Ref: 69381, KM-M07012.DOC

MINERAL RESOURCES TASMANIA

A Division of
DEPARTMENT of INFRASTRUCTURE,
ENERGY and RESOURCES

Enquiries: Ralph Bottrill
Phone: (03) 6233 8359
Email: rbottrill@mrt.tas.gov.au
Our File: Document2S

05/02/2007

K.C. Morrison Pty Ltd
41 Tasma St
North Hobart
Tas., 7000

Attention: Ken Morrison

Dear Ken

**JOB M07/014: PETROLOGY,
TRIAL HARBOUR**

Three thin sections and rock samples from the above locations were submitted by yourself for brief petrography and photography. They were polished and examined by transmitted and reflected polarised light and stereo-microscopic techniques, and the report is enclosed.

An invoice for $643.50 covering these analyses: 3 polished thin sections @ $45 ea., 3 microscopic descriptions @ $50 ea..; 3 XRDs @ $70 ea.; 6 photos @ $10 ea.; 20 sample bags @ 0.50; $20 handling, $58.50 GST) will be forwarded.

Yours sincerely

R S Bottrill
**MINERALOGIST-PETROLOGIST**

# PETROLOGICAL EXAMINATION OF ROCK SAMPLES FROM TRIAL HARBOUR

**An unpublished Mineral Resources Tasmania report**

**for K.C. Morrison Pty Ltd**

**R.S. Bottrill**

**MRT MinPet Job No. Job M07/014**

**5/2/07**

**Summary**

Three rock samples, from drilling near Trial Harbour, were found to be texturally and mineralogically complex metamorphosed mafic to calc-silicate rocks. The mineralogies vary from diopside-vesuvianite- amphibole to amphibole-phlogopite and amphibole-biotite-quartz assemblages. The rocks are interpreted to be hornfelsed, dolomitic-mafic sedimentary breccias or conglomerates, perhaps equivalents of the early Cambrian Cleveland-Waratah Association. The rocks have been highly decarbonated and dehydrated at low pressure and high temperature, probably by a granite intrusion, and one has been migmatised. They all contain some very minor mineralisation: abundant pyrrhotite and very minor chalcopyrite, pyrite and other sulphides. There has been some retrogression, but there is little indication of late stage hydrothermal veining or alteration. The sulphides appear to have been introduced pre-hornfelsing, perhaps during a hydrothermal carbonate-alteration phase, and recrystallised by contact metamorphism.

# INTRODUCTION

Three drillcore samples, from TDR1 drilled recently by Stellar Resources at the Devises prospect near Trial Harbour, were submitted by Ken Morrison for polished thin section preparation, petrography and photography. They were thin sectioned and polished at MRT and examined by transmitted and reflected polarised light and stereo-microscopic techniques, and are described below. X-ray diffraction (XRD) was also carried out in support of the analyses, and the results are included in appendix 1 below.

The TRD-1 collar location by GPS is 353831mE, 5358959mN (AMG 66). The hole was drilled on azimuth $055^0$ AMG at a dip of -45 degrees. The three samples used for thin sections, XRD and XRF were numbered 1, 2 and 3 and came from 73.0, 91.5 and 109.5 metres down hole.

# PETROLOGICAL EXAMINATION

**Sample 1 (G403089): 73m**

In hand specimen the rock sample is a fine grained, mottled (brecciated?) rock with dark green-grey clasts in a red-grey matrix. There is no strong foliation but there is some thin, irregular sulphide-rich veining. Mineralisation is represented by abundant disseminated, vein-style and globular fine sulphides (mostly pyrrhotite).

In thin section the rock is a complex, unfoliated, heterogenous calc-silicate hornfels or skarn composed mostly of magnesian and calcium silicates of variable grain size and distribution. The main minerals are:

- Clinopyroxene (diopside?) fine grained (<0.05mm), colourless, ~25%
- Amphibole (hastingsite?), medium grained (<0.2mm), green ~20%
- Vesuvianite, coarse grained (<5mm), ~15%,
- Mica (phlogopite?), medium to coarse-grained (<0.2mm), colourless,~10%
- Calcite(?), medium grained (<0.2mm), ~5%
- Chlorite (+/- serpentine), green, fine grained, replacing mica and unknown minerals, and surrounding sulphides, ~5%

- Sphene?, fine grained, ~2%
- Opaques (sulphides), ~12%.

The diopside is mostly present in very fine grained zones, acting as a matrix to a heterogeneous set of clasts, to a few mm diameter, which contain vesuvianite, amphiboles, calcite, and phlogopite. The distribution of these minerals suggests the rock may have been a carbonate-altered (dolomitised), matrix-supported, mafic breccia, which has been hornfelsed under high temperature and low fluid pressure. The diopside-rich matrix may represent rapid devolatilisation zones in dolomite-rich rocks, with the coarser grained patches (amphibole +/- vesuvianite +/- phlogopite) representing crystallisation under lower temperature, higher fluid pressure and more hydrous conditions.

The small patches of sulphide-serpentine aggregates are enigmatic but may represent retrogression and sulphidation of a high temperature mineral (forsterite or enstatite?). Alternatively, it could represent retrogression of an Mg-Fe sulphide mineral like tochilinite?

The only alteration is probably retrograde metamorphic-related, represented by small disseminated patches of serpentine and chlorite, as described above. No veining is apparent.

Mineralisation comprises abundant disseminated sulphides, mostly anhedral pyrrhotite (~10%, <2mm) with lesser pyrite (~2%, <2mm) and trace chalcopyrite (<0.1mm) and possibly trace sphalerite. The pyrite is anomalously anisotropic and possibly As-rich? Some very fine grained patched of pyrite may indicate replacement of pyrrhotite, but in general pyrite grains are surrounded by pyrrhotite, suggesting the reverse reaction. Some occurs in highly poikiloblastic, skeletal grains, perhaps replacing intergranular carbonate and mica.

**Sample 2 (G403090): 91.5m**

In hand specimen the rock sample is a fine grained, mottled (brecciated?), dark grey and brown rock with some irregular white carbonate patches. There is no visible foliation and no indication of veining. Mineralisation is represented by abundant disseminated fine sulphide (mostly pyrrhotite, <1mm, and iron oxides).

In thin section the rock is a heterogenous, unfoliated, brecciated hornfels composed of:

- Amphibole (hastingsite?), fine to medium grained (<1 mm), green ~30%
- Mica (phlogopite-biotite?), very fine to medium grained, colourless-pink-green,~30%
- Clinopyroxene (diopside?) medium grained, colourless, poikiloblastic, ~15%
- Calcite(?), medium grained, ~10%
- Chlorite (+/- serpentine), green, fine grained, partly replacing mica and totally replacing some unknown minerals, and surrounding sulphides, ~5%
- Opaques (sulphides and oxides), ~10%.

The rock is a matrix-supported breccia which contains calcite +/- clinopyroxene +/- amphibole +/- phlogopite clasts to a few mm diameter hosted by a phlogopite-rich matrix.

The amphibole partly replaces primary clinopyroxene, and is in turn veined and partly replaced by phlogopite. There are minor late stage serpentine-calcite veins. Alteration is represented by the widespread phlogopite alteration of diopside and amphibole, and some minor, diffuse, carbonate-chlorite zones and veinlets.

Mineralisation comprises abundant disseminated sulphides, mostly anhedral/skeletal pyrrhotite (~8%, ~0.5mm) with trace chalcopyrite. There is also about 2% magnetite and about 1% ilmenite, both as fine disseminated grains (<0.05mm), mostly in poikiloblastic skeletal aggregates (<0.2mm), stringers and veinlets.

The distribution of magnetite and ilmenite in fine stringers, veinlets and skeletal poikiloblasts, cutting silicate mineral grains, suggests they must have been remobilised and/or recrystallised at high temperature. Their inhomogeneous distribution may be partly

due to original local concentrations, perhaps in heavy mineral-rich layers in a mafic sedimentary rock.

**Sample 3 (G403091): 109.5m**

In hand specimen the rock sample is a fine grained, mottled (brecciated?) rock with dark green-grey and red-grey patches (clasts?). There is no strong foliation or veining. Mineralisation is represented by abundant disseminated, fine sulphides (mostly pyrrhotite).

In thin section the rock is a heterogenous, brecciated hornfels or skarn composed mostly of calc-silicates of variable grain size. The main minerals are:

- Amphibole (hastingsite?), very fine grained to medium grained (<1mm), poikiloblastic, green ~30%
- Mica (phlogopite-biotite?), medium to coarse-grained, red-brown,~30%
- Quartz and plagioclase, very fine grained,~15%
- Sericite(?), fine grained, ~15%
- Vesuvianite?, coarse grained, colourless, ~2%
- Opaques (sulphides), ~8%.

The rock generally consists of biotite clasts brecciated and veined by amphiboles and contorted cherty quartzofeldspathic veins. It may have been a hornfelsed and calc-silicate-altered dolomitised mafic breccia, which has been incipiently migmatitised at high temperature.

Alteration is represented by sericitisation (of Kspar?) in the chert veins, although this could also be considered retrograde metamorphism.

Mineralisation comprises abundant disseminated sulphides, mostly anhedral pyrrhotite (~5%, ~0.2mm) and pyrite (~5%, ~0.2mm) with trace chalcopyrite. The pyrite is anomalously anisotropic and possibly As-rich?

## DISCUSSION AND INTERPRETATION

These rocks are mostly unusual calc-silicate to mafic hornfelsed breccias. The mineralogies vary from diopside-vesuvianite- amphibole to amphibole-phlogopite and amphibole-biotite-quartz assemblages. Some calcite remains, but the rocks have been highly decarbonated and dehydrated at low pressure and high temperature, probably by a granite intrusion, and one has been migmatised. They may, alternatively, be tectonic breccias, but no well defined foliations have been identified in these rocks. They all contain some minor mineralisation: abundant pyrrhotite and minor chalcopyrite, pyrite and other sulphides. There has been some retrogression, but there is little indication of late stage hydrothermal veining or alteration. The sulphides appear to have been introduced pre-hornfelsing, perhaps during a hydrothermal carbonate-alteration phase, and metamorphically recrystallised.

The rocks are interpreted to be hornfelsed, dolomitic-mafic sedimentary breccias or conglomerates, probably a correlate of the early Cambrian Cleveland-Waratah Association, or perhaps the lower Dundas Group. The conglomerates in these units contain mostly mafic volcanics(?),with some ultramafic, pelitic, siliceous and dolomitic sedimentary clasts also. No chromite was identified in these samples, but there may have been a minor Cr-poor ultramafic component present. If it is lacking it suggests it may have been deposited pre-Dundas Group.

These brecciated mafic-rich sequences were partly carbonate (dolomite?) altered at low to moderate temperature and some sulphides may have been introduced or remobilised by hydrothermal fluids during this stage. Later Devonian granite emplacement altered these dolomitic rocks to metamafites, migmatites and calc-silicate hornfels or skarns, during thermal metamorphism from the underlying granite. This formed a very complex sequence of diopside +/- vesuvianite +/- phlogopite +/- amphibole +/- calcite +/- feldspar bearing hornfels and breccias.

There does not appear to be much evidence for extensive hydrothermal activity during this hornfelsing, especially as hydrothermal veins appear to be absent or very minor. Some retrograde alteration of these metamorphic rocks was, however, indicated by minor chlorite and serpentine alteration of primary silicates.

The mineral reactions, following the deposition of the sediments, probably included the following:

*Stage 1 (low grade metamorphism - early metasomatism):*

Primary silicates (+Ca, $CO_2$) -> Chlorite, Serpentine, Clays, Dolomite & Quartz

*Stage 2 (high temperature metamorphism+/- metasomatism):*

Dolomite -> Brucite + Calcite

Dolomite + Chlorite -> Magnesiohastingsite + Calcite

Dolomite + Serpentine -> Diopside + Calcite

Dolomite + Serpentine -> Forsterite + Calcite

Clays -> Feldspars?

*Stage 3 (retrograde metamorphism):*

Olivine -> Serpentine

Phlogopite -> Chlorite

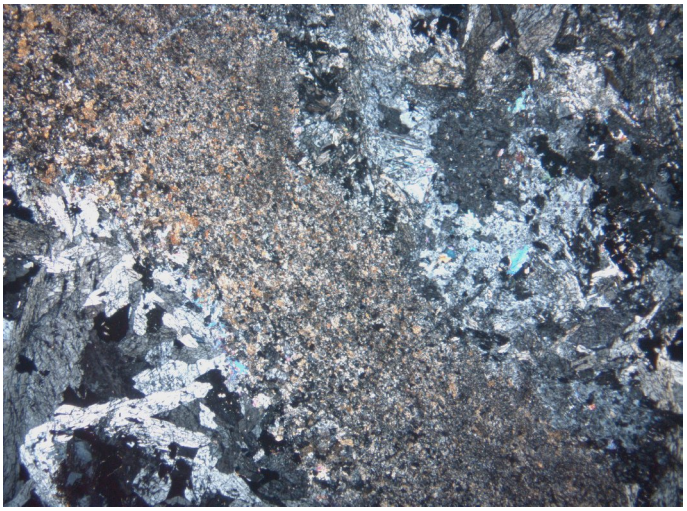
Feldspars -> Sericite

Both the serpentinite and diopside-rich sequences contain minor mineralisation, consisting of abundant pyrrhotite and minor pyrite and chalcopyrite and possible trace sphalerite.

The relation between the carbonate (dolomite) alteration and mineralisation is unclear. The carbonates are atypical of those in the Zeehan-Dundas and Heazlewood-Magnet-Waratah districts, notably lacking siderite and rhodochrosite. Such dolomitic alteration

styles may possibly relate to gold mineralisation in some mafic rocks, e.g. at Beaconsfield and the Forster Prospect. No evidence for such mineralisation is present in these rocks.

There is no good evidence for any pre-existing magmatic sulphides occurring within these rock sequences. Sulphides were only seen as minor, sporadic disseminations, unrelated to any veining or other rock structures, or to the host mineralogy. They are quite irregular in size and shape and do not exhibit any forms suggestive of melt droplets, segregations or cumulates. The hornfelsing event was apparently very dry, from its anhydrous mineralogy, and thus unlikely to have been associated with much hydrothermal fluid and later hydrous metamorphic minerals do not appear to be associated with sulphides, excepting serpentine. The sulphides thus appear to have been mostly introduced relatively early in the geological history (pre- hornfelsing). It is speculated that they were either introduced as sedimentary material or with the early carbonate alteration.



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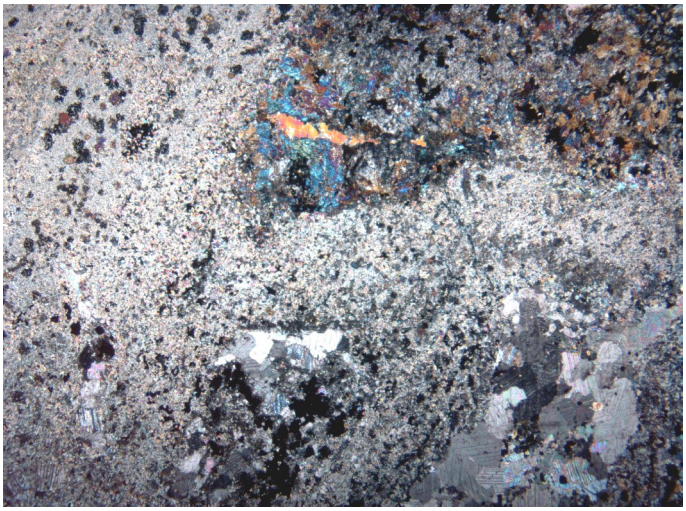

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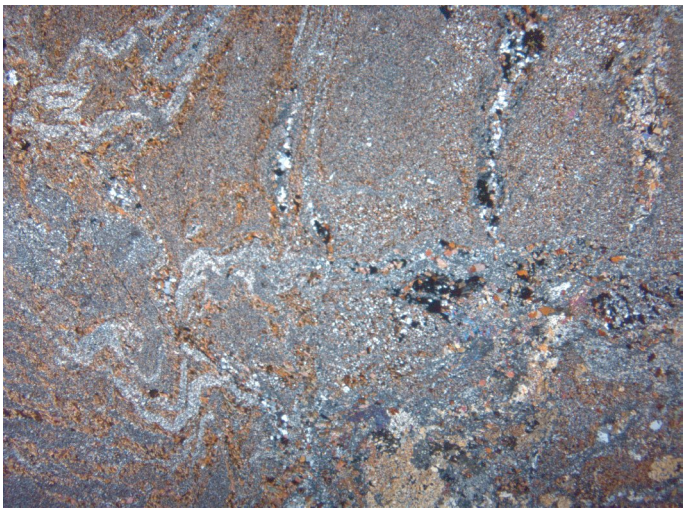

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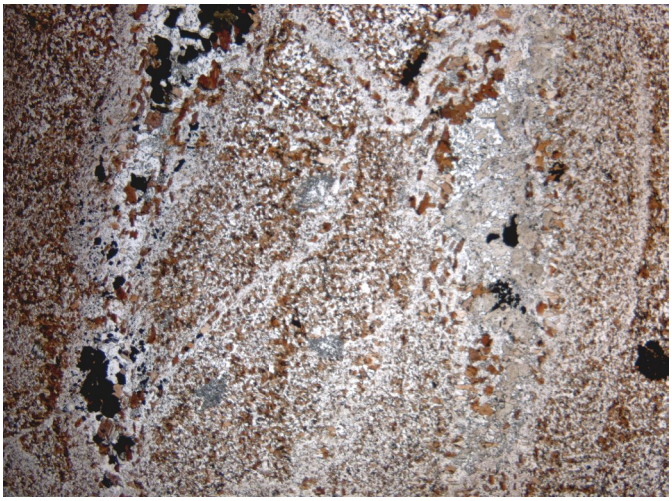

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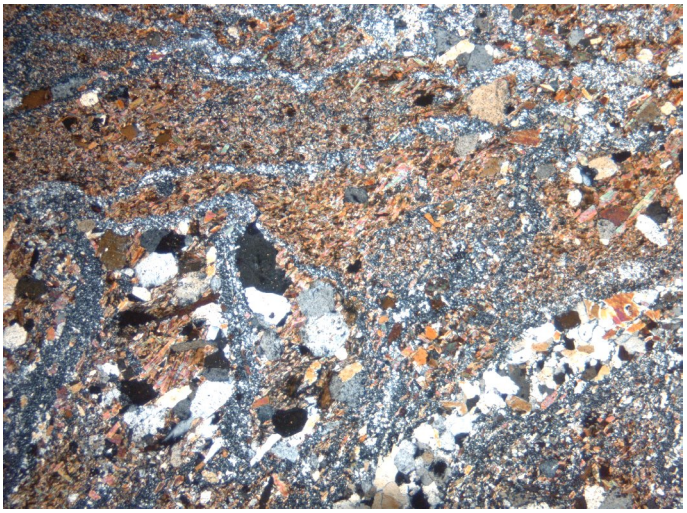

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**Petrographic images**

Fig. 1 Sample G403089: 1X, XPL, TL, FOV 10x7 mm. Hornfels breccia showing very fine grained diopside-matrix/veins and coarser clasts containing vesuvianite, amphibole and mica.

Fig. 2 Sample G403090: 1X, XPL, TL, FOV 10x7 mm. Hornfels breccia showing very fine grained diopside-matrix and coarser clasts containing calcite, amphibole, clinopyroxene and mica.

Fig. 3 Sample G403091: 1X, XPL, TL, FOV 10x7 mm. Hornfels breccia showing very fine grained biotite-quartz clasts with some biotite selvages and cut by fine ptygmatic quartzo-feldspathic (migmatitic) veins and also brecciated and partly replaced by amphiboles associated with sulphides.

Fig. 4 Sample G403091: 2.5X, PPL, TL, FOV 4.4x2.9 mm. A close up of part of Fig. 3, showing pale green amphibole, colourless quartz and feldspar, red-brown biotite and opaque sulphides.

Fig. 5 Sample G403091: 2.5X, XPL, TL, FOV 4.4x2.9 mm. Biotite hornfels breccia cut by fine ptygmatic quartzo-feldspathic (migmatitic) veins and also veined and partly replaced by amphiboles associated with sulphides.

Fig. 6 Sample G403091: 2.5X, XPL, TL, FOV 4.4x2.9 mm. Biotite hornfels breccia cut by fine ptygmatic quartzo-feldspathic (migmatitic) veins and also veined and partly replaced by amphiboles associated with sulphides.

Appendix 1: XRD Analyses

**Mineral Resources Tasmania**

**Client:** K. Morrison
**Sample Location:** Trial Harbour
**MRT Job Number:** M012/07
**Analysis:** Mineralogy
**Method:** X-Ray Diffraction

**Results:**

| ***Reg. No.*** | ***ID*** | ***Minerals Identified*** |
|---|---|---|
| G403089 | 1 | major Clinopyroxene, Mica[1], Chlorite, Amphibole, Vesuvianite, minor Pyrrhotite |
| G403090 | 2 | dominant Mica[1], minor Calcite, trace Clinopyroxene, Chlorite, Ilmenite, ? |
| G403091 | 3 | dominant Mica[1], minor Quartz, Amphibole, Plagioclase, Chlorite, trace Pyrite, 6.14Å |

? may be another mineral present
6.14Å Uncertain – may be Molybdenite or Tungstenite??
[1] probably Biotite