PETROGRAPHIC REPORT ON THREE DRILL CORE SAMPLES FROM THE THURSDAY'S GOSSAN PROJECT, WESTERN VICTORIA

For

Stavely Minerals

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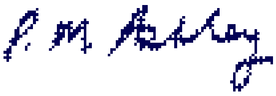

Introduction

A suite of three drill core samples from the Thursday's Gossan project in the Cambrian age Stavely Belt in western Victoria was submitted for petrographic preparation, description and interpretation. Samples were from drill holes SMD050 (at 86.8 m and 97.1 m) and SMD054 at 96.4 m. The first sample was of fresh, rather massive sulphides, but the other two samples appeared to be partly supergene-affected and were rather soft, clayey and fragmentary. Brief drill core descriptions and handspecimen photos for the samples were provided, along with comprehensive geochemical data for the SMD050 samples.

Petrographic sections were prepared at Geochempet Services in Brisbane, with polished thin sections (PTS) being prepared from each sample. Subsequently, PTS were examined microscopically in transmitted and reflected light. All samples were measured for magnetic susceptibility (but all had very low susceptibility) and representative photomicrographs of textural and mineralogical characteristics were taken.

The purpose of the petrographic work was mainly to identify the sulphide mineralogy and paragenetic relationships, and to confirm primary rock types and imposed alteration characteristics, in these strongly mineralised samples (with high Cu and/or Ni values).

Summary descriptions of the samples are listed following:

SMD050 86.8 m PTS

Summary: Sulphide-quartz rock, derived from intense hydrothermal replacement of an original ultramafic rock. There are sparsely scattered relict chromite grains attesting to the ultramafic parentage, but the remainder was completely replaced by abundant fine to medium grained quartz and sulphides. There are domains of largely massive sulphides and those that are more quartz-rich, with the latter locally having a few small crystal-lined cavities. Massive sulphide domains are dominated by bornite, with minor paragenetically early pyrite, and paragenetically later chalcocite and digenite. In the more quartz-rich zones, pyrite is more abundant, accompanied by bornite, with minor chalcocite and digenite. Pyrite in this paragenesis commonly contains small inclusions of tennantite, bornite, digenite and chalcopyrite. Throughout the sample, bornite appears to be locally replaced by chalcocite and digenite, and hosts rather rare grains of a stannite-like phase (?stannoidite) and enargite, and a few fine scale intergrowths with chalcopyrite. No particulate gold, or Ag-rich phase was observed.

SMD050 97.1 m PTS

Summary: Intensely altered ultramafic rock, perhaps involving hydrothermal replacement and a possibly deep supergene overprint. The interpreted protolith was replaced by assemblages that range from fine grained quartz-rich (originally chalcedonic) and containing scattered small cavities, to those rich in a clay (smectite) phase (e.g. nontronite). These assemblages contain residual chromite, inherited from the protolith, with chromite being more concentrated in the clay-rich domains. It is likely that the protolith experienced considerable dissolution and volume loss in order to concentrate chromite. Small sulphide grains and aggregates occur throughout, but are more common in the clay-rich domains. Sulphides occur in composite aggregates and as individual grains and include millerite (most common), siegenite, pyrite, violarite and rare sphalerite. It is possible that pentlandite could have occurred as a hypogene phase, but was replaced.

SMD054 96.4 m PTS

Summary: Strongly hydrothermally altered ultramafic rock, probably overprinted by deep supergene alteration. The original rock was a serpentinite, perhaps containing abundant serpentine minerals and Mg-rich chlorite, and hosting sparse grains of relict chromite. The imposed hydrothermal alteration was probably of low temperature type, resulting in patchy replacement by quartz and an abundant clay phase (e.g nontronite) and minor sulphides. The latter tend to be concentrated along the original serpentinite foliae. It is likely that small amounts of Ni-bearing sulphides (millerite, possible pentlandite) were initially deposited, along with trace pyrite, but these were succeeded by locally abundant Cu sulphides (chalcocite, digenite) forming fine grained disseminations, grading to semi-massive aggregates. No other Cu sulphide minerals are recognised. Supergene alteration effects could be partly manifest in the abundant clay phase (commonly impregnated by goethite) and the Cu sulphides.

Interpretation and comment

Each of the samples examined represents the product of intense alteration, as a result of interaction of protolith material with hydrothermal fluids, and perhaps in two of the samples (SMD050/97.1 m and SMD054/96.4 m) with deep supergene influences. In each sample, primary characteristics were almost completely destroyed, but there has been preservation of sparse to locally abundant grains of chromite. This phase represents a refractory mineral inherited from an ultramafic composition protolith. The chromite grains are locally up to 2 mm across (in SMD054/96.4) and are commonly fractured. Their morphology, grainsize and interpreted composition (probably rather Cr-rich, judging by their dark orange-red-brown colour) are typical of those found in mantle-derived ultramafic rocks (e.g. harzburgite) and their serpentinised equivalents (i.e. serpentinite). In SMD/96.4 m, there are vestiges of relict foliated texture of a serpentinite protolith and some preservation of serpentine minerals and chlorite, but in the other two samples, these characteristics were completely obliterated.

As mentioned above, each of the samples is the product of intense alteration. In SMD050/86.8 m, there was replacement by fine to medium grained sulphides (dominant bornite and pyrite) and quartz, with evident dissolution of the rock and development of scattered cavities, now lined by small, stubby quartz crystals. The type of alteration in this sample could be viewed as a variant of silicification, with introduction of silica, S and metals (mainly Cu) and removal of Mg. In SMD050/97.1 m, the rock was replaced by varying proportions of fine grained quartz (maybe recrystallised from original chalcedony) and a smectite clay phase (e.g. nontronite), and disseminated sulphides. Significant dissolution and volume reduction of the protolith must have occurred, as chromite is residually enriched (perhaps to 10 x its original concentration in the ultramafic protolith). The smectite phase could represent a low temperature degradation product of former serpentine and/or chlorite. Sulphides in this sample are mainly concentrated into the clay domains and include Ni- and Fe-bearing types (millerite, siegenite, pyrite and violarite, with rare sphalerite). The presence of Ni-bearing sulphides does not necessarily mean that Ni was introduced hydrothermally into the rock – clearly S was introduced, but it could have reacted with Ni that was being residually enriched from the protolith. In SMD054/96.4 m, the vestiges of the serpentinite protolith were partly replaced by clay (nontronite) and lesser quartz and sulphides, with the latter dominated by chalcocite and digenite, and traces of Ni sulphides, and deposited mostly along foliation-concordant bands. In this sample, it is evident that S and Cu must have been hydrothermally introduced.

Alteration in SMD050/97.1 m and SMD054/96.4 m could be viewed as being of low temperature type and varying between silicification and argillic alteration. In all three samples examined, it could be inferred that quartz textures observed are typical of deposition at a rather shallow crustal position, i.e. shallow mesothermal to (more likely) epithermal conditions. In the latter two samples, it can also be inferred that deep supergene processes probably operated, maybe to enhance clay development and in SMD054/96.4 m, produce goethite impregnation of clay. It is also possible that in these two samples, traces of pentlandite could have occurred but were variably replaced by minerals that could be inferred to be of supergene derivation, i.e. violarite and digenite.

Each of the samples contains sulphide minerals, ranging from abundant (and locally massive) in SMD050/86.8 m to rather finely disseminated in SMD050/97.1 m. Each also contains residual relict grains of chromite, inherited from the ultramafic protoliths. Due to interpreted residual enrichment, chromite is estimated to be present at ~5% in SMD050/97.1 m, a much higher value than would be expected in a serpentinite. In SMD050/86.8 m, there is a bornite-rich, largely massive zone, bordering on to a zone with strongly disseminated pyrite + bornite. Subordinate chalcocite and minor digenite accompany bornite (and appear to be paragenetically later), with bornite also hosting small amounts of a stannite-like phase (maybe stannoidite), enargite and chalcopyrite. Some larger pyrite grains host small inclusions of tennantite, bornite, digenite and chalcopyrite. In SMD050/97.1 m, disseminated fine grained sulphides occur as individual grains and more typically, as small composites. Millerite is the most abundant sulphide, occurring discretely and in composites with siegenite (which it might replace) and violarite. The latter phase has relict texture inferring that it could have replaced prior pentlandite. Traces of pyrite are also observed in this sample, and there are a couple of composites involving millerite and sphalerite. In SMD054/96.4 m, it is apparent that a small amount of millerite, pyrite and pentlandite has formed as fine disseminations. Locally, the Ni sulphides appear to be replaced by digenite. Elsewhere in this sample, there are rather abundant amounts of fine grained chalcocite and digenite, concentrated into foliation-concordant bands. There is no textural evidence in this sample, for chalcocite and digenite to have replaced prior Cu sulphide phases such as bornite or chalcopyrite.

No discrete Ag-bearing phase, or gold, was observed in SMD050/86.8 m, despite high assay values of Ag and Au being recorded for the sample interval. In the absence of a Ag-rich phase, it is speculated that high Ag values could be accommodated in solid solution in chalcocite and bornite. Regarding gold, it might occur in particulate form in the rock, but was simply not intersected in the plane of the polished surface of the section. Gold can also be held in solid solution in bornite. The Ni-bearing sulphide inventory in SMD050/97.1 m and SMD054/96.4 m would explain the assay values of Ni. Anomalous values of Co in the former sample could be held in siegenite, and anomalous Zn would clearly occur in sphalerite.

The ultramafic protolith material would probably make a good host for sulphide mineralisation, given appropriate structural channelling of hydrothermal fluids. The ultramafic rock is likely to be strongly chemically reactive and might offer a significant redox and pH change to buffer hydrothermal fluids that were probably rather oxidising and acidic. Alteration of silicic-argillic type would infer acidic conditions and the largely hypogene sulphide mineral assemblages with phases such as bornite-chalcocite-digenite-pyrite and millerite-pyrite-violarite certainly infer oxidising conditions. Acidic dissolution of host rocks could explain development of cavities and in SMD050/97.1 m, the residual enrichment of chromite.

Individual sample descriptions

SMD050 86.8 m PTS

Summary: Sulphide-quartz rock, derived from intense hydrothermal replacement of an original ultramafic rock. There are sparsely scattered relict chromite grains attesting to the ultramafic parentage, but the remainder was completely replaced by abundant fine to medium grained quartz and sulphides. There are domains of largely massive sulphides and those that are more quartz-rich, with the latter locally having a few small crystal-lined cavities. Massive sulphide domains are dominated by bornite, with minor paragenetically early pyrite, and paragenetically later chalcocite and digenite. In the more quartz-rich zones, pyrite is more abundant, accompanied by bornite, with minor chalcocite and digenite. Pyrite in this paragenesis commonly contains small inclusions of tennantite, bornite, digenite and chalcopyrite. Throughout the sample, bornite appears to be locally replaced by chalcocite and digenite, and hosts rather rare grains of a stannite-like phase (?stannoidite) and enargite, and a few fine scale intergrowths with chalcopyrite. No particulate gold, or Ag-rich phase was observed.

Handspecimen: The drill core sample is composed of a sulphide-rich rock (Fig. 1). A zone of largely massive bornite, with minor included pyrite is up to 2.5 cm wide and occurs at a moderate angle to the core axis and is bordered by zones of semi-massive sulphides, containing abundant pyrite and bornite, and probably minor chalcocite (Fig. 1). This zone also contains significant quartz that host scattered small cavities up to a few millimetres across (Fig. 1). The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

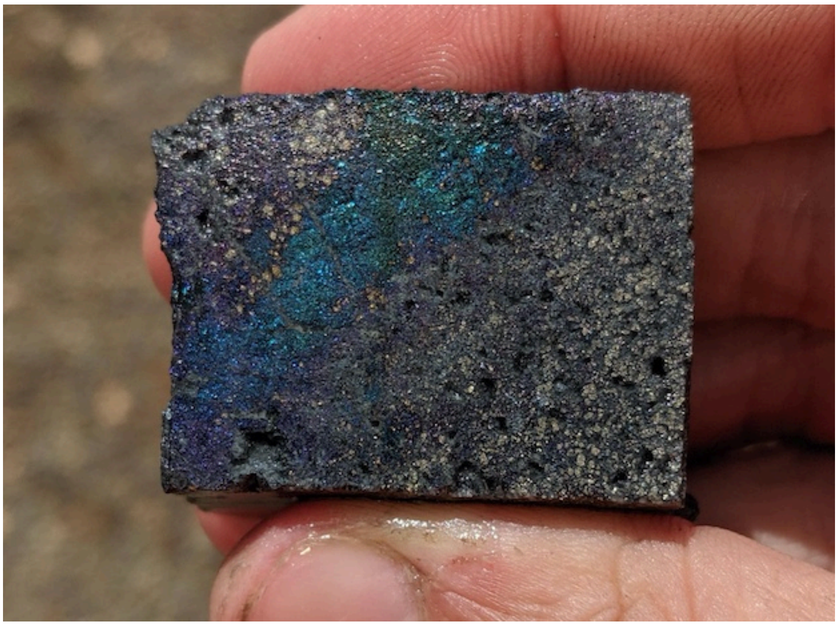

Fig. 1: Drill core sample of semi-massive sulphides, with bornite-dominant domain at left and more pyrite-rich zones either side. There is considerable gangue quartz, hosting scattered small cavities.

Petrographic description

a) Primary rock characteristics: In the section, it is evident that the sample is a sulphide-quartz rock. There is no relict texture recognised, but there are a few (~10) isolated relict grains of chromite up to 0.9 mm across (Fig. 2). These are locally fractured and invaded by sulphides and quartz (Fig. 2), but their presence is indicative of an ultramafic composition protolith (e.g. serpentinite or its precursor, harzburgite). It is suggested that there was almost complete replacement of the protolith by sulphides and quartz, with only the retention of sparse chromite grains.

b) Alteration and structure: Intense hydrothermal alteration was imposed on the protolith, with complete replacement, except for the sparse grains of chromite, and there was development of a few scattered voids, typically lined by small stubby quartz crystals (Fig. 3). About 40% of the section is occupied by a bornite-rich zone, with minor quartz interstitial to bornite, and relatively sparse included masses of pyrite, chalcocite and digenite. The remainder contains more dominant, fine to medium grained inequigranular quartz, with strongly disseminated pyrite and bornite, minor chalcocite and digenite, as well as hosting a few cavities up to 2.5 mm across (Fig. 3). Chromite grains are hosted in quartz-rich zones as well as within bornite (Fig. 2). The observed alteration in the sample is viewed as being of intense sulphide-quartz type, i.e. a variant of silicification. Textures of quartz are typical of those formed in the shallow mesothermal to epithermal environment.

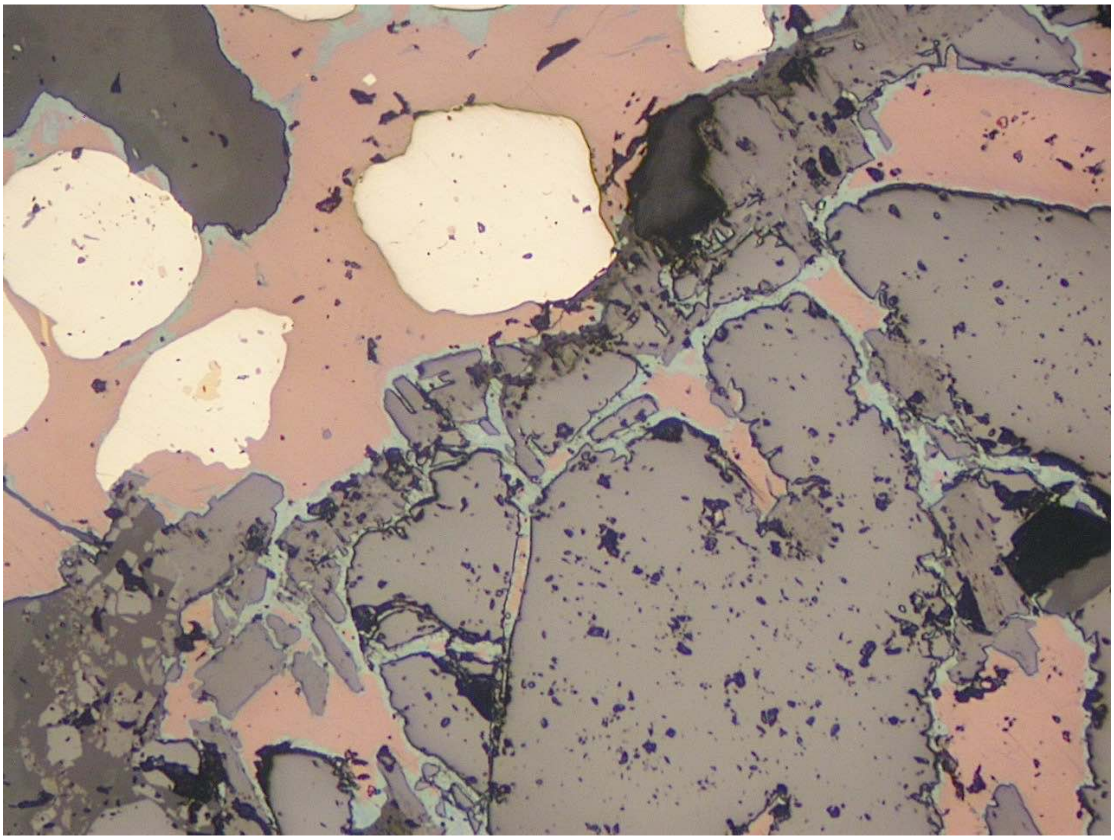

Fig. 2: Fractured chromite grain (mid grey), invaded by bornite and digenite (pale blue) and abutting a bornite-rich zone hosting a few pyrite grains (pale creamy). Plane polarised reflected light, field of view 1 mm across.

c) Mineralisation: The sample contains abundant sulphides, ranging from a largely massive bornite-rich zone up to 2.5 cm wide, to a more quartz-rich zone with strongly disseminated pyrite and bornite. There are very sparsely distributed grains of chromite up to 0.9 mm across, with fractures filled by sulphides and quartz (Fig. 2). In the more quartz-rich domain, there are scattered sulphide composite aggregates, ranging from pyrite-rich to bornite-rich and up to a few millimetres across, with bornite typically associated with minor paragenetically later chalcocite and digenite, and rare grains (mostly as exsolution lamellae) of chalcopyrite and a stannite-like phase (e.g. stannoidite) (Fig. 4). Pyrite in these aggregates occurs in individual grains up to 1 mm across, commonly hosting small inclusions of tennantite, bornite, digenite and chalcopyrite. In the more bornite-rich domain, there are more sparsely scattered, paragenetically early grains of pyrite up to 1 mm (Fig. 2), irregular aggregates of paragenetically later chalcocite (locally veinlike and replacive towards bornite, and up to 3 mm long) and minor associated digenite. Within bornite-rich masses, there are a few grains up to 0.7 mm across of a stannite-like phase (e.g. stannoidite) (Fig. 5) and uncommon small grains of enargite (up to 0.2 mm), and small zones of fine grained veining and exsolution intergrowths of chalcopyrite. No particulate gold, or Ag-rich phase was observed.

Mineral Mode (by volume): quartz 55%, bornite 25%, pyrite 13%, chalcocite 4%, digenite 2% and traces of chromite, chalcopyrite, stannoidite, tennantite and enargite.

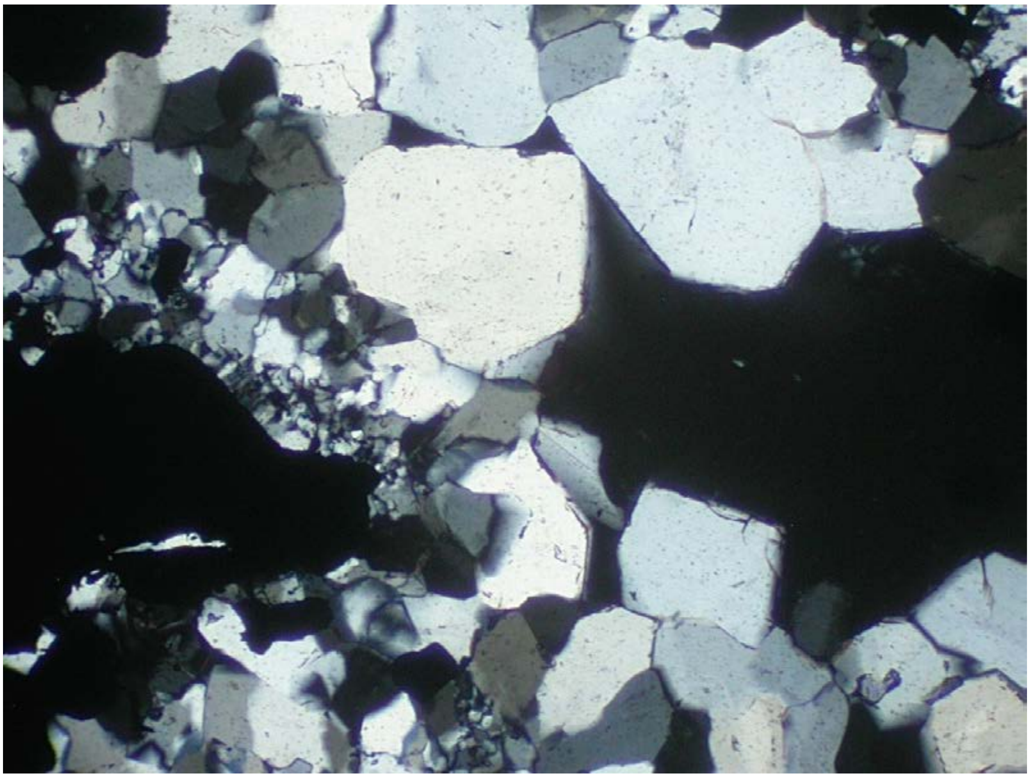

Fig. 3: Typical quartz texture in the sample, with stubby crystals projecting into a void at right. The black mass at left is an aggregate of pyrite and bornite. Transmitted light, crossed polarisers, field of view 2 mm across.

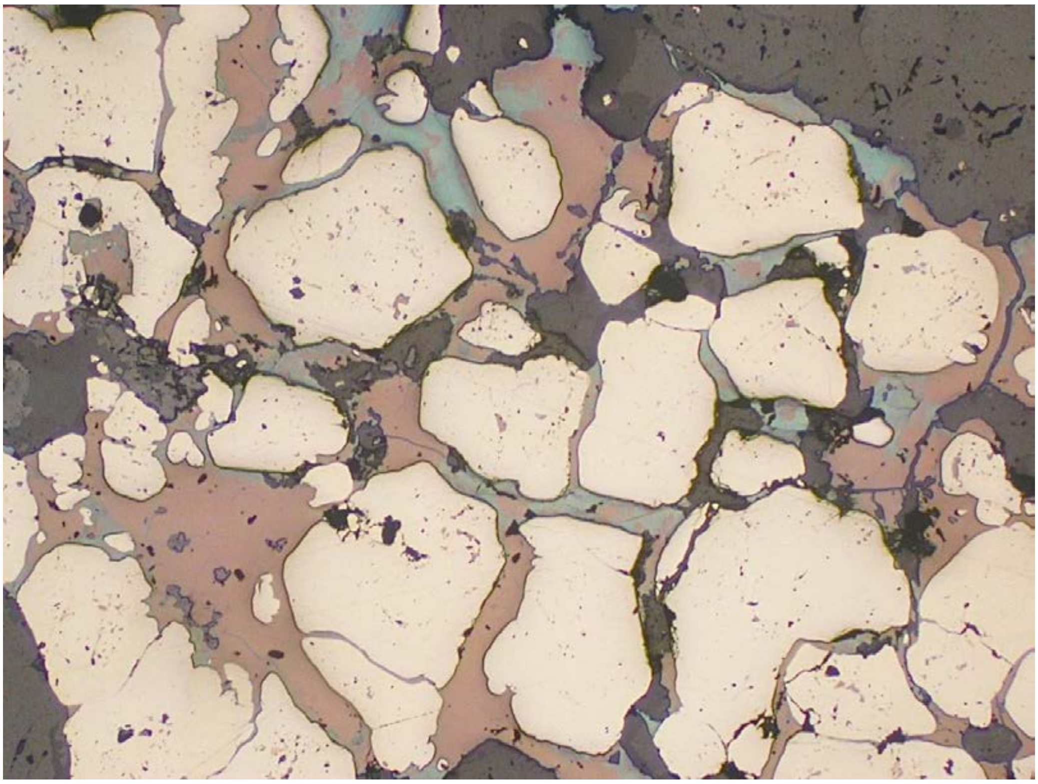

Fig. 4: Typical sulphide aggregate in the quartz-rich part of the sample. Pyrite (pale creamy) is enclosed and veined by bornite and minor digenite (bluish). Plane polarised reflected light, field of view 2 mm across.

Interpretation and comment: It is interpreted that the sample is a sulphide-quartz rock, representing the product of intense hydrothermal replacement of an ultramafic protolith. There are sparsely scattered relict chromite grains attesting to the ultramafic parentage, but the remainder was completely replaced by abundant quartz and sulphides. There are domains of largely massive sulphides and those that are more quartz-rich, with the latter locally having a few small crystal-lined cavities. Massive sulphide domains contain abundant bornite, with minor paragenetically early pyrite, and paragenetically later chalcocite and digenite. In the more quartz-rich zones, pyrite is more abundant, accompanied by bornite, with minor chalcocite and digenite. Pyrite in this paragenesis commonly contains small inclusions of tennantite, bornite, digenite and chalcopyrite. Bornite appears to be locally replaced by chalcocite and digenite throughout the sample, and contains a few grains of a stannite-like phase (?stannoidite) and enargite, and a few fine scale intergrowths with chalcopyrite. No particulate gold, or Ag-rich phase was observed. It is assumed that the high Ag in assay values could be held in solid solution in the Cu sulphide phases.

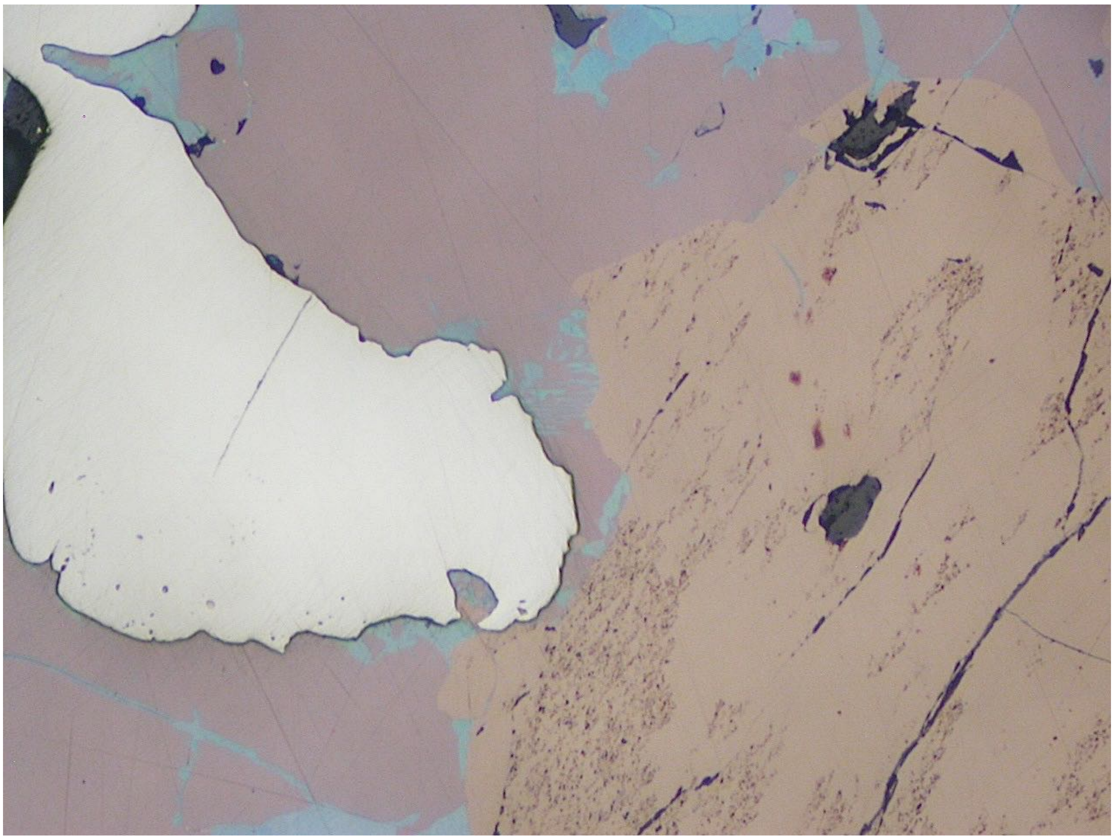

Fig. 5: Bornite-rich zone containing a grain of pyrite at left and a grain of possible stannoidite (pale orange-brown) at right. Bornite is invaded by a little paragenetically later digenite (bluish). Plane polarised reflected light, field of view 1 mm across.

SMD050 97.1 m PTS

Summary: Intensely altered ultramafic rock, perhaps involving hydrothermal replacement and a possibly deep supergene overprint. The interpreted protolith was replaced by assemblages that range from fine grained quartz-rich (originally chalcedonic) and containing scattered small cavities, to those rich in a clay (smectite) phase (e.g. nontronite). These assemblages contain residual chromite, inherited from the protolith, with chromite being more concentrated in the clay-rich domains. It is likely that the protolith experienced considerable dissolution and volume loss in order to concentrate chromite. Small sulphide grains and aggregates occur throughout, but are more common in the clay-rich domains. Sulphides occur in composite aggregates and as individual grains and include millerite (most common), siegenite, pyrite, violarite and rare sphalerite. It is possible that pentlandite could have occurred as a hypogene phase, but was replaced.

Handspecimen: The drill core sample is composed of fragments including larger entities of pale grey to pale creamy chalcedonic quartz up to 4 cm across and smaller khaki to grey, fine grained sulphide-bearing clayey aggregates up to several millimetres across and a loose, dark grey matrix, probably with considerable dispersed sulphides and a sub-metallic oxide mineral (e.g. chromite) (Fig. 6). The chalcedonic fragments are elongate to irregular in shape and locally have faint colloform banding, as well as scattered cavities up to a few millimetres across (Fig. 7). Clay-rich fragments appear to also have some chalcedonic quartz and scattered grains of a pale golden sulphide mineral and a little pyrite, as well as the dark grey oxide phase. The sample is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

Fig. 6: Drill core sample of strongly fragmented material. Large fragments are dominated by fine grained chalcedonic quartz. Dark colour is due to sulphide-impregnated clay and disseminated chromite.

Petrographic description

a) Primary rock characteristics: In the section, the sample contains several fine grained quartz-rich fragments up to 4 cm across, as well as abundant, but smaller (up to several millimetres) irregular to elongate fragments that are dominated by a fine grained turbid brown-khaki clay mineral phase (e.g. the smectite phase nontronite), but evidently with a compositional gradation into the quartz-rich type (Figs 8, 9). Neither type has any preservation of diagnostic relict texture, but in both there are scattered relict chromite grains up to 1.2 mm across, as well as a scattering of isolated (liberated) grains. Chromite is considerably more abundant in the clay-rich fragments (Fig. 9) and their presence indicates that the protolith must have been of ultramafic type, e.g. serpentinite or protolith harzburgite.

Fig. 7: Offcut from the polished thin section showing a large chalcedonic quartz fragment with faint colloform banding and scattered cavities. The dark material on either side contains scattered small fragments of clay-rich altered rock, disseminated chromite and fine grained sulphides.

b) Alteration and structure: It is interpreted that an ultramafic protolith was subject to intense, low temperature hydrothermal alteration and maybe overprinted by deep supergene alteration. The protolith was replaced and probably considerably dissolved, leading to volume reduction and consequent concentration of scattered grains of residual refractory chromite (Figs 9, 10). Many fragments are dominated by finely inequigranular quartz (maybe having replaced former chalcedony), in places with irregular to elongate cavities lined by small crystals (Fig. 8) and also containing small amounts of clay, residual chromite and traces of disseminated sulphides (mostly millerite). There is evidently a gradation from the quartz-rich altered fragments to those that are smaller, and clay-rich (nontronite), in which fine grained quartz is minor or absent, but there are grains of disseminated relict chromite and individual grains and aggregates of sulphides up to 0.5 mm across, with the latter locally abundant and much more common than in the quartz-rich fragments (Figs 9, 10). Individual sulphide grains and composite aggregates include millerite (most common), siegenite, pyrite, violarite and rare sphalerite (Figs 1, 11, 12). Disaggregation of the clay-rich fragments has led to liberation of individual grains of chromite, and of sulphides. The observed alteration could be viewed as of silicification and argillic imposed on an ultramafic protolith, but the influence of deep supergene alteration is also possible and might explain the abundant clay phase and some of the sulphide mineralogy (e.g. presence of violarite).

c) Mineralisation: The sample contains disseminated chromite grains up to 1 mm across, most commonly hosted in the clay-rich fragments and as individual, liberated grains (Figs 9, 10). Chromite is also very sparse present in the quartz-rich fragments. Disseminated sulphides occur throughout, but are again more common in the clay-rich fragments and as small, liberated grains and aggregates. It is considered that disseminated sulphides were part of an initial hypogene assemblage, but were overprinted by a more oxidised assemblage, maybe at lower temperature and possibly involving deep supergene alteration. Sulphide aggregates are up to 0.5 mm across and are commonly dominated by millerite, but there are also discrete aggregates of pyrite and siegenite $(Ni,Co)_3S_4$ (Figs 10, 11, 12). Violarite is recognised in many small composites with millerite and could be speculated to have replaced earlier pentlandite (Figs 11, 12). A couple of composites involving millerite show fine intergrowths with sphalerite and in some composites, siegenite is enclosed by millerite (Fig. 12)

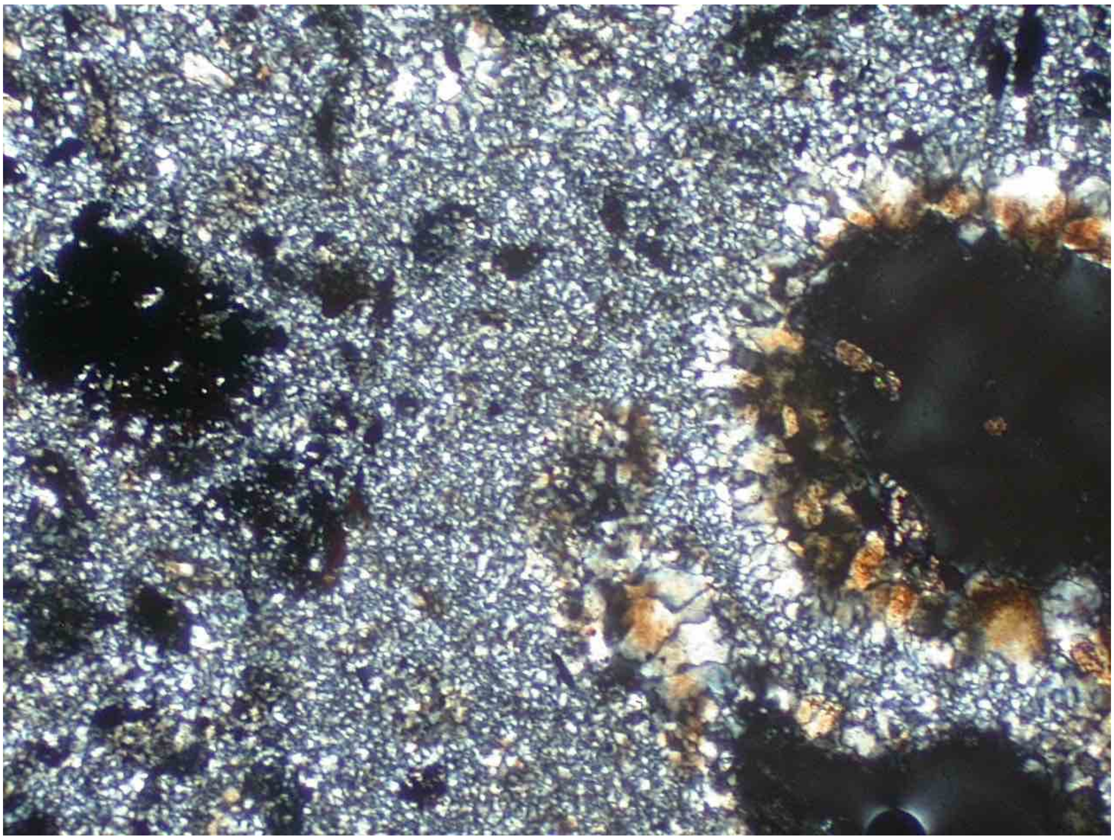

Fig. 8: Typical texture in fine grained quartz-rich fragment, with cavities at right lined by small crystals. The black aggregate at left is millerite. Transmitted light, crossed polarisers, field of view 2 mm across.

Mineral Mode (by volume): quartz 60%, clay (nontronite) 30%, chromite 5%, millerite 3%, siegenite 1% and traces of pyrite, violarite and sphalerite.

Interpretation and comment: It is interpreted that the sample represents an intensely altered ultramafic rock. It could have sustained intense hydrothermal replacement (silicification, argillic alteration) and a possibly deep supergene overprint. The interpreted protolith was replaced by fine grained quartz-rich (originally chalcedonic) grading to clay-rich (nontronite) assemblages, with the quartz-rich zones containing scattered small cavities. These assemblages contain residual chromite, inherited from the protolith, with chromite being more concentrated in the clay-rich domains, maybe due to the protolith having been considerably dissolved and undergoing volume loss in order to concentrate chromite. Small sulphide grains and aggregates occur throughout, but are more common in the clay-rich domains. Sulphides occur in composite aggregates and as individual grains and include millerite (most common), siegenite, pyrite, violarite and rare sphalerite. It is possible that pentlandite could have occurred as a hypogene phase, but was replaced.

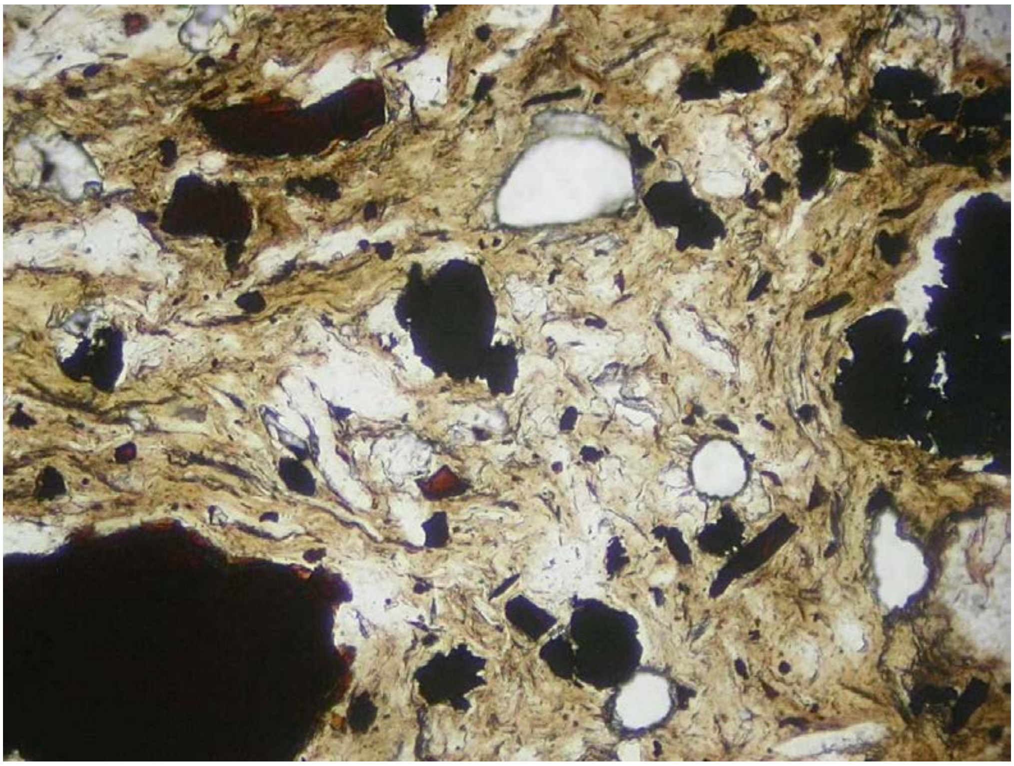

Fig. 9: Part of a clay (nontronite)-rich fragment, containing relict chromite grains (dark brown) and smaller sulphide aggregates (black). Plane polarised transmitted light, field of view 2 mm across.

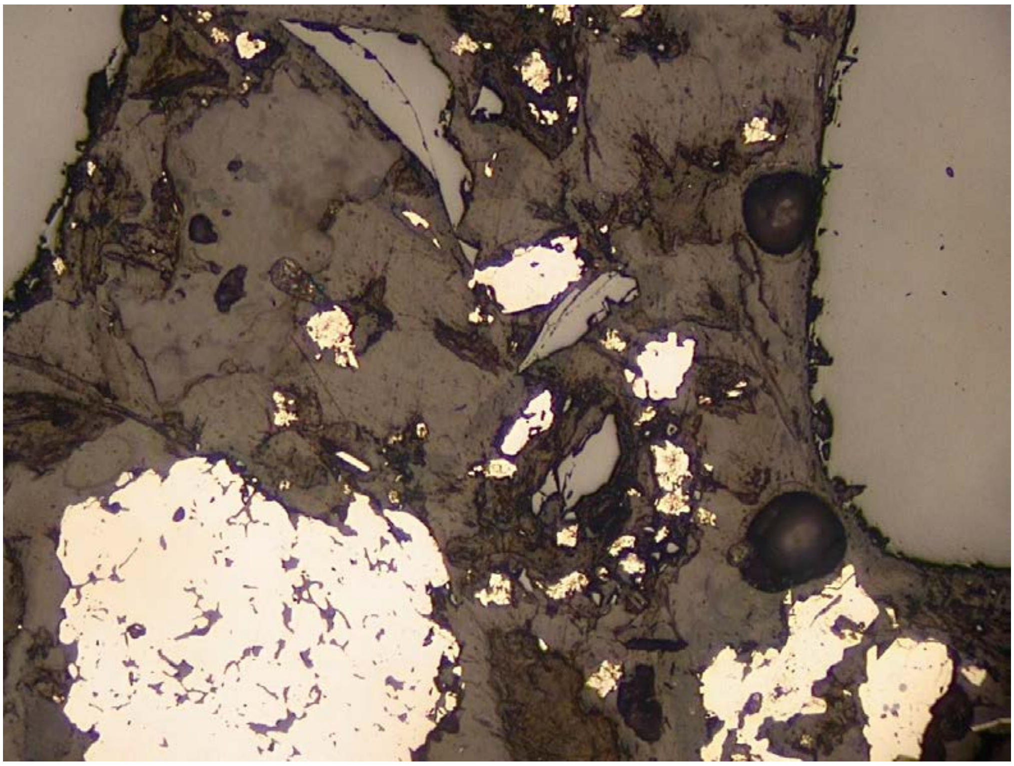

Fig. 10: Clay-rich fragment containing residual grains of chromite (mid grey) and sulphide grains and aggregates. The pale yellow grains are millerite (e.g. lower right) and the whiter aggregates with a slight pink tint are siegenite. Plane polarised reflected light, field of view 1 mm across.

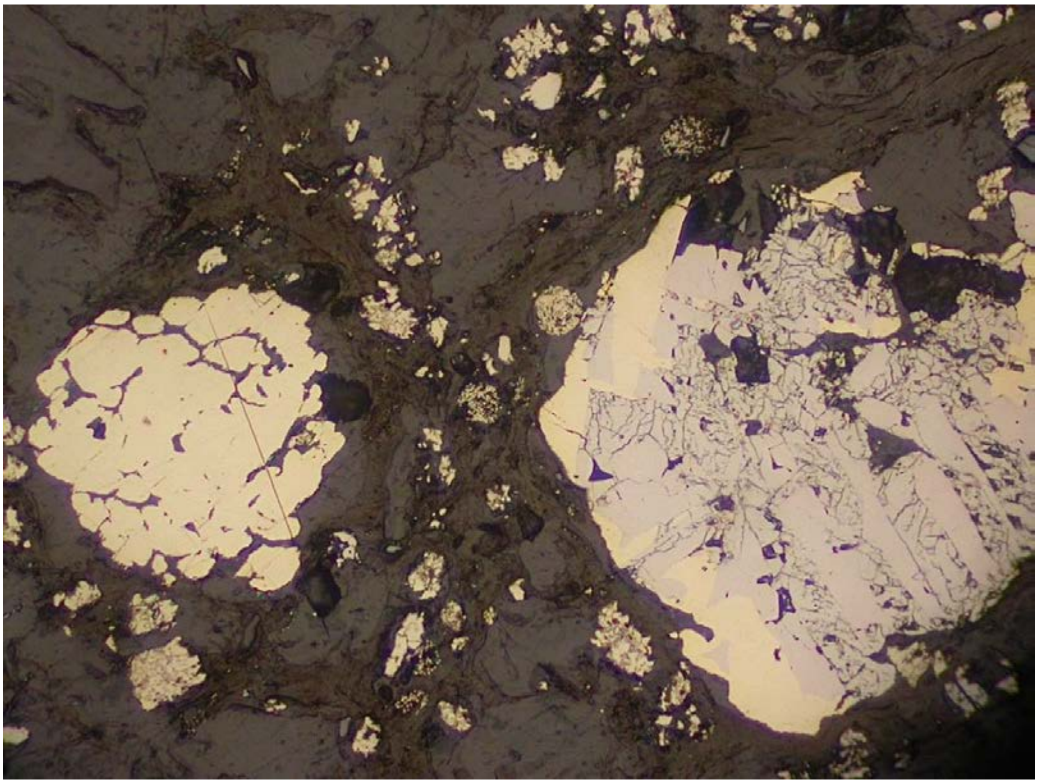

Fig. 11: Millerite aggregates (pale yellow) in clay-rich matrix. The aggregate at right is a composite with violarite (very pale grey-mauve). Plane polarised reflected light, field of view 1 mm across.

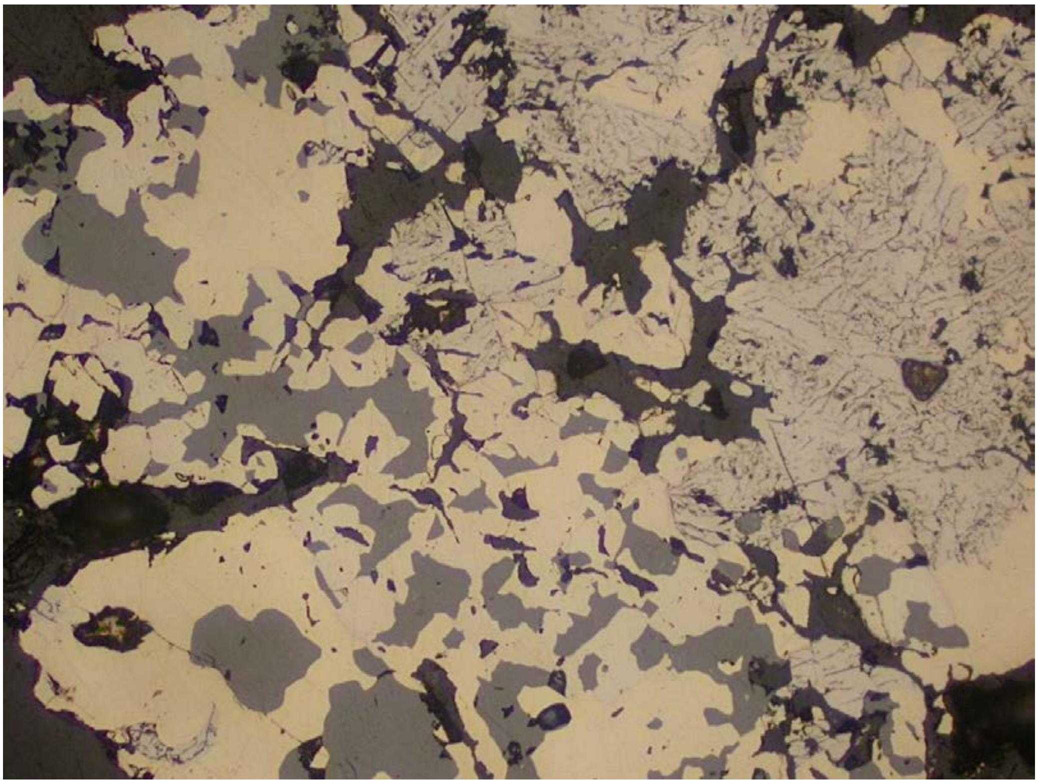

Fig. 12: Composite aggregate of millerite (pale yellow) containing irregular masses of violarite (pale grey-mauve at right), sphalerite (mid grey) and siegenite (slightly whiter than millerite at left). Plane polarised reflected light, field of view 0.5 mm across.

SMD054 96.4 m PTS

Summary: Strongly hydrothermally altered ultramafic rock, probably overprinted by deep supergene alteration. The original rock was a serpentinite, perhaps containing abundant serpentine minerals and Mg-rich chlorite, and hosting sparse grains of relict chromite. The imposed hydrothermal alteration was probably of low temperature type, resulting in patchy replacement by quartz and an abundant clay phase (e.g nontronite) and minor sulphides. The latter tend to be concentrated along the original serpentinite foliae. It is likely that small amounts of Ni-bearing sulphides (millerite, possible pentlandite) were initially deposited, along with trace pyrite, but these were succeeded by locally abundant Cu sulphides (chalcocite, digenite) forming fine grained disseminations, grading to semi-massive aggregates. No other Cu sulphide minerals are recognised. Supergene alteration effects could be partly manifest in the abundant clay phase (commonly impregnated by goethite) and the Cu sulphides.

Handspecimen: The drill core sample is composed of a crudely banded black to brown and khaki coloured, fine grained clay-rich and locally sulphide-bearing rock (Fig. 13), maybe representing the product of strong hydrothermal alteration and subsequent supergene processes. Colour banding is on a scale of up to 1-2 cm, with banding at a high angle to the core axis. It might reflect original foliation in the host rock, the nature of which is obscure due to the imposed alteration (Fig. 13). Brown to khaki bands could be dominated by a fine grained smectite clay (e.g. nontronite) and goethite, and the black bands contain finely disseminated to locally semi-massive fine grained metallic grey sulphides (e.g. chalcocite) (Fig. 13). The rock also has considerable porosity, with scattered small cavities and is essentially non-magnetic, with susceptibility of <10 x 10^{-5} SI.

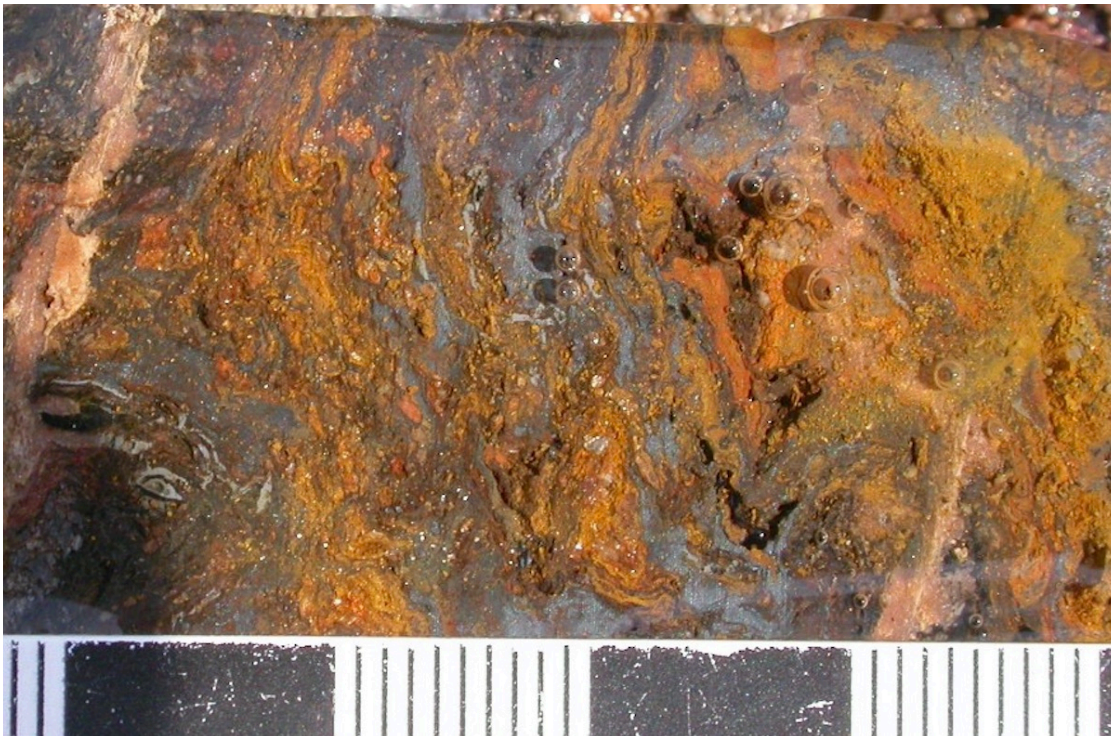

Fig. 13: Drill core sample showing crudely banded texture and small cavities, with a composition dominated by goethite-impregnated clay. The grey bands contain fine grained Cu sulphides.

Petrographic description

a) Primary rock characteristics: In the section, it is apparent that the protolith is very strongly altered, probably from effects of hydrothermal flux and superimposed deep supergene processes. Relict characteristics are preserved in places, suggesting that the protolith was a foliated serpentinite, containing sparsely scattered relict grains of chromite up to 2 mm across (mostly <0.6 mm) (Fig. 14). The ultimate protolith was probably harzburgite, but it was serpentinised and developed an anastomosing foliation.

b) Alteration and structure: It is that an ultramafic protolith developed an initial alteration assemblage of fine to medium grained serpentine minerals (could include lizardite and/or antigorite) and near-colourless, Mg-rich chlorite (Fig. 14). It was then overprinted by a hydrothermal alteration assemblage that could be transitional between silicification and argillic, wirth partial degradation of serpentine and chlorite to a smectite clay phase (e.g. nontronite) and patchy fine to medium grained quartz (in irregular to elongate aggregates co-planar with prior foliation), as well as minor disseminations and elongate aggregates of sulphides. It is likely that some of the clay that has formed is of supergene origin, as much is variably impregnated by orange-brown goethite. Furthermore, the sulphide mineral inventory, dominated by chalcocite and digenite, could also be in part a product of supergene alteration.

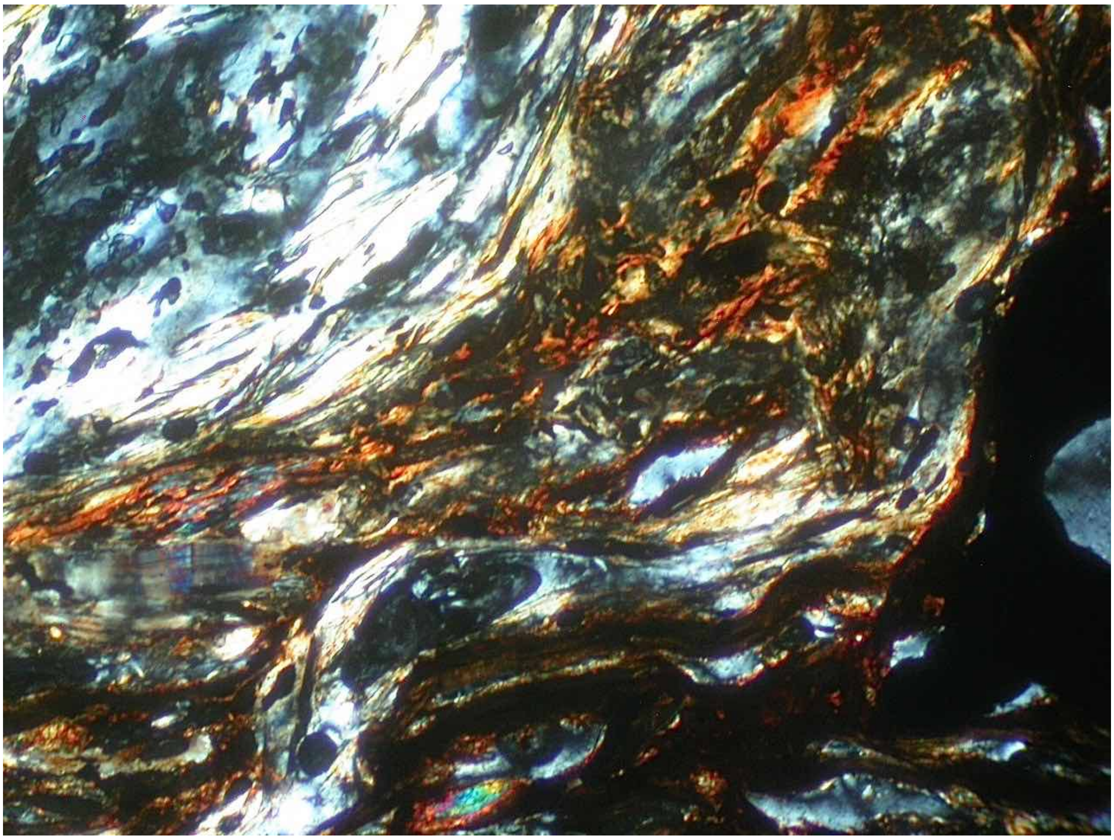

Fig. 14: Relict foliated serpentinite, displaying degradation to goethite-impregnated clay (e.g. nontronite). The black aggregate at right is relict chromite. Transmitted light, crossed polarisers, field of view 2 mm across.

c) Mineralisation: Sparsely distributed relict chromite grains from the ultramafic protolith occur throughout. Grains are up to 2 mm across and are locally fractured (Fig. 15). In part of the sample, there are minor aggregates up to 0.8 mm (mostly <0.4 mm) of millerite and pyrite, locally aligned along relict serpentinite foliation (Fig. 15). Elsewhere in the rock, there are relatively abundant fine grained aggregates, forming foliation-concordant strongly disseminated to semi-massive bands up to several millimetres wide of fine grained chalcocite (individual grains up to 0.4 mm) and/or digenite (Fig. 16). Rarely, digenite is observed to enclose (and probably replace) small grains of millerite and cleaved pentlandite. No other Cu sulphide minerals were observed in the sample.

Mineral Mode (by volume): clay (e.g. nontronite) 60%, serpentine minerals 20%, quartz and chlorite each 5%, chalcocite and digenite each 4%, chromite and goethite each 1% and traces of millerite, pyrite and pentlandite.

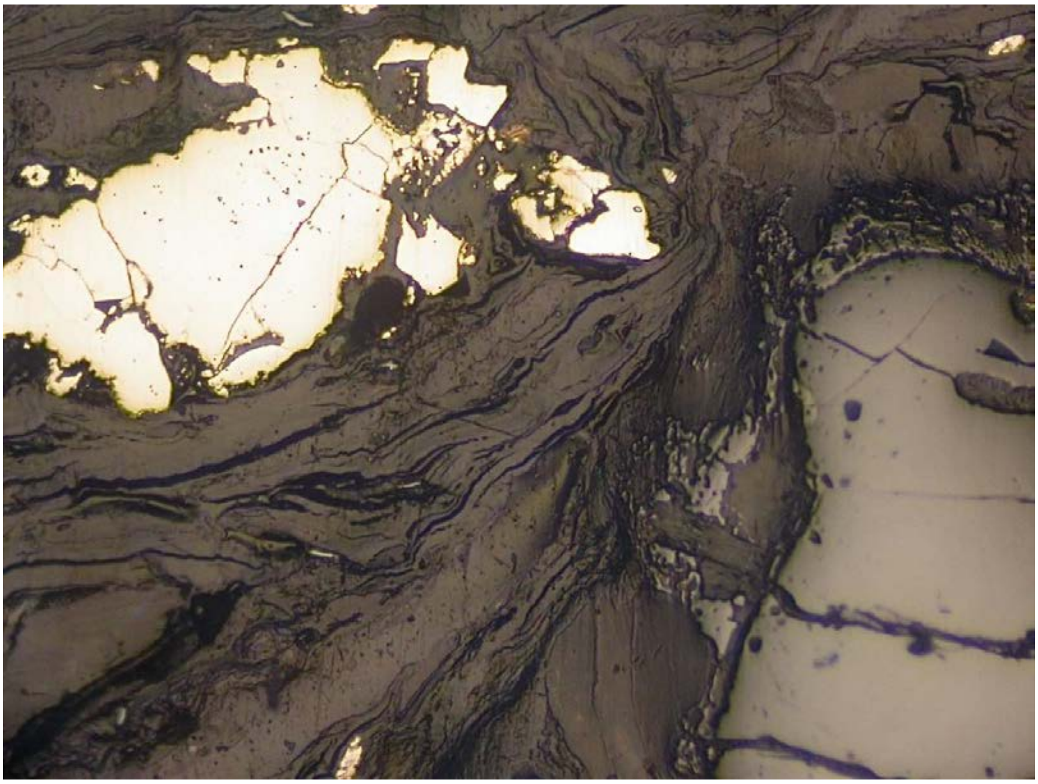

Fig. 15: Millerite aggregate (pale yellow) and a grain of relict chromite (mid grey) hosted in clay-degraded, foliated serpentinite. Plane polarised reflected light, field of view 1 mm across.

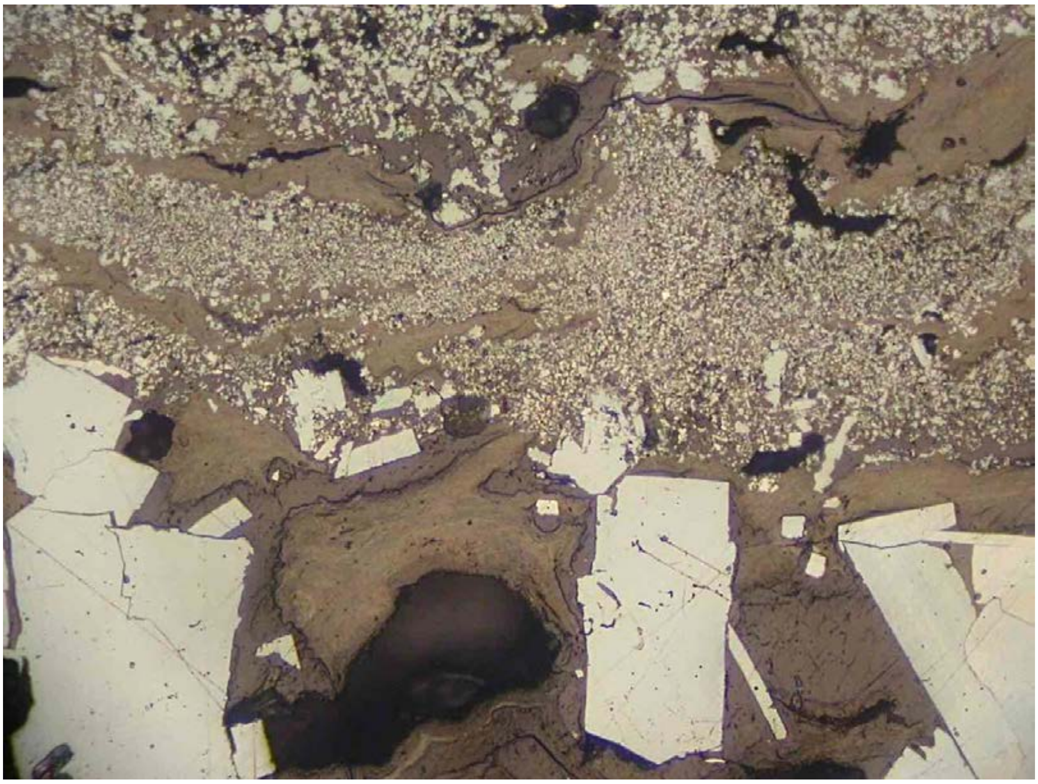

Fig. 16: Band of finely disseminated digenite (bluish) and chalcocite (above) and discrete blocky grains of chalcopyrite (pale blue-grey; lower) in clay-degraded foliated serpentinite. Plane polarised reflected light, field of view 1 mm across.

Interpretation and comment: It is interpreted that the sample represents an ultramafic rock (e.g. serpentinite, derived from a harzburgite precursor) that experienced strong hydrothermal alteration and probable overprinting by deep supergene alteration. The original contained abundant serpentine minerals and Mg-rich chlorite, and hosted sparse grains of relict chromite. The imposed hydrothermal alteration was probably of low temperature type, causing patchy replacement by quartz and an abundant clay phase (e.g nontronite) and minor sulphides. The latter tend to be concentrated along the original serpentinite foliae. Small amounts of Ni-bearing sulphides (millerite, possible pentlandite) and pyrite were initially deposited, then succeeded by locally abundant Cu sulphides (chalcocite, digenite) forming fine grained disseminations, grading to semi-massive aggregates. No other Cu sulphide minerals are recognised. Supergene alteration effects could be partly manifest in the abundant clay phase (commonly impregnated by goethite) and the Cu sulphides.