

Applied Petrological Services

**PETROLOGICAL STUDIES
OF
SUB-SURFACE SAMPLES
FROM
THE EMMA GOLD EXPLORATION PROJECT AREA**

**FOR
NEWMONT EXPLORATION AUSTRALIA PTY LTD**

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APS Report 310
Project No. 26028

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SUMMARY

1. A petrological study has been undertaken on twenty-five (25) subsurface samples collected from the Emma prospect area, located approximately 100 km northeast of the Tanami Mine Mill, Tanami Desert, Northern Territory Australia. The petrology samples submitted by Newmont Exploration Pty Ltd comprise drill chip and are described mostly as intrusive related with strong hematitic overprinting, and possibly representing part of the Winnecke Creek intrusive suite.
2. The rocks mostly comprise variably metamorphosed, metasomatised and tectonically deformed biotite, amphibole and ilmenite-bearing syenogranite, alkali syenogranite and quartz syenite rock types, some host to igneous style quartz veining also subjected to thermal and tectonic overprinting. Some of these rock types have porphyry textures. Both the equigranular and porphyry textured types have granophyric intergrowths of quartz and alkali feldspar, either interstitial to framework mineralogy or in groundmass assemblages. The nature of the metasomatic, metamorphic and tectonic deformation textures and mineralogy is indicative of thermal metamorphism in a strain environment suggesting that the sampled intrusions are relatively early on a regional time-frame, pre-dating a later intrusive stage causative to thermal metamorphism and metasomatism (and some component of tectonic overprinting). Petrological features indicative of an early regional time frame, together with the presence of granophyric textures, provides a basis for grouping these rocks with the Winnecke Creek intrusive suite. Mineralisation within these rocks may potentially be associated with the pre-metamorphic, igneous style quartz veining or metasomatism associated with the metamorphic overprint.
3. Less abundant within the petrology suite are tectonically deformed and thermally metamorphosed and metasomatised, fine grained intermediate igneous rocks and one sedimentary rock. The metamorphosed/metasomatised fine-grained, porphyritic intermediate rocks comprise andesite and/or trachyte and may be part of the Nanny Goat Creek group of extrusive rocks. Mineralisation within these rocks may be associated with the metamorphic-related metasomatism represented by discrete quartz and quartz + biotite veining.
4. Strongly weathered “cover” sediments comprise part of the petrology suite. These are lithic and feldspathic, quartz-rich siltstones and silty mudstones in which the detrital framework clast assemblages may be interpreted to be of granitoid and metamorphic provenance, the former probably including eroded Winnecke Intrusion suite rocks.

RESULTS

QUARTZ SYENITE, ALKALI-FELDSPAR SYENOGRANITE & SYENOGRANITE

TABLE 1. PETROLOGICAL SUMMARY: INTERMEDIATE TO ACID INTRUSIONS			
Sample	Comment	Lithology and Replacement	Deposition
26028.01 EMRB041 26-27	The rock is an ilmenite bearing syenite/syenogranite. The nature of the recrystallised quartz, comprising abundant granoblastic textured quartz, indicates recrystallisation took place at elevated temperatures (>300 °C). Fluid inclusions and secondary biotite in fractures indicates a metasomatic component to recrystallisation.	Biotite quartz syenite/syenogranite 1.(met).quartz, biotite, muscovite 2.illite/sericite 3.hematite, smectite/kaolin clays	1.(cavity/fracture) biotite, quartz, alkali feldspar, opaque (→ hematite) 2.(fractures) hematite, kaolin clays
26028.02 EMRB027 34-35	Secondary fluid inclusions in quartz and secondary biotite in microfractures indicate metasomatism associated with metamorphism represented mainly by recrystallisation of quartz. A strain fabric is associated with the peak metamorphism. Relic saline primary inclusions are present in vein quartz.	Biotite quartz syenite/syenogranite 1.(met) quartz, biotite, alkali feldspar, muscovite, tourmaline, apatite, hematite 2.illite, epidote 3.hematite, kaolin clays	1.(fracture) quartz, biotite, alkali feldspar (→ hematite) 2.(fracture) hematite, goethite
26028.03 EMRB016 38-39	An ilmenite bearing syenogranite. Metasomatism is syn-deformation and represented by veining and fluid inclusion trails in quartz. The vein mineralogy is deformed together with replacement and relic primary minerals.	Ilmenite bearing syenogranite 1.(met) quartz, biotite, muscovite, alkali feldspar, sulphides, sphene 2.illite 3.hematite	1.(fracture/microfracture) alkali feldspar, muscovite, biotite, amphibole, quartz 2.(microfracture) hematite
26028.05 EMAC041 39-41	Early metamorphism and metasomatism are represented by muscovite after feldspar and quartz veinlets, both of which are deformed and recrystallised with the primary mineralogy. Relic saline fluid inclusions are contained within deformed early quartz veins.	Biotite syenogranite/alkali feldspar syenogranite 1.(met) quartz, muscovite, K- feldspar, biotite 2.sericite 3.hematite	1.(fractures/cavities) quartz, muscovite 2.(microfracture/shear) sericite 3.(microfracture) hematite
26028.08 EMRB024 45-48	Quartz + alkali feldspar veining hosted by the syenite has been metamorphosed together with the syenite. There are no fluid inclusions within the recrystallised vein quartz to indicate significant fluids associated with the metamorphism.	Quartz veined, biotite amphibole quartz syenite 1.(met) quartz, biotite 2.sericite/illite	1.(fracture) quartz, alkali feldspar; quartz
26028.10 EMRB035 42-45	The deformed quartz veining may relate to metasomatism, which took place during metamorphism, or it might be related to an igneous hydrothermal stage. Sericite post-dates the quartz veining and has enhanced plastic deformation.	Quartz veined intermediate igneous rock 1.quartz, muscovite 2.sericite, rutile	1.(fracture/microfracture) quartz 2.(shear/cavity) sericite

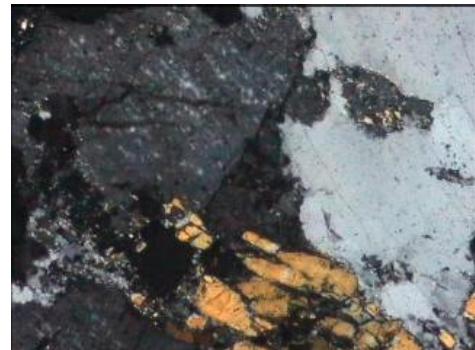
26028.11 EMRB021 42-45 m	A plastically deformed quartz vein. The nature of the granoblastic secondary quartz and porphyroclastic textures indicates that deformation took place at temperatures greater than 300 °C. Hydrothermal overprinting of the quartz vein is represented by sericitic clay and an abundance of secondary fluid inclusions in framework quartz.	Unresolvable wallrock fragment in quartz vein 1.(met) quartz, muscovite 2.sericitic	1.(fracture) quartz; quartz 2.(shear/cavity) sericite, pyrite 3.(microfracture) hematite, goethite
26028.14 EMAC021 27-30	The rock is a metamorphosed and metasomatised alkali feldspar granite. Fluid inclusions and quartz + biotite veinlets provide evidence of a metasomatic component to metamorphism.	Alkali feldspar syenogranite 1.quartz, biotite, rutile 2.illitic clay 3.hematite	1.(cavity/shear) quartz, biotite 2.(microfracture) hematite
26028.20 EMAC030 56-57	The primary rock is a biotite quartz syenite to alkali feldspar granite. The rock has only localised deformation or recrystallisation. Metasomatism is represented by biotite veinlets.	Alkali feldspar syenogranite 1.(met) biotite 2.hematite	1.(microfracture) biotite 2.(microfracture) hematite
26028.21 EMAC036 34-35	While there is undulatory extinction and sub-grain boundary development in quartz, there is no significant recrystallisation. Metasomatism and metamorphism are represented mainly by secondary biotite. Primary magnetite and ilmenite are present.	Alkali feldspar syenogranite 1.(met) biotite, rutile 2.sericitic/illite, carbonate 3.hematite	1.(microfracture, quartz 2.(microfracture) biotite (→ sericite) 3.(shear/cavity) sericite 4.(microfracture) hematite
26028.22 EMAC036 34-35	Metasomatism is partly represented by quartz + K-feldspar + biotite + cordierite veins that themselves have been partly deformed. Where not deformed the quartz + alkali feldspar assemblage is stable within the metamorphic regime represented by biotite and muscovite after plagioclase (albite).	Biotite alkali feldspar syenogranite 1.(met) biotite, muscovite, quartz, cordierite 2.sericitic/illite 3.hematite	1.(microfracture) quartz, feldspar, biotite, cordierite (→ illite) 2.(microfracture) hematite
26028.24 EMAC042 30-33	The rock is mostly stable within the peak metamorphic regime, but quartz is locally recrystallised and biotite has formed after hornblende. Secondary fluid inclusions and biotite veinlets represent metasomatism. Relic saline fluid inclusions are present in vein quartz.	Hornblende bearing Alkali feldspar syenogranite 1.biotite, quartz 2.sericitic 3.hematite	1.(microfracture) biotite, quartz 2.(shear) sericite, quartz

26028.25 EMRB039 41-42 m	Multiple quartz veins have been deformed and metamorphosed together with the host wallrock to indicate quartz veining pre-dated metamorphism and deformation. The quartz veining may have been igneous related. Relic primary saline fluid inclusions indicate an early igneous hydrothermal association.	Biotite hornblende alkali feldspar syenogranite 1.(met) quartz, biotite, rutile 2.illitic clay 3.hematite, smectite clays	1.(microfracture) quartz; quartz, biotite 2.(microfracture) hematite, kaolin clays
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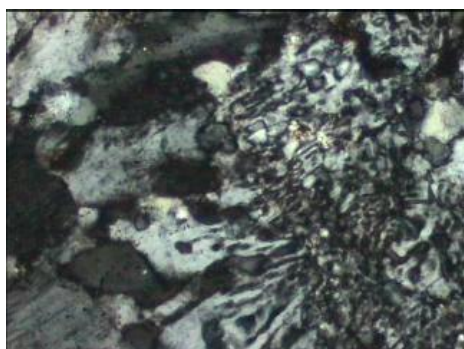


Left. 26028.01. Quartz and K-feldspar rock, with K-feldspar impregnated with hematite.

Right. 26028.24. Quartz and alkali feldspar and hornblende. 1200 μm . cpl.



The majority of the drill chip samples of this study comprise fine to medium grained intermediate to acid igneous rocks. The proportion of modal quartz, alkali feldspar and plagioclase in these rocks is such that they can be classified as quartz syenites, synogranites through to alkali-feldspar syenogranites. Quartz comprises around 15 to 30%, whereas plagioclase generally comprises around 10 to 15% leaving alkali feldspar the main modal “framework” component in these rocks. Mafic minerals present, usually interstitial to and enclosed by feldspars and quartz comprise brown biotite and green-brown hornblende. Trace amounts of zircon and Fe/Ti-oxides are present, the latter not that well preserved but in places preserved as inclusions within quartz and feldspar. Ilmenite is the Fe/Ti-oxide mineral mostly preserved as inclusions in quartz and feldspar grains.



Left. 26028.03. Graphic intergrowths...300 μm . cpl.
Right. 26028.21. Graphic intergrowths...1200 μm . cpl.



A feature of these rocks is the presence of graphic intergrowths of alkali feldspar and quartz occurring either interstitial to quartz and alkali feldspar or substituting for framework quartz and alkali feldspar. Plagioclase most commonly occurs as euhedral inclusions enclosed by alkali feldspar. In some places the quartz in the quartz + alkali-feldspar graphic intergrowths is continuous with early quartz veining. A feature of these rocks is the widespread presence of ultra fine-grained hematite inclusions within alkali feldspar (albite and K-feldspar), a feature of incipient and deep weathering. The abundance of alkali feldspar in these rocks together with the distribution of hematite gives the rocks a mostly red-brown colour in hand-specimen.

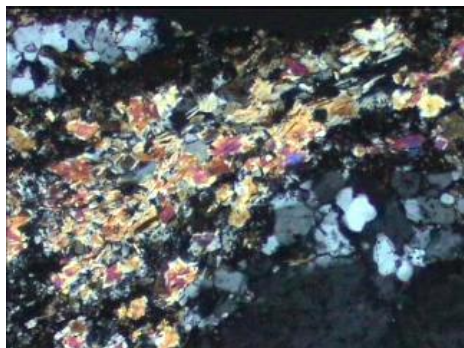


Left. 26028.01. Ilmenite inclusions in feldspar and quartz. 300 µm rl/ppl.

Right. 26028.02. Secondary biotite after primary biotite. 600 µm. ppl.

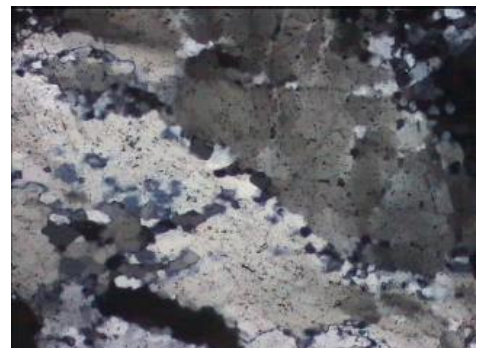


With thermal and tectonic overprinting, the primary “framework” quartz is variably deformed. With deformation quartz is recrystallised along grain boundaries and shears, resulting in granoblastic to porphyroclastic textures. Quartz not recrystallised has undulatory extinction and sub-grain boundary development. Some muscovite and secondary biotite and alkali feldspar are interlocking with the recrystallised quartz. Secondary biotite has formed after plagioclase, hornblende and primary biotite in association with the thermal and tectonic overprint. Primary Fe/Ti-oxides are altered to rutile and secondary biotite and some amounts of quartz. Tourmaline is present in some of these early secondary assemblages.



Left. 26028.03. Secondary muscovite after feldspars intergrown with granoblastic quartz. 600 µm. cpl.

Right. 26028.11. Recrystallised primary quartz with granoblastic domains and overall porphyroclastic texture. 1200 µm. cpl.

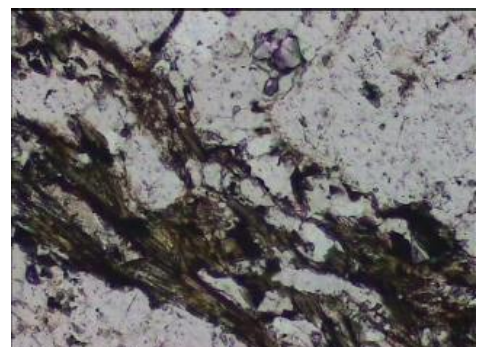


Earliest fractures within these alkalic igneous rocks are filled mostly with fine to very fine-grained anhedral quartz some interlocking with minor amounts of alkali feldspar. Generally the quartz and alkali feldspar within these early veins has been recrystallised together with the quartz in the host rock. Secondary fracturing and microfracturing crossing wallrock and early quartz ± K-feldspar veining is filled with biotite and some amounts of muscovite and quartz. Secondary fluid inclusions in quartz of the vein and wallrock assemblages comprise populations of co-existing gas-rich/filled and aqueous liquid-rich types. Some locally preserved primary fluid inclusions comprise halite (and other daughter salt) bearing, aqueous liquid-rich types.

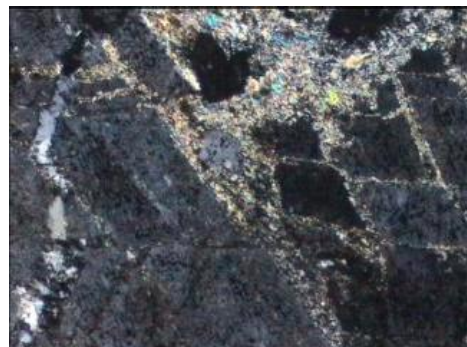


Left. 26028.08. Recrystallised quartz + K-feldspar veinlet. 600 µm. cpl.

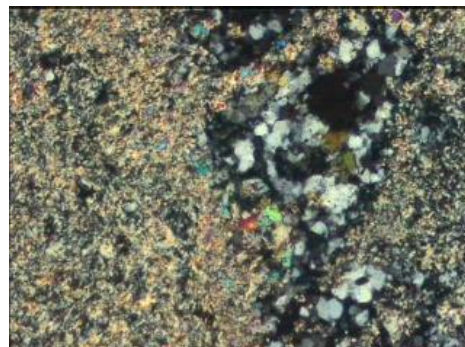
Right. 26028.02. Multiple biotite veinlets crossing quartz and feldspar. 600 µm. ppl.



Early thermal, tectonic and metasomatic overprinting, the latter mostly represented by biotite veining and secondary fluid inclusion trails, is post-dated by relatively low temperature hydrothermal alteration. Pervasive sericite/illite, mostly formed after plagioclase and contained along shears and microfractures, represents the hydrothermal overprinting. In one example, pervasive sericite has replaced all earlier mineralogy leaving only domains of recrystallised quartz, which have become enclosed within the plastically deformed and voluminous sericite.



Left. 26028.05. Sericite veinlets crossing early quartz vein and framework K-feldspar. 1200 μm . Pervasive sericite after feldspar enclosing domains of granoblastic quartz + muscovite. cpl. Right. 26028.10. 1200 μm . cpl.



INTERMEDIATE TO ACID PORPHYRY ROCKS

**TABLE 2. PETROLOGICAL SUMMARY:
QUARTZ SYENITE, ALKALI FELDSPAR SYENOGRANITE AND SYENOGRANITE PORPHYRY**

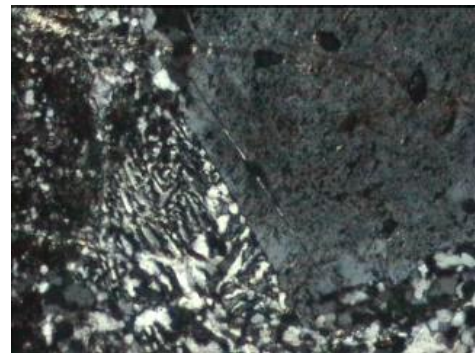
Sample	Comment	Lithology and Replacement	Deposition
26028.09 EMRB031 36-39 m	Metasomatism associated with metamorphism of the igneous rock is represented by biotite + K-feldspar + quartz veinlets. Early (igneous related) quartz veining is strongly recrystallised in association with metamorphism of the host rock.	Biotite quartz syenite porphyry 1.(met) quartz, K-feldspar, biotite, rutile 2.sericitic/illite 3.hematite	1.(fractures) quartz, biotite 2.(microfracture) biotite 3.(microfracture) hematite
26028.15 EMAC013 39-42	An amphibole quartz alkali feldspar syenite, in which the groundmass is dominated by graphically intergrown quartz and K-feldspar. Metamorphism and deformation have occurred together with metasomatism represented by biotite after feldspar and microfractures filled with quartz + biotite and biotite.	Quartz syenite/alkali-feldspar syenogranite porphyry 1.(met) quartz, biotite, muscovite, rutile 2.illite/sericite 3.hematite	1.(microfracture/fracture) quartz, biotite 2.(microfracture) hematite
26018.18 EMAC044 21-24 m	A secondary equigranular quartz + K-feldspar groundmass assemblage is probably texturally and compositionally indistinguishable from a primary one with the exception of the presence of muscovite. Metasomatism is represented by biotite veinlets.	Quartz syenite porphyry 1.(met) quartz, K-feldspar, biotite, muscovite, rutile 2.sericitic/illite 3.hematite	1.(microfracture) biotite, muscovite 2.(shear) muscovite

26028.23 EMAC040 30-32	Alkali feldspar and quartz are mostly present in the form of graphic intergrowths. Metamorphism is accompanied by plastic deformation and metasomatism represented by fluid inclusion trails and biotite veinlets.	Biotite syenogranite (porphyry) 1.(met) biotite, muscovite, quartz, rutile 2.sericitic/illite 3.hematite	1.(microfracture) biotite 2.(microfracture) hematite
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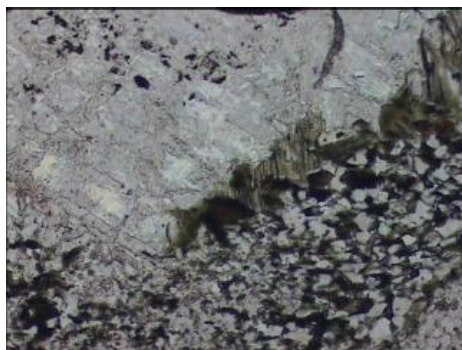
Amongst the majority of intermediate to acid igneous rocks of this study, classified as quartz syenite, alkali-feldspar syenogranite and syenogranite, there are some with porphyritic textures. These rocks generally have abundant phenocrysts of alkali feldspar and less abundant plagioclase in groundmasses rich in alkali feldspar and quartz. In most examples the groundmass quartz and alkali feldspar are present as graphic intergrowths. Minor amounts of biotite are present as phenocrysts and groundmass components and Fe/Ti-oxides (ilmenite) and zircon are present in the groundmass or as inclusions in phenocrysts.



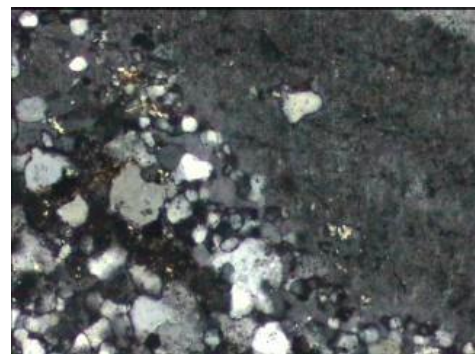
Left. 26028.09. Porphyry texture with hematitic nature due to hematite in alkali feldspar.
Right. 26028.09. Alkali feldspar phenocryst in groundmass comprising graphic K-feldspar + quartz intergrowth. 1200 μm . cpl.



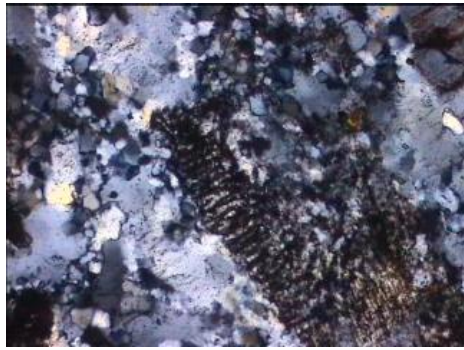
With thermal and tectonic overprinting, groundmass assemblages are recrystallised, some being replaced by equigranular or granoblastic quartz + alkali feldspar. In some examples, recrystallised quartz in the groundmass is interlocking with secondary biotite and muscovite. In association with the thermal overprint, a metasomatic overprint is represented by filling of networks of microfractures within platy biotite and less abundant muscovite and quartz.



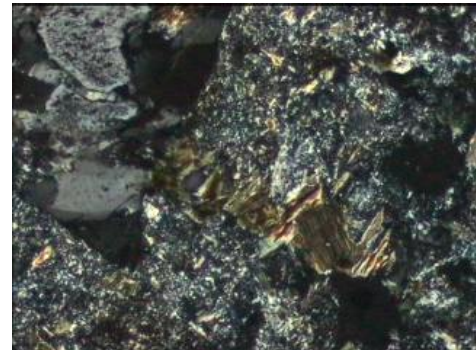
Left. 26028.15. Secondary biotite intergrown with quartz in groundmass and at K-feldspar phenocryst margin. 600 μm . ppl.
Right. 26028.18. Secondary, equigranular quartz and K-feldspar in groundmass and phenocryst reaction rims. 600 μm . cpl.



In some examples, angular fragments of graphically intergrown quartz and alkali feldspar are enclosed by quartz that is strongly recrystallised and deformed. Secondary biotite has formed after primary biotite and plagioclase, whereas primary alkali feldspar phenocrysts have remained stable, although they exhibit undulatory extinction and sub-grain boundary development in the same way as relic quartz. Sericitic and/or illitic clay forms an overprint to the early deformation, and thermal/metasomatic alteration in some examples, with the sericitic/illitic clay formed mostly after plagioclase.



Left. 26028.23. Fragment of graphic quartz + K-feldspar intergrown with recrystallised quartz cement. 1200 μm . cpl.
Right. 26028.09. Early biotite and later illitic clay formed after plagioclase phenocryst. 600 μm . cpl.



METAMORPHOSED SEDIMENTS AND VOLCANIC ROCKS

**TABLE 3. PETROLOGICAL SUMMARY:
METAMORPHOSED SEDIMENTS AND VOLCANIC ROCKS**

Sample	Comment	Lithology and Replacement	Deposition
26018.12 EMRB021 54-55	The rock represents hydrothermal overprinting of a metamorphosed silty mudstone or muddy siltstone. An early metamorphic replacement assemblage including unresolvable poikiloblasts is overprinted by sericitic/illitic clay.	Silty mudstone 1.(met) quartz, alkali feldspar, biotite, Al-silicate mineral 2.sericitic/illite 3.hematite, goethite	1.(microfracture) quartz 2.(cavity) hematite, goethite
26028.13 EMRB022 51-54 m	Metasomatism related to the metamorphism is represented by quartz + biotite veinlets and some component of early replacement. Lower temperature hydrothermal overprinting is represented by sericitic/illitic clay.	Andesite/trachyte 1.(met) K-feldspar, quartz, biotite 2.illite/sericite 3.kaolinite, hematite	1.(microfracture/cavity) quartz, biotite
26018.17 EMAC043 54-57 m	The distribution of biotite within the metamorphic and metasomatic replacement assemblages defines a weak schistosity. Earliest metasomatism is represented by quartz veining, which has been deformed. Deformation post-dated metasomatism.	Quartz andesite 1.(met) albite, biotite, alkali feldspar, rutile 2.hematite	1.(fracture) quartz, biotite; quartz 2.(microfracture) hematite
26028.19 EMAC045 12-13	There is an abundance of secondary brown biotite in the groundmass indicating a more mafic primary rock type. Metasomatism is represented mainly by the extent of biotite veinlet development. Magnetite is present in the primary rock type.	Andesite or trachyte 1.(met) quartz, alkali feldspar, biotite, muscovite 2.sericitic/illite 3.hematite, kaolinite	1.(microfracture) biotite (\rightarrow smectite, kaolinite, hematite), opaque (\rightarrow hematite) 2.(microfracture) hematite, smectite/kaolinite

Metamorphosed porphyritic intermediate volcanic rock types present amongst the petrology suite include those interpreted to be quartz andesite, andesite and possible trachyte. Poorly preserved groundmasses are determined or interpreted to have been mainly pilotaxitic or trachytic in texture. Mostly preserved apatite and ghosted or pseudomorphed Fe/Ti-oxides are present in the groundmass assemblages. Included in this group of rocks is one metamorphosed silty mudstone in which the more obvious silt-sized fragments are interpreted to have comprised detrital quartz.



Left. 26028.17. Strain fabric superimposed upon porphyritic quartz andesite.

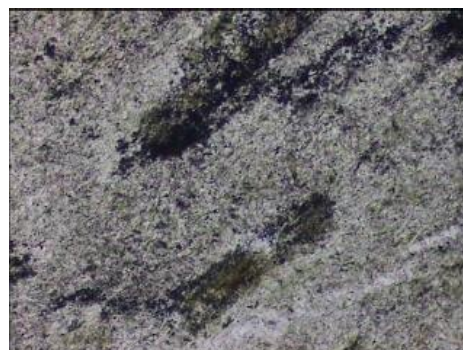
Right. 26028.17. Sub-rotation of feldspar quartz phenocryst in secondary feldspar + biotite groundmass and concentration of biotite defining strain fabric. 1200 μm . ppl.



Metamorphic replacement assemblages within the volcanic rocks include quartz, alkali feldspar, biotite and muscovite. Strain fabrics within some examples are defined by preferred orientation of the metamorphic minerals, and in one example there is some segregation of biotite to create a weak schistosity. Altered phenocrysts have been attenuated and/or rotated within the plane of strain. In association with the metamorphism of the volcanic rocks, microfractures are filled with biotite and quartz. Metamorphism of the sedimentary rock includes ghosted and/or leached poikiloblasts that were possibly an Al-silicate mineral.



Left. 26028.12. Former fragmental texture preserved by the distribution of crystalline metamorphic replacement assemblage. 1200 μm . cpl.
Right. 26028.13. Strain fabric defined by attenuation of phenocrysts in deformed trachytic to pilotaxitic groundmass. 1200 μm .

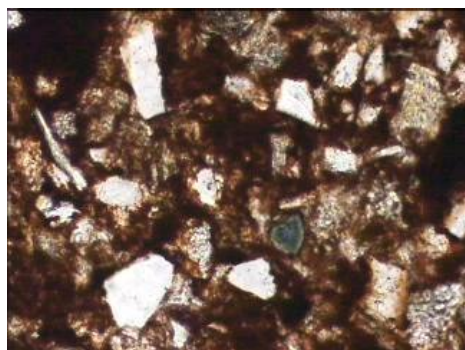


COVER SEDIMENTS

**TABLE 4. PETROLOGICAL SUMMARY:
COVER SEDIMENTS**

Sample	Comment	Lithology and Replacement	Deposition
26028.04 EMRB031 6-9	There is no evidence of metamorphism or hydrothermal alteration beneath a strong weathering assemblage.	Silty mudstone and siltstone 1.kaolinite, smectite, hematite, goethite	1.(microfracture) hematite, goethite
26028.06 EMAC046 11-12 m	The rock is a strongly weathered and oxidised sediment primarily of metamorphosed and metasomatised granitoid provenance. A cover sediment or something that is part of the transported regolith.	Quartz-rich sandstone siltstone 1.kaolinite, hematite, goethite	1.(microfracture/fracture) goethite, amorphous silica, kaolin clays, hematite

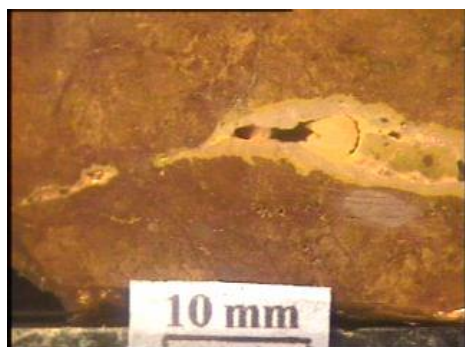
26028.07 EMAC049 12-13m	A quartz, muscovite and feldspar-rich siltstone mainly of acid igneous rock provenance. Possible bioclast fragments (foram tests) are present within the detrital clast assemblage. The rock has not been subjected to metamorphism or hydrothermal alteration.	Lithic feldspathic quartz siltstone 1.kaolinite, hematite, goethite	1.(microfracture) kaolinite, hematite
26028.16 EMAC043 15-18	A weathered cover-sediment that has not been subjected to any form of metamorphism, deformation and hydrothermal alteration. The framework clast assemblage is probably of granitoid provenance.	Quartz rich siltstone 1.kaolin clays, goethite, hematite	1.(microfracture) hematite, goethite



Left. 26028.07. Typical fragmental texture with quartz and ghosted feldspar detrital fragments. 300 μ m.
Right. 26028.07. Possible bioclast fragment amongst detrital fragments. 300 μ m. ppl.



A group of rocks present in the petrology suite includes sediments that have not been subjected to any metamorphism or hydrothermal alteration. These rocks are strongly weathered silty mudstones and siltstones in which the detrital framework clast assemblages comprise predominant quartz and less abundant feldspar and lithic fragments. Detrital muscovite and tourmaline are also present amongst the framework clast assemblages. Possible bioclast fragments are present in one example, otherwise the main provenance of these sediments is interpreted to be granitoid and related (thermal) metamorphic rocks.



Left. 26028.06. Weathered sediment host to low temperature vein.
Right. 26028.06. Banded kaolin, goethite and amorphous silica vein in fragmental textured wallrock. 1200 μ m. ppl.



APPENDIX ONE:
PETROGRAPHIC/MINERAGRAPHIC DESCRIPTIONS

SAMPLE NUMBER: 26028.01, 05959
 LOCATION: EMRB0041/26-27m
 ROCK NAME: Metamorphosed/metasomatised biotite
 quartz syenite/syenogranite

FIELD DESCRIPTION: None provided
 OFFCUT DESCRIPTION:

The sample is of medium to dark red-brown, weathered and oxidised, strongly deformed, fine grained, equigranular textured intermediate to acid igneous rock. Primary quartz is attenuated and generally deformed.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a deformed primary equigranular igneous texture. The rock was composed of equigranular, subhedral to anhedral quartz, alkali feldspar and plagioclase in the proportions: 20/70/10. The alkali feldspar (orthoclase) has abundant perthitic textures. Secondary mica minerals replace plagioclase. Ghosted/pseudomorphed biotite and Fe/Ti-oxides are interlocking with or interstitial to the framework quartz and feldspar minerals. Relic grains of zircon are present. Relic grains of ilmenite occur as inclusions within alkali feldspar.

ALTERATION

REPLACEMENT

Replacement is moderate to strong. Relic coarse-grained quartz has undulatory extinction and sub-grain boundary development. Most of the primary quartz is recrystallised, being replaced by fine to very fine-grained granoblastic quartz. Some grains of secondary (brown) biotite are intergrown with the secondary quartz. Plates of fine-grained muscovite and later sericitic/illitic clay replace plagioclase. Some amounts of fine-grained biotite have formed after alkali feldspar. Alkali feldspar has widespread deformation twinning.

Abundant grains of ultra fine-grained hematite occur as inclusions within alkali feldspar, mostly concentrated along annealed microfractures and microshears. Hematite has formed after primary Fe/Ti-oxides, and primary and secondary biotite. Residual alkali feldspar and biotite are altered to smectitic and kaolin clays.

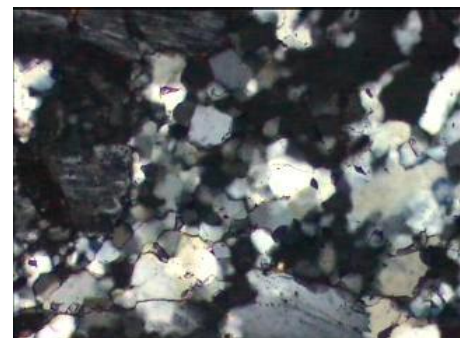
DEPOSITION

Fine-grained (brown) biotite has formed in cavities along discrete shears. Secondary fluid inclusions are contained along annealed microshears and microfractures. Populations of co-existing CO₂-bearing, gas-rich/filled and aqueous liquid-rich inclusions comprise the secondary fluid inclusions. Very fine-grained granoblastic quartz is contained along discontinuous microfractures; some intergrown with brown biotite and secondary alkali feldspar. Ghosted, tabular opaque minerals (→ hematite) are intergrown with quartz, muscovite, biotite and alkali feldspar.

Ultra fine-grained hematite is contained along cavities formed along interconnecting microfractures and microfractures. Some hematite is intergrown with kaolin clays.

COMMENTS

The rock is an ilmenite bearing syenite/syenogranite. There is strong recrystallisation of primary quartz and plastic deformation of alkali feldspar. The nature of the recrystallised quartz, comprising abundant granoblastic textured quartz, indicates recrystallisation took place at elevated temperatures (>300 °C). Fluid inclusions and secondary biotite in fractures indicates a metasomatic component to recrystallisation. Right. Recrystallised (granoblastic) primary quartz. 600 μm. cpl.



SAMPLE NUMBER: 26028.02, 05984
 LOCATION: EMRB0027/34-35 m
 ROCK NAME: Metamorphosed and metasomatised
 biotite quartz syenite/syenogranite
 FIELD DESCRIPTION: None provided



OFFCUT DESCRIPTION:

The sample is of medium to dark grey-brown to brown-grey, oxidised and weathered, fine to medium grained, metamorphosed intermediate to acid igneous rock. Secondary biotite is contained along shears and microfractures.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well to poorly preserved primary, equigranular igneous texture. The primary rock comprised interlocking, subhedral to anhedral quartz, alkali feldspar and plagioclase in the following proportions: 20/70/10. Grains of ghosted biotite are interlocking with and interstitial to the primary quartz and feldspar assemblage. Perthite and orthoclase comprise the primary alkali feldspar assemblage. Brown biotite is preserved as inclusions within orthoclase. Some microcline is present. The more euhedral plagioclase is pseudomorphed and in places is enclosed by anhedral alkali feldspar. Grains of zircon occur as inclusions within framework silicate minerals. Ghosted and relic ilmenite grains are present.

ALTERATION

REPLACEMENT

Alteration is strong. Primary quartz is plastically deformed and recrystallised. Relic coarser grained quartz has undulatory extinction, sub-grain boundaries and crenulate grain boundaries. Most primary quartz is recrystallised, the secondary quartz comprising granoblastic quartz and being intergrown with secondary green-brown biotite. Primary alkali feldspar is mostly preserved but in places is replaced by biotite, secondary alkali feldspar and fine-grained muscovite. Recrystallised quartz is interlocking with secondary alkali feldspar. Early muscovite and later, pervasive illitic clay replace plagioclase. Primary biotite is replaced by green-brown biotite interlocking with granoblastic quartz. Trace amounts of epidote have formed after plagioclase. Grains of tourmaline and apatite are intergrown with secondary biotite and alkali feldspar. Hematite is interlocking with secondary biotite, quartz and alkali feldspar.

Ultra fine-grained hematite occurs as inclusions within secondary and primary alkali feldspar. Residual plagioclase is altered to kaolin clays. Ultra fine to very fine-grained hematite has formed after primary and secondary biotite. Hematite has formed after ilmenite.

DEPOSITION

A network of discrete fractures and microfractures is filled mainly with very fine-grained granoblastic quartz interlocking with green-brown biotite and very fine-grained alkali feldspar (impregnated with ultra fine-grained hematite).

Abundant secondary fluid inclusions within quartz and relic alkali feldspar are concentrated along annealed microfractures and microshears. Co-existing CO₂-bearing gas-rich and aqueous liquid-rich inclusions comprise the secondary fluid inclusions. Halite daughter minerals are present in some relic, primary aqueous liquid-rich inclusions.

Hematite and goethite fill residual cavities and late microfractures.

COMMENTS

A metamorphosed and metasomatised biotite syenite/syenogranite. Secondary fluid inclusions in quartz and secondary biotite in microfractures indicate metasomatism associated with metamorphism represented mainly by recrystallisation of quartz. A strain fabric is associated with the peak metamorphism.

Right. Secondary green biotite intergrown with granoblastic quartz after primary biotite. 600 μ m. ppl.



SAMPLE NUMBER: 26028.03, 05985
 LOCATION: EMRB0016/38-39 m
 ROCK NAME: Metamorphosed and deformed
 syenogranite
 FIELD DESCRIPTION: None provided



OFFCUT DESCRIPTION:

The sample is of medium brown to grey-brown, oxidised and weathered, deformed and metamorphosed fine to medium grained, intermediate to acid igneous rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well to poorly preserved primary equigranular igneous texture. The primary rock comprised interlocking, subhedral to anhedral (hypidiomorphic textured) quartz, alkali feldspar and plagioclase in the proportions: 25/65/10. Ghosted or partly preserved grains of brown biotite are interstitial to, interlocking with or as inclusions within the quartz and feldspar grains. Grains of zircon are present, and ilmenite grains are preserved as inclusions within silicate minerals (or recrystallised silicate minerals). Graphic intergrowths of quartz and alkali feldspar are present. Alkali feldspar is predominantly orthoclase in composition, with domains of perthite present. Plagioclase present is albitic in composition.

ALTERATION

REPLACEMENT

Alteration is strong. Primary quartz is mostly recrystallised, the secondary quartz comprising fine to very fine grained granoblastic quartz. Relic primary quartz has undulatory extinction and extensive sub-grain boundary development. Secondary quartz is intergrown with brown-green biotite, muscovite and very fine-grained alkali feldspar. Alkali feldspar is recrystallised along grain boundaries and partly altered to plates of biotite and muscovite. Plagioclase is altered to early plates of biotite and muscovite and later, more pervasive illitic clay. Ghosted tabular opaque minerals (sulphides?) and sphene are interlocking with secondary mica minerals, quartz and feldspar.

Primary albite and primary and secondary K-feldspar are impregnated with ultra fine-grained hematite. Ultra fine-grained hematite has formed after primary and secondary biotite, and primary Fe/Ti-oxides. Secondary opaque (sulphide) minerals are replaced by hematite.

DEPOSITION

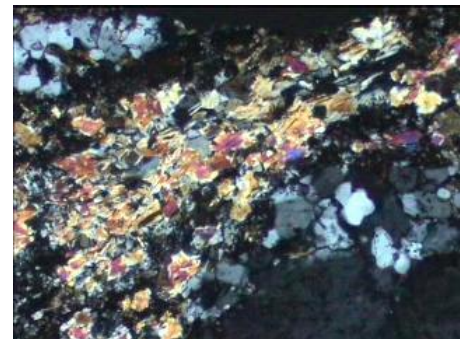
A network of microfractures and fractures is filled with very fine to fine grained alkali feldspar, muscovite, brown-green biotite, green amphibole and very fine-grained granoblastic quartz. In some places, fine-grained platy muscovite is concentrated along shears.

Ultra fine-grained hematite has formed along late microfractures and in residual cavities (within shears).

COMMENTS

A tectonically deformed, metamorphosed and metasomatised ilmenite bearing syenogranite. Metasomatism is syn-deformation and represented by veining and fluid inclusion trails in quartz. The vein mineralogy is deformed together with replacement and relic primary minerals.

Right. Fine-grained muscovite intergrown with secondary, granoblastic quartz in shear/fracture. 600 μ m. cpl.



SAMPLE NUMBER: 26028.04, 05986
 LOCATION: EMRB0031/6-9 m

ROCK NAME: Strongly weathered and oxidised, silty mudstone and siltstone

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of medium to dark red-brown, strongly oxidised and weathered, fine grained sedimentary rock. The distribution of hydrated Fe-oxides preserves a laminated structure.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well preserved primary fragmental texture. A moderately well sorted, matrix to framework clast supported population of angular silt to less-than silt-sized detrital fragments comprises the primary fragmental texture. The resolvable silt-sized fragments comprise quartz, muscovite and ghosted/pseudomorphed feldspar fragments. Sparse sedimentary rock fragments are resolvable. Systematic variation in framework clast grain-size defines a primary lamination. Present are some laminae poor in silt-sized detrital fragments (comprising masked, detrital clays or secondary clays after detrital clay).

ALTERATION

REPLACEMENT

Alteration is moderate to strong. Detrital lithic and feldspar fragments are altered to kaolin and less abundant smectite clays. All preserved detrital mineralogy and secondary clay mineralogy is strongly masked or overprinted by dense concentrations of ultra fine grained hematite and goethite.

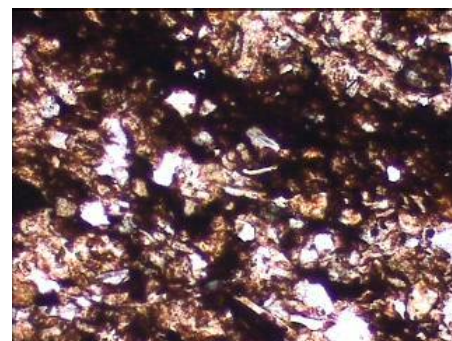
DEPOSITION

Microfractures are filled with ultra fine-grained hematite and goethite.

COMMENTS

A primary laminated silty mudstone and siltstone. There is no evidence of metamorphism or hydrothermal alteration beneath a strong weathering assemblage.

Right. Fragmental texture defined by a detrital assemblage dominated by quartz and muscovite fragments. 600 μ m. ppl.



SAMPLE NUMBER: 26028.05, 06782
 LOCATION: EMAC0041/39-40m

ROCK NAME: Syenogranite/alkali feldspar
 syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of mottled pale to medium grey and medium to dark brown, weathered and oxidised, silicic altered, metamorphosed, medium grained intermediate to acid igneous rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary equigranular (hypidiomorphic) igneous texture. The primary rock comprised interlocking anhedral to subhedral quartz, alkali feldspar and plagioclase in the proportions: 30/60/10. Subhedral to euhedral, ghosted/pseudomorphed plagioclase crystals are interlocking with or poikilitically enclosed by more voluminous and less euhedral alkali feldspar (orthoclase and perthite) and quartz. Ghosted/pseudomorphed grains of biotite are present.

ALTERATION

REPLACEMENT

Alteration is moderate to strong. Primary quartz is strongly recrystallised, the secondary quartz comprising fine to very fine grained granoblastic quartz. Remaining primary quartz has strong sub-grain boundary development. Quartz is mainly recrystallised along grain boundaries and along abundant shear planes. Plagioclase is altered to early fine-grained muscovite and later pervasive sericite. Where shears traverse alkali feldspar the alkali feldspar is replaced by very fine-grained granoblastic K-feldspar intergrown with very fine-grained muscovite. Primary biotite is altered to very fine-grained secondary biotite intergrown with quartz and muscovite. Secondary K-feldspar and some primary K-feldspar is altered to sericite, mostly along penetrative shears traversing early shears along which secondary K-feldspar and quartz are formed.

Primary and secondary alkali feldspar is impregnated with ultra fine-grained hematite (in association with abundant hematite veinlets).

DEPOSITION

Early fractures and cavities along shears are filled with very fine-grained granoblastic quartz. Very fine-grained muscovite is intergrown with the quartz. Abundant secondary fluid inclusions are contained along annealed microfractures and micros shears within quartz. The secondary inclusions comprise CO₂-bearing, gas-rich and coexisting aqueous liquid-rich types. Preserved primary, aqueous liquid-rich types contain abundant daughter minerals in places, including halite.

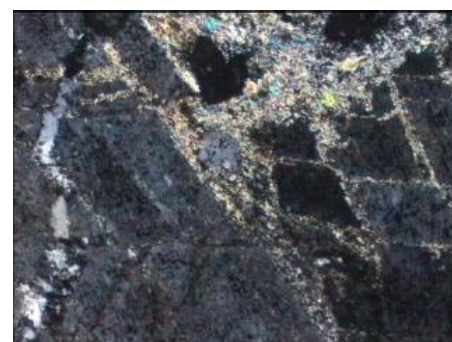
Later microfractures and shears crosscutting early quartz veinlets are filled with or concentrate sericitic clay.

Late stage microfracturing is filled with ultra fine-grained hematite.

COMMENTS

Early metamorphism and metasomatism are represented by muscovite after feldspar and quartz veinlets, both of which are deformed and recrystallised with the primary mineralogy. Late hydrothermal overprinting is represented by sericite after plagioclase and some secondary K-feldspar, and sericite formed along shears and microfractures crossing early quartz veining.

Right. Sericite after alkali feldspar and sericite veinlets. 1200 μ m. cpl.



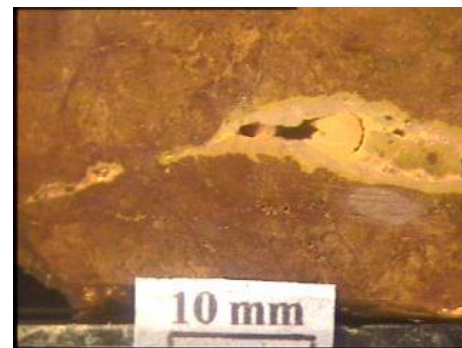
SAMPLE NUMBER: 26028.06, 06783
 LOCATION: EMAC0046/11-12 m

ROCK NAME: A strongly weathered and oxidised
 quartz-rich sandy siltstone.

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of medium red-grey-brown, strongly oxidised and weathered sedimentary rock or finely sheared and fragmented acid igneous rock. Silica and clay veining cut the rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well preserved fragmental texture. A moderately well sorted, matrix to framework clast supported population of angular silt to sand-sized detrital fragments comprises the fragmental texture. Angular fragments of (mono and polycrystalline) quartz dominate the framework clast assemblage. Less abundant are fragments of preserved muscovite and ghosted/pseudomorphed feldspar (mostly alkali feldspar) and biotite. The coarser grained quartz fragments have undulatory extinction and sub-grain boundary development. A former clay-sized matrix comprises about 15% of the rock. Detrital hematite (after ilmenite?) and rutile are present.

ALTERATION

REPLACEMENT

Replacement is moderate. Detrital quartz and muscovite remain unaltered. Feldspar fragments and matrix are altered to kaolin clays intergrown with amorphous silica about veins and veinlets. Distal to veins and veinlets, the clay altered component and some amounts of detrital muscovite and quartz components are strongly masked by ultra fine-grained hematite and goethite.

DEPOSITION

Cavities and an irregular network of fractures and microfractures are filled with intergrown and colloform to crustiform banded goethite, amorphous silica and kaolin clays. Less penetrative fractures/microfractures are filled with hematite and goethite only.

COMMENTS

The rock is a strongly weathered and oxidised sediment primarily of metamorphosed and metasomatised granitoid provenance. A cover sediment or something that is part of the transported regolith. Right. Banded kaolin clay, amorphous silica and goethite filling fractures within weathered sedimentary rock. 1200 μ m. ppl.



SAMPLE NUMBER: 26028.07, 06784
 LOCATION: EMAC0049/12-13m

ROCK NAME: Strongly weathered, lithic feldspathic
 quartz siltstone

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of medium to dark red-brown to grey-brown, strongly oxidised and weathered, laminated/bedded fine grained sedimentary rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary fragmental texture. A moderately well sorted, matrix to framework clast supported population of silt-sized, detrital clasts comprises the fragmental texture. The framework clast assemblage is dominated by detrital quartz and ghosted/pseudomorphed feldspar (mostly alkali feldspar). Less abundant are fragments of muscovite and trace amounts of detrital tourmaline. Ghosted/pseudomorphed opaque minerals are also present. Clay-sized matrix comprises about 10 to 15% of the rock. Possible silt to sand-sized bioclast fragments are present amongst the framework clast assemblage. The distribution and grain-size variation of the framework clast types defines a laminated structure. Sparse sand-sized quartz + alkali feldspar rock fragments are present.

ALTERATION

REPLACEMENT

Replacement is strong. Detrital feldspar and matrix is altered to pervasive kaolin clays intergrown with ultra fine-grained hematite and goethite. Detrital opaque minerals are altered to hematite and goethite, which also form a pervasive overprint to detrital quartz and muscovite.

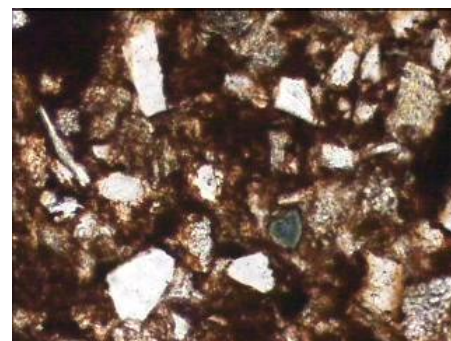
DEPOSITION

Discrete microfractures are filled with kaolin clays and ultra fine-grained hematite.

COMMENTS

A quartz, muscovite and feldspar-rich siltstone mainly of acid igneous rock provenance. Possible bioclast fragments (foram tests) are present within the detrital clast assemblage. The rock has not been subjected to metamorphism or hydrothermal alteration.

Right. Primary fragmental texture dominated by detrital quartz and feldspar with some grains of detrital tourmaline present. 300 μ m. ppl.



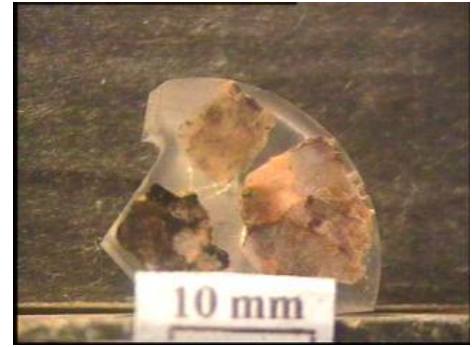
SAMPLE NUMBER: 26028.08, 06785
 LOCATION: EMRB0024/45-48m

ROCK NAME: Metamorphosed, quartz veined, biotite
 and amphibole quartz syenite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of pale grey-brown and medium to dark grey-brown, weathered and oxidised, deformed, quartz veined, coarse grained, intermediate to acid igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary, coarse grained equigranular (hypidiomorphic to poikilitic) igneous texture. The rock mainly comprises interlocking subhedral to anhedral quartz, alkali feldspar and plagioclase in the proportions: 15/75/10. Abundant, anhedral, tabular alkali feldspar (microcline) is interlocking with and enclosing finer grained more euhedral plagioclase (albite to oligoclase). Anhedral quartz is mostly interstitial to alkali feldspar, but in places is mutually interlocking with alkali feldspar and albite. Grains of anhedral (brown) biotite and partly preserved amphibole are mutually interlocking with feldspar and quartz. Grains of zircon are present as inclusions within quartz, feldspars and mafic minerals. Partly preserved grains of ilmenite are present.

ALTERATION

REPLACEMENT

Alteration is moderate. Primary quartz is recrystallised along grain boundaries and discrete shears the secondary quartz being fine to very fine grained and granoblastic in texture. Coarser grained quartz has undulatory extinction and sub-grain boundary development. Primary biotite is partly altered to finer grained secondary, brown biotite along grain margins. Amphibole is altered to aggregates of fine-grained brown biotite. Secondary biotite has formed after alkali and plagioclase feldspar. More pervasive sericitic/illitic clay as formed after plagioclase.

DEPOSITION

Fractures are filled with quartz and alkali feldspar. Together with the wallrock quartz, the fracture-filling quartz is recrystallised, being replaced by very fine to fine grained granoblastic quartz interlocking with minor amounts of anhedral alkali feldspar.

COMMENTS

The rock is a metamorphosed ilmenite bearing quartz syenite. Quartz + alkali feldspar veining hosted by the syenite has been metamorphosed together with the syenite. There are no fluid inclusions within the recrystallised vein quartz to indicate significant fluids associated with the metamorphism.

Right. Recrystallised quartz + alkali feldspar (albite) vein crossing deformed microcline crystal. 1200 μ m. cpl.



SAMPLE NUMBER: 26028.09, 06786
 LOCATION: EMRB0031/36-39 m

ROCK NAME: Metamorphosed, quartz veined, biotite
 quartz syenite porphyry

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of mottled pale to medium grey-brown and grey, weathered and oxidised, deformed and metamorphosed, fine grained, intermediate to acid igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well preserved primary porphyritic texture. Mostly preserved, tabular, subhedral to euhedral medium grained phenocrysts are in a finer grained and recrystallised groundmass. The phenocrysts comprise alkali feldspar (orthoclase and microcline) and ghosted mafic phenocrysts and less abundant plagioclase (albite to oligoclase). The groundmass comprises equigranular quartz and K-feldspar with large domains of graphically intergrown anhedral quartz and K-feldspar. Groundmass quartz is interpreted to have comprised 15% to 20% of the rock. Relic grains of zircon are present. Ghosted primary Fe/Ti-oxides are present.

ALTERATION

REPLACEMENT

Alteration is moderate. Groundmass quartz is recrystallised and locally granoblastic in texture. The secondary quartz is intergrown with secondary K-feldspar also a recrystallisation product of groundmass feldspar. Grains of brown-green biotite are interlocking with the secondary quartz and K-feldspar. Primary mafic minerals are replaced by interlocking, fine to very fine-grained green-brown biotite, K-feldspar and anhedral quartz. Green-brown biotite has formed after K-feldspar and plagioclase phenocrysts. Rutile has formed after primary Fe/Ti-oxides.

Sericitic/illitic clay has formed after residual plagioclase phenocrysts.

Relic primary and secondary K-feldspar are impregnated with ultra fine-grained hematite (in association with hematite formed along microfractures). Hematite has formed after primary Fe/Ti-oxides.

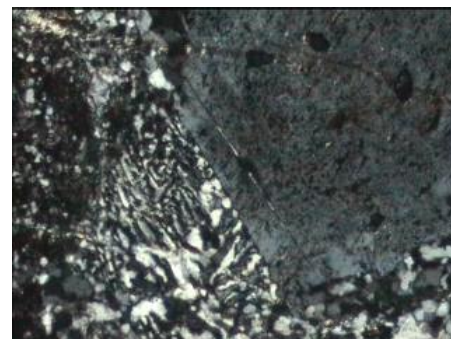
DEPOSITION

Early fractures are filled with very fine-grained granoblastic quartz, a recrystallisation of early quartz veining. Green-brown biotite has formed along discrete microfractures and cavities along more penetrative shears within the wallrock and early quartz veining.

COMMENTS

A quartz syenite porphyry. Metasomatism associated with metamorphism of the igneous rock is represented by biotite + K-feldspar + quartz veinlets. Early (igneous related) quartz veining is strongly recrystallised in association with metamorphism of the host rock.

Right. Alkali feldspar phenocryst and groundmass comprising graphic intergrowths of quartz and K-feldspar. 1200 μm . cpl.



SAMPLE NUMBER: 26028.10, 06787
 LOCATION: EMRB0035/42-45

ROCK NAME: Deformed, phyllic altered,
 metamorphosed/metasomatised, and
 quartz veined intermediate igneous
 rock.

FIELD DESCRIPTION: None provided
 OFFCUT DESCRIPTION:

The sample is of pale to medium brown-grey, weakly weathered and oxidised, phyllic altered, deformed, quartz veined, fine-grained intermediate igneous rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The wallrock has a very poorly preserved primary inequigranular igneous texture. Irregular domains of deformed and recrystallised quartz are interposed with more voluminous domains of ghosted and deformed feldspar. Relict grains of euhedral zircon are present amongst the domains of ghosted feldspar.

ALTERATION

REPLACEMENT

Replacement is strong to complete. Most primary quartz is recrystallised, comprising fine to very fine-grained granoblastic quartz. Some plates of muscovite are interlocking with the secondary quartz. Residual primary quartz has extensive sub-grain development. Primary feldspar is replaced by pervasive sericite. A sub-preferred orientation of sericite defines a preferred strain fabric. Remaining primary quartz is attenuated within the plane of strain defined by sericite. Grains of rutile are intergrown with the sericite.

DEPOSITION

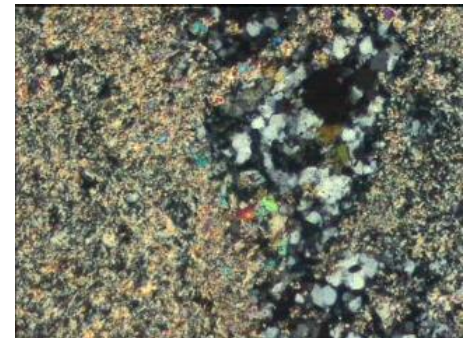
Fractures and microfractures are filled with quartz. The quartz has undulatory extinction, sub-grain boundary development and extensive recrystallisation along grain boundaries. Very fine-grained granoblastic quartz exists along framework quartz grain boundaries. Sericite has formed interstitial to the recrystallised quartz and along shears within the deformed quartz.

Deformed quartz within the wallrock and vein are host to abundant secondary fluid inclusions concentrated along annealed microshears. The inclusions comprise co-existing aqueous liquid-rich and gas/vapour-rich types.

COMMENTS

Fluid inclusions in quartz related to the sericite overprint to early metamorphism of a quartz veined intermediate igneous rock (possibly a syenite). The deformed quartz veining may relate to metasomatism, which took place during metamorphism, or it might be related to an igneous hydrothermal stage. Sericite post-dates the quartz veining and has enhanced plastic deformation.

Right. Pervasive sericite after igneous feldspar partly enclosing domains of granoblastic quartz interlocking with minor amounts of muscovite. 1200 μm . cpl.



SAMPLE NUMBER: 26028.11, 06788
 LOCATION: EMRB0021/42-45 m

ROCK NAME: Hydrothermally overprinted,
 deformed/metamorphosed quartz vein

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of pale to medium brown and brown-grey, oxidised and weathered quartz vein material. Hematite within the quartz veining is concentrated along shears and microfractures.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

Fragments of wallrock entrained within the quartz vein material have no resolvable features of primary rock type.

ALTERATION

REPLACEMENT

Replacement of the wallrock fragments is complete. Replacement assemblages comprise interlocking very fine-grained anhedral quartz and muscovite. Muscovite is degraded to sericitic clay.

DEPOSITION

The vein assemblage comprises fine to medium grained anhedral quartz. The quartz has strong undulatory extinction and sub-grain boundary development. The “framework” quartz is strongly recrystallised along grain boundaries and shears. The recrystallised quartz is granoblastic in texture, with some extensive domains of granoblastic quartz interposed with remaining deformed quartz defining porphyroclastic textures.

Discrete shears crossing the quartz veining are the focus of selvages of sericitic clay.

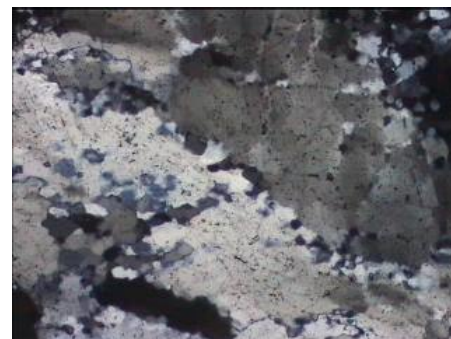
Abundant secondary fluid inclusions contained within the “framework” quartz is contained along abundant annealed microshears/microfractures. The secondary fluid inclusions comprise co-existing aqueous liquid-rich and gas/vapour-rich types. Grains of ultra fine-grained pyrite occur as inclusions within the quartz together with the fluid inclusions.

Ultra fine-grained hematite and goethite are contained discrete, late microfractures.

COMMENTS

Plastically deformed quartz vein. The nature of the granoblastic secondary quartz and porphyroclastic textures indicates that deformation took place at temperatures greater than 300 °C. Metamorphism of wallrock fragments is represented by quartz + muscovite, whereas hydrothermal overprinting of the quartz vein is represented by sericitic clay contained along shears and quartz grain boundaries, and an abundance of secondary fluid inclusions in framework quartz.

Right. Deformed quartz and recrystallised quartz contained along “framework” quartz grain margins. 1200 µm. cpl.



SAMPLE NUMBER: 26028.12, 06789
 LOCATION: EMRB0021/54-55 m

ROCK NAME: Illitic clay altered, metamorphosed silty mudstone

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of mottled pale brown grey to medium red-brown, locally oxidised and weathered metamorphosed fine-grained sedimentary rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a very poorly preserved primary fragmental texture. Ghosted, silt to fine sand-sized detrital fragments contained within a finer grained crystalline replacement assemblage formed after a detrital clay component defines the fragmental texture. The silt-sized detrital fragments are resolvable as having been dominated by quartz and including muscovite and probable feldspar. Relic grains of detrital zircon are present. The distribution and grain-size variation of the silt-sized component defines a crude bedding/lamination.

ALTERATION

REPLACEMENT

Replacement is complete. Silt-sized detrital quartz is recrystallised, the secondary quartz intergrown with very fine grained, granoblastic quartz formed after a former clay-sized medium. Ghosted grains of alkali feldspar and biotite are interlocking with the quartz. Ghosted/leached poikiloblasts are present; poikilitically-enclosing grains of recrystallised detrital quartz and ghosted biotite and alkali feldspar.

The poikiloblasts are altered to sericitic/illitic clay, as is the finer grained alkali feldspar.

The remnants of the poikiloblasts are replaced by concentrations of ultra fine-grained hematite.

DEPOSITION

Discrete microfractures are filled with very fine-grained anhedral quartz.

Cavities resulting from leaching at the sites of the former poikiloblasts are filled with ultra fine-grained hematite and goethite.

COMMENTS

The rock represents hydrothermal overprinting of a metamorphosed silty mudstone or muddy siltstone. An early metamorphic replacement assemblage including unresolvable poikiloblasts is overprinted by sericitic/illitic clay.

Right. Ghosted silt-sized detrital fragments contained within metamorphosed silt to clay-sized medium. 1200 μ m. cpl.



SAMPLE NUMBER: 26028.13, 06790
 LOCATION: EMRB0022/51-54 m

ROCK NAME: Sericitic clay altered, metamorphosed
 and metasomatised andesite/trachyte

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The samples is of pale to medium grey-brown and grey, weathered and oxidised, tectonically deformed and metamorphosed fine-grained intermediate igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a very poorly preserved primary porphyritic texture. Ghosted, fine grained, tabular to prismatic phenocrysts are in a finer grained secondary groundmass. Phenocryst morphologies are of alkali feldspar (with ghosted crosshatch twinning of microcline) and amphibole. The distribution of secondary groundmass minerals partly preserves a former trachytic to pilotaxitic (feldspar-rich) groundmass texture. Ghosted Fe/Ti-oxides and mafic minerals are also present in the groundmass. Relic grains of apatite are present in the groundmass.

ALTERATION

REPLACEMENT

Alteration is complete. The groundmass is replaced by pervasive secondary, very fine to ultra fine grained K-feldspar intergrown with less abundant anhedral quartz and green-brown biotite. Green-brown biotite has formed after mafic minerals in the groundmass and amphibole phenocrysts. The altered mafic minerals in the groundmass and phenocrysts have been attenuated and rotated within a common plane of strain. Domains of granoblastic quartz interlocking with biotite are present in some strain shadows formed about phenocrysts. Alkali feldspar phenocrysts are altered to sericitic/illitic clay, which has also formed after secondary alkali feldspar within the groundmass.

Residual feldspar is altered to kaolin clays. Ultra fine grained hematite forms an overprint to biotite in places and occurs as inclusions within any remaining alkali feldspar.

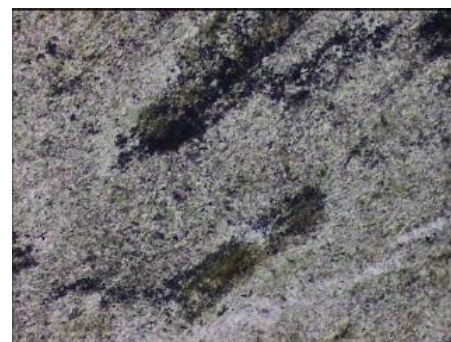
DEPOSITION

Microfractures and discrete cavities formed along shears are filled with very fine-grained granoblastic quartz interlocking with less abundant biotite.

COMMENTS

A thermally metamorphosed porphyritic intermediate igneous rock, possibly an andesite or trachyte. Metasomatism related to the metamorphism is represented by quartz + biotite veinlets and some component of early replacement. Lower temperature hydrothermal overprinting is represented by sericitic/illitic clay after secondary and primary alkali feldspar.

Right. Attenuation of altered mafic minerals in a secondary groundmass assemblage defining strain fabric. 600 μ m. ppl.



SAMPLE NUMBER: 26028.14, 06791
 LOCATION: EMAC0021/27-30 m

ROCK NAME: Metamorphosed and metasomatised,
 alkali feldspar syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of medium brown to red-brown, weathered and oxidised, deformed and metamorphosed, medium grained, intermediate to acid igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well preserved primary, inequigranular to equigranular igneous texture. The rock is composed mainly of interlocking, anhedral to subhedral, tabular alkali feldspar (microcline) and quartz. Minor amounts of euhedral plagioclase are enclosed by alkali feldspar. Ghosted grains of Fe/Ti-oxides are present. Relic grains of zircon are present as inclusions within feldspar and quartz. Quartz, alkali feldspar and plagioclase are present in the proportions: 30/65/5. Trace amounts of ilmenite are present as inclusions in feldspar.

ALTERATION

REPLACEMENT

Alteration is moderate. Primary quartz is recrystallised along grain boundaries and penetrative to non-penetrative shears. The secondary quartz is granoblastic in texture. Remaining primary quartz has undulatory extinction and sub-grain boundary development. Porphyroclastic textures are present in places. Grains of green-brown biotite are intergrown with the secondary quartz. Alkali feldspar has undulatory extinction, is locally altered to biotite, and is impregnated with ultra fine-grained hematite. Plagioclase (albite) is altered to illitic clay, and residual albite impregnated with ultra fine-grained hematite. Primary Fe/Ti-oxides are altered to rutile and biotite and later hematite.

DEPOSITION

Cavities formed along penetrative shears are filled with very fine-grained anhedral quartz interlocking with biotite.

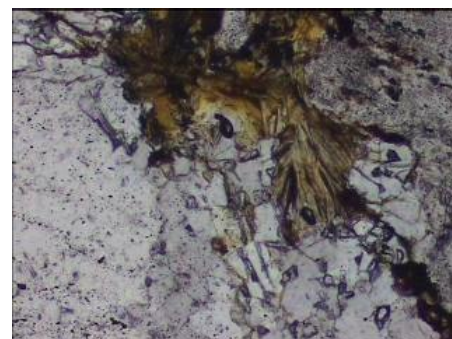
Abundant secondary fluid inclusions are contained along annealed microshears. The fluid inclusions comprise aqueous liquid-rich types co-existing with CO₂-bearing gas-rich/filled types.

Hematite has formed along late microfractures and shears.

COMMENTS

The rock is a metamorphosed and metasomatised alkali feldspar granite. Fluid inclusions and quartz + biotite veinlets provide evidence of a metasomatic component to metamorphism.

Right. Secondary (brown) biotite intergrown with recrystallised (granoblastic) quartz. 600 µm. ppl.



SAMPLE NUMBER: 26028.15, 06792
 LOCATION: EMAC0013/39-42 m
 ROCK NAME: Sericite altered, metamorphosed and
 metasomatised quartz alkali feldspar
 syenite porphyry

FIELD DESCRIPTION: None provided
 OFFCUT DESCRIPTION:

The sample is of mottled medium red-brown and brown-grey, oxidised and weathered, deformed and metamorphosed, fine to medium grained, intermediate igneous rock. The rock is alkali feldspar-rich.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well preserved primary porphyritic to equigranular texture. Ghosted, tabular, euhedral phenocrysts are contained within a fine-grained primary matrix. The phenocryst morphologies are of alkali feldspar and less abundant plagioclase feldspar and mafic minerals (? amphibole). The groundmass comprises mostly to partly preserved graphically intergrown K-feldspar and quartz. Grains of brown biotite are interlocking with the groundmass quartz and K-feldspar. Grains of zircon are present in the groundmass and as inclusions within phenocrysts. Ghosted grains of ilmenite are present in the groundmass. The primary proportions of quartz, alkali feldspar and plagioclase are estimated to be 20/70/10.

ALTERATION

REPLACEMENT

Replacement in association with deformation is moderate. In many places, groundmass quartz is recrystallised and intergrown with platy brown-green biotite. The quartz is locally granoblastic in texture. In other places a sub-preferred orientation of biotite defines a local strain fabric. Plagioclase is altered to plates of muscovite and biotite. Amphibole is replaced by aggregates of green-brown biotite intergrown with quartz. Remaining primary quartz has undulatory extinction and sub-grain boundary development. Ilmenite is altered to intergrowths of rutile, biotite and quartz.

Primary and secondary alkali feldspar is partly altered to sericitic/illitic clay, whereas residual plagioclase is extensively altered to sericitic/illitic clay. Some amounts of illitic clay have formed after primary and secondary biotite.

Remaining, abundant alkali feldspar is impregnated with ultra fine-grained hematite.

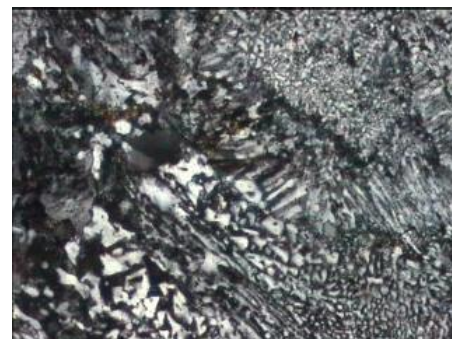
DEPOSITION

Early microfractures and fractures are filled with very fine-grained granoblastic quartz interlocking with plates of green-brown biotite. Biotite is also present in cavities formed along discrete shears.

Late microfractures and cavities along shears are filled with hematite.

COMMENTS

An amphibole quartz alkali feldspar syenite, in which the groundmass is dominated by graphically intergrown quartz and K-feldspar. Metamorphism and deformation have occurred together with metasomatism represented by biotite after feldspar and microfractures filled with quartz + biotite and biotite. A sericite/illite overprint is present. Right. Widespread graphic intergrowths of alkali feldspar and quartz in the groundmass. 1200 μm cpl.



SAMPLE NUMBER: 26028.16, 06793
 LOCATION: EMAC0043/15-18 m

ROCK NAME: Weathered quartz-rich siltstone

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of pale to medium red-brown and grey-brown, oxidised and weathered, fine grained sedimentary rock. A poorly defined lamination is present.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary fragmental texture. A moderately well sorted, matrix to framework clast supported population of angular, silt-sized detrital clasts comprises the fragmental texture. The silt-sized framework clast assemblage is dominated by preserved quartz and ghosted feldspar. Less abundant, mostly preserved grains of detrital muscovite are present. Detrital opaque minerals are also present. Matrix is estimated to have been about 10% of the rock. The subtle grain-size variation amongst framework clasts defines a laminated structure.

ALTERATION

REPLACEMENT

Replacement is moderate to strong. Detrital quartz is preserved. Feldspar fragments and matrix are altered to pervasive kaolin clays intergrown with ultra fine-grained goethite and hematite. Detrital muscovite is partly altered to kaolin clays. Opaque detrital minerals are altered to hematite. Ultra fine-grained hematite forms an overprint to the residual detrital quartz component and kaolin clays.

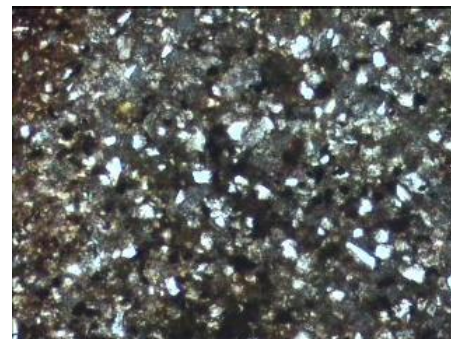
DEPOSITION

Microfractures are filled with hematite and goethite.

COMMENTS

A weathered cover sediment that has not been subjected to any form of metamorphism, deformation and hydrothermal alteration. The framework clast assemblage is probably of granitoid provenance.

Right. Primary fragmental texture defined by a population of silt-sized detrital fragments. 1200 μm . ppl.



SAMPLE NUMBER: 26028.17, 06794
 LOCATION: EMAC0043/54-57 m
 ROCK NAME: Deformed, metamorphosed and
 metasomatised quartz andesite

FIELD DESCRIPTION: None provided
 OFFCUT DESCRIPTION:

The sample is of pale to medium brown-grey to grey, partly oxidised and weathered, metamorphosed and deformed, fine grained, porphyritic texture, intermediate igneous rock. Feldspar phenocrysts are present. A strain fabric defined by the distribution of biotite is present.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a moderately well to poorly preserved primary porphyritic texture. Moderately amounts of ghosted and partly preserved, tabular, subhedral to euhedral phenocrysts are contained within a fine-grained secondary groundmass. Preserved grains of apatite are present within the groundmass. The phenocryst assemblage comprises partly preserved plagioclase, preserved quartz and pseudomorphed amphibole. The distribution and grain-size variation of secondary groundmass minerals preserves a primary pilotaxitic texture. Ghosted biotite and Fe/Ti-oxides are present in the groundmass.

ALTERATION

REPLACEMENT

Replacement in association with deformation is strong. Plagioclase phenocrysts are altered to albite and biotite. Mafic phenocrysts are altered to intergrowths of brown-green biotite and very fine-grained quartz. The groundmass is altered to pervasive brown-green biotite, very fine grained quartz and alkali feldspar. A sub-preferred orientation and segregation of platy biotite defines a penetrative strain fabric. Primary Fe/Ti-oxides are altered to intergrowths of rutile and biotite.

Secondary albite is impregnated with ultra fine-grained hematite.

DEPOSITION

Early fracturing is filled mainly with very fine-grained anhedral quartz. The quartz is granoblastic in texture and interlocking with minor amounts of green-brown biotite. The veinlets have been deformed and dislocated within the plane of strain defined by the distribution and orientation of biotite within the groundmass replacement assemblage.

Late microfractures are filled with ultra fine-grained hematite.

COMMENTS

The rock is a metamorphosed and metasomatised andesite. The distribution of biotite within the metamorphic and metasomatic replacement assemblages defines a weak schistosity. Earliest metasomatism is represented by quartz veining, which has been deformed. Deformation post-dated metasomatism.

Right. Rotated and deformed feldspar phenocryst in secondary groundmass complete with penetrative strain fabric. 1200 μ m. ppl.



SAMPLE NUMBER: 26028.18, 06795
 LOCATION: EMAC0044/21-24 m

ROCK NAME: Metasomatised and metamorphosed
 quartz syenite porphyry

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of medium red-brown to grey-brown, oxidised and weathered, metasomatised, predominantly fine grained porphyritic intermediate to acid igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary porphyritic texture. Abundant, fine to medium grained, tabular, to prismatic, anhedral, preserved and pseudomorphed phenocrysts are in a finer grained secondary groundmass. The phenocryst assemblage comprises preserved quartz and alkali feldspar (orthoclase), and ghosted/pseudomorphed amphibole and plagioclase. Primary groundmass textures are not preserved, but are interpreted to have been equigranular/hypidiomorphic and to have comprised quartz and K-feldspar. Biotite microphenocrysts are present. Ghosted Fe/Ti-oxides are present in the groundmass. Relic grains of magnetite are present in the groundmass. Quartz comprises about 20% of the rock.

ALTERATION

REPLACEMENT

Replacement is strong. The primary quartz + K-feldspar groundmass is recrystallised, being replaced by equigranular very fine-grained quartz and K-feldspar interlocking with less abundant biotite and muscovite. Amphibole phenocrysts are replaced by intergrown green-brown biotite, rutile and anhedral quartz. Plagioclase phenocrysts are altered plates of early biotite and muscovite and more pervasive later sericite/illite. Alkali feldspar phenocrysts are altered to equigranular domains of quartz + alkali feldspar, particularly at grain margins. Primary Fe/Ti-oxides are altered to intergrowths of biotite and rutile.

Fe-oxides have formed after any residual primary Fe/Ti-oxides.

Alkali feldspar (phenocrysts and groundmass) is impregnated with ultra fine-grained hematite.

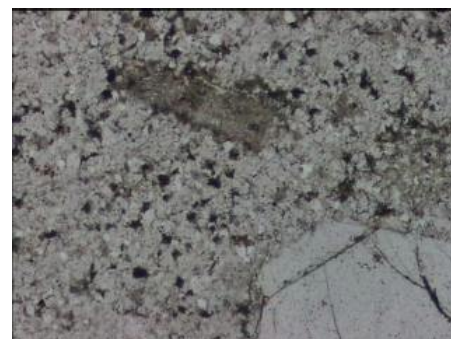
DEPOSITION

Discrete microfractures and cavities formed along shears are filled with platy brown biotite and muscovite.

Sericite has formed along later and more discrete shears.

COMMENTS

A metamorphosed and metasomatised, but relatively undeformed porphyry. A secondary equigranular quartz + K-feldspar groundmass assemblage is probably texturally and compositionally indistinguishable from a primary one with the exception of the presence of muscovite. Metasomatism is represented by biotite veinlets. Thermal metamorphism. Right. Relict quartz phenocryst and ghosted plagioclase phenocryst in equigranular secondary groundmass assemblage. 1200 μm . ppl.



SAMPLE NUMBER: 26028.19, 06796
 LOCATION: EMAC0045/12-13 m

ROCK NAME: Metasomatised and metamorphosed
 andesite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of medium red-brown to grey-brown, weathered and oxidised, metamorphosed and deformed, predominantly fine grained, porphyritic, intermediate igneous rock. Ghosted feldspar phenocrysts are evident. Biotite veinlets are present.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a poorly preserved primary porphyritic texture. Ghosted, tabular, subhedral to anhedral phenocrysts are contained within a fine-grained secondary groundmass. Phenocryst morphologies are of plagioclase, alkali feldspar and amphibole. Primary groundmass textures are not readily resolvable but possible pilotaxitic to trachytic textures are preserved by the distribution and grain-size variation of secondary minerals in some places. Ghosted or partly preserved Fe/Ti-oxides are present in the groundmass. Relic grains of apatite are present in the groundmass. Primary quartz component is estimated to have been less than 20%. Trace amounts of relic magnetite are present.

ALTERATION

REPLACEMENT

Replacement is complete. The groundmass is replaced by pervasive equigranular alkali feldspar and quartz interspersed with abundant grains of biotite and less abundant muscovite. Plagioclase feldspar phenocrysts are altered to plates of muscovite and biotite, and later illitic/sericitic clay. Alkali feldspar phenocrysts are altered to early plates of brown biotite and late sericitic/illitic clay. Amphibole phenocrysts are altered to aggregates of brown biotite.

Secondary alkali feldspar and residual primary alkali feldspar is impregnated with ultra fine-grained hematite. Some amounts of alkali and plagioclase feldspar are altered to late kaolin clays. Hematite has formed after primary Fe/Ti-oxides.

DEPOSITION

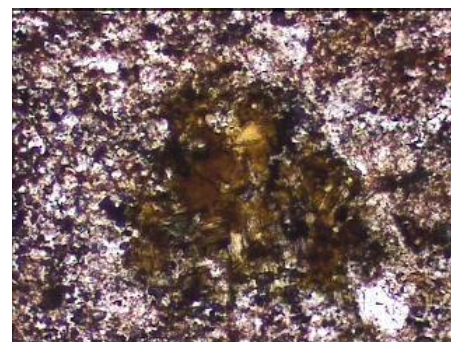
A network of microfractures is filled with fine to very fine-grained brown biotite (altered to smectite/kaolin clays and ultra fine-grained hematite). Opaque minerals intergrown with the biotite are altered to hematite.

Late microfractures are filled with ultra fine-grained hematite and smectite/kaolinite clays.

COMMENTS

A metamorphosed and metasomatised andesite or trachyte. There is an abundance of secondary brown biotite in the groundmass indicating a more mafic primary rock type. Metasomatism is represented mainly by the extent of biotite veinlet development. Magnetite is present in the primary rock type.

Right. Secondary, brown biotite formed after primary mafic phenocryst. 600 μm . ppl.



SAMPLE NUMBER: 26028.20, 06797
 LOCATION: EMAC0030/56-57

ROCK NAME: Metamorphosed and metasomatised
 alkali feldspar syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of pale to medium red-brown to grey-brown, weathered and oxidised, medium to coarse grained, intermediate to acid igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary equigranular to inequigranular texture. The rock is composed mainly of anhedral, tabular alkali feldspar (orthoclase, microcline and perthite). Minor amounts of anhedral quartz occur interstitial to the alkali feldspar or are interlocking with the alkali feldspar. Minor amounts of euhedral, prismatic plagioclase (albite to oligoclase) occur as inclusions within the alkali feldspar. Grains of green biotite and zircon occur as inclusions within the alkali feldspar and quartz. Quartz, alkali feldspar and plagioclase are present in the proportions of: 20/70/10.

ALTERATION

REPLACEMENT

Alteration in association with deformation is weak. Quartz is locally recrystallised, mainly along grain boundaries and discrete shears. The secondary quartz is granoblastic in texture, and intergrown with grains of brown biotite. Plates of brown biotite have in places formed after plagioclase. Primary biotite is partly altered to or rimmed by finer grained brown biotite.

Alkali feldspar is impregnated with ultra fine-grained hematite proximal to late hematite veinlets.

DEPOSITION

Discrete microfractures are filled with brown biotite. Some brown biotite is concentrated along feldspar grain boundaries.

Hematite is concentrated in late-stage microfractures and shears.

COMMENTS

The primary rock is a biotite quartz syenite to alkali feldspar granite. The rock has only localised deformation or recrystallisation. Metasomatism is represented by biotite veinlets.

Right. Biotite formed along feldspar grain boundary and in a microfracture. 300 μ m. ppl.



SAMPLE NUMBER: 26028.21, 06798
 LOCATION: EMAC0036/34-35 m

ROCK NAME: A metasomatised and weakly
 metamorphosed alkali feldspar
 syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of mottled medium to dark brown-grey and red-brown, oxidised and weathered, deformed and metamorphosed, intermediate to acid, fine-grained igneous rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary equigranular texture. The rock mostly comprises an assemblage of interlocking, anhedral alkali feldspar (orthoclase) and quartz. Contained within the quartz and alkali feldspar are less abundant grains of tabular to prismatic, euhedral plagioclase (albite to oligoclase). Much of the quartz and oligoclase occurs as graphic intergrowths. Ghosted, anhedral mafic minerals (amphibole) and Fe/Ti-oxides are interstitial to the quartz and feldspar. Relic grains of apatite and zircon are present. Quartz, alkali feldspar and plagioclase are present in the proportions (30/60/10). Relic grains of ilmenite and magnetite are present as inclusions within quartz.

ALTERATION

REPLACEMENT

Alteration is moderate. Primary quartz has sub-grain boundary development and undulatory extinction. Mafic minerals and Fe/Ti-oxides are altered to pervasive green-brown biotite locally intergrown with grains and aggregates of rutile. Plates and aggregates of biotite have formed after alkali and plagioclase feldspar. More pervasive sericite has formed after residual plagioclase. Sericite has formed after biotite. Quartz is host to carbonate inclusions together with fluid inclusions in some places. Co-existing gas-rich/filled and aqueous liquid-rich types comprise the inclusions.

Alkali feldspar is impregnated with ultra fine-grained hematite.

Hematite has formed after primary Fe/Ti-oxides.

DEPOSITION

Discrete microfractures are filled with very fine-grained anhedral quartz; the quartz being plastically deformed (undulatory extinction and sub-grain boundary development).

A later network of microfractures is filled with green and green-brown biotite (→ sericite).

Sericite has formed in cavities and along late-stage shears.

Late microfractures and residual cavities are filled with hematite.

COMMENTS

The primary rock is an alkali feldspar syenogranite to syenogranite. While there is undulatory extinction and sub-grain boundary development in quartz, there is no significant recrystallisation. Metasomatism and metamorphism are represented mainly by secondary biotite. Primary magnetite and ilmenite are present.

Right. Graphic intergrowth of quartz and alkali feldspar with quartz veinlet traversing. 1200 μ m. cpl.



SAMPLE NUMBER: 26028.22, 06798
 LOCATION: EMAC0036/34-35 m

ROCK NAME: Metasomatised and metamorphosed
 biotite alkali feldspar syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of mottled pale to medium grey-brown to red-brown, oxidised and weathered, metamorphosed or altered, medium grained, intermediate to acid igneous rock. Concentrations of biotite are present.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary equigranular to inequigranular igneous texture. The rock is composed mainly of anhedral, tabular mutually interlocking alkali feldspar and quartz. Less abundant amounts of more euhedral plagioclase (andesine to oligoclase) are enclosed by or interlocking with the quartz and alkali feldspar (orthoclase, microcline and perthite). Graphic intergrowths of quartz and alkali feldspar are present interstitial to coarser grained quartz and alkali feldspar. Sparse grains of brown biotite occur as inclusions within quartz and feldspar. Quartz, alkali feldspar and plagioclase are present in the proportions: 30/60/10. Partly preserved Fe/Ti-oxides are present. Ghosted, anhedral mafic minerals are interstitial to the quartz and feldspars.

ALTERATION

REPLACEMENT

Alteration is weak. Brown-green biotite has formed after primary mafic and Fe/Ti-oxide minerals. Plates of biotite and muscovite have formed after plagioclase. More pervasive, later sericite/illite has formed after plagioclase. Quartz has undulatory extinction and sub-grain boundary development, and in places is recrystallised along grain boundaries and discrete shears. The secondary quartz is granoblastic in texture. Biotite and cordierite (→ sericite) are intergrown with the recrystallised quartz. Some cordierite has formed after plagioclase, the cordierite altered to sericite.

Alkali feldspar, including primary albite, is impregnated with ultra fine-grained hematite. Residual primary Fe/Ti-oxides are altered to hematite.

DEPOSITION

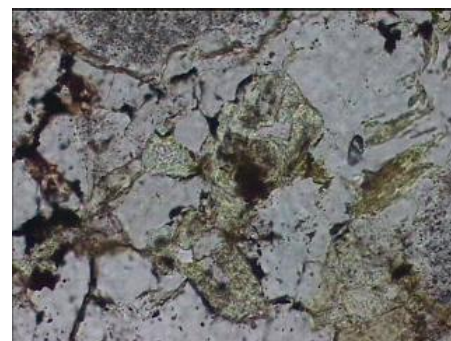
Microfractures crosscutting framework quartz and feldspar are filled with interlocking quartz, K-feldspar, brown-green biotite and ghosted grains of tabular cordierite.

Late microfractures and residual cavities are filled with hematite.

COMMENTS

The primary rock is an alkali feldspar syenogranite. Metasomatism associated with metamorphism and deformation is partly represented by quartz + K-feldspar + biotite + cordierite veins that themselves have been partly deformed. Where not deformed the quartz + alkali feldspar assemblage is stable within the metamorphic regime represented by biotite and muscovite after plagioclase (albite).

Right. Ghosted cordierite crystals contained within quartz + K-feldspar + biotite veinlets. 300 μ m. ppl.



SAMPLE NUMBER: 26028.23, 06800
 LOCATION: EMAC0040/30-32 m

ROCK NAME: Metamorphosed, deformed and
 metasomatised biotite syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of medium grey-brown to red-brown, weathered and oxidised, deformed and metamorphosed, fine to medium grained, intermediate to acid igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary equigranular texture. The rock is composed mainly of fine grained, anhedral, tabular alkali feldspar interlocking with less abundant but similar grain-sized quartz. Much of the alkali feldspar present is in the form of graphic intergrown with quartz. Less abundant grains of subhedral to euhedral, mostly pseudomorphed, plagioclase is enclosed by the alkali feldspar and quartz. Grains of ghosted Fe/Ti-oxides and relic zircon are present. Ghosted mafic minerals are interstitial to an interlocking with the quartz and feldspars. Quartz, alkali feldspar and plagioclase are present in the proportions: 25/60/15. Grains of primary biotite are present.

ALTERATION

REPLACEMENT

Alteration is moderate to strong. Plagioclase is altered to early biotite and muscovite and later, more pervasive sericite. Mafic minerals are replaced by intergrowths of green-brown biotite and anhedral quartz. Coarser grained primary quartz is recrystallised, the secondary quartz being granoblastic and intergrown with biotite and less abundant muscovite. Primary Fe/Ti-oxides are altered to intergrowths of biotite, quartz and rutile. Alkali feldspar is deformed, with undulatory extinction and sub-grain boundary development.

Alkali feldspar is impregnated with ultra fine-grained hematite. Residual primary Fe/Ti-oxides are altered to hematite.

DEPOSITION

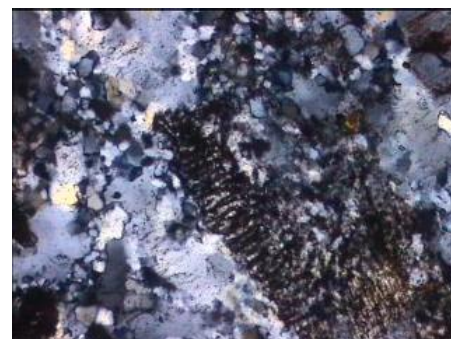
A network of discrete microfractures is filled with green-brown biotite. Secondary fluid inclusions are contained along annealed microshears within primary quartz. The inclusions comprise co-existing gas-rich and aqueous liquid rich types.

Late microfractures are filled with hematite.

COMMENTS

The primary rock is a syenogranite. Alkali feldspar and quartz are mostly present in the form of graphic intergrowths. Metamorphism is accompanied by plastic deformation and metasomatism represented by fluid inclusion trails and biotite veinlets.

Right. Graphic intergrown of quartz and alkali feldspar (impregnated with hematite) enclosed by a domain of recrystallised quartz. 1200 μ m, cpl.



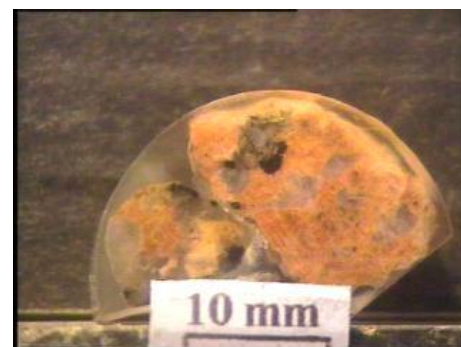
SAMPLE NUMBER: 26028.24, 07149
 LOCATION: EMAC0042/30-33

ROCK NAME: Hornblende biotite alkali-feldspar
 syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of pale to medium red-brown and brown-grey, weathered and oxidised, deformed and metamorphosed, fine to medium grained, intermediate to acid igneous rock. Amphibole is present in the rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock has a primary inequigranular to equigranular igneous texture. The rock is composed mainly of mutually interlocking, anhedral, tabular alkali feldspar (orthoclase and perthite) and quartz. Finer grained, euhedral to subhedral plagioclase, enclosed by quartz and alkali feldspar, is less abundant. Grains of brown hornblende are interlocking with and interstitial to the quartz and feldspar. Quartz, alkali feldspar and plagioclase are present in the proportions: 35/60/10. Grains of zircon are present.

ALTERATION

REPLACEMENT

Alteration is weak. Minor amounts of brown biotite have formed after and about primary hornblende. Quartz is recrystallised along grain boundaries and shears, the secondary quartz being granoblastic in texture. Some secondary alkali feldspar and biotite is intergrown with the secondary quartz. Remaining primary quartz has undulatory extinction and sub-grain boundary development. Alkali feldspar has undulatory extinction. Plagioclase is altered to sericitic clay.

Alkali feldspar is impregnated with ultra fine-grained hematite.

DEPOSITION

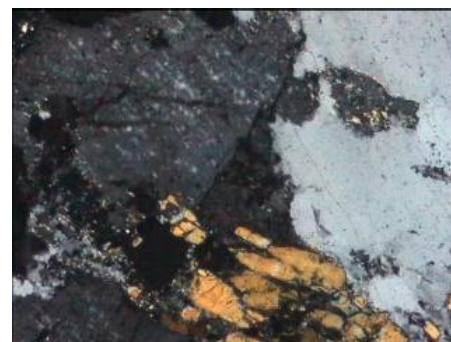
Microfractures within hornblende are filled with brown biotite and biotite intergrown with quartz. More penetrative microfractures and fractures are filled with very fine-grained quartz, the quartz being recrystallised and granoblastic in texture. Abundant secondary fluid inclusions are concentrated along annealed microshears within quartz. The inclusions comprise aqueous liquid-rich types co-existing with gas-rich types. Some aqueous inclusions have daughter salts present.

Late shears contain selvages of sericitic clay some merging with early quartz veinlets.

COMMENTS

The rock is a hornblende-bearing alkali feldspar syenogranite. The rock is mostly stable within the peak metamorphic regime, but quartz is locally recrystallised and biotite has formed after hornblende. Secondary fluid inclusions and biotite veinlets represent metasomatism.

Right. Brown hornblende interlocking with and enclosed by alkali feldspar and quartz. 1200 μ m. cpl.



SAMPLE NUMBER: 26028.25, 07150
 LOCATION: EMRB0039/41-42 m

ROCK NAME: Deformed/metamorphosed, biotite
 hornblende alkali feldspar syenogranite

FIELD DESCRIPTION: None provided

OFFCUT DESCRIPTION:

The sample is of mottled medium to dark brown-grey and red-brown, weathered and oxidised, multiple quartz veined mainly fine-grained intermediate to acid igneous rock.



THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The wallrock has a poorly preserved primary equigranular igneous texture. The rock is composed mainly of interlocking, anhedral, tabular alkali feldspar (orthoclase and perthite) and quartz. The quartz and alkali feldspar encloses less abundant amounts of more euhedral plagioclase. Quartz, alkali feldspar and plagioclase are present in the proportions: 25/65/10. Grains of zircon occur as inclusions in silicate minerals. Grains of brown biotite and green-brown amphibole are interlocking with and interstitial to quartz and feldspars.

ALTERATION

REPLACEMENT

Replacement is moderate. Primary quartz is recrystallised along grain boundaries and penetrative shears. The secondary quartz is very fine grained and granoblastic in texture. Brown biotite is intergrown with the secondary quartz. Remaining primary quartz has undulatory extinction and sub-grain boundary development. Alkali feldspar has undulatory extinction and sub-grain boundary development. Brown-green biotite intergrown with quartz has formed after hornblende. Rutile and biotite have formed after primary Fe/Ti-oxides.

Illitic clay has formed after plagioclase and some amounts of alkali feldspar.

Alkali feldspar is impregnated with ultra fine-grained hematite. Hematite has formed after remaining primary Fe/Ti-oxides. Biotite is altered to hematite and smectite clays.

DEPOSITION

A network of early fractures and microfractures is filled with quartz. The quartz is deformed; with recrystallisation resulting in granoblastic textures, and sub-grain boundary development in residual quartz. Biotite is intergrown with the secondary quartz, and later microfractures are filled with biotite. Secondary fluid inclusions in quartz comprise co-existing aqueous liquid-rich and gas-rich/filled types. Present are sparse, relic, halite daughter salt bearing, and aqueous liquid-rich primary types.

Late microfracturing is filled with hematite and kaolin clays.

COMMENTS

The primary rock is an alkali feldspar syenogranite. Multiple quartz veins have been deformed and metamorphosed together with the host wallrock to indicate quartz veining pre-dated metamorphism and deformation. The quartz veining may have been igneous related. Relic primary saline fluid inclusions indicate an early igneous hydrothermal association. Metasomatic overprinting is represented mainly by secondary fluid inclusions in quartz.

Right. Deformed and recrystallised quartz vein crossing primary alkali feldspar crystal. 1200 μ m cpl.

