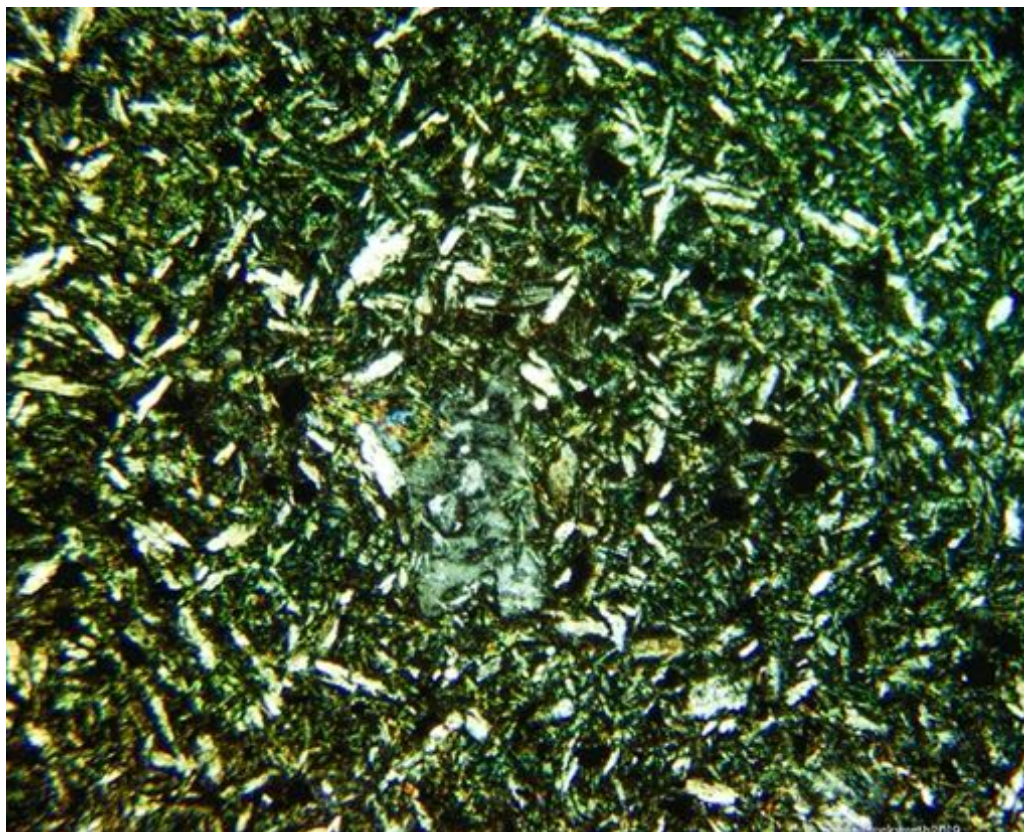
Fine-grained disseminated anhedral to subhedral magnetite with strong hematite alteration is disseminated throughout the altered groundmass.

Amygdales are 1mm-1cm across and are infilled with chlorite-epidote and carbonate. Chalcopyrite and bornite with occasional covellite alteration occur in carbonate-epidote filled vugs and the copper sulphides appear to paragenetically associated with the epidote-carbonate assemblage – this is similar to sample 163040.

**Summary:** Chlorite-carbonate-epidote altered sparsely phyric amygdaloidal meta-basalt with copper sulphides in carbonate amygdales.

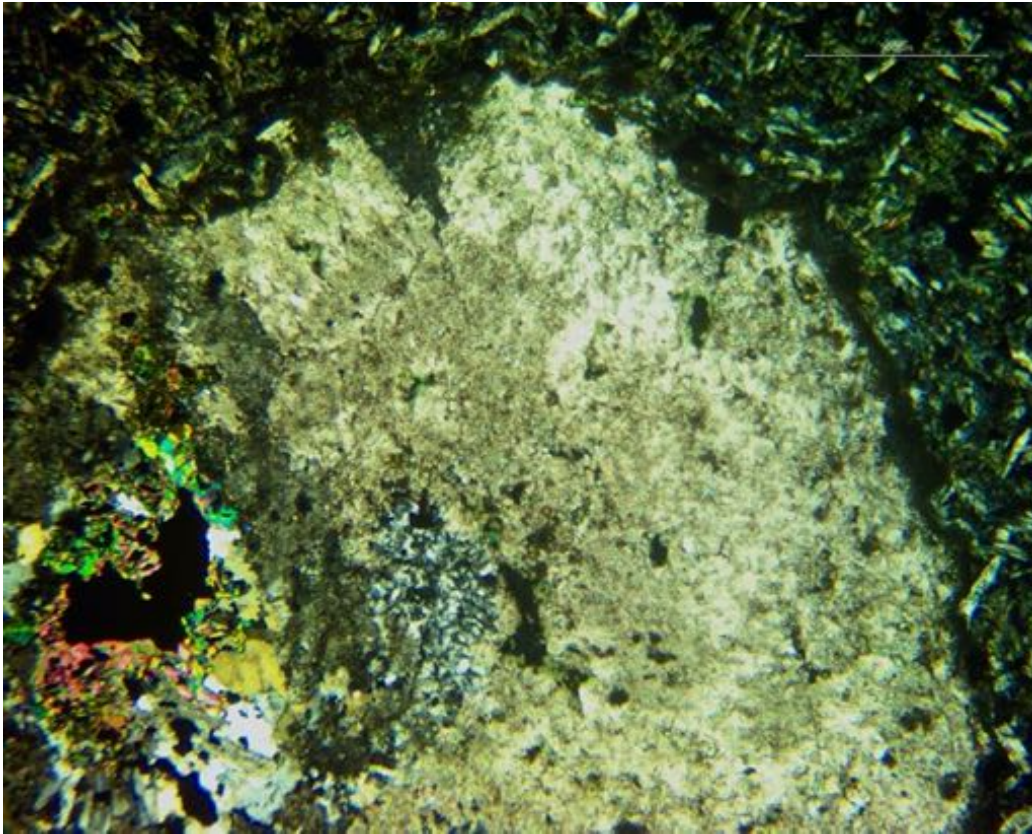


**Plane polarised light photomicrograph of sample 163193 (x2) illustrating the texture with green chlorite alteration and colourless carbonate patches. Green spots maybe completely replaced ferromagnesian phases.**

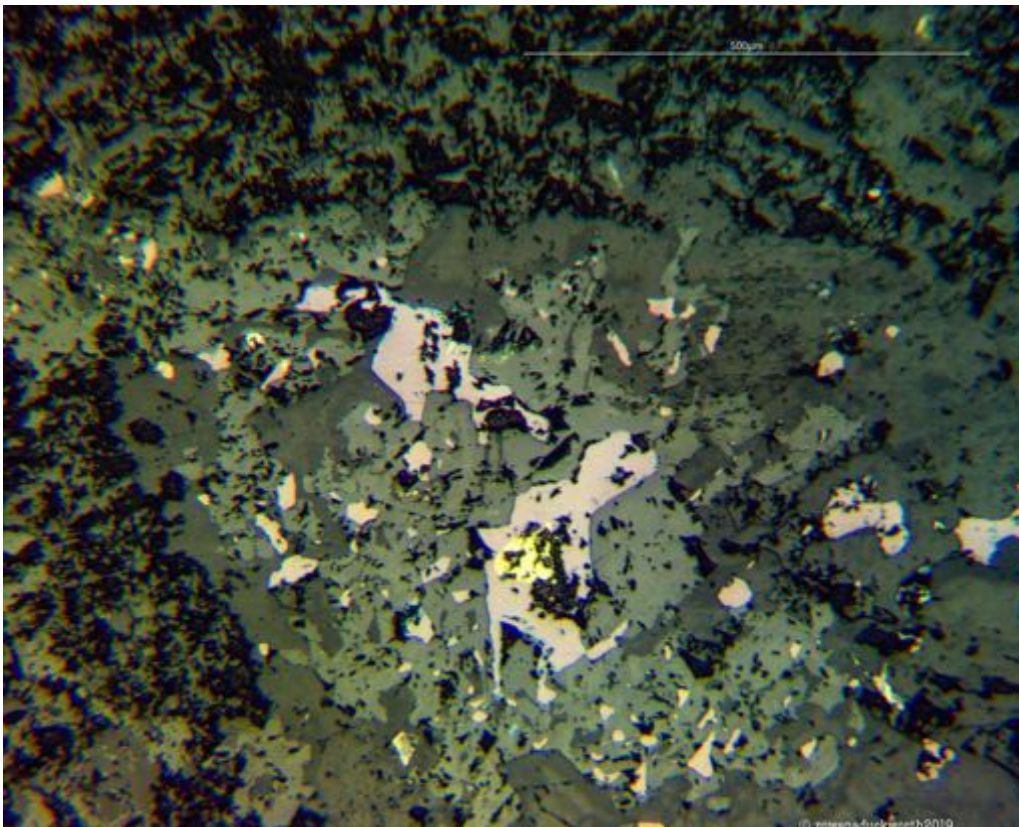


**Cross polarised light photomicrograph of sample 163193 (x4) illustrating a relict plagioclase phenocryst in highly chlorite altered microlitic groundmass.**





**Cross polarised light photomicrograph of sample 163193 (x10) illustrating texture of carbonate filled vug with highly birefringent epidote around opaque bornite and chalcopyrite.**



**Reflected light photomicrograph of sample 163193 (x4) illustrating chalcopyrite and pink bornite in vug with epidote and carbonate. Note rims of blue covellite.**

**163207****Thin section and offcut of sample 163207**

**Mineralogy:** Quartz, feldspar, hematite, goethite, sericite, clays, muscovite.

The hand specimen shows a pale fine-grained rock with red alteration and veining. The thin section shows a pale laminated rock with red alteration domains and red veining with dendritic feathery bleeding of the red phase into the host rock along the vein edges.

Microscopically, this sample is fine-grained laminated quartz-feldspar sedimentary rock. Very fine anhedral feldspar and quartz grains forming a granular grain supported texture. The feldspars are quite strongly altered to earthy hematite in the red layers and it may be that the more heavily iron-altered darker zones may be more feldspathic?

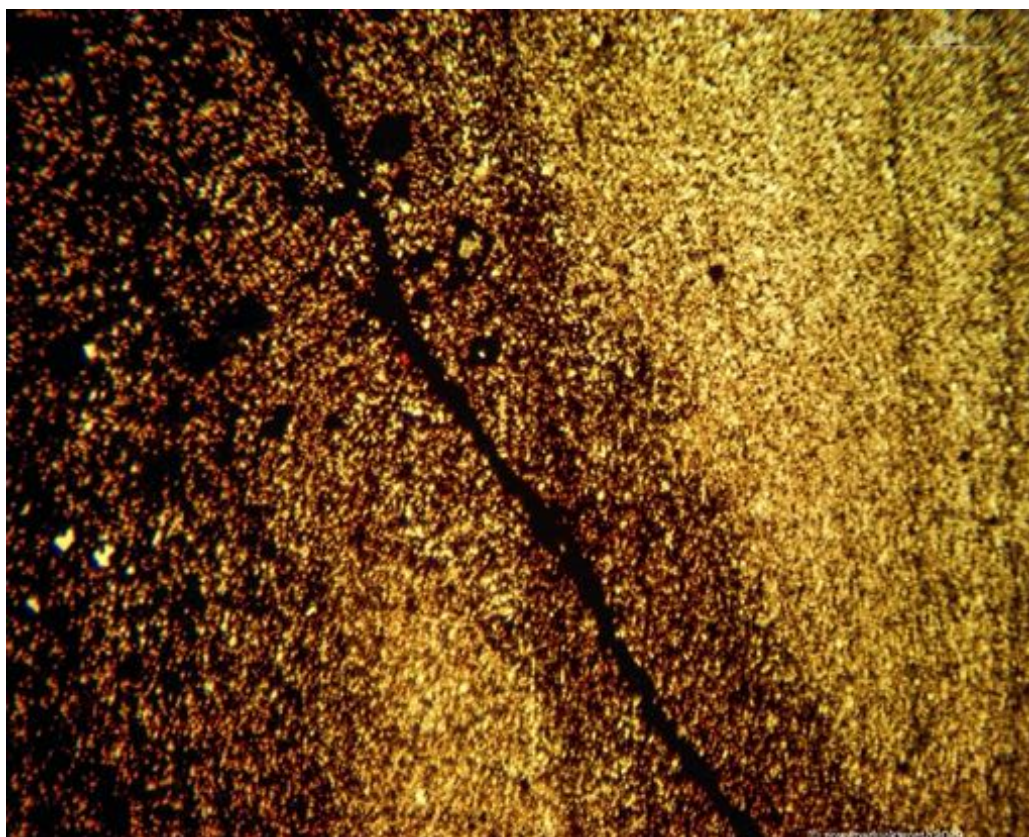
Grain size is generally less than 0.05mm, but some paler laminae are more quartz rich with a grain size that is slightly coarser- around 0.1mm. Minor muscovite have a preferred orientation and alignment that is at a high angle (30°) to the laminations. Occasional micas are bent indicating mild ductile deformation.

Feldspars are hematite altered in the red zones but sericitised and clay altered in the rest of the sample.

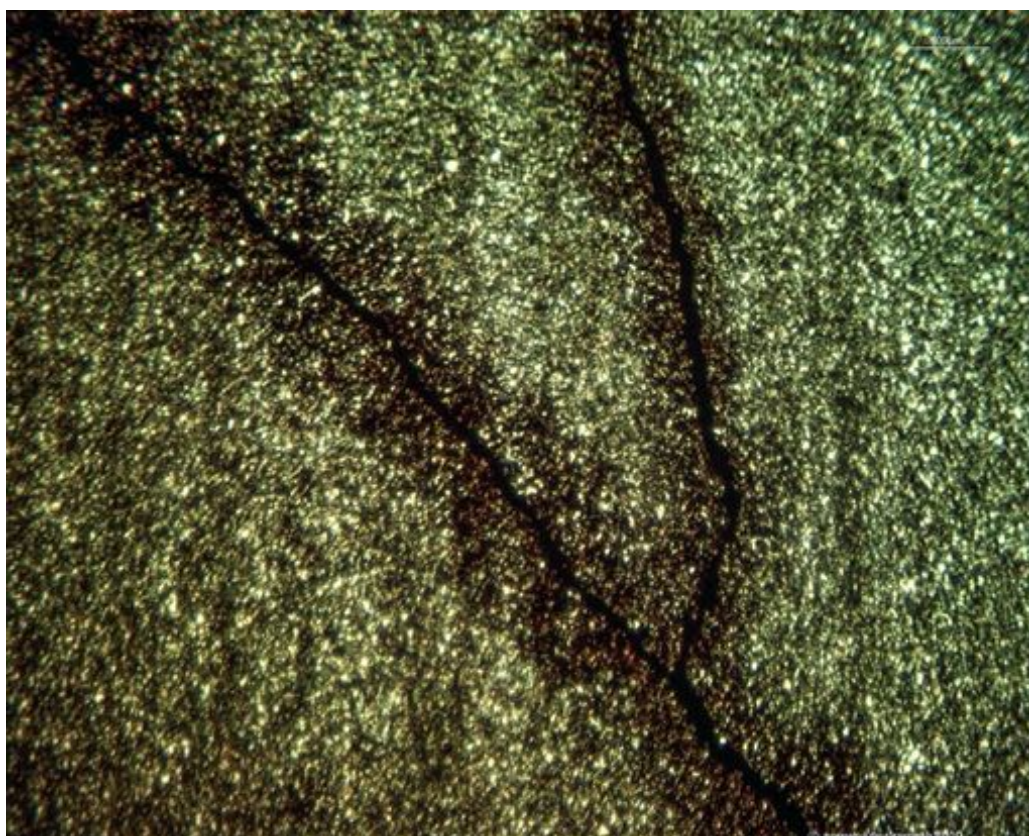
The sharp alteration hematite alteration front may reflect sharp redox changes or simply mineralogical/permeability variations.

**Summary:** Very fine-grained rock variably hematized laminated quartzo-feldspathic meta-siltstone with a weak schistosity at a high angle to sedimentary laminations.



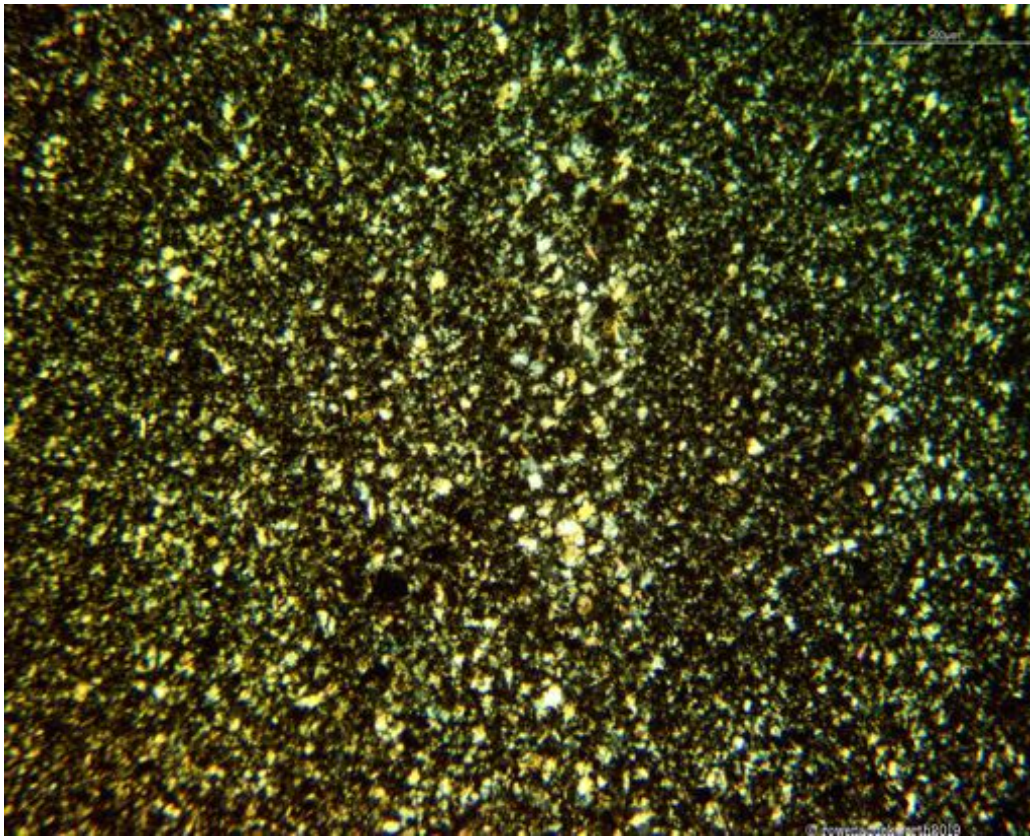


**Plane polarised light photomicrograph of sample 163207 (x4) illustrating the texture with variably iron altered layers and opaque hematite veining.**

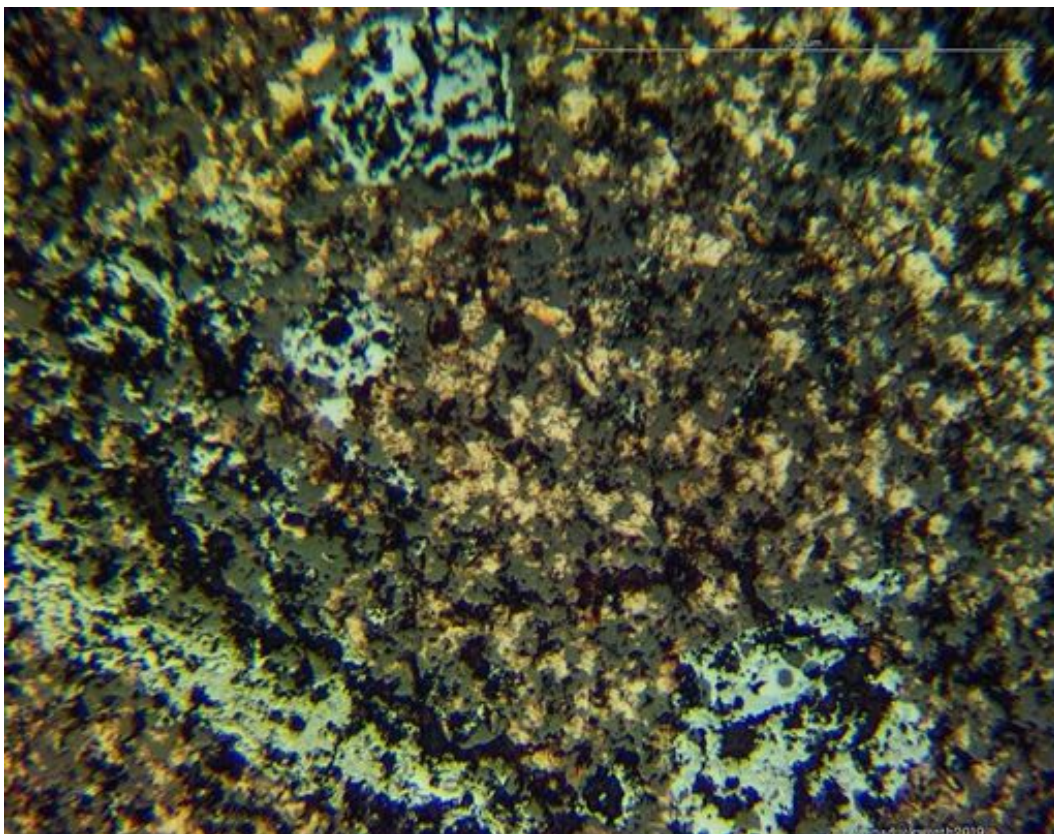


**Cross polarised light photomicrograph of sample 163207 (x2) illustrating fine grained groundmass with iron oxide alteration around hematite veinlets.**



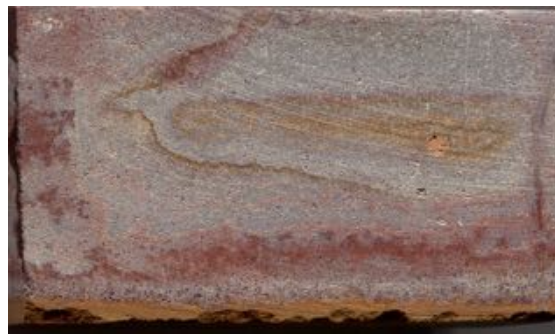


**Cross polarised light photomicrograph of sample 163207 (x4) illustrating texture with fine grained quartz, altered feldspar and minor muscovite.**



**Reflected light photomicrograph of sample 163207 (x10) illustrating ragged hematite grains and vein.**



**163219****Thin section and offcut of sample 163219**

**Mineralogy:** Sericite, pyrite, quartz, hematite, muscovite, iron hydroxyoxides, chlorite

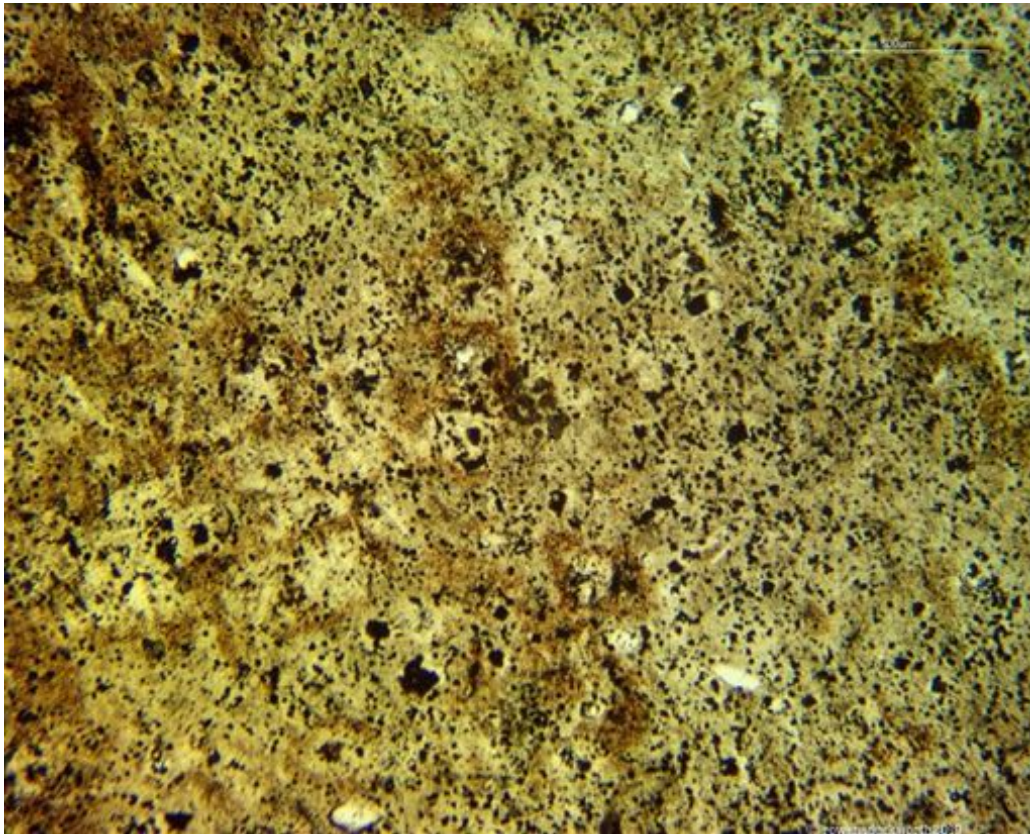
The hand specimen shows a weathered iron stained pale fine-grained rock. The thin section shows hematite and limonite stained pale to colourless rock.

Microscopically, this sample is a strongly altered with abundant sericite and pyrite. The alteration has wiped out all primary mineral and textures, but the shape of the patchy sericite alteration does suggest possible ex-feldspar crystals, possibly phenocrysts, so this may be an altered porphyritic rock?

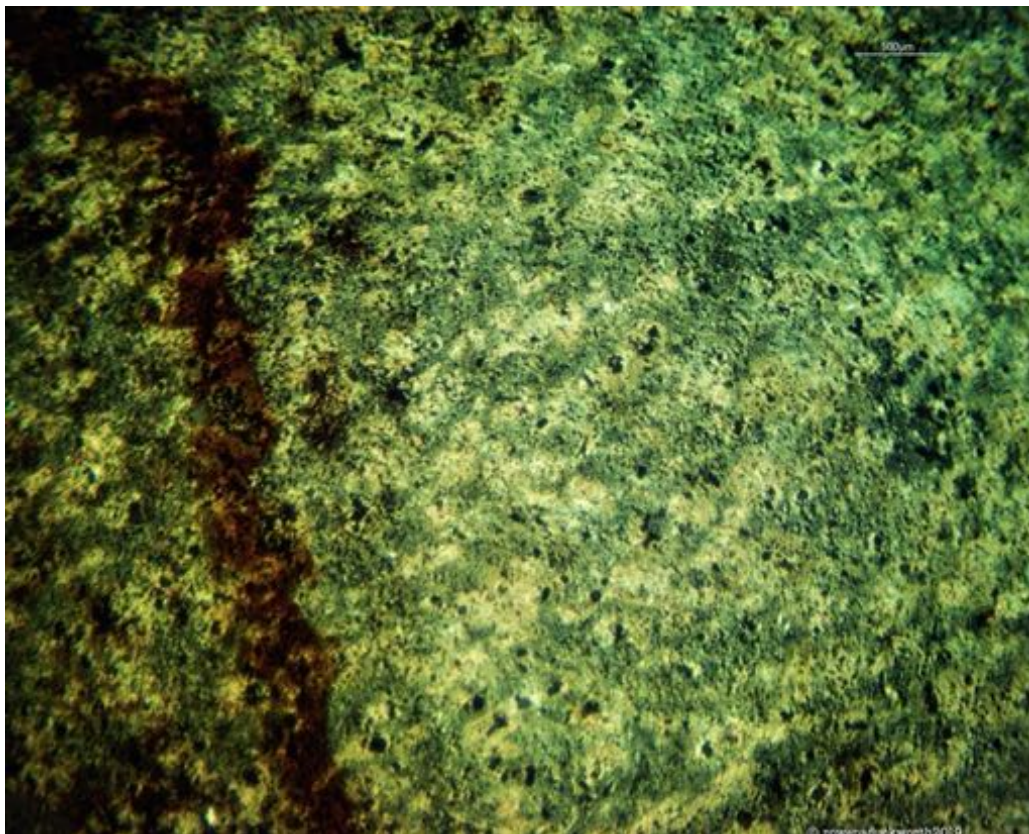
The matrix around the sericitised areas is composed of fine-grained quartz and chlorite, though the grain size is very small, and this may need to be verified by electron microprobe/SEM.

Fine grained (0.02-0.1mm) disseminated pyrite is abundant throughout the section. Late iron oxide alteration and veining is paragenetically late.

**Summary:** Sericite-pyrite-quartz-chlorite altered possible igneous feldspar porphyritic rock?

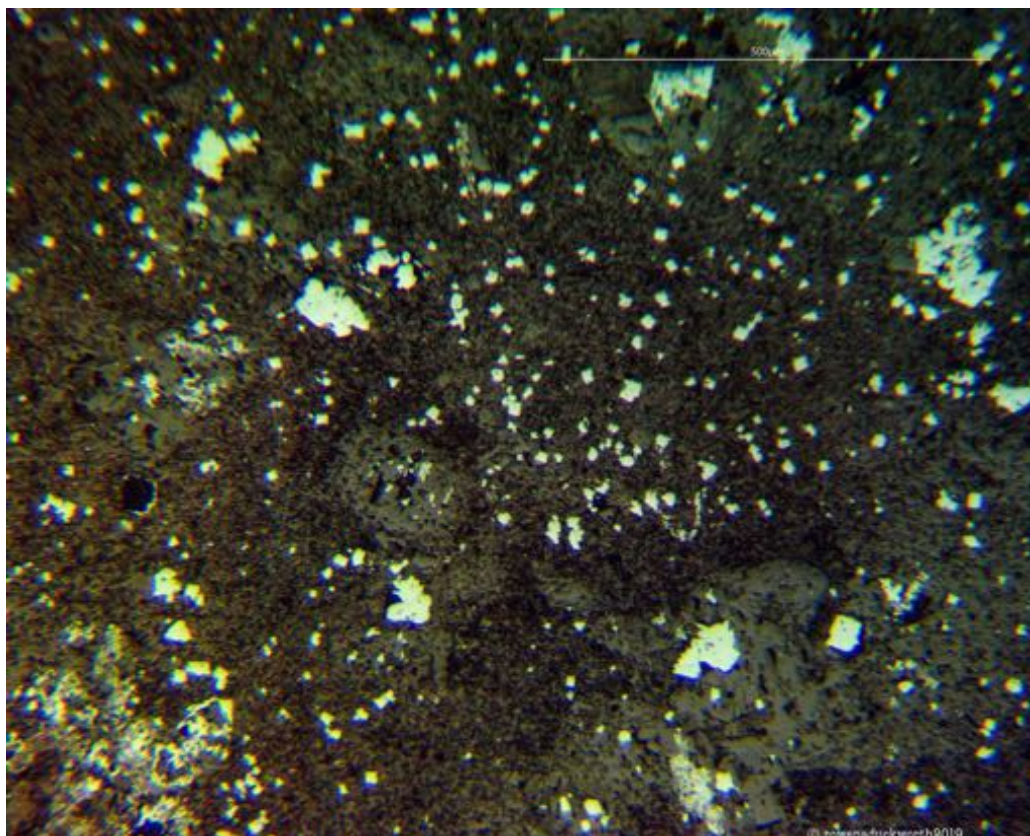


**Plane polarised light photomicrograph of sample 163219 (x4) illustrating the texture with abundant fine grained disseminated opaque pyrite.**

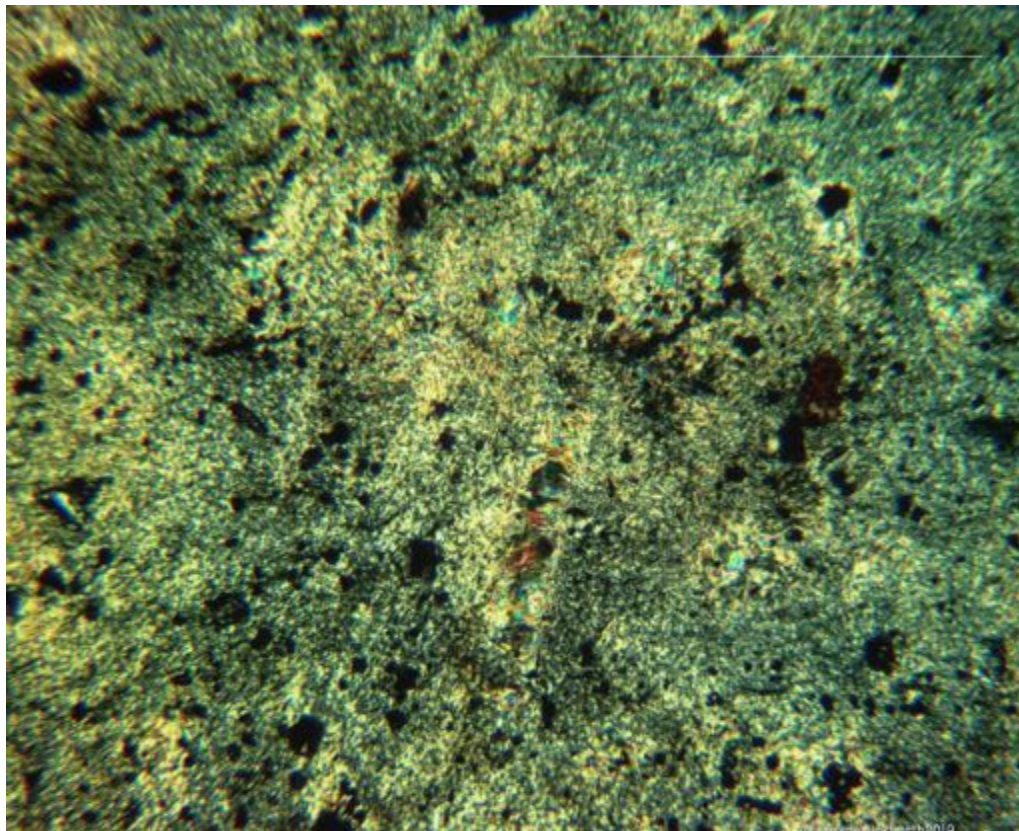


**Cross polarised light photomicrograph of sample 163219 (x2) illustrating intensely altered rock texture.**

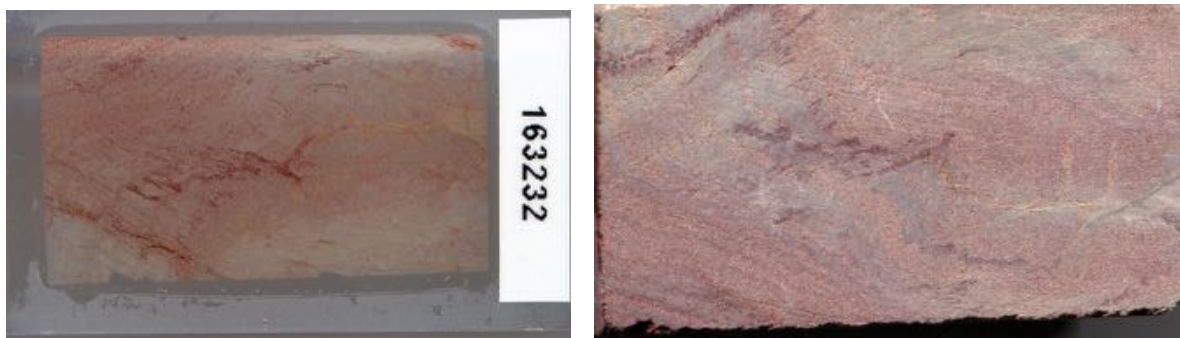




**Reflected light photomicrograph of sample 163219 (x10) illustrating abundant fine grained disseminated pyrite.**



**Cross polarised light photomicrograph of sample 163219 (x10) illustrating sericite alteration possibly after feldspar crystals?**

**163232****Thin section and offcut of sample 163232**

**Mineralogy:** Quartz, sericite, clays, feldspar, hematite, albite, limonite.

The hand specimen is a patchy grey-pink rock with laminated domains. The thin section is a pale-pinkish rock with yellow and red iron staining.

Microscopically, this is a granular textured quartzo-feldspathic rock with intense sericite-clay alteration.

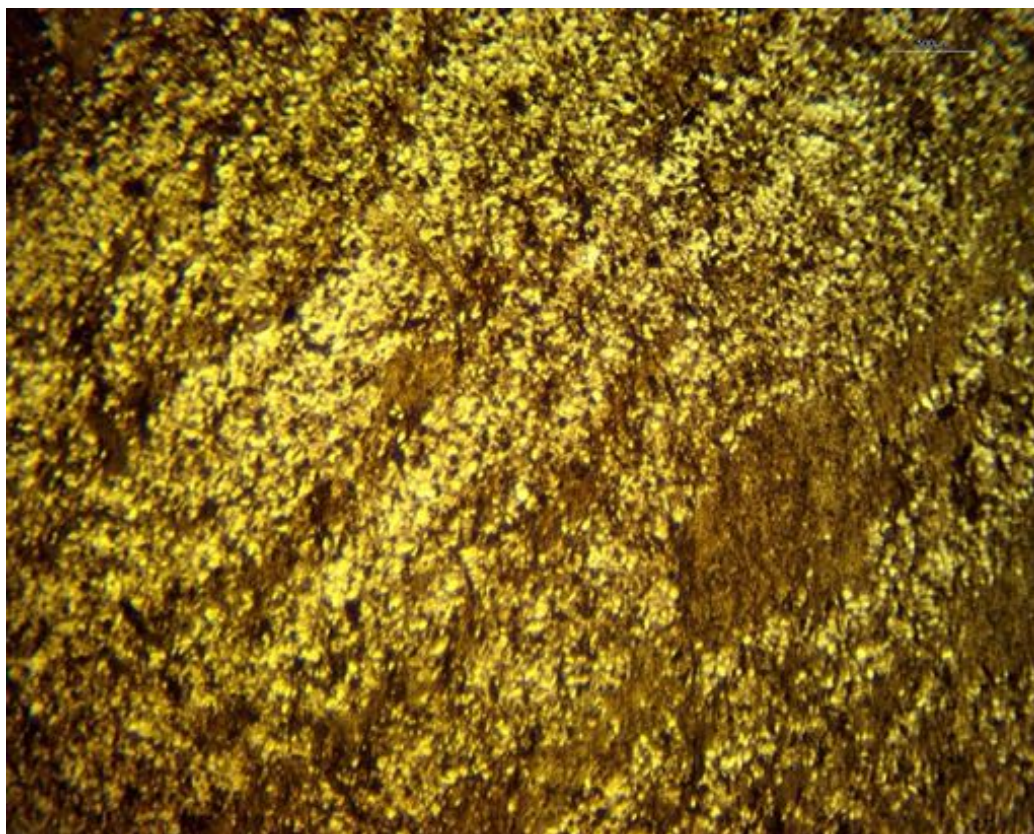
The average grain size is less than 0.1 mm and the quartz grains are anhedral, with blurry grain boundaries and display mild undulose extinction suggesting a degree of mild ductile deformation at some point in time. Feldspars grains are less common and are strongly clay and sericite altered.

Laminated domains are composed of quartz rich bands alternating with sericite-clay layers which may show a crenulation cleavage. Wavy laminations may be primary sedimentary structures; however, the hand sample shows possible axial planar cleavage suggesting a tectonic formation. Foliated textures within sericite-clay bands are common.

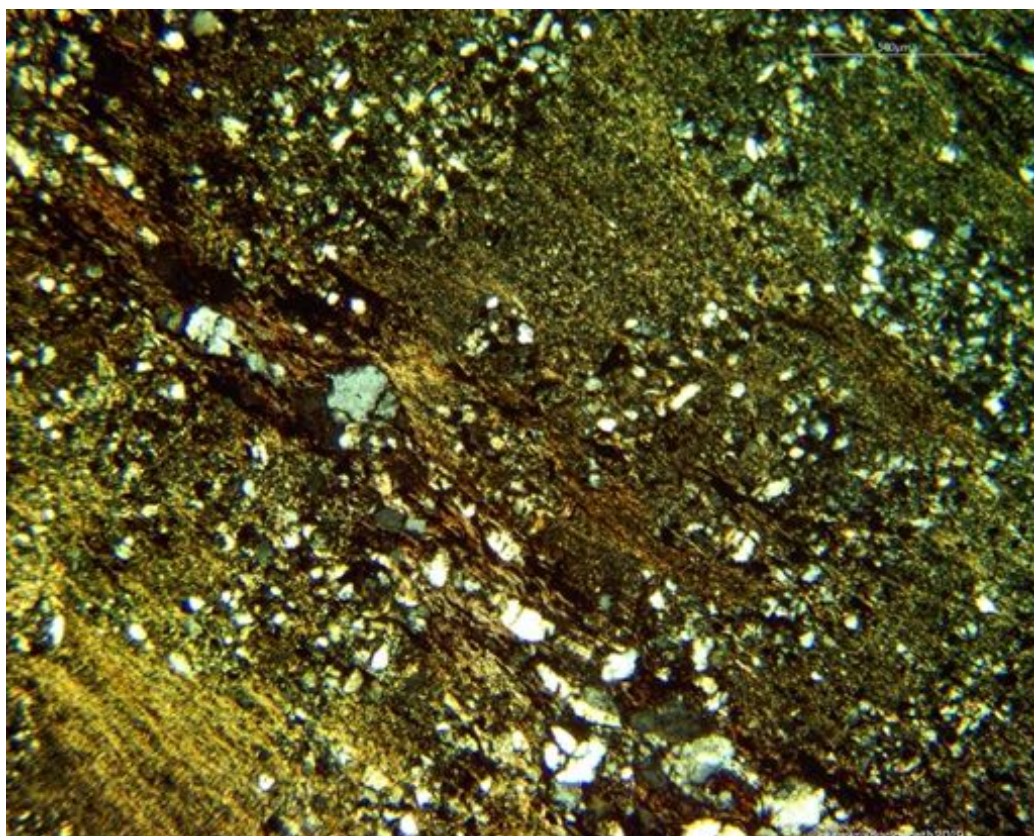
In one corner there is an albite vein with a grain size around 0.2mm that has associated chlorite-hematite -clay alteration

**Summary:** Sericite-clay altered laminated quartzo-feldspathic meta-siltstone with secondary albite veining.



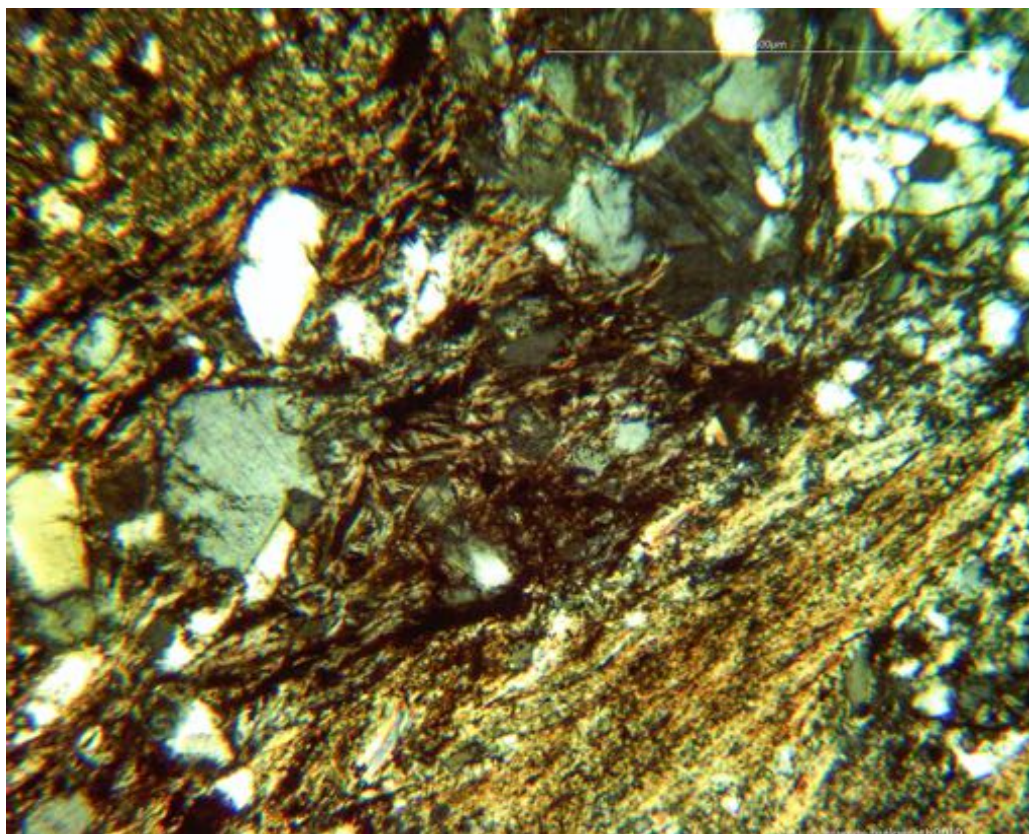


**Plane polarised light photomicrograph of sample 163232 (x2) illustrating the laminated texture with colourless granular quartz and darker fine grained sericitic-clay layers with a foliation at a high angle to the layering.**

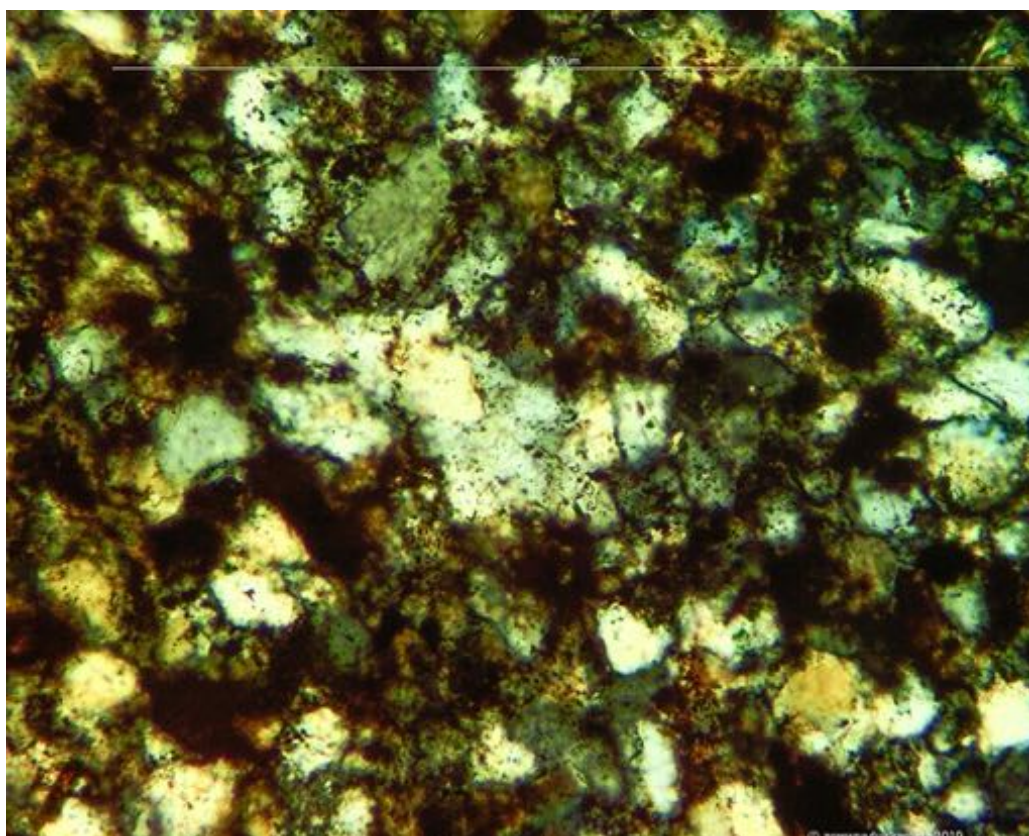


**Cross polarised light photomicrograph of sample 163232 (x4) illustrating texture of fine grained quartzo-feldspathic rock with extensive sericite-clay alteration.**





**Cross polarised light photomicrograph of sample 163232 (x10) illustrating the fine grained clay-hematite-chlorite alteration around coarse grained albite vein.**



**Cross polarised light photomicrograph of sample 163232 (x20) illustrating texture of the quartz rich sample with patchy hematite alteration.**



**163256****Thin section and offcut of sample 163256**

**Mineralogy:** Chlorite, carbonate, plagioclase feldspar, rutile, hematite.

The hand specimen is a mottled grey to dark grey rock with patchy brown spots. The thin section shows a dark green rock with some colourless patches and brown mottling.

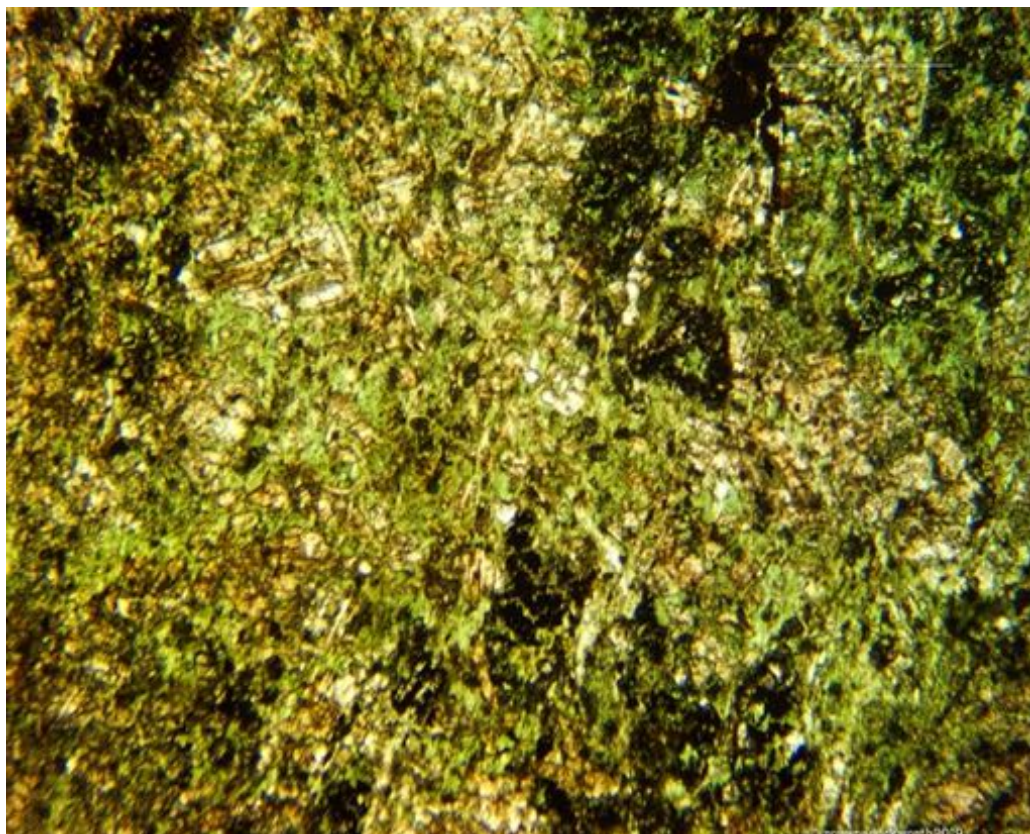
Microscopically, this sample is a pervasively chlorite-carbonate altered possible igneous rock?

Relict plagioclase feldspars in the chloritised groundmass are 0.2mm long. No other primary phase was seen, but the relict microlitic texture indicates a possible altered basaltic rock.

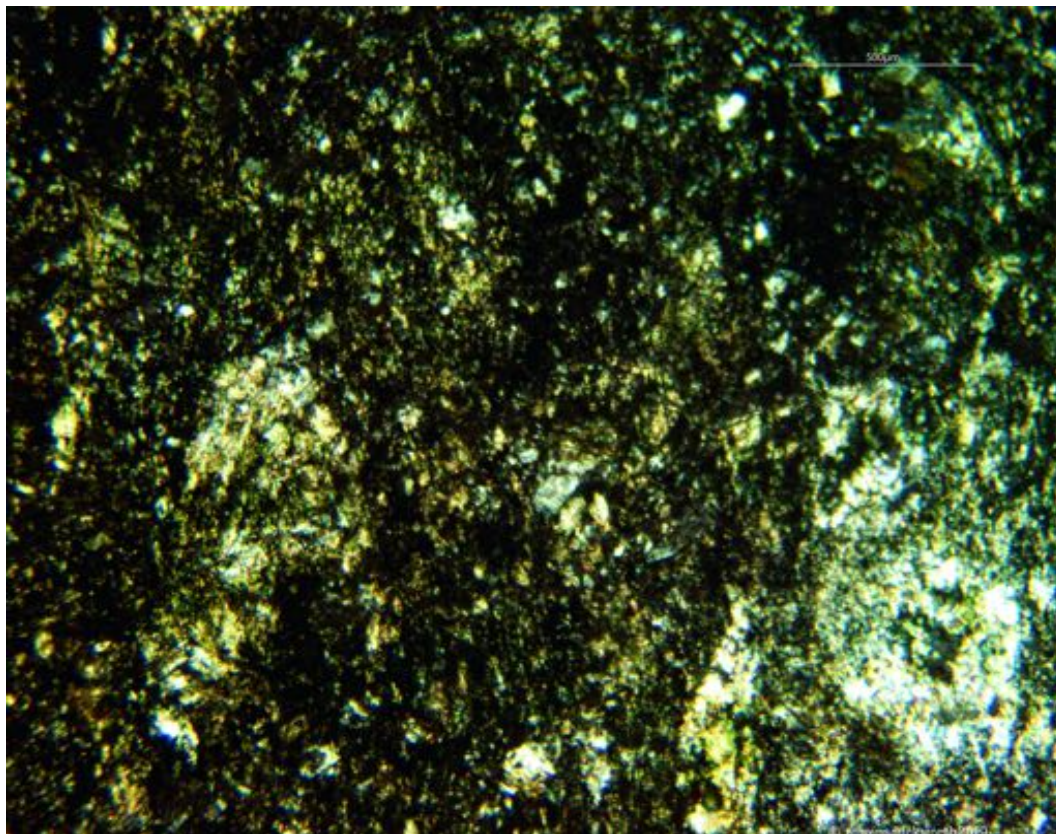
The chlorite is apple green in plane polarised light and has strong blue anomalous interference colours. Patchy carbonate alteration is partially replaced by the chlorite.

Opaque phases in this rock are dominantly hematite and rutile.

**Summary:** Pervasively chlorite-carbonate altered possible meta-basalt?

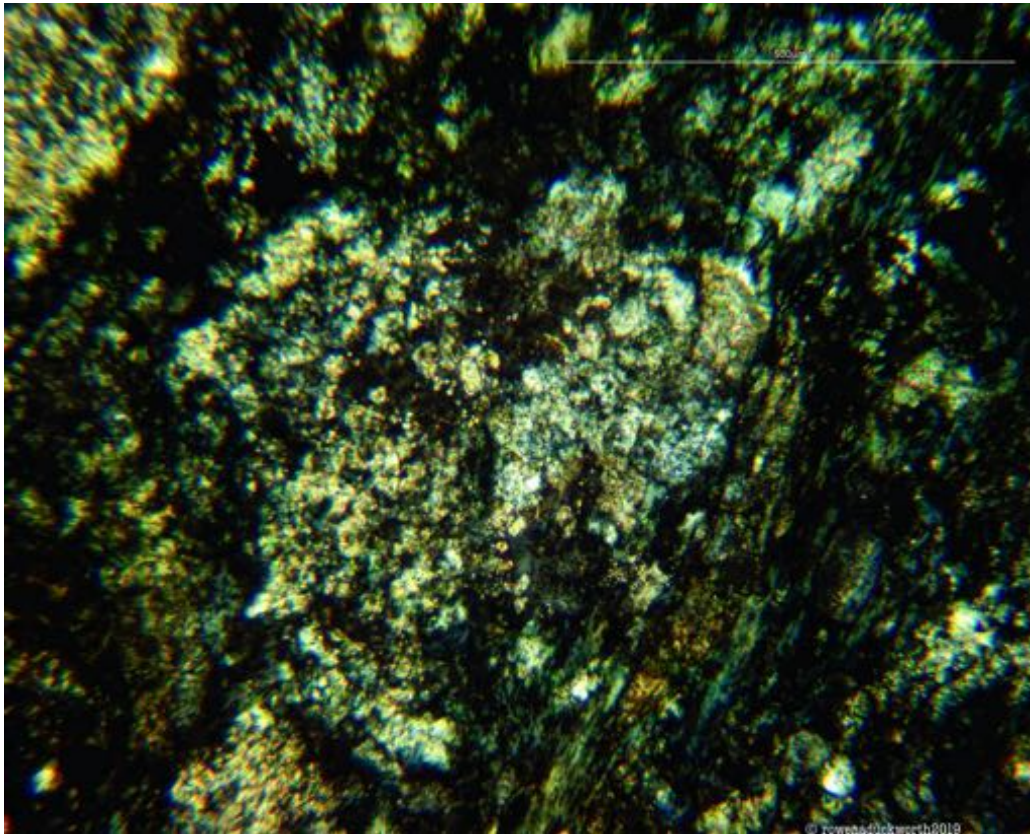


**Plane polarised light photomicrograph of sample 163256 (x4) illustrating the chlorite altered rock with relict feldspar laths.**

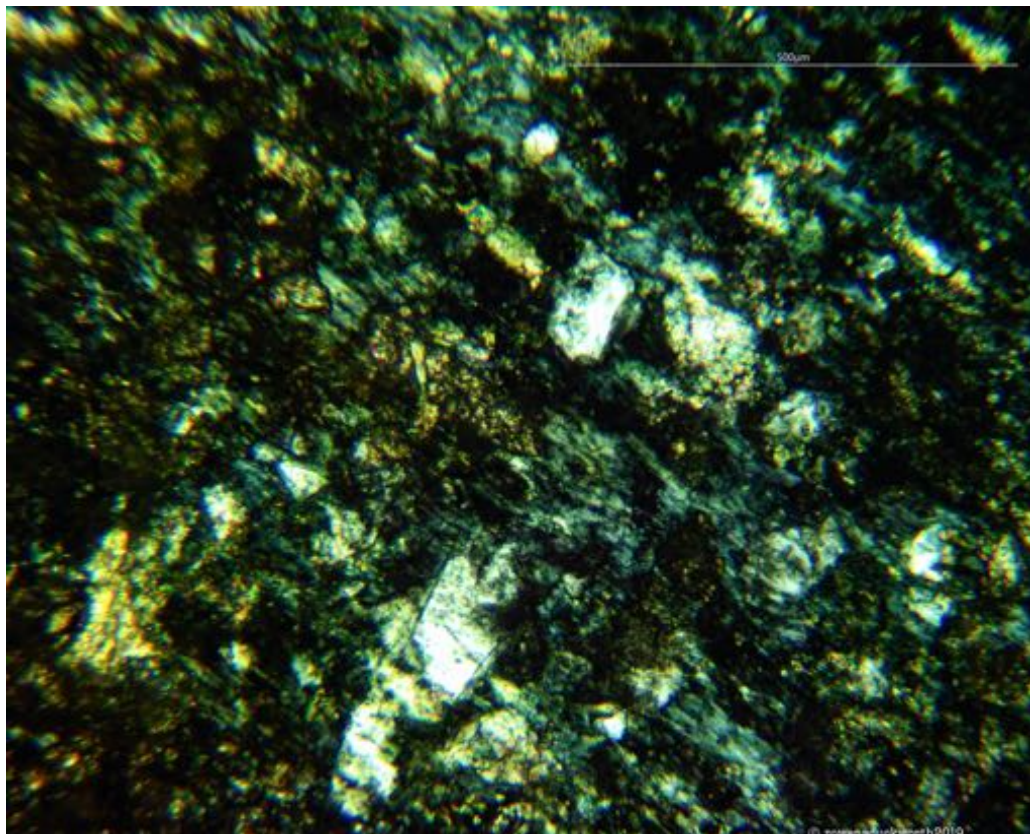


**Cross polarised light photomicrograph of sample 1163256 (x4) illustrating the texture with pervasive chlorite alteration and patchy carbonate alteration..**





**Plane polarised light photomicrograph of sample 163256 (x10) illustrating patchy carbonate alteration surrounded by chlorite.**



**Cross polarised light photomicrograph of sample 163256 (x10) illustrating occasional plagioclase grains within the chlorite alteration.**

**163271****Thin section and offcut of sample 163271**

**Mineralogy:** Chlorite, epidote, carbonate, plagioclase feldspar, quartz, rutile, magnetite, hematite.

The hand specimen is a fine-grained grey homogenous rock with abundant white and green flecks. The thin section is dominantly dark green, with common paler green yellow patches and abundant disseminated opaques- approximately 10-15%. Occasional infilled vugs are pale in colour.

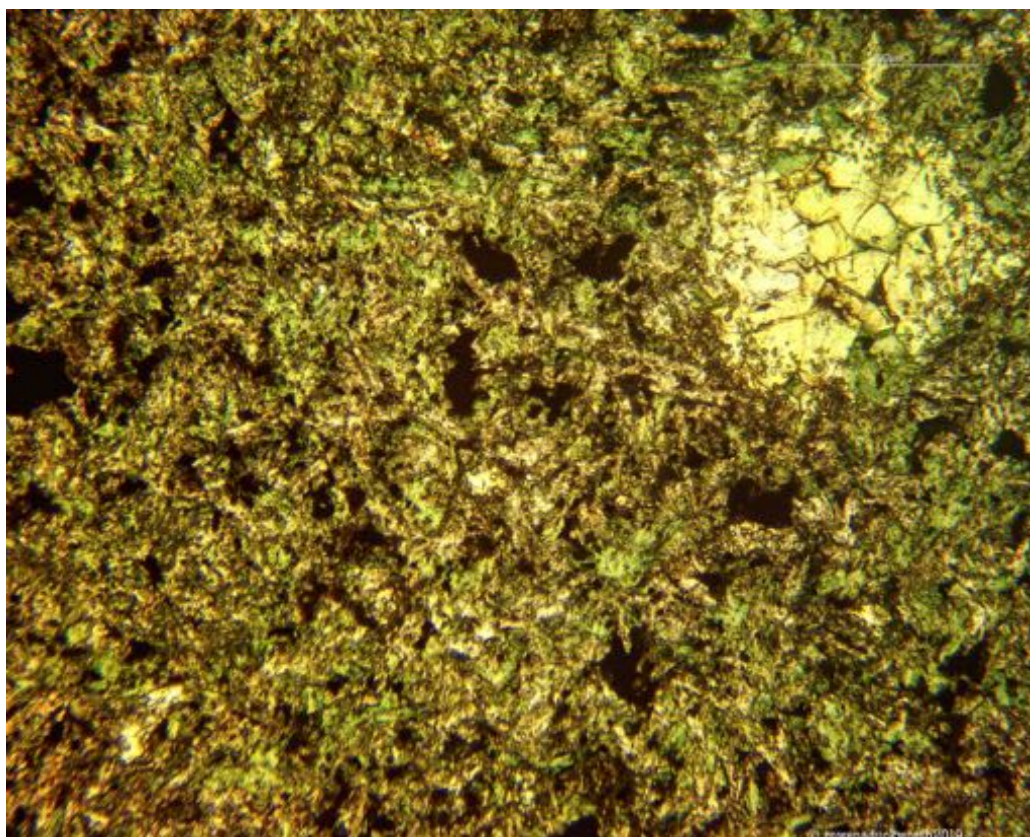
Microscopically, this sample is a fine-grained chloritised and epidote altered igneous rock with no obvious remaining ferromagnesian phases, but scarce, 1mm long, plagioclase phenocrysts are evident in a highly altered groundmass that has a microlitic feldspathic texture. Amygdales are generally infilled with quartz, carbonate, and epidote and one shows a chlorite halo.

The groundmass has a microlitic texture with interlocking strongly to completely altered feldspar laths that have a grain size less than 0.1mm and is now strongly epidote-chlorite-carbonate altered with regularly disseminated ragged subhedral to anhedral magnetite which shows incipient alteration to haematite. Magnetite grains range in size between 0.1-0.3 mm. Occasional rutile is associated with the magnetite and the chlorite.

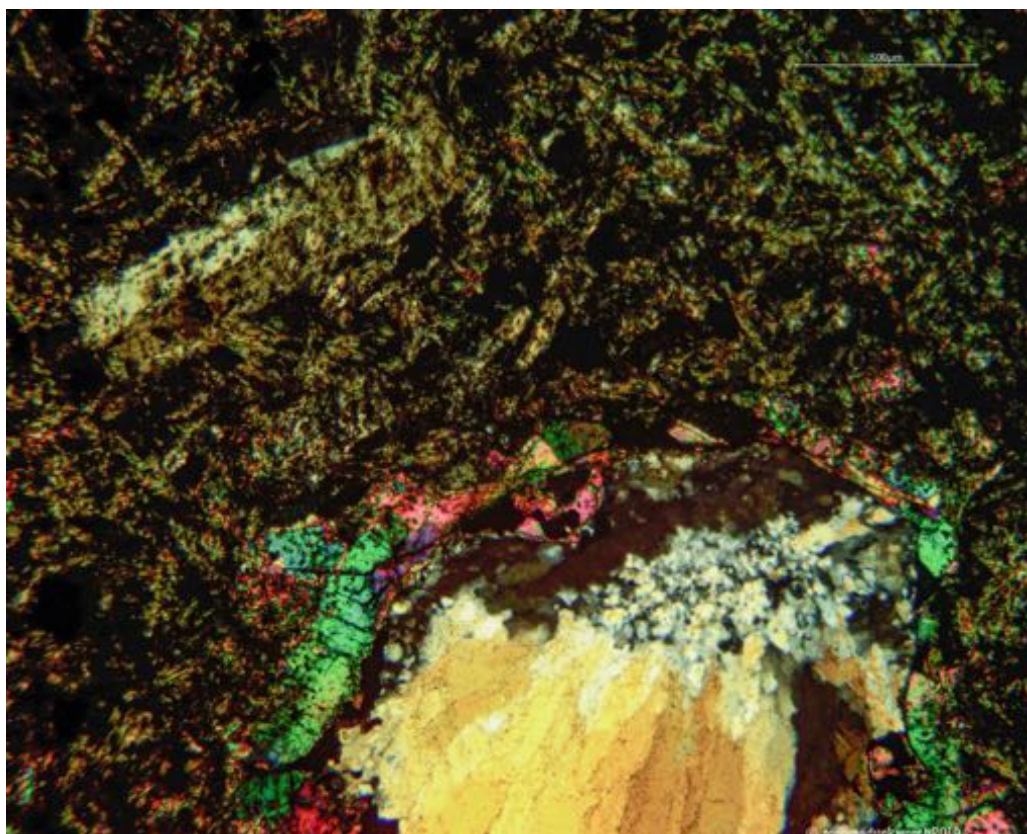
Alteration and infill paragenesis appear to be:- quartz- carbonate-epidote-chlorite-magnetite hematite-rutile.

**Summary:** Epidote-chlorite-carbonate scarcely porphyritic propylitically altered amygdaloidal meta-basalt.



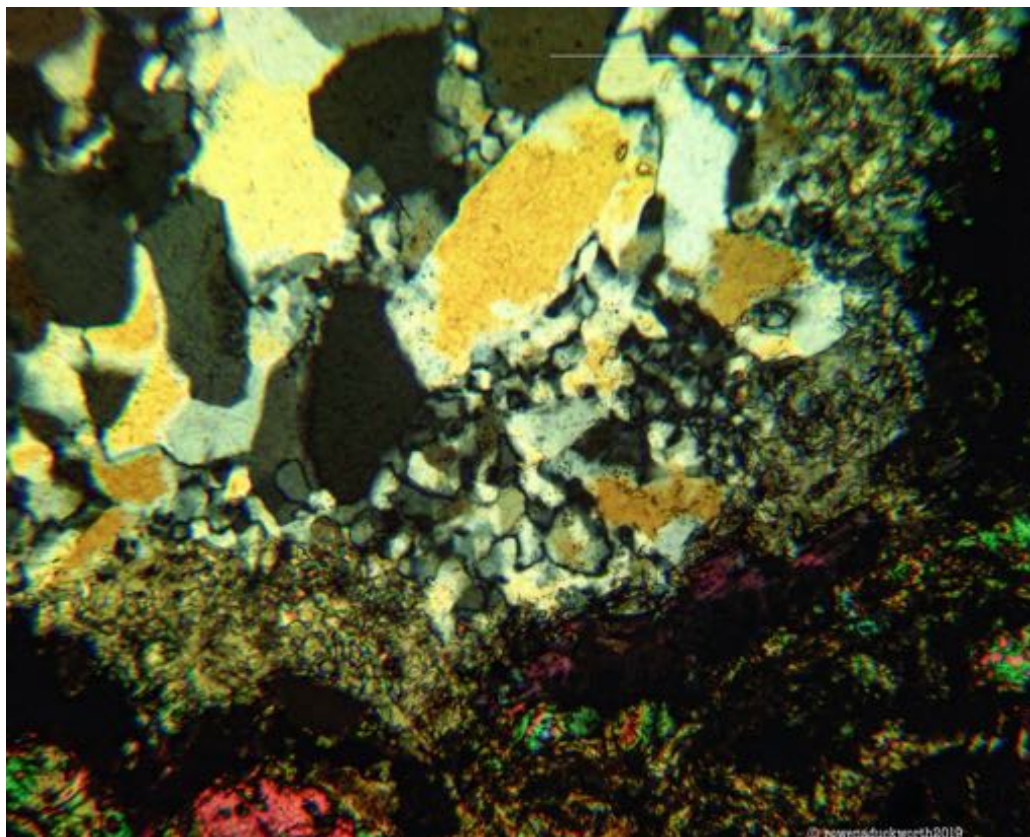


**Plane polarised light photomicrograph of sample 163271 (x4) illustrating the texture with feldspar laths and epidote cluster partially replaced by green chlorite and carbonate.**

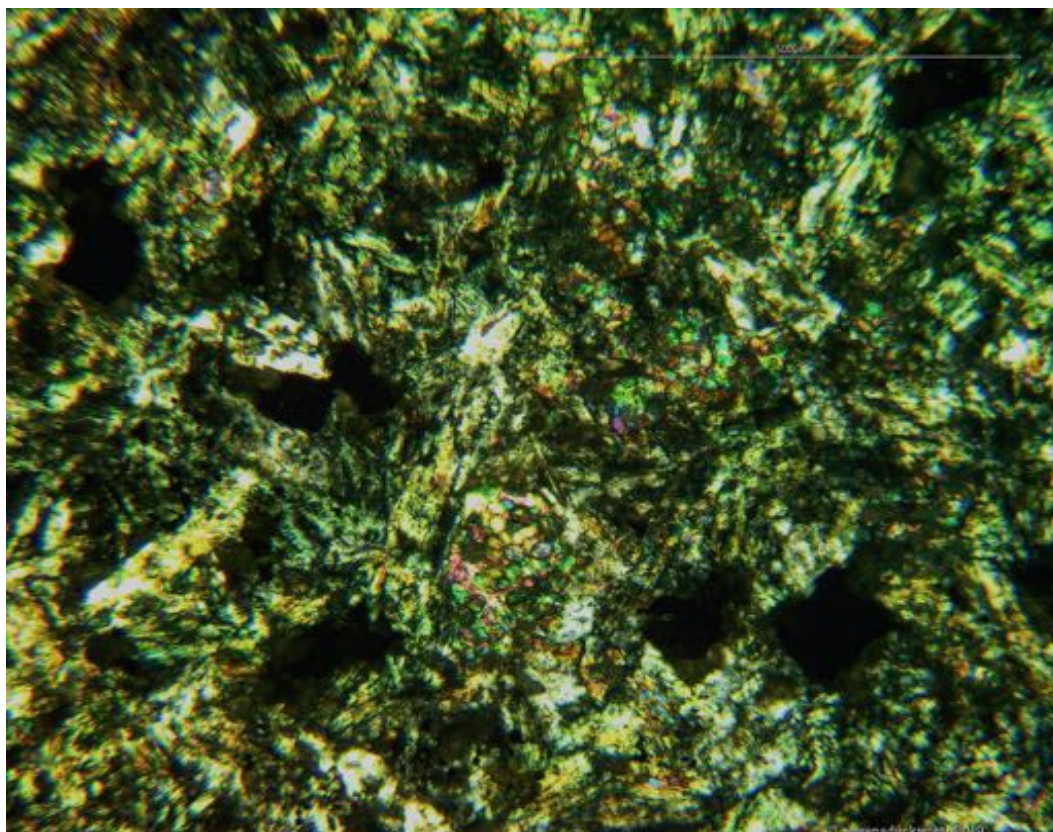


**Cross polarised light photomicrograph of sample 163271 (x4) showing the uncommon plagioclase phenocrysts and quartz-epidote filled amygdale.**





**Cross polarised light photomicrograph of sample 163271 (x10) showing quartz, carbonate, epidote filled amygdale.**



**Cross polarised light photomicrograph of sample 163271 (x4) illustrating chlorite-epidote altered groundmass texture with interlocking ex-feldspar laths.**



**163281****Thin section and offcut of sample 163281**

**Mineralogy:** Plagioclase feldspar, chlorite, epidote, hematite, clinopyroxene.

The hand specimen is a fine-grained grey homogenous rock with abundant disseminated opaque phases. The thin section is dominantly green, homogenous, with common disseminated opaques- approximately 15%.

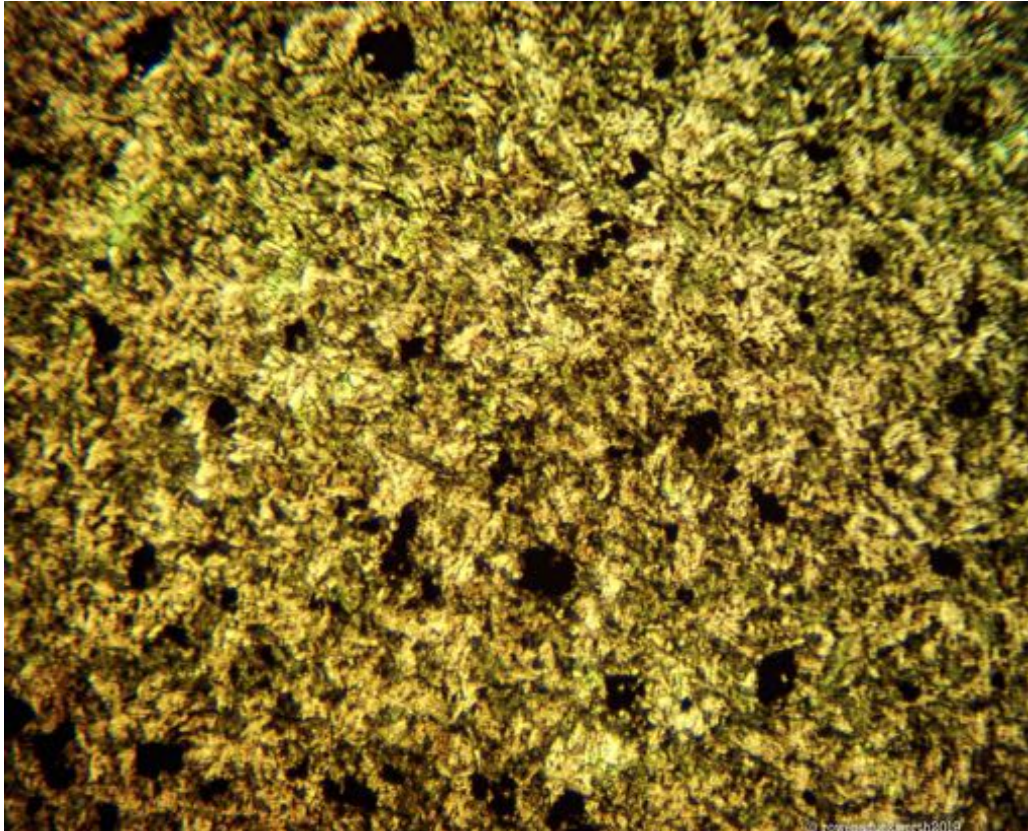
Microscopically, this sample is a fine to medium grained chloritised and epidote altered igneous rock with no obvious remaining ferromagnesian phases.

The highly altered groundmass has a relict interlocking microlitic feldspathic texture with feldspar laths between 0.2-0.3mm long. There is strong epidote-chlorite-alteration which precludes the estimation of the feldspar composition.

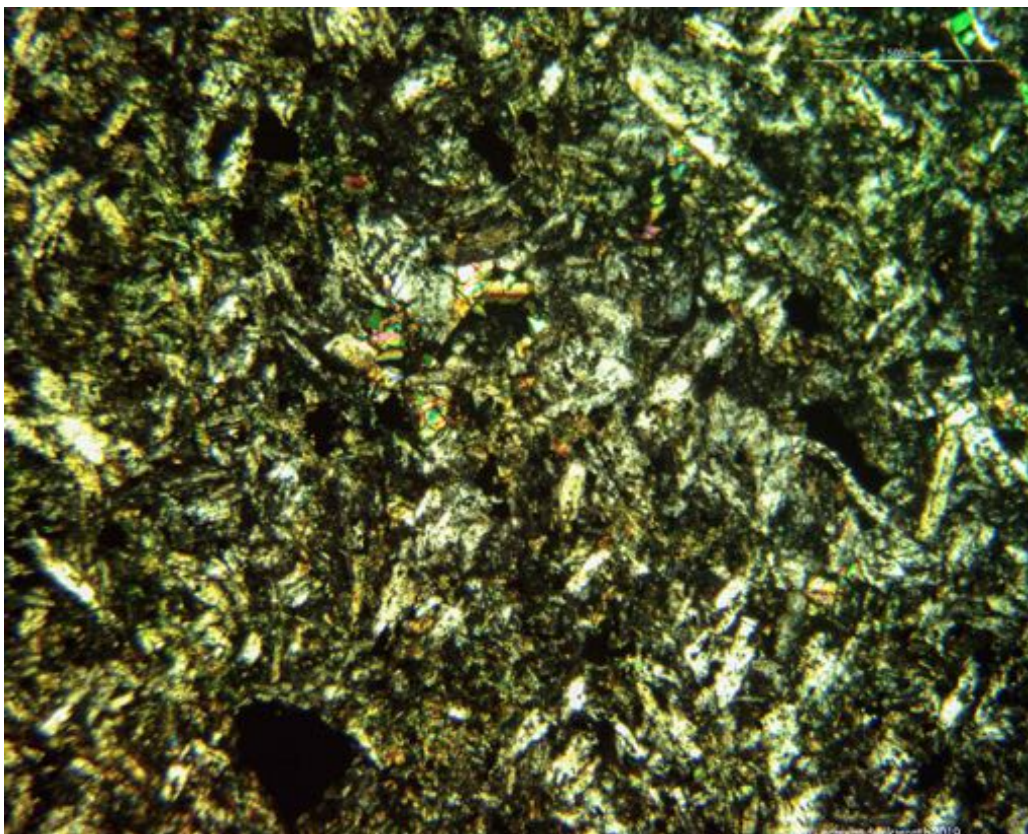
Regularly disseminated ragged subhedral to anhedral grains of hematite after magnetite occur throughout the sample. These grains range in size between 0.1-0.3 mm. The iron oxides appear to partially replace chlorite so may be secondary rather than a primary phase.

Occasional grains of relict clinopyroxene occur in the chlorite-epidote altered groundmass, but no phenocrysts are obvious. No amygdalae occur in this section and interestingly, no carbonate alteration was seen in this sample.

**Summary:** Chlorite-epidote altered meta-basalt.

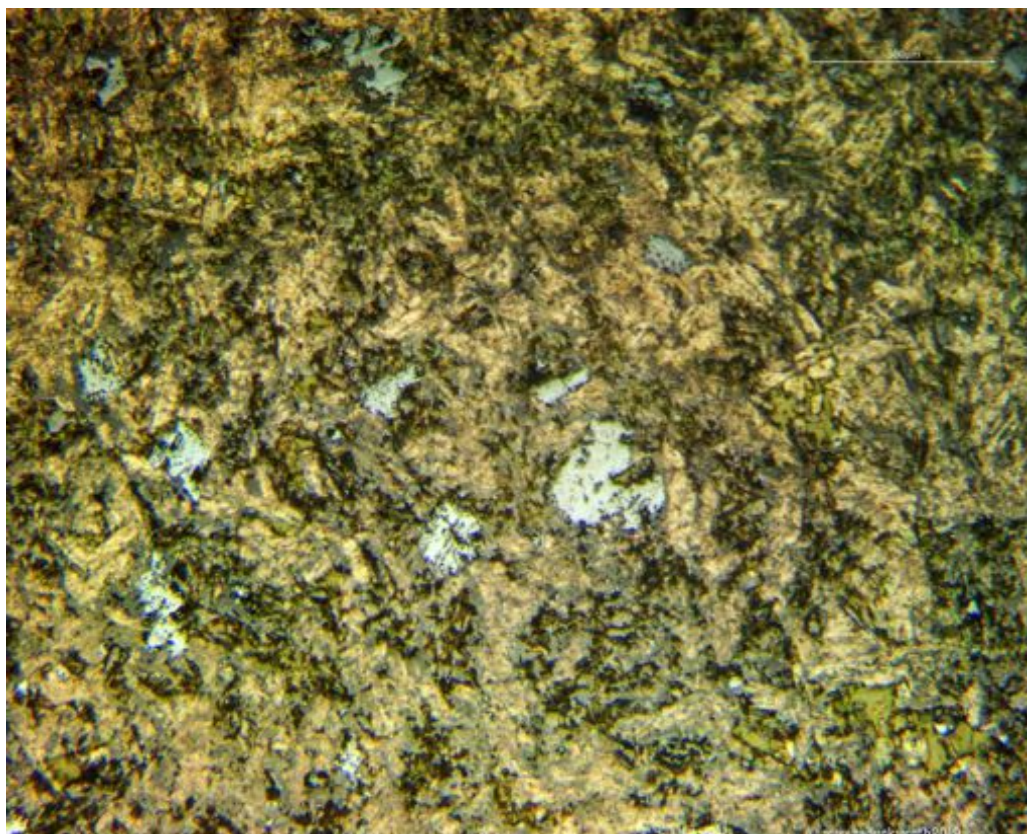


**Plane polarised light photomicrograph of sample 163281 (x2) illustrating the texture with feldspar, chlorite, epidote and disseminated opaques.**

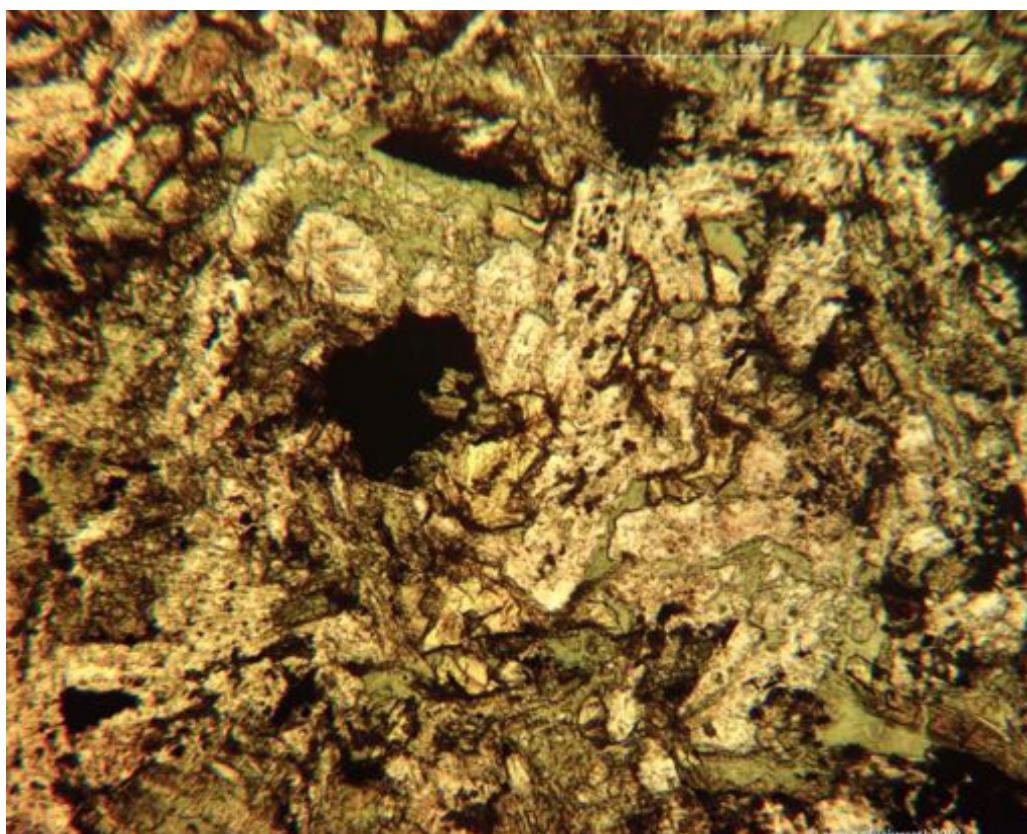


**Cross polarised light photomicrograph of sample 163281 (x4) illustrating chlorite-epidote alteration.**

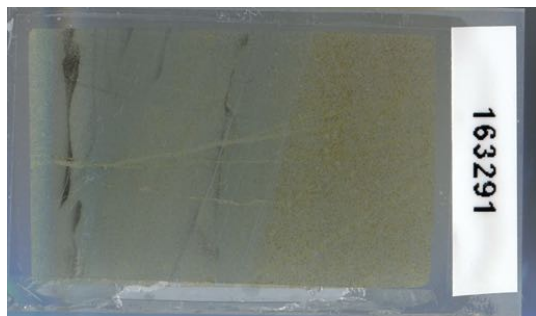




**Reflected and plane polarised light photomicrograph of sample 163281 (x4) illustrating the texture of variably hematized ragged magnetite grains.**



**Plane polarised light photomicrograph of sample 163281 (x10) illustrating chlorite-epidote alteration of plagioclase and opaque magnetite after green chlorite?**

**163291****Thin section and offcut of sample 163291**

**Mineralogy:** Quartz, epidote, carbonate, material, apatite.

The hand specimen shows a layered rock with dark green wedge layers in a pale pistachio green fine-grained rock. The thin section shows colourless and pale yellowish layers with thin discontinuous bulbous lenses of darker material.

Microscopically, this sample is a very fine-grained quartz rock with pervasive epidote and lesser carbonate alteration and two sets of veining- one set of paragenetically earlier thin quartz veins cut by later thicker quartz-epidote veins. Darker green bands in the hand sample contain more epidote and the paler area have less epidote and more carbonate.

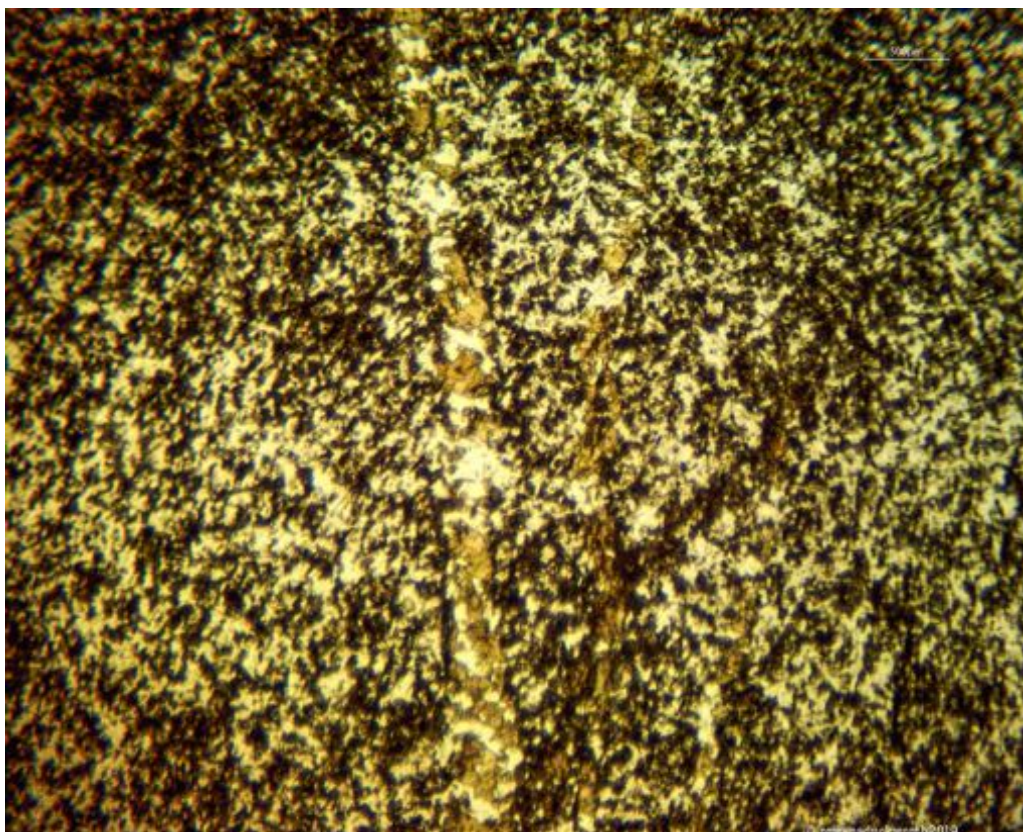
The quartz grain size is 0.05-0.1mm with slightly coarser 0.1mm epidote grains that are ubiquitously distributed in certain layers forming the green colouration seen in the hand sample. Very occasional needles of apatite were observed.

Quartz-epidote veins that are 0.1-0.2mm wide cut earlier very thin quartz veins which occur as 0.1-0.3mm wide bands of thin parallel veins. The late quartz-epidote veins do contain lesser amount of carbonate and the epidote-carbonate alteration therefore is probably associated with this veining.

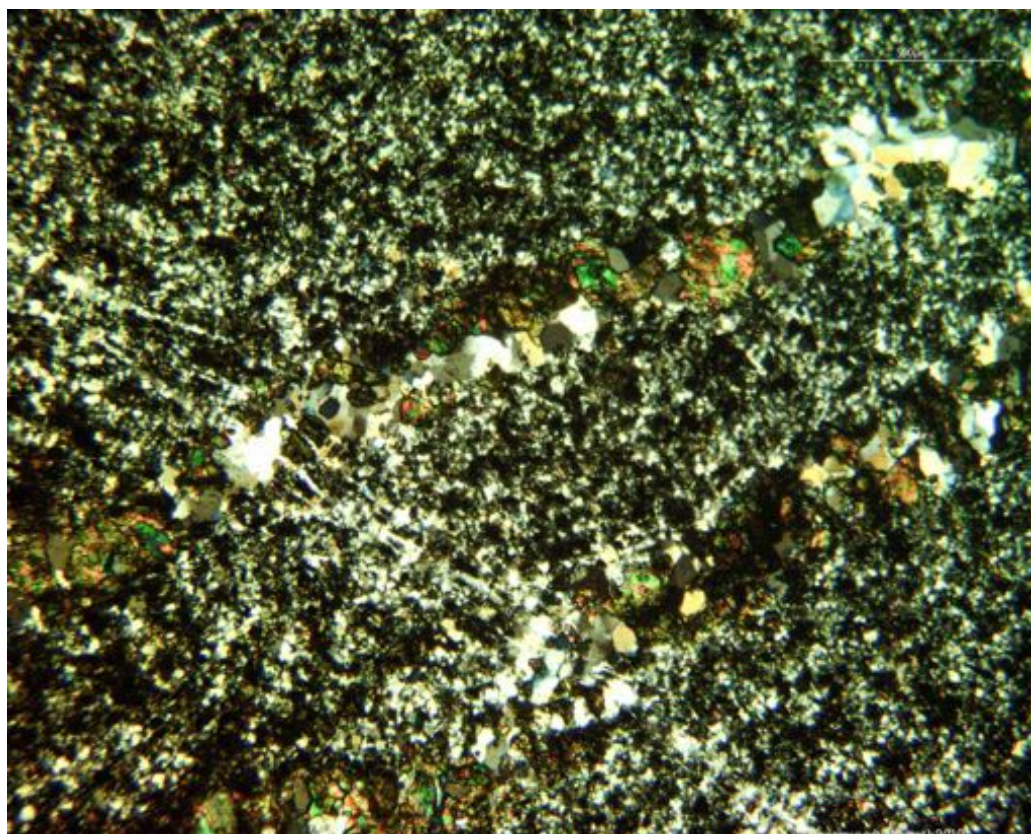
Non reflective opaque material occurs as thin lenses and this is probably carbonaceous material.

**Summary:** Epidote-carbonate altered fine-grained quartz siltstone with quartz and quartz-epidote veining.



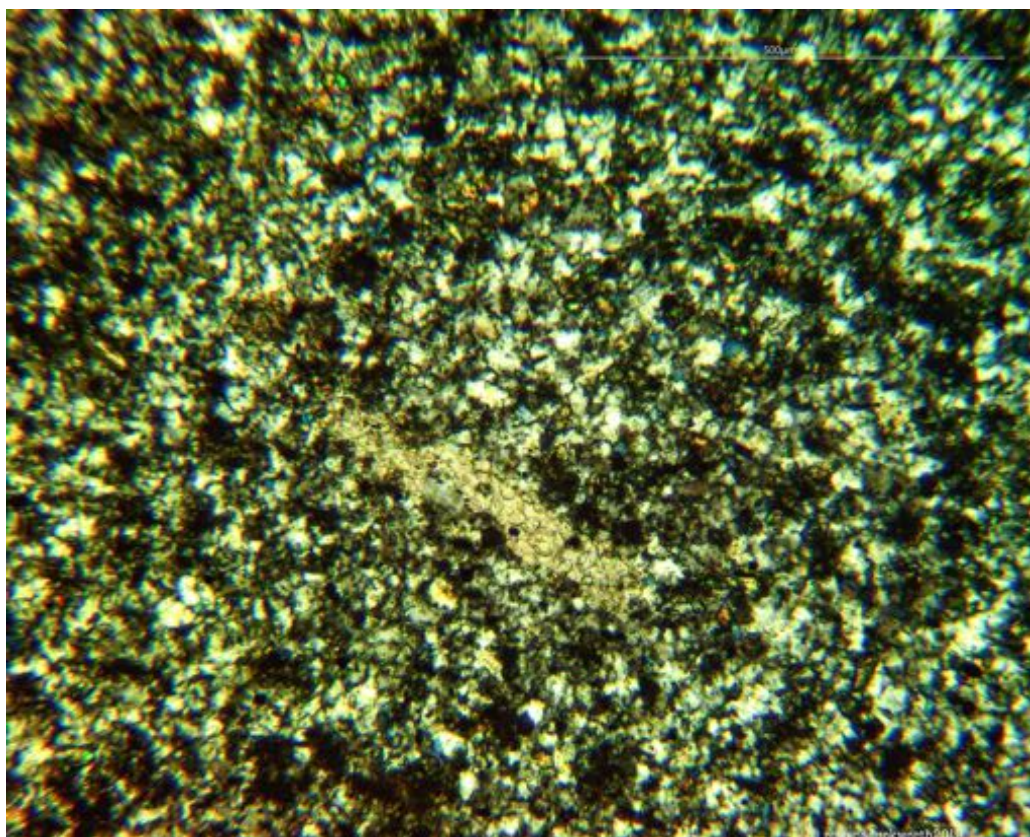


**Plane polarised light photomicrograph of sample 163291 (x2) illustrating fine-grained quartzite with pervasive epidote alteration cut by quartz-epidote veins.**

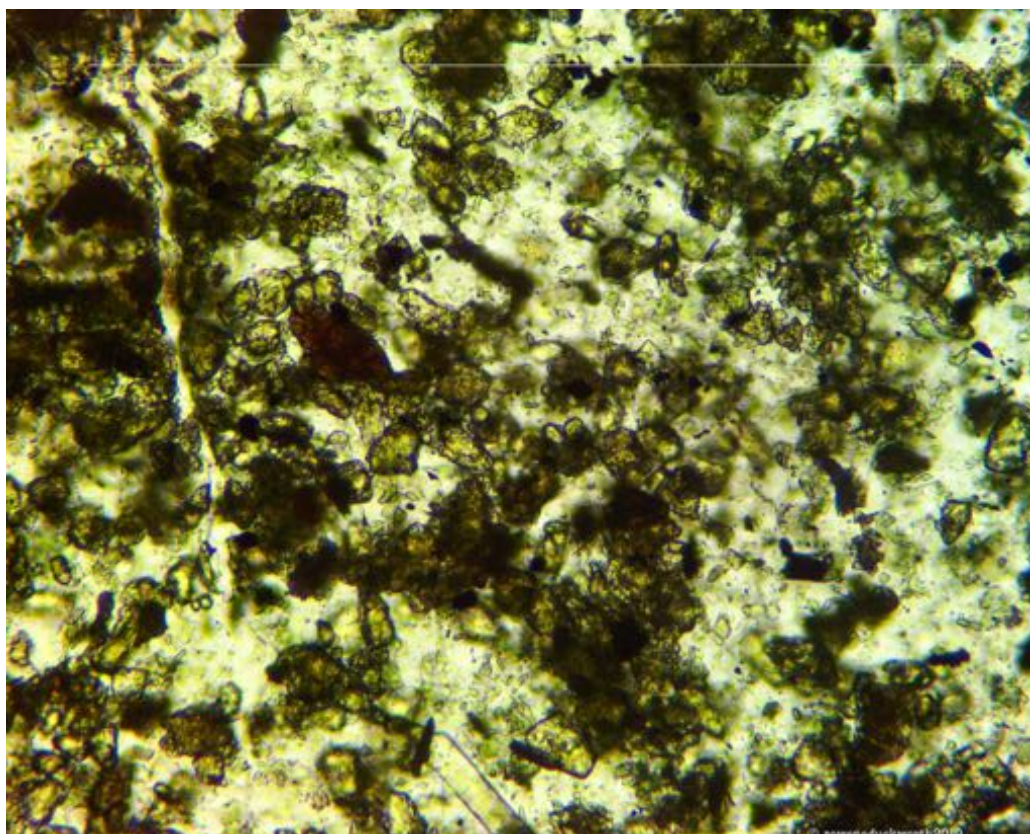


**Cross polarised light photomicrograph of sample 163291 (x4) illustrating thin quartz veins cut by quartz-epidote veins.**





**Cross polarised light photomicrograph of sample 163291 (x10) illustrating carbonate alteration in epidotised quartzite.**



**Cross polarised light photomicrograph of sample 163291 (x20) showing fine grained epidote with quartz cut by thin quartz vein. Note the apatite needle (bottom centre).**



**163299****Thin section and offcut of sample 163299**

**Mineralogy:** Quartz, clays, rutile, hematite.

The hand specimen is a pale pink-grey rock with common white patches and thin pale veins. The thin section is basically colourless with common small white flecks and negligible opaques.

Microscopically, this over 90 % quartz and the quartz grains range in size from 0.1-0.5mm. They are commonly subhedral to anhedral, occasional grains have secondary quartz overgrowths. No undulose extinction was observed but there is a slight flattening and alignment of the grains.

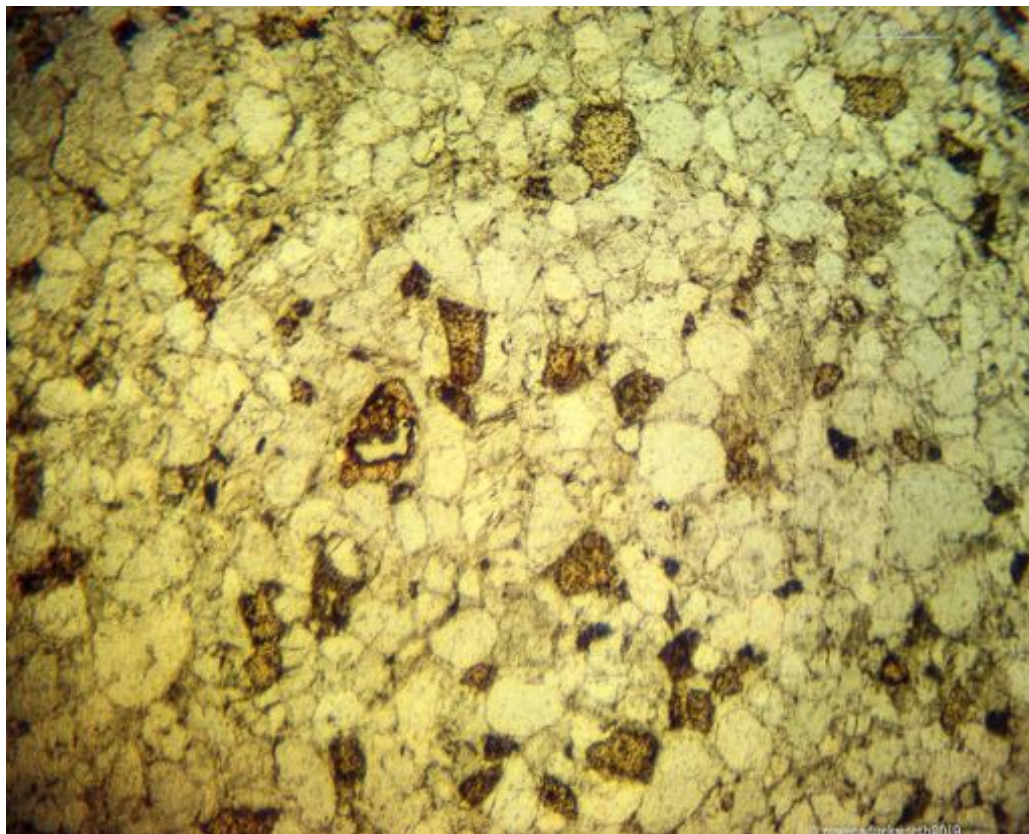
Clay patches occur between the quartz grains and this form around 10% of the rock. These may be altered feldspar grains as the distribution is quite regular.

Rutile grains are ragged 0.1-0.4mm across. Rare hematite was observed.

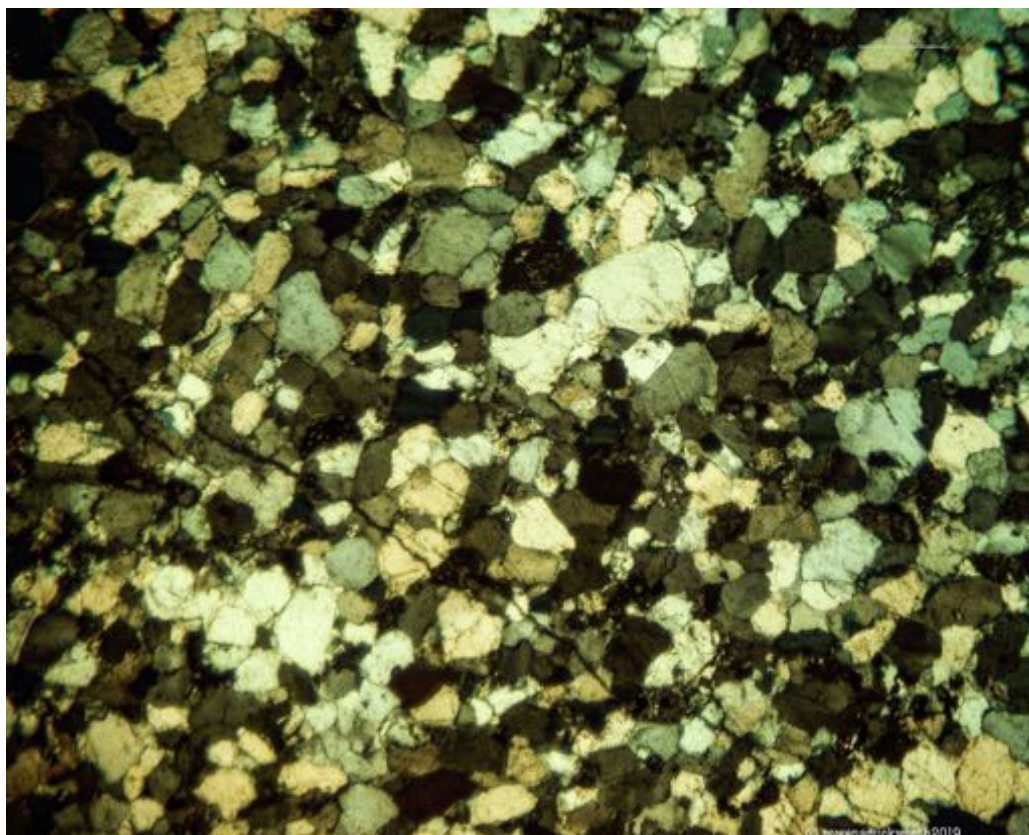
Thin opaque veinlets contain non-reflective opaque material.

**Summary:** Fine-grained quartzite.



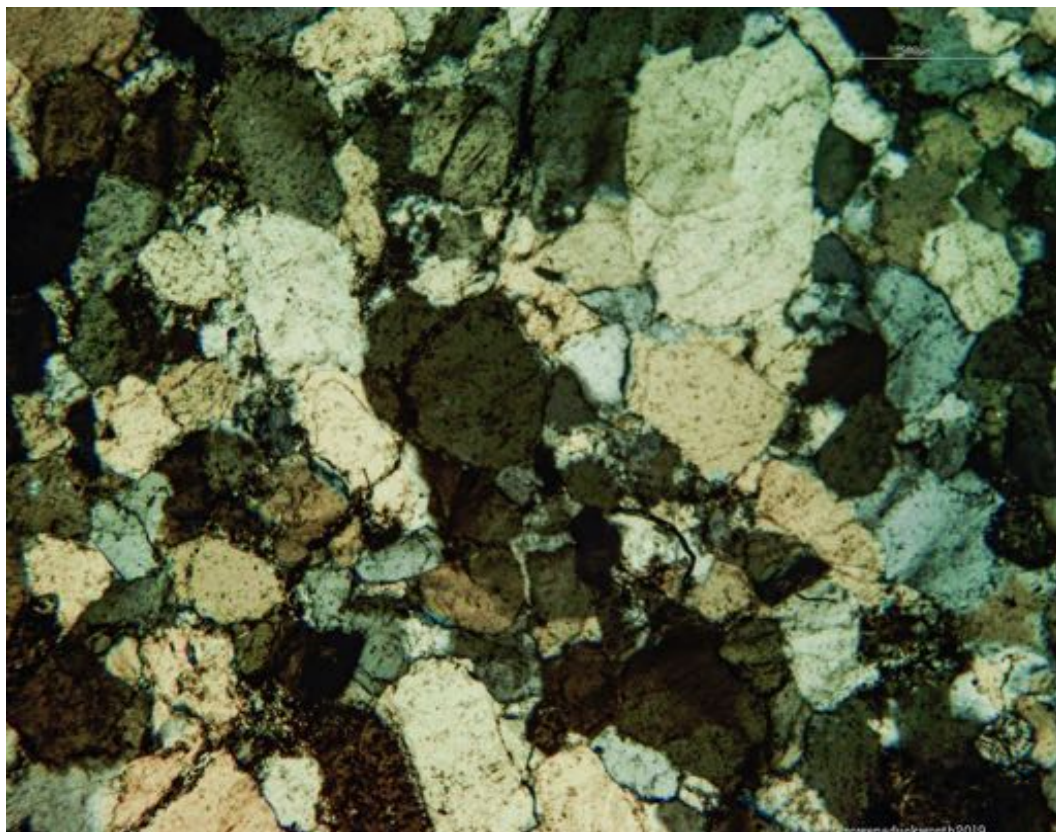


**Plane polarised light photomicrograph of sample 163299 (x2) illustrating quartz grains and brown rutile. Cloudy clay patches may be completely altered feldspars?**

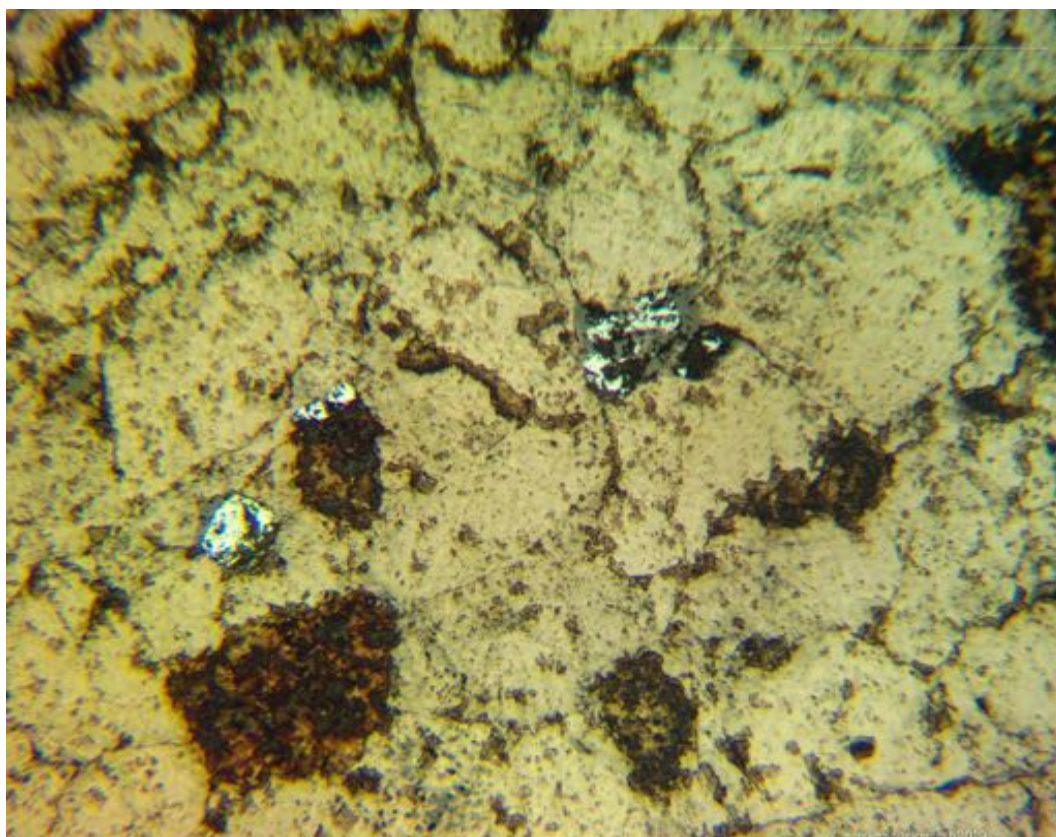


**Cross polarised light photomicrograph of sample 163299 (x2) illustrating texture with anhedronal quartz grains showing a rough alignment.**





**Cross polarised light photomicrograph of sample 163299 (x4) illustrating granular quartz texture with some grains with secondary quartz overgrowths.**



**Reflected and plane polarised light photomicrograph of sample 163299 (x10) illustrating probable degraded magnetite with secondary rutile and hematite.**



**163322****Thin section and offcut of sample 163322**

**Mineralogy:** Quartz, non-reflective opaques, clays, hematite.

The hand specimen is a pale pink fine-grained homogenous sample and the thin section shows an homogenous colourless rock.

Microscopically, this is a sandstone and is composed of over 70% quartz with less than 10% clays which may be altered feldspar grains. Non-reflective opaque phases constitute around 20% of the sample.

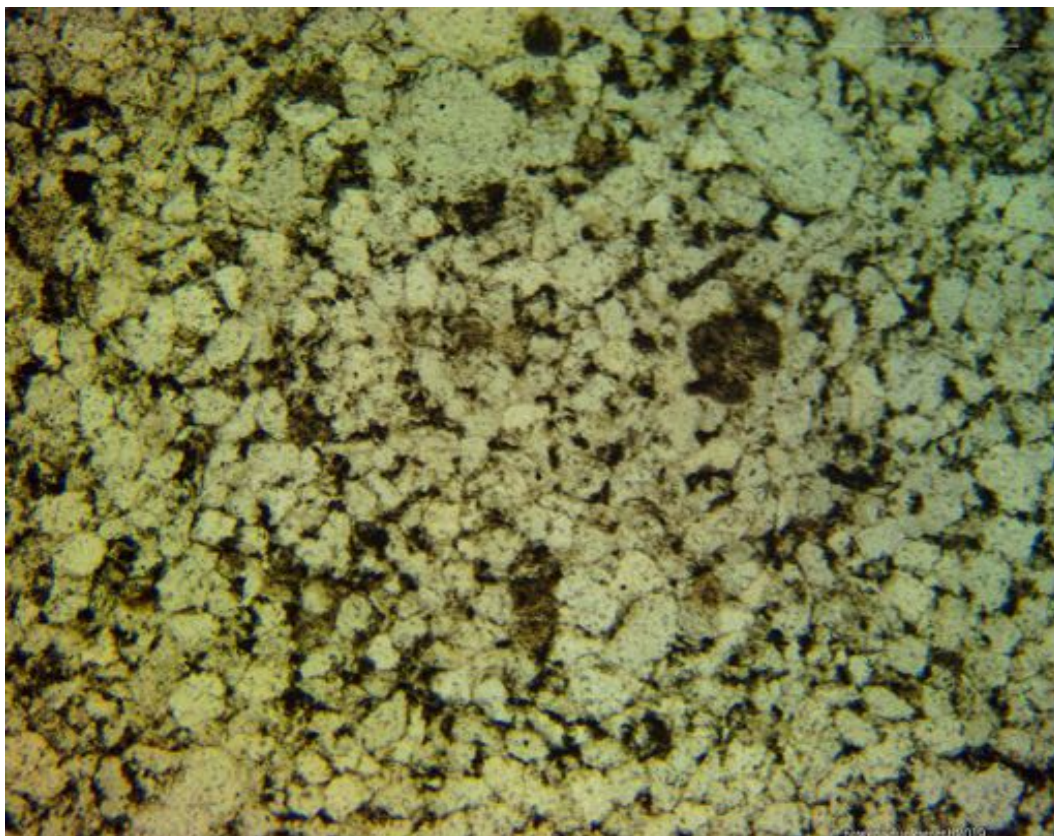
The quartz grains are interlocking, commonly around 0.2-0.3mm across with scattered larger subrounded quartz grains that have a 0.5-1mm size range. No layering, flattening or bedding was observed in this section. The rock is granular and grain supported with no matrix.

Clays make up about 10% of the sample and these are probably altered feldspar grains as they have a sub angular-subrounded outline and occur within the interlocking quartz framework.

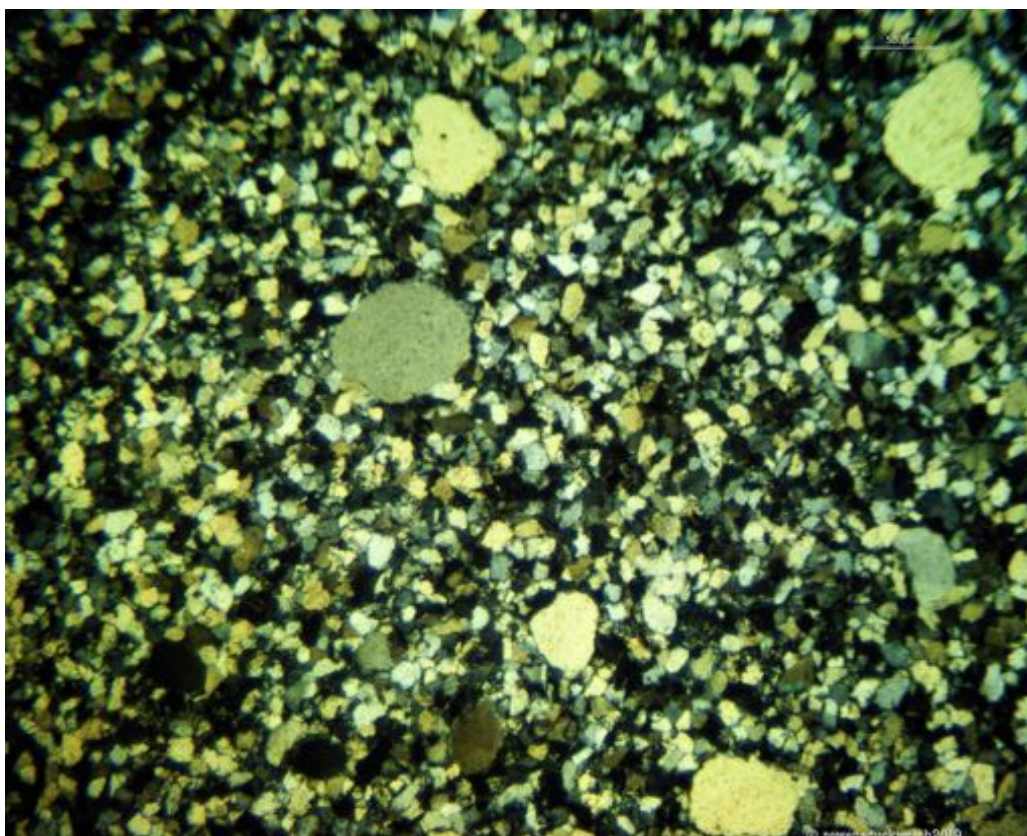
Non reflective opaque phases are scattered throughout the rock in patches and wrapped around quartz grains. The grain size and the non-reflective behavior make these difficult to identify, but rare specular hematite suggest that at least the opaques that rim the quartz grains may be secondary iron oxides (hence the pale pink colour of the hand sample).

**Summary:** Sub-arkosic meta-sandstone/ fine grained quartzite.



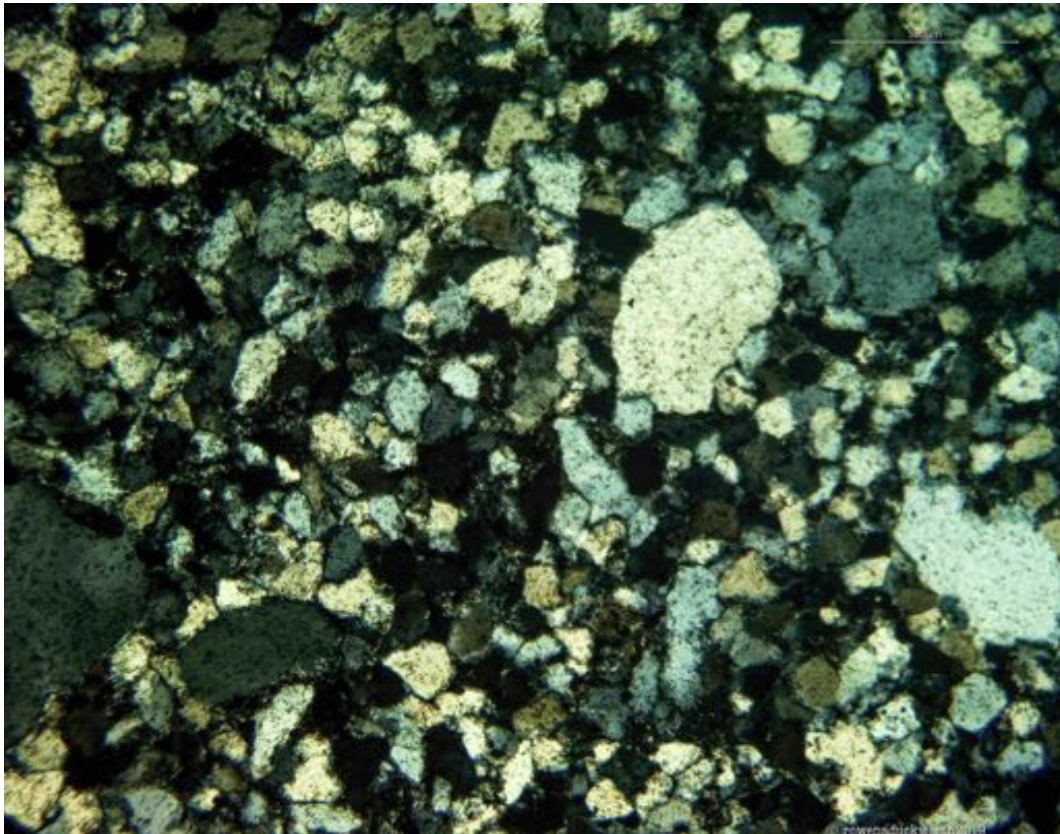


**Plane polarised light photomicrograph of sample 163322 (x2) illustrating the texture with interlocking granular quartz, occasional clay patches and opaque phases.**

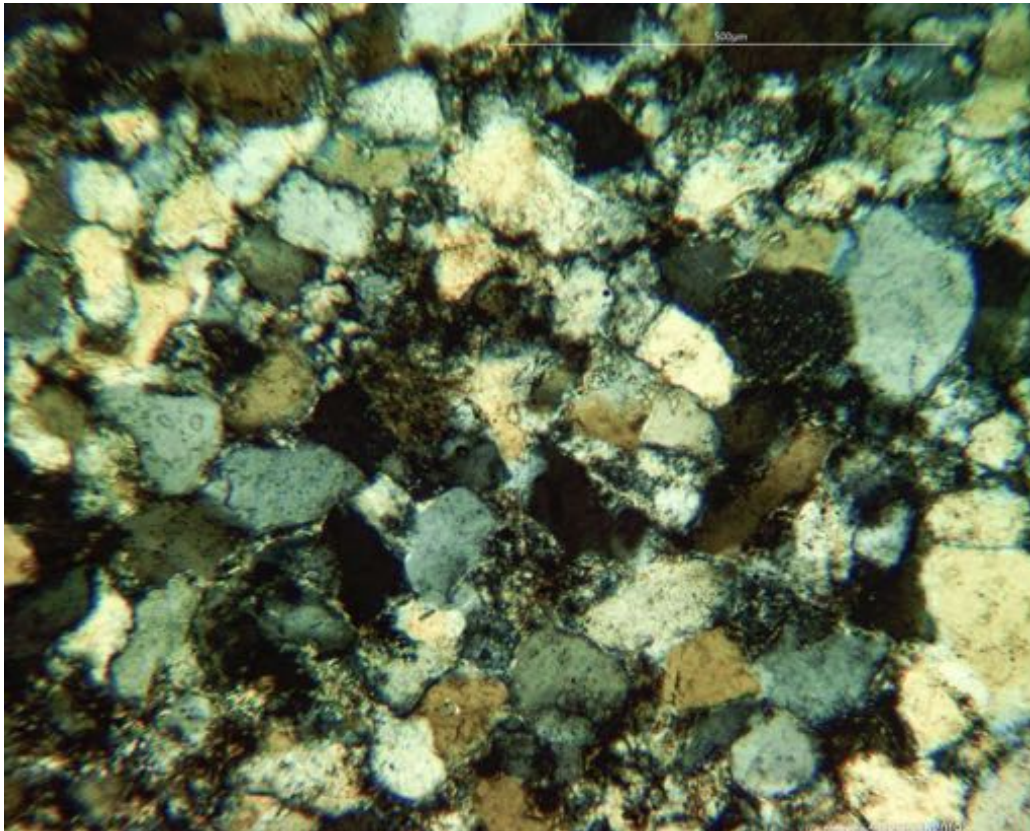


**Plane polarised light photomicrograph of sample 163322 (x4) illustrating coarse rounded quartz grains in finer quartz rich matrix.**



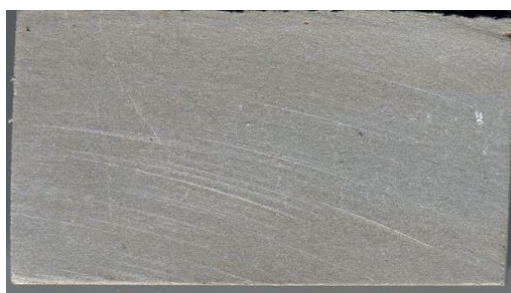
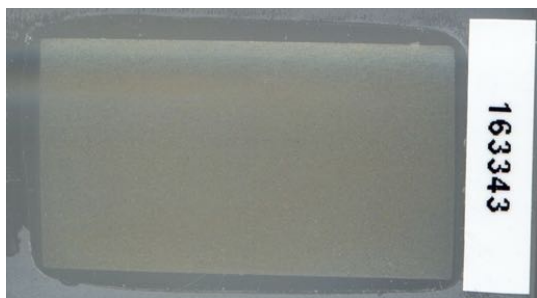


**Cross polarised light photomicrograph of sample 163322 (x4) illustrating coarser and finer grained quartz ...**



**Cross polarised light photomicrograph of sample 163322 (x10) illustrating anhedral quartz with clay altered feldspars.**



**163343****Thin section and offcut of sample 163343**

**Mineralogy:** Sericite, quartz, chlorite, rutile, muscovite, hematite.

The hand specimen is a foliated pale grey-yellow brown fine-grained rock. The thin section shows a mottle yellow-colourless fine-grained rock.

Microscopically, this sample is a fine grained (less than 0.05mm) quartz rich sample with 20% scattered coarser 0.1mm rounded quartz grains with a fine-grained sericite and chlorite matrix that shows a distinct alignment of the mica flakes.

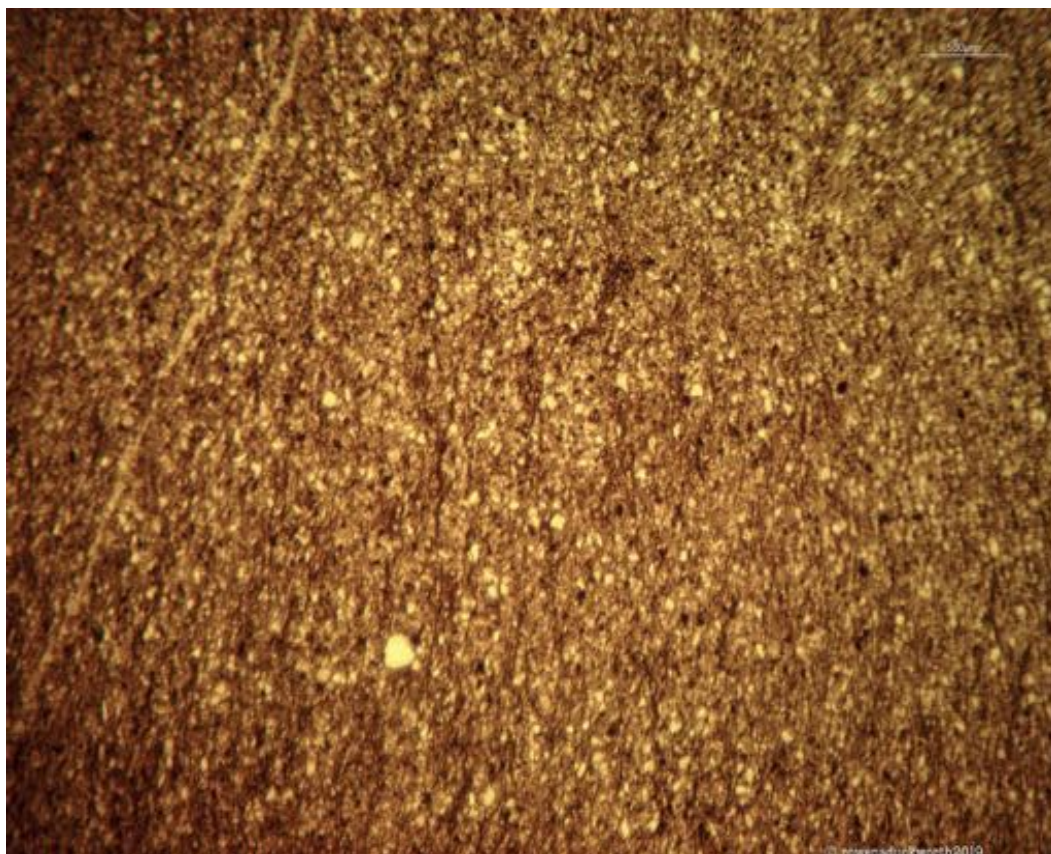
The foliated fine-grained sericite-chlorite matrix contains about 5% muscovite that has a grain size of around 0.2mm.

Scattered rutile grains have a grain size less than 0.1mm and are show an alignment parallel to the foliation orientation.

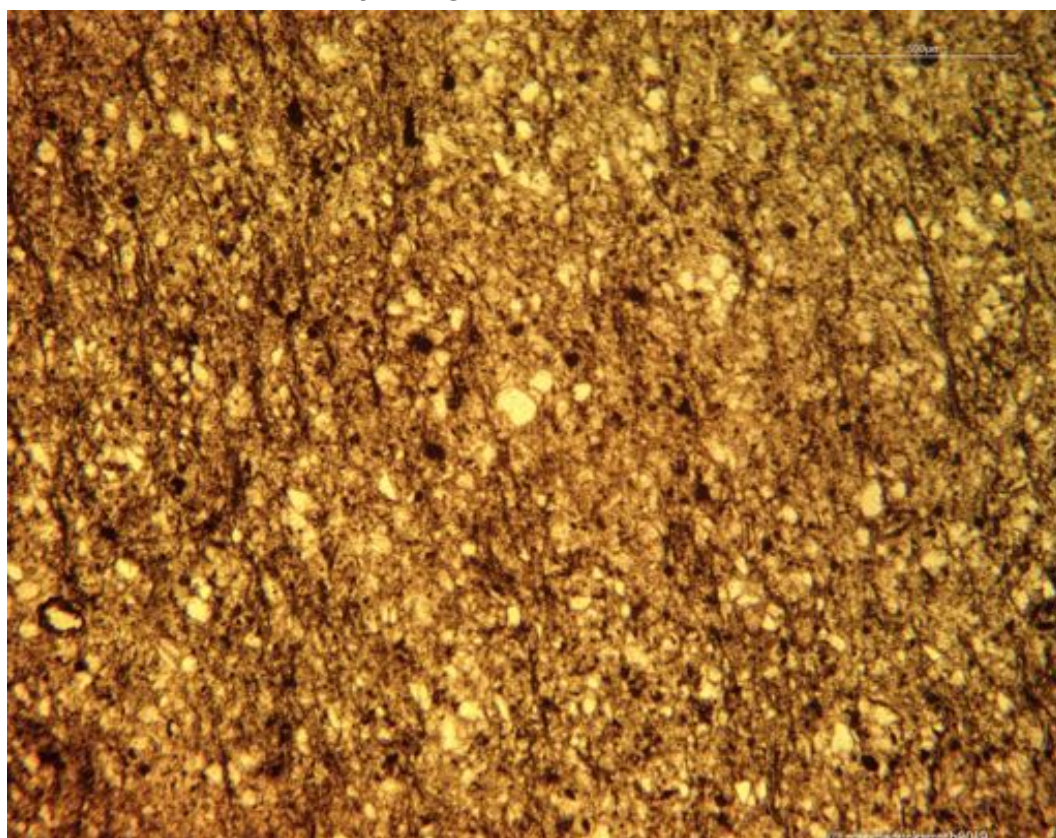
Thin quartz veins cut the sample at a high angle to the foliation.

**Summary:** Foliated sericite-chlorite altered meta-siltstone.



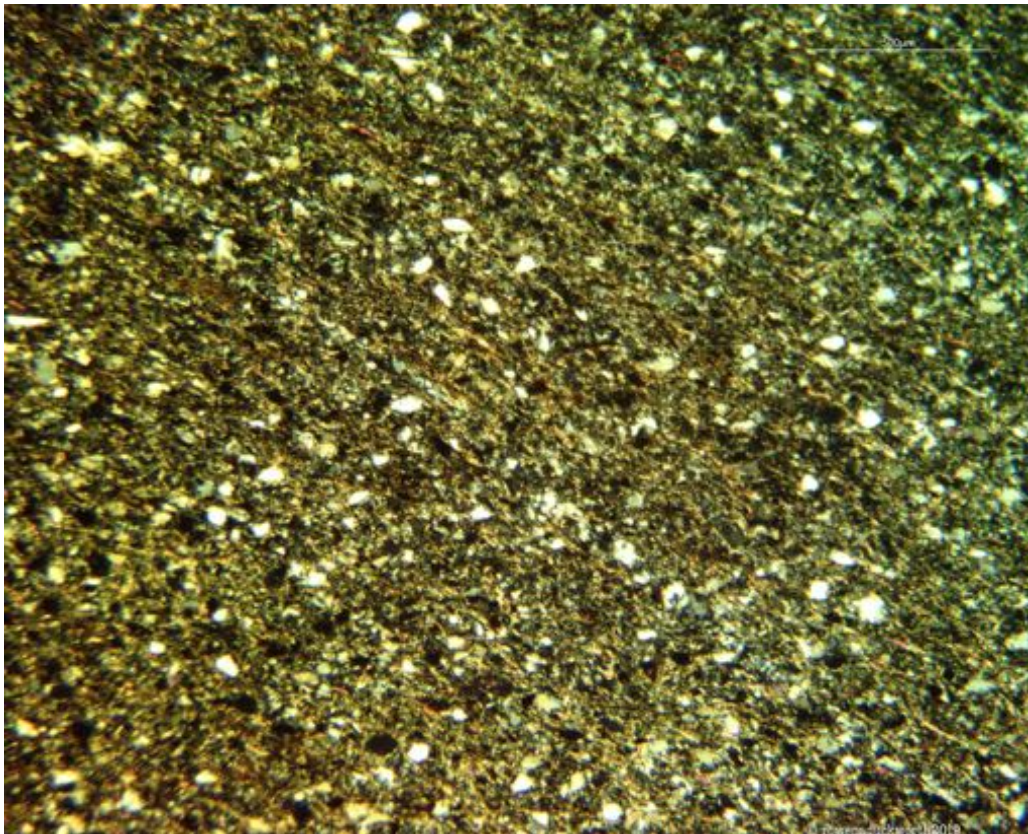


**Plane polarised light photomicrograph of sample 163343 (x2) illustrating the texture of the foliated very fine-grained sediment.**

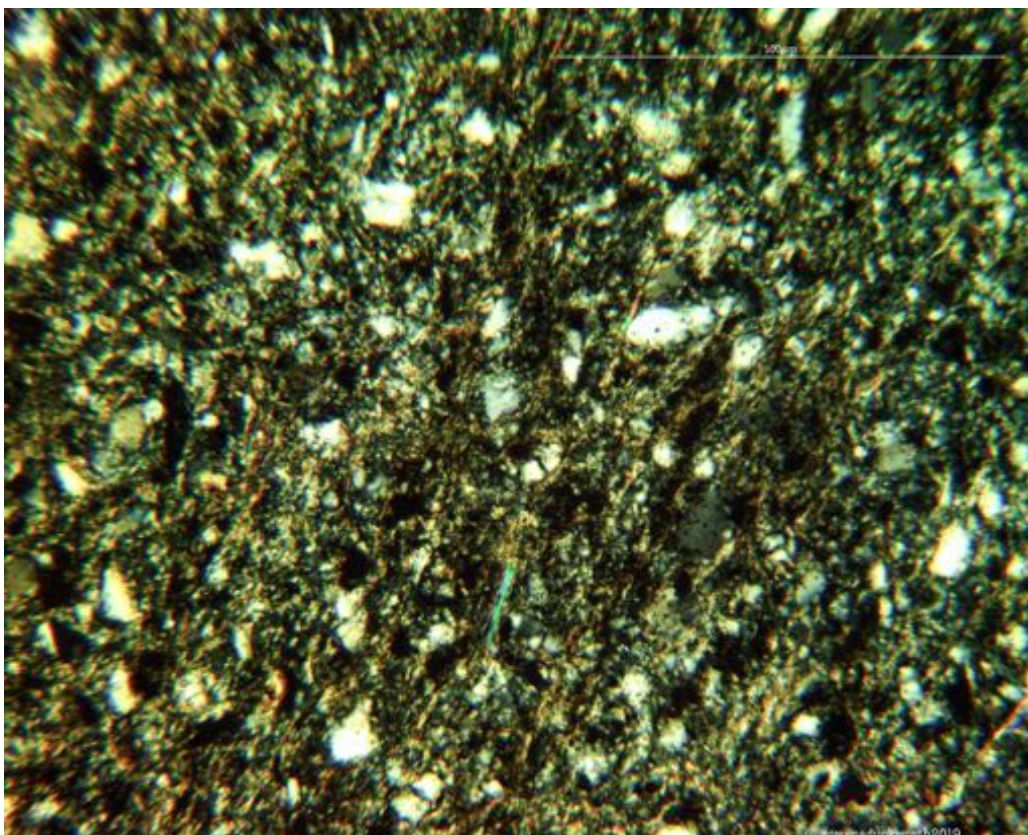


**Plane polarised light photomicrograph of sample 163343 (x4) illustrating texture with subrounded coarser quartz grains in finer grained quartz.**



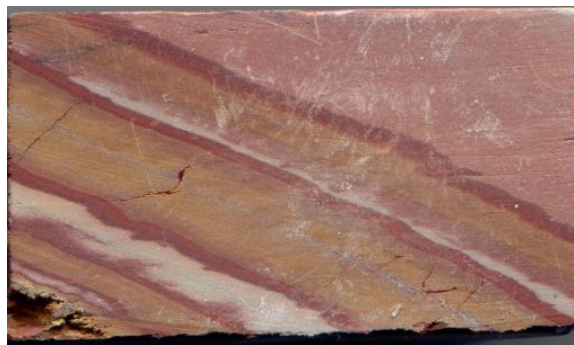


**Cross polarised light photomicrograph of sample 163343 (x4) illustrating quartz grains in foliated sericite-chlorite matrix.**



**Cross polarised light photomicrograph of sample 163343 (x10) showing foliation defined by aligned micas.**



**163366****Thin section and offcut of sample 163366**

**Mineralogy:** Sericite, hematite, goethite, quartz, iron hydroxyoxides.

The hand specimen is layered with red, dark red, yellow and pale bands. The thin section shows a similar texture with well-defined alternating red, yellow and colourless bands often with dark red margins.

Microscopically, this sample is a strongly hematized and sericitized fine-grained laminated rock. The stripy fabric is reminiscent of “zebra” rock.

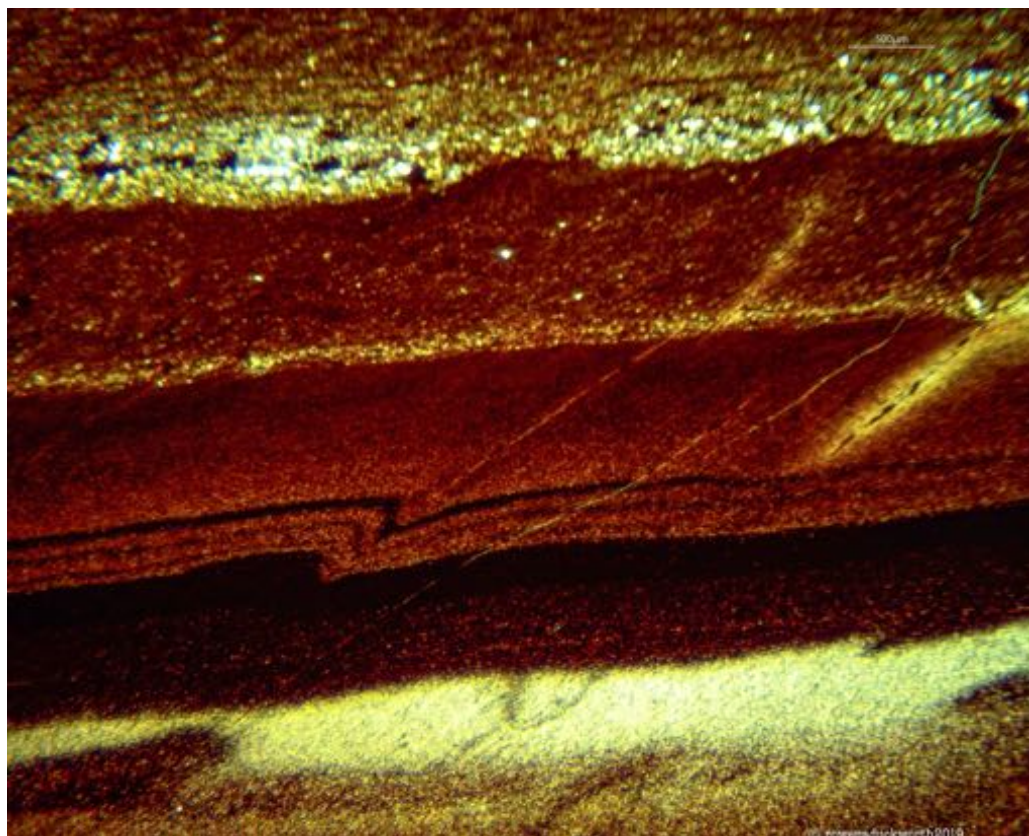
The paler bands consist of fine-grained quartz (0.01mm) alternating with yellow quartz layers with a strong sericite overprint and red and dark red layers that are strongly hematized. The sericite is aligned and defines a foliation. Hematized layers are also foliated and the foliation at an angle of about 45° to the laminations.

Some coarser (0.2mm) quartz grains at the base of laminations may indicate graded bedding and could be a way up indicator.

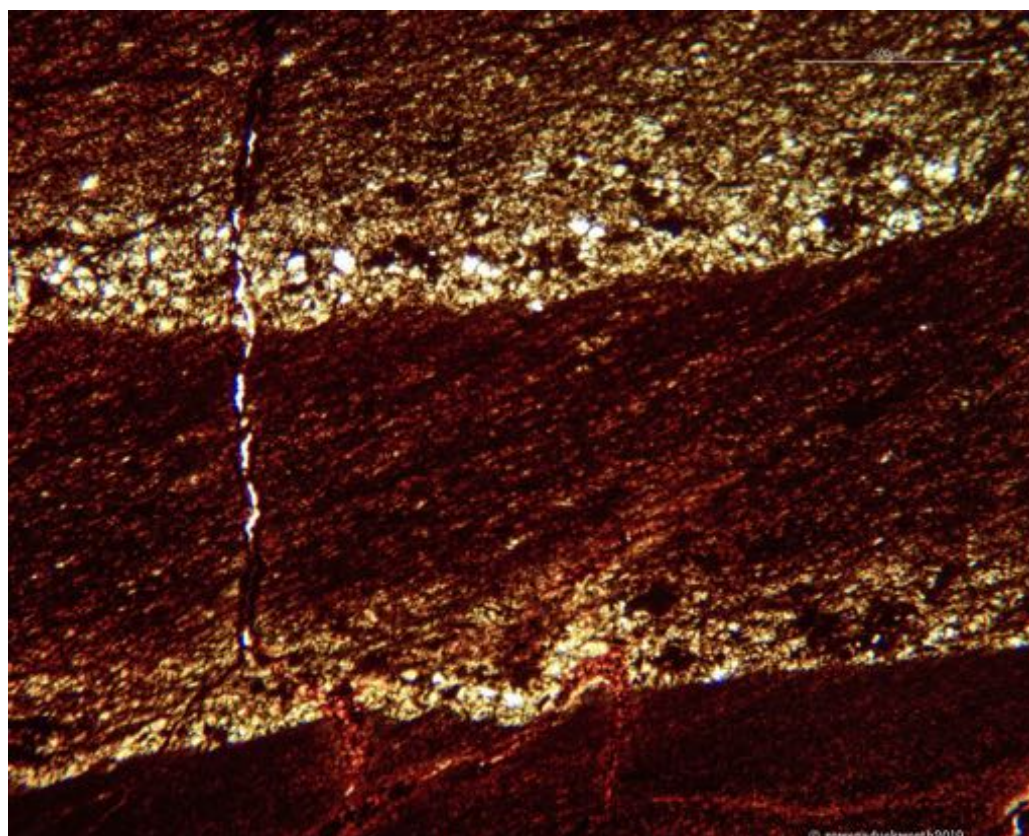
Micro-faulting on the mm scale or less and small-scale kinking/folding is common. Thin quartz and hematite veins crosscut the layers.

**Summary:** Sericite-hematite altered, foliated, laminated quartz meta-siltstone.



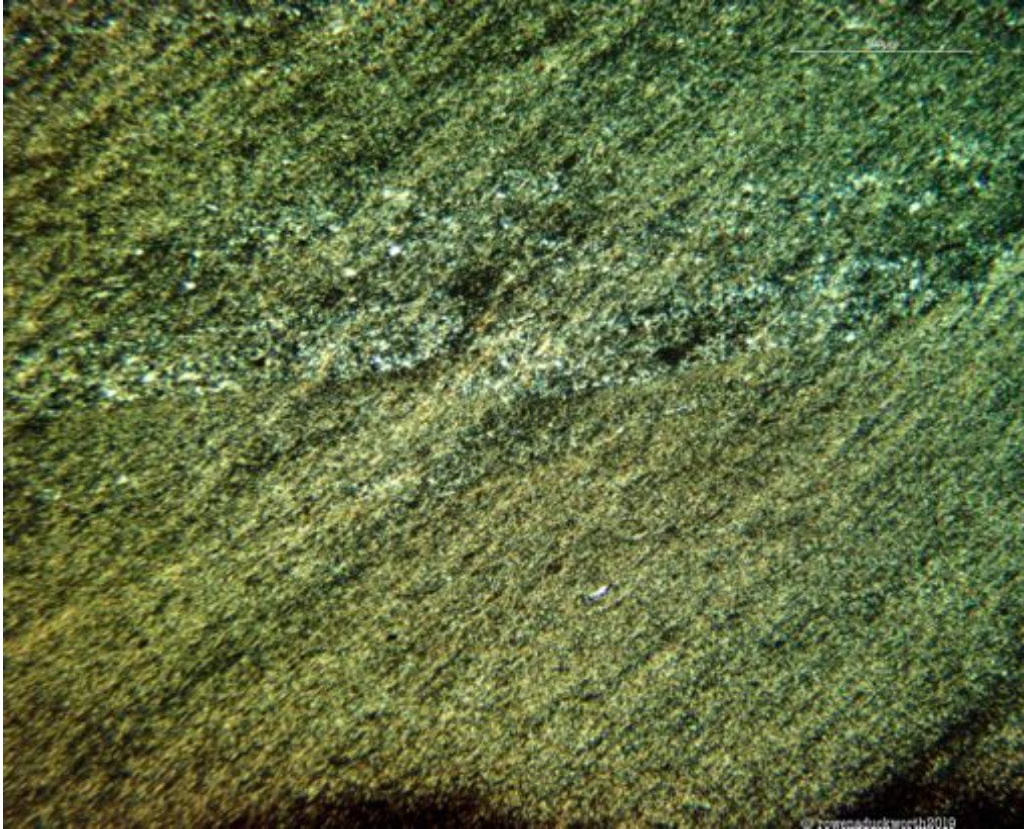


Plane polarised light photomicrograph of sample 163366 (x2) illustrating the texture of the very fine-grained laminated rock. Note the kinking.

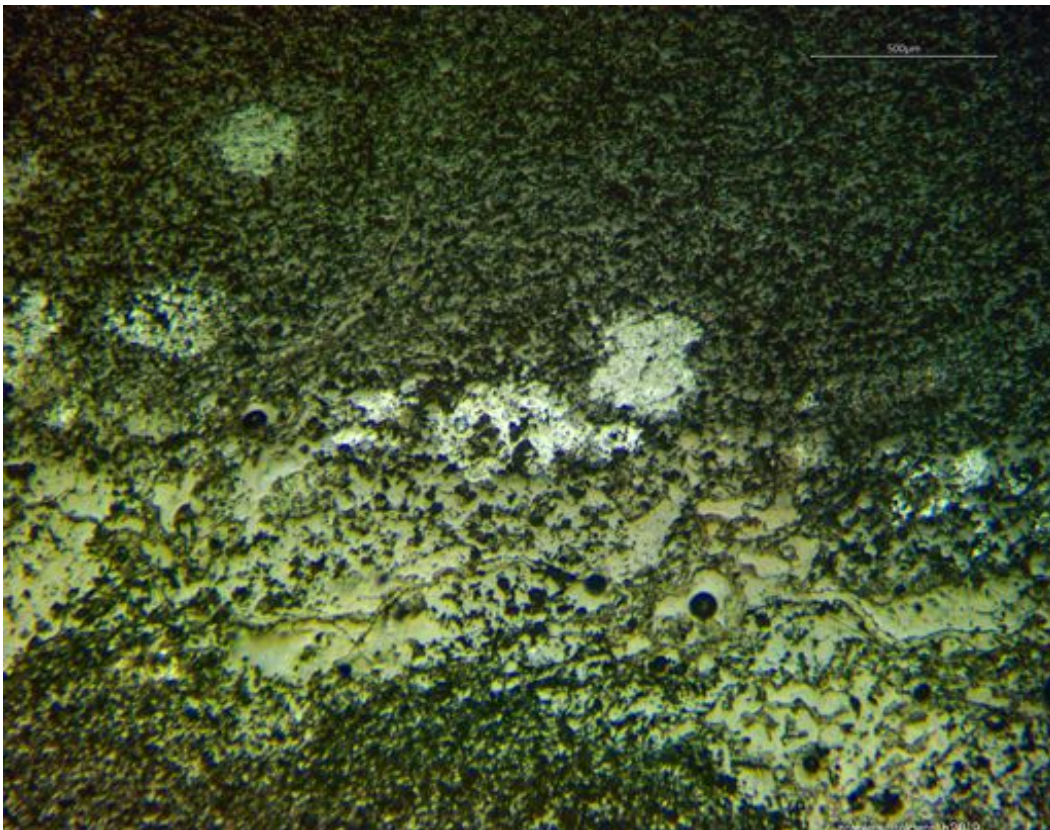


Plane polarised light photomicrograph of sample 163366 (x4) illustrating the graded bedding and late veining. Hematised layer is foliated.



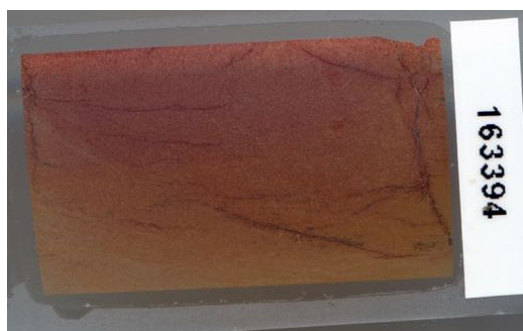


**Cross polarised light photomicrograph of sample 163366 (x4) illustrating texture of paler beds that are strongly sericitised and foliated. Note micro-faulted coarse quartz rich bed that is partially overprinted by sericite.**



**Reflected light photomicrograph of sample 163366 (x4) illustrating rare specular hematite at one end of the section associated with a layer of coarse-grained quartz.**



**163394****Thin section and offcut of sample 163394**

**Mineralogy:** Hematite, quartz, sericite, chlorite.

The hand specimen shows a pale red fine-grained rock with dark veinlets. The thin section shows a red rock grading to orange rock with some discontinuous dark veinlets/fractures.

Microscopically, this is a quartz-sericite-chlorite-iron oxide altered rock with more earthy hematite alteration in the darker red domains.

In the paler domain there is approximately 30% quartz, 30% sericite 30% hematite and 10% chlorite. In the darker red domain hematite increases at the expense of chlorite and some of the white mica.

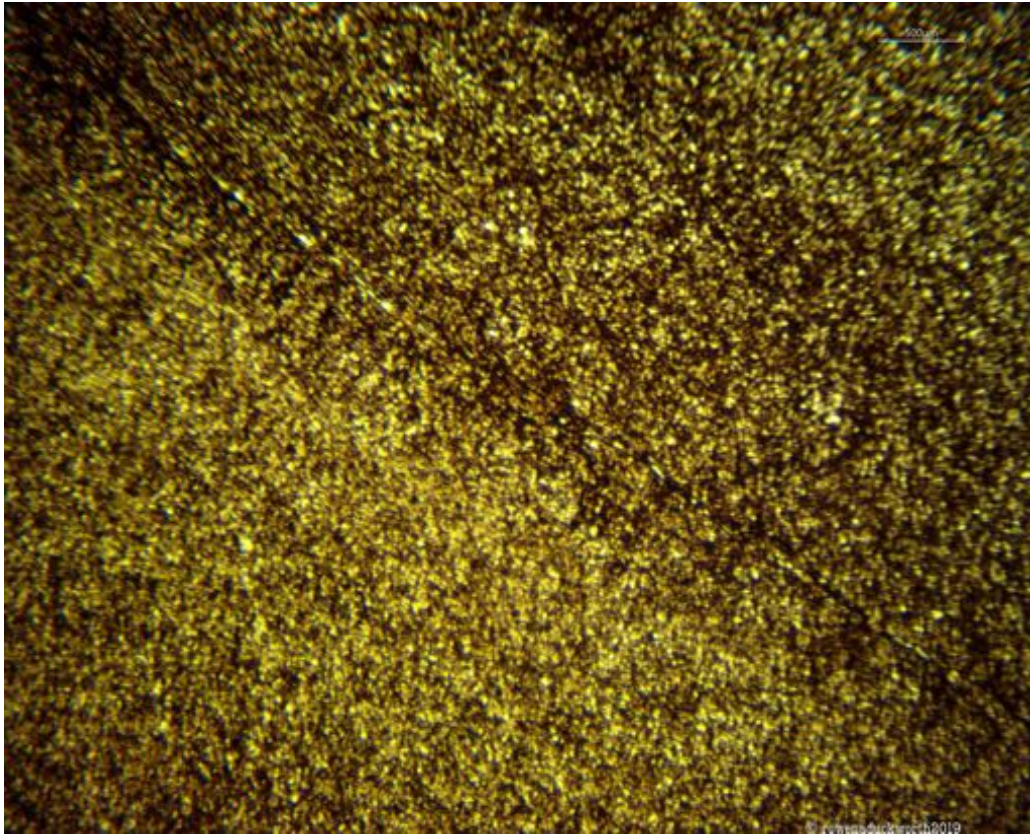
The grain size of the quartz, mica and chlorite is 0.01mm or less and individual grains are hard to resolve even at high magnification.

The iron oxide alteration is paragenetically late and forms an anastomosing replacement texture.

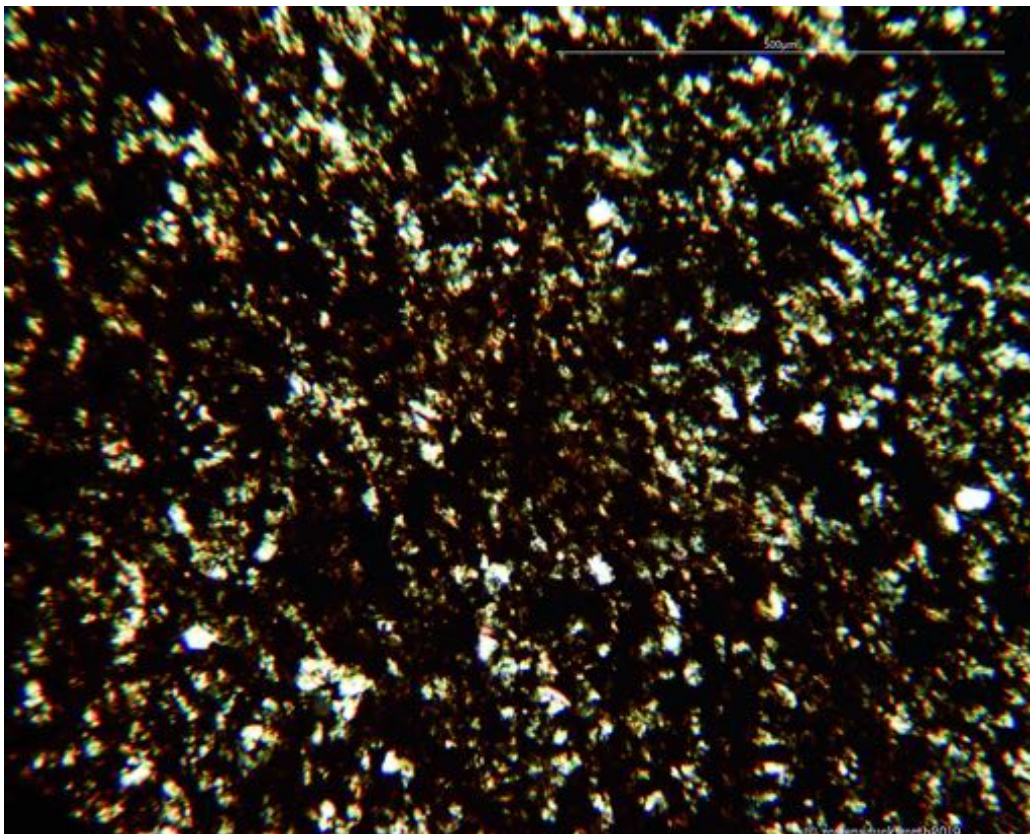
Quartz and hematite veins cut the sample, and several fractures are also evident.

**Summary:** Sericitised and weakly chlorite altered meta-siltstone with late hematite alteration.



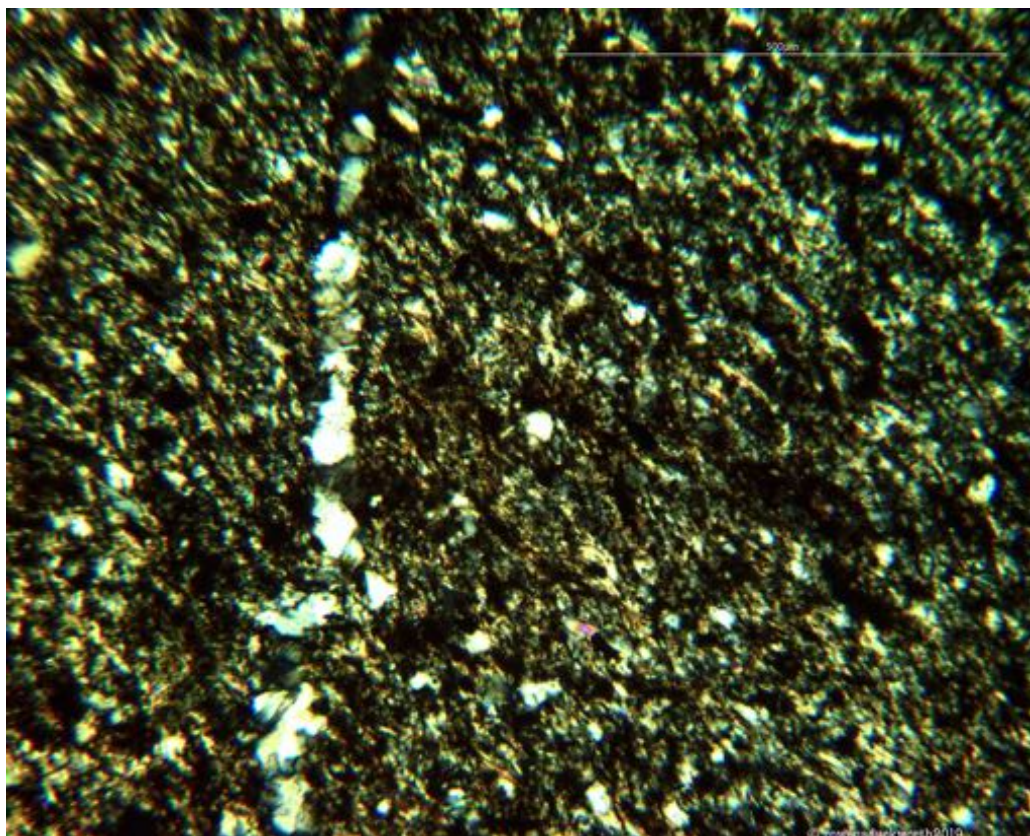


**Plane polarised light photomicrograph of sample 163394 (x2) illustrating the texture across the gradational boundary between the paler and darker red layers.**

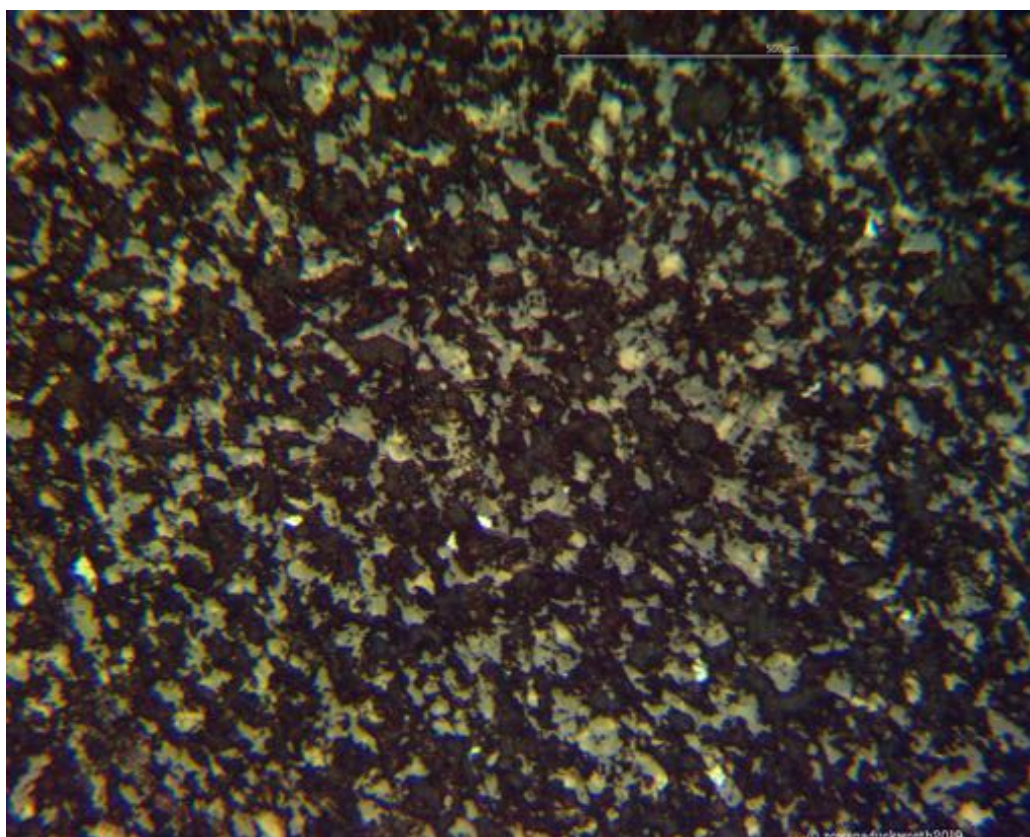


**Cross polarised light photomicrograph of sample 163394 (x10) illustrating the dark red anastomosing iron oxide alteration of the quartz-mica rich fine-grained rock.**





**Cross polarised light photomicrograph of sample 163394 (x10) illustrating the quartz-sericite-chlorite texture of the paler domain cut by quartz vein.**



**Reflected light photomicrograph of sample 163394 (x10) illustrating occasional bright white hematite flecks and more common dark red non reflective earthy hematite.**



**163415****Thin section and offcut of sample 163415**

**Mineralogy:** Sericite, clays, quartz, hematite, iron hydroxyoxides.

The hand specimen shows a very pale rock with some coarser beds and patches of iron straining. The thin section shows a thinly bedded sample that is dominantly pale in colour.

Microscopically, this sample is a very fine-grained, laminated, sericitised siltstone with sedimentary structures that are way up indicators.

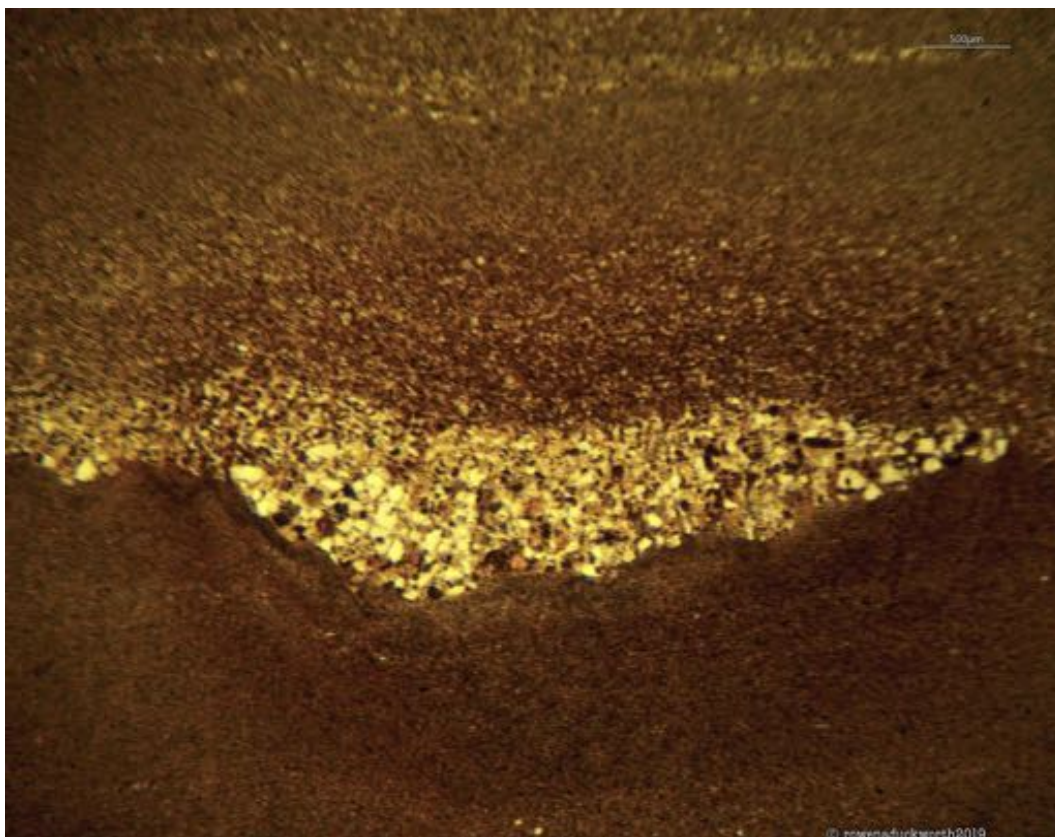
Coarse grained quartz-rich layers have quartz grains on the order of 0.1mm across, whereas in the finer grained layers the grains are not resolvable even at high magnification. These very fine-grained layers are composed of sericite and clays. Graded bedding is common though so there is variability in grain size.

The coarse quartz grains forms load casts at the base of beds and one area of micro-scale cross bedding was observed. Both of these structures suggest the way up of this section is towards the label.

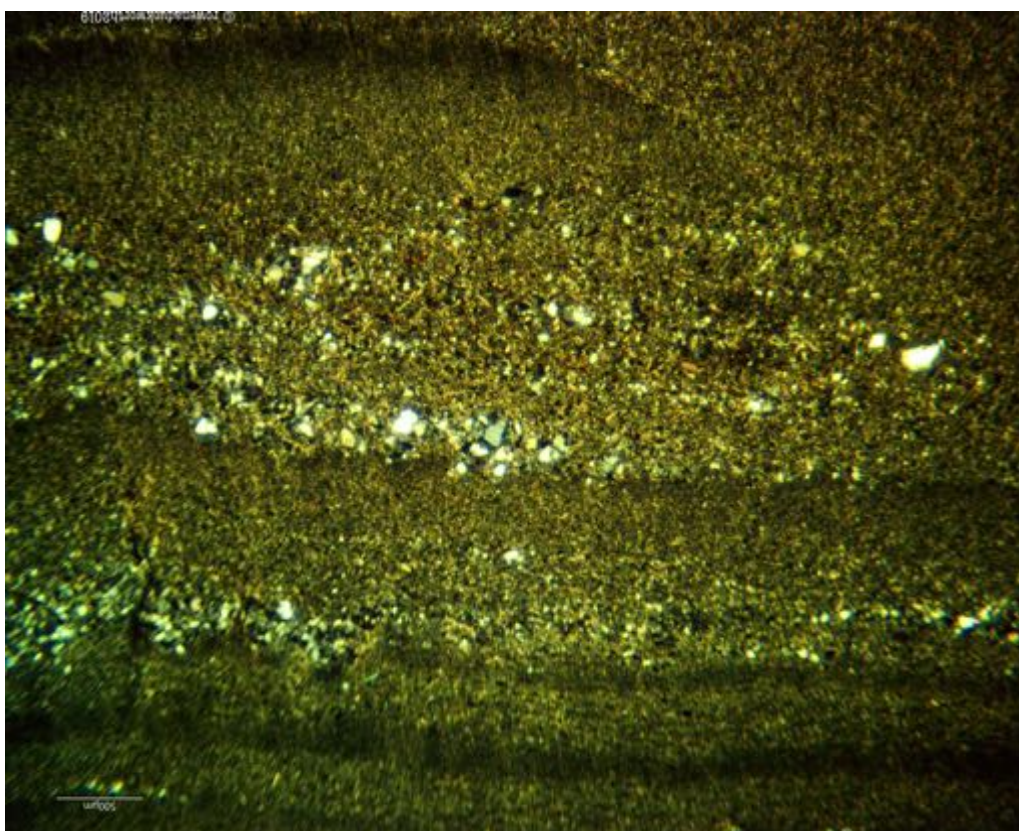
Iron alteration in this sample is minimal with uncommon hematite and limonite straining.

**Summary:** Very fine-grained, laminated, sericitised siltstone with way up indicators.



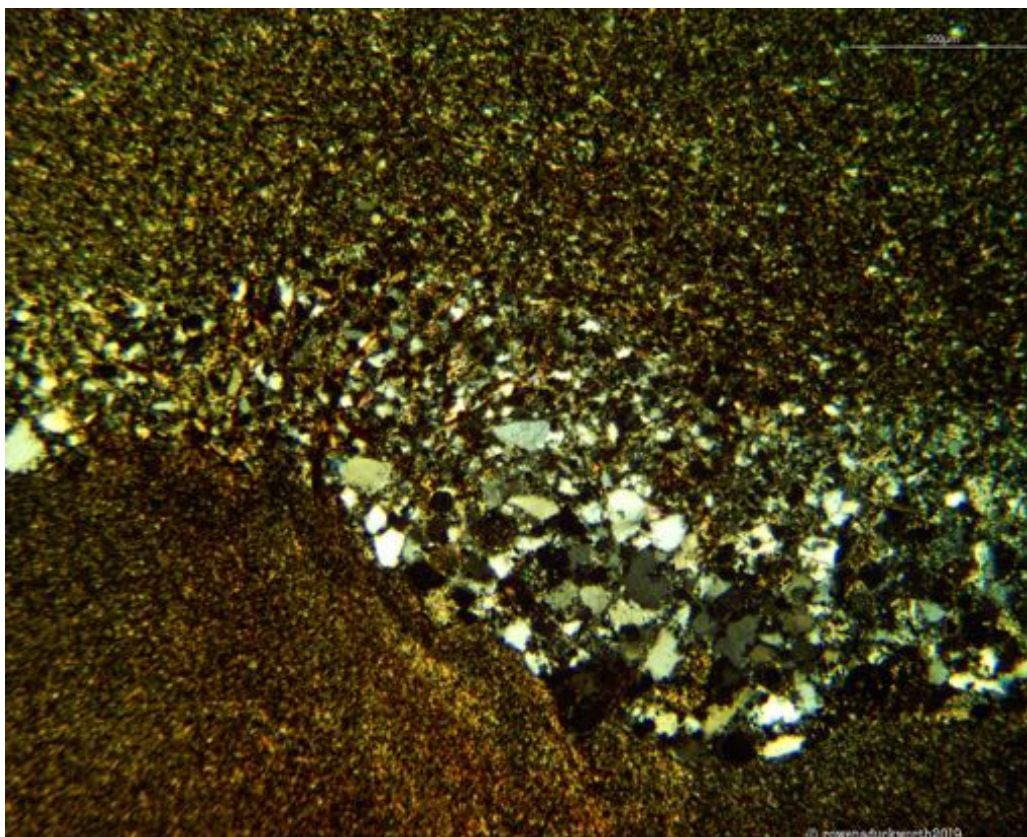


**Plane polarised light photomicrograph of sample 163415 (x2) illustrating coarse grained load structure in very fine grained laminated sediment.**

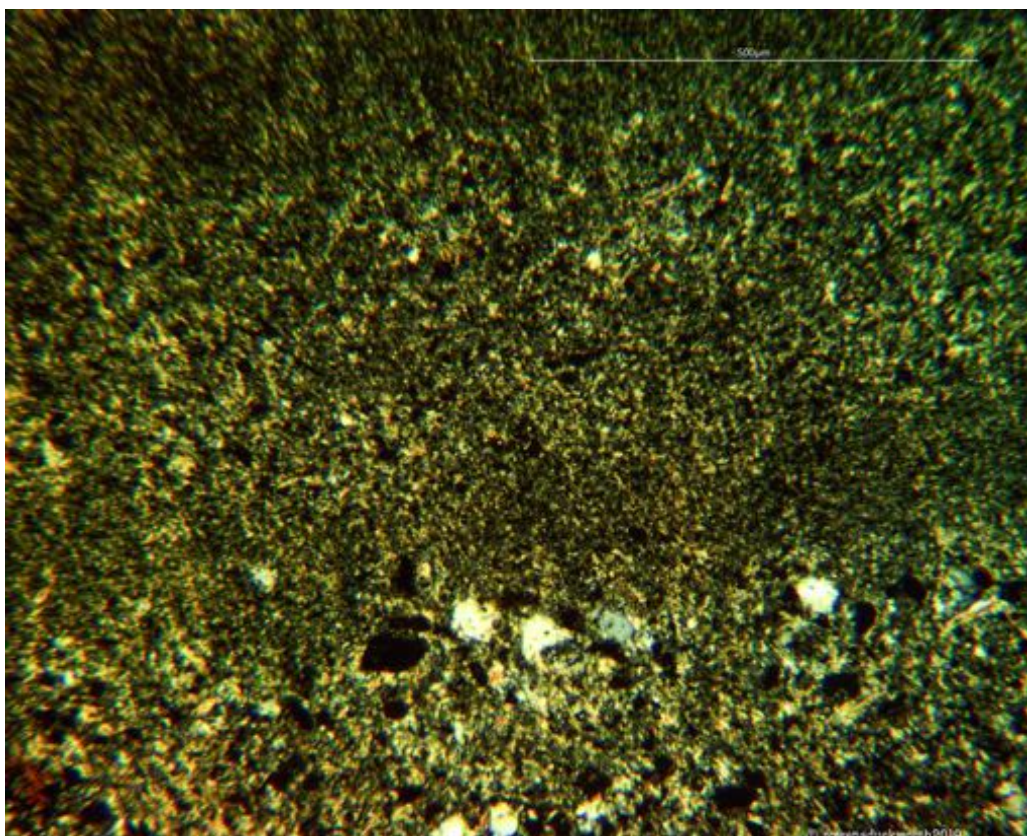


**Cross polarised light photomicrograph of sample 163415 (x2) illustrating cross stratification texture .**



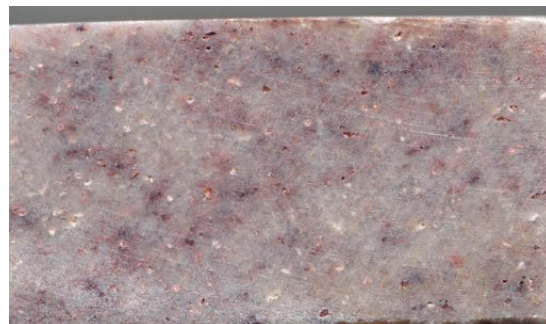
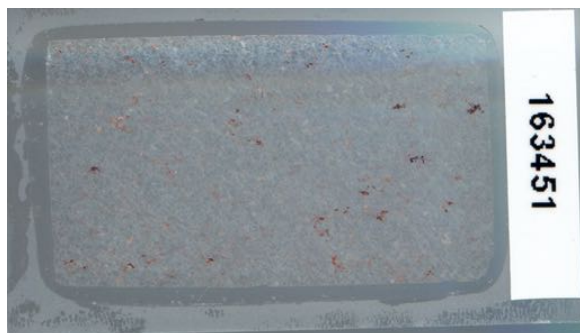


**Cross polarised light photomicrograph of sample 163415 (x4) illustrating quartz and altered feldspar grains in load structure indicating way up to the top of the section.**



**Cross polarised light photomicrograph of sample 163415 (x10) illustrating variations in grain size across the laminations.**



**163451****Thin section and offcut of sample 163451**

**Mineralogy:** Quartz, hematite, clays.

The hand specimen is a porous patchy white-pink rock with pale specks. The thin section is a pale-colourless rock with occasional red specks.

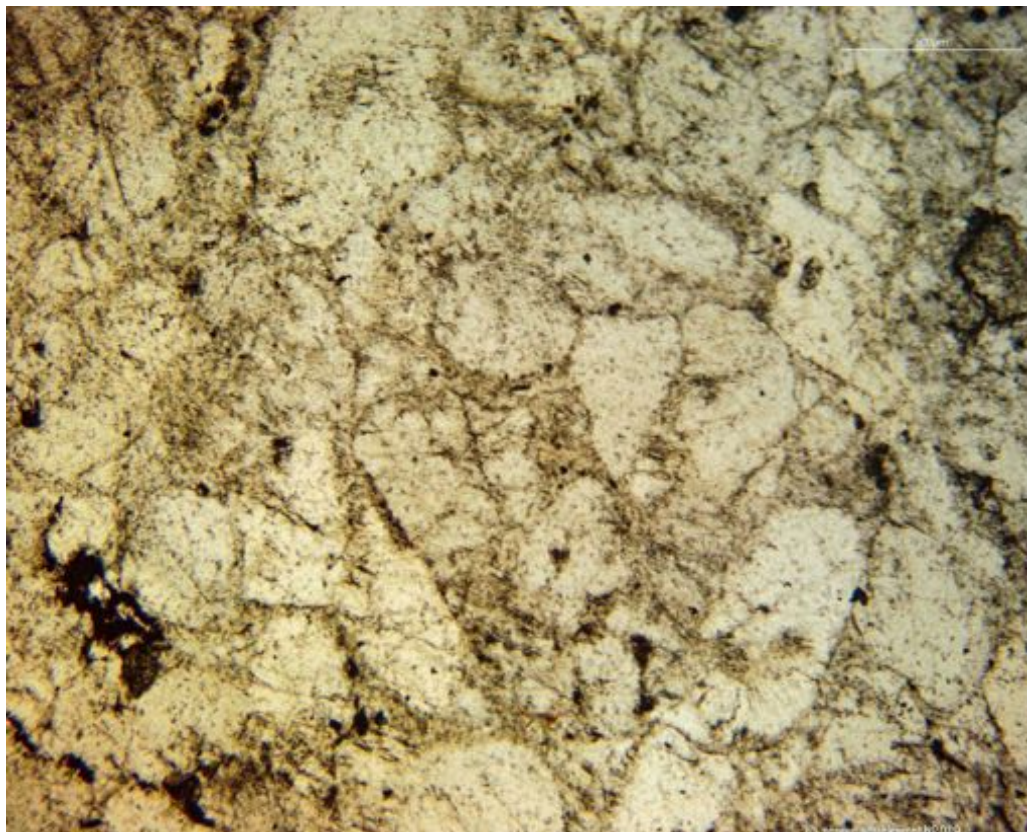
Microscopically, this is a granular textured quartz-rich rock with no obvious matrix.

The quartz grain size ranges between 0.1 and 0.5 mm and the grains are anhedral, oval to subrounded/subangular, and some display mild undulose extinction. Secondary quartz overgrowths are common. Quartz grains are 'dirty' and this clouding may be due to micro inclusions.

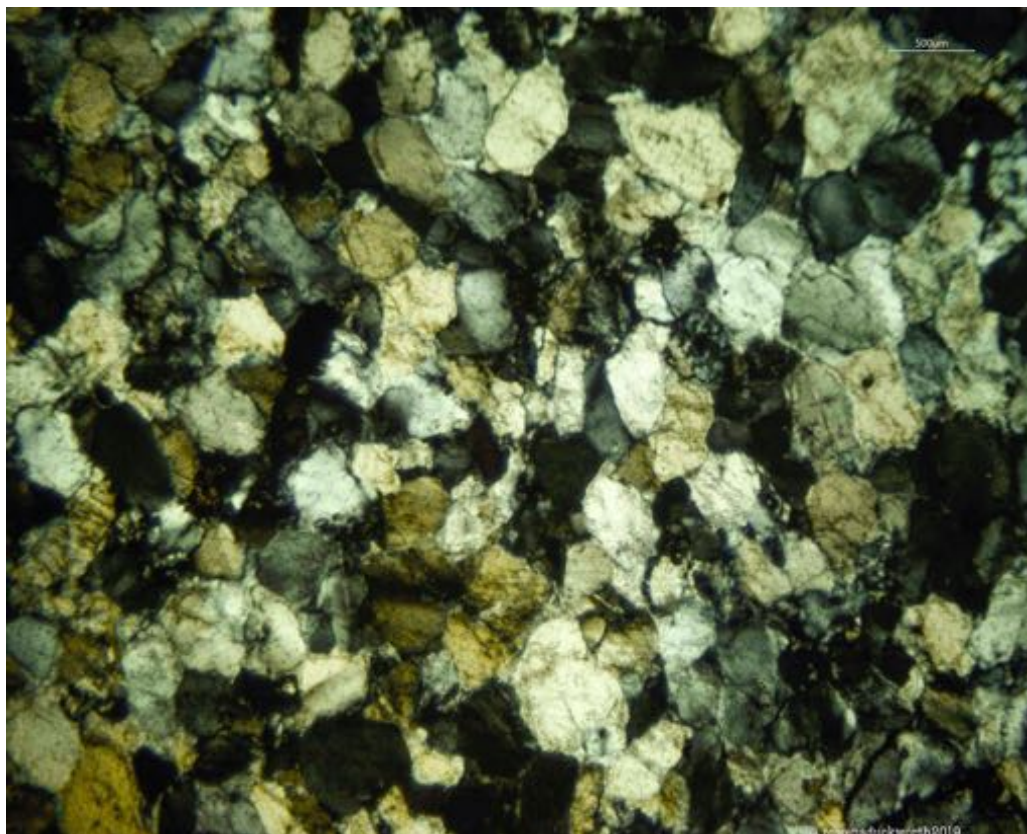
Scattered red hematite (around 5%) and occasional clays (1-2%) occur between quartz grains and the hematite imparts a pink colouration to the rock.

**Summary:** Quartzite with mild hematite alteration.



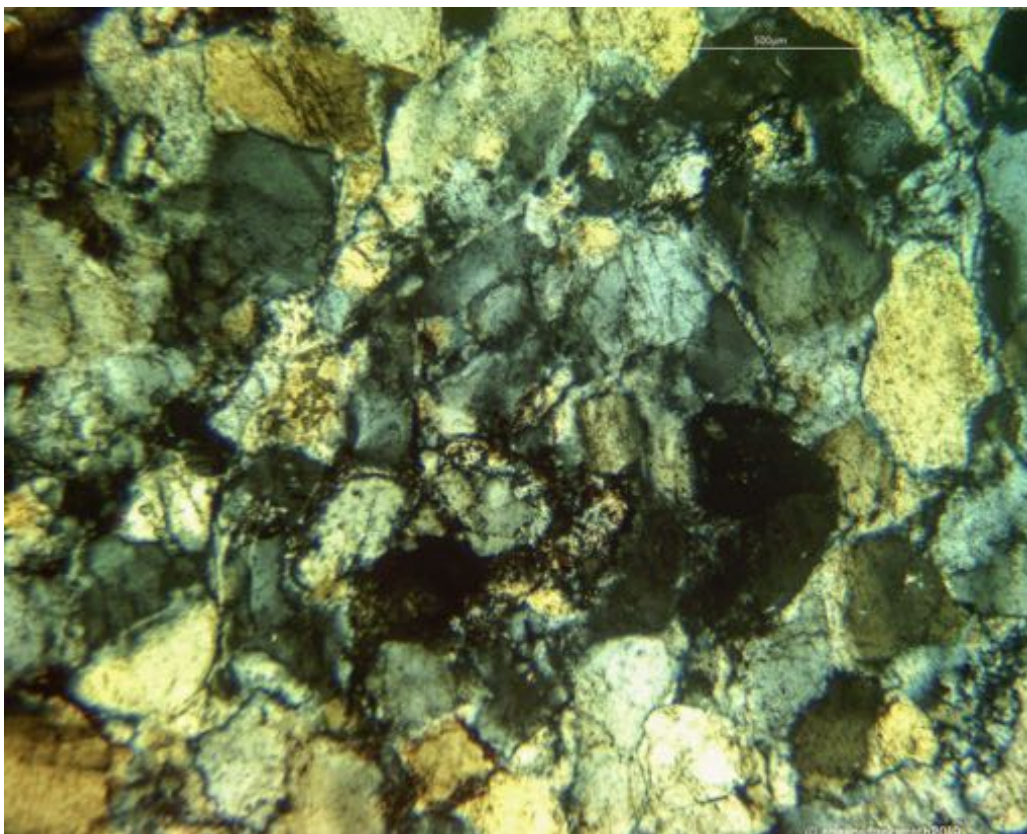


**Plane polarised light photomicrograph of sample 163451 (x2) illustrating the interlocking texture with 'dirtier' secondary quartz growths around cleaner earlier quartz grains.**

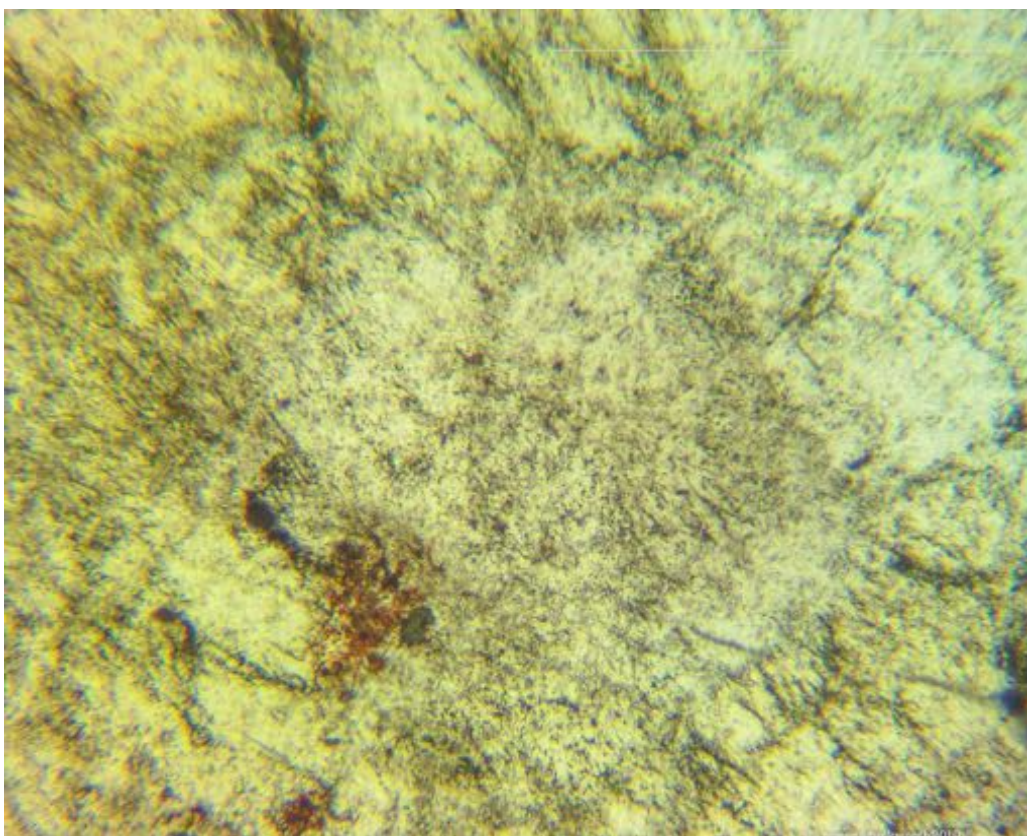


**Cross polarised light photomicrograph of sample 163451 (x2) illustrating the texture of quartzite. Note many quartz grains have thin secondary rims.**



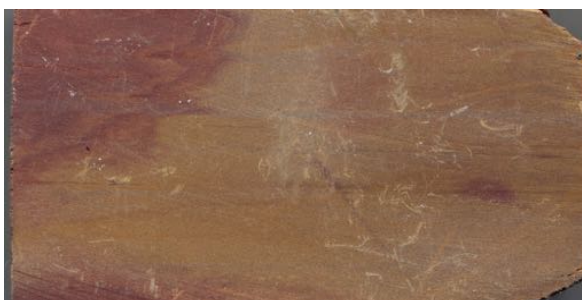


**Cross polarised light photomicrograph of sample 163451 (x4) illustrating the rimming of quartz grains and uncommon opaques.**



**Plane polarised light photomicrograph of sample 163451 (x10) illustrating hematite between quartz grains.**



**163462****Thin section and offcut of sample 163462****Mineralogy:**

The hand specimen shows a yellow fine-grained rock with darker red alteration particularly at one edge. The thin section shows a strongly coloured sample that grades through orange to deep red.

Microscopically, this is a variably hematized quartz-feldspar-sericite rock with a grain size that would classify it as a siltstone- less than 0.05mm. However, this grain size is nearly unresolvable even at high magnification.

Paler layers are more siliciclastic, and less iron altered, and there are two foliations evident- one that parallels the fine laminations, and another at an angle of about 30° to that.

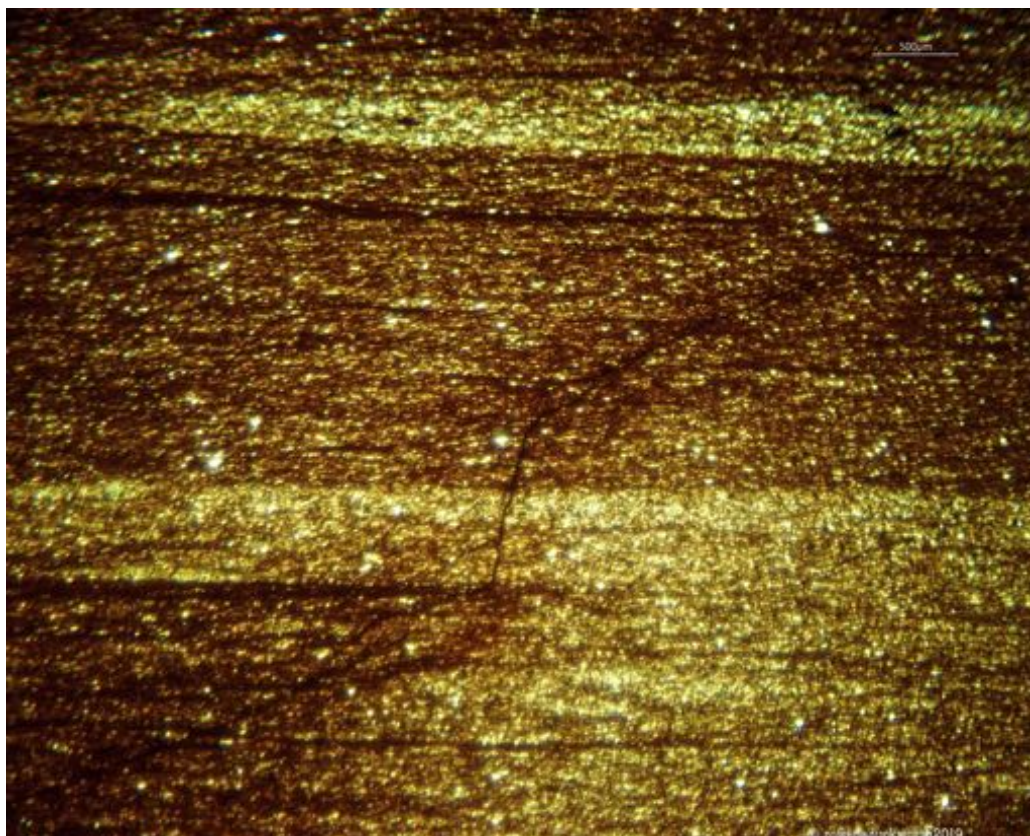
Quartz is the dominant phase and feldspars are always sericite +/-hematite altered, so it is hard to estimate their abundance.

Hematite alteration seems to be permeability controlled along the fine-grained sedimentary layers, but some veining crosscuts the laminations suggesting possibly a second hematite alteration stage.

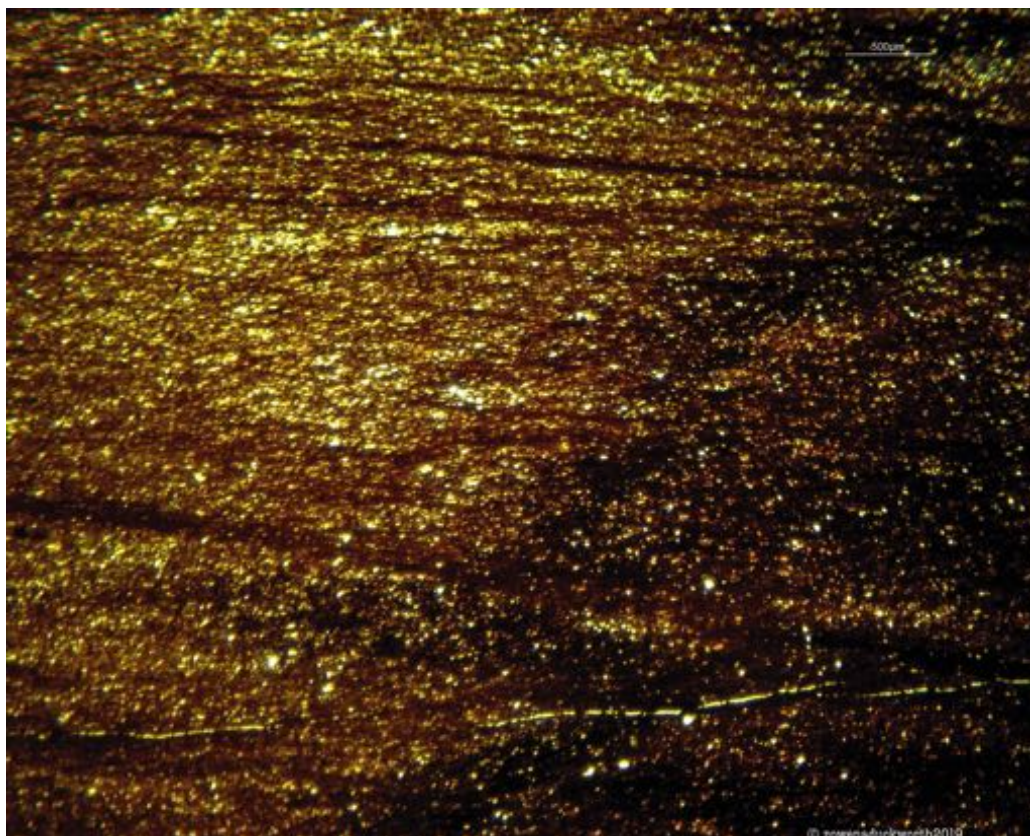
Interestingly, there is one short quartz vein with quartz sericite alteration that visibly overprints the hematite alteration, indicating a later quartz-sericite alteration stage.

**Summary:** Variably hematized, foliated and laminated quartz-feldspar-sericite meta-siltstone.





**Plane polarised light photomicrograph of sample 163462 (x2) illustrating the iron oxide altered laminated texture.**

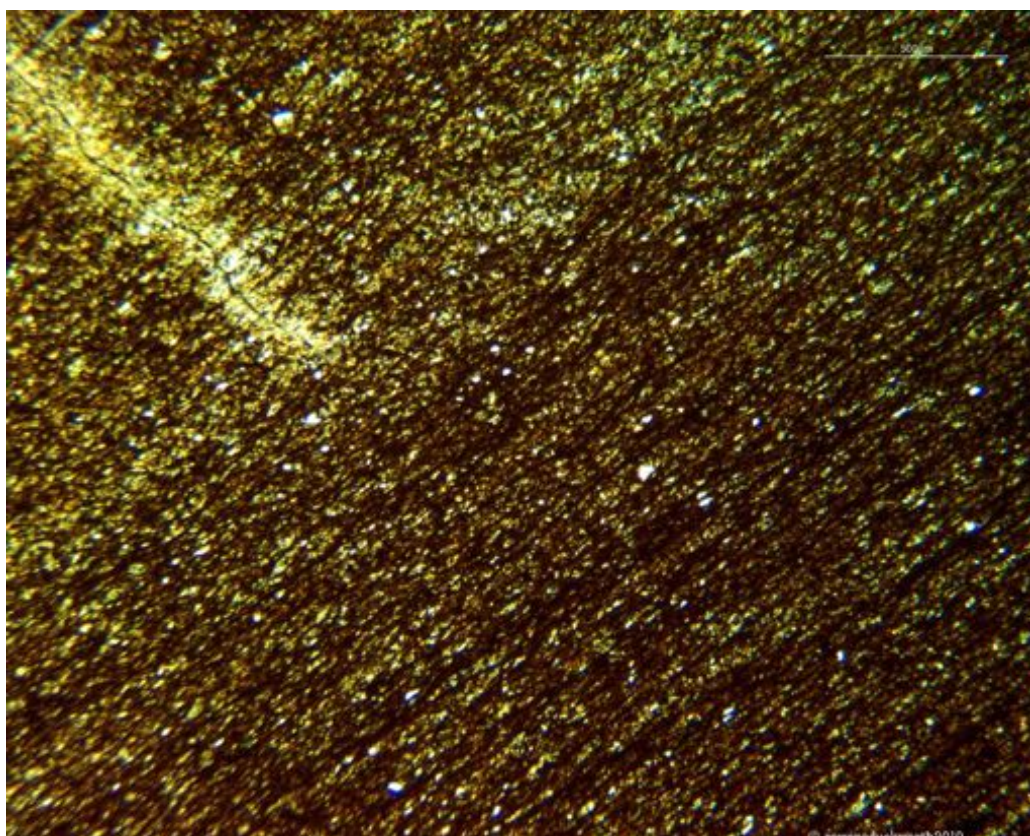


**Plane polarised light photomicrograph of sample 163462 (x2) illustrating the texture of an hematite alteration front.**





**Plane polarised light photomicrograph of sample 163462 (x4) illustrating fine grained foliated texture with two foliations.**



**Cross polarised light photomicrograph of sample 163462 (x4) illustrating quartz sericite alteration around thin veining overprinting hematite alteration.**