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Petrographic Description for Sample 24/4/111

REPORT # **2781**

CLIENT **Newcrest Mining Ltd – SE Australia Exploration**

ORDER NO **Email, J. Holliday, 10 September 2002**

CONTACT **Mr John Holliday**

REPORT BY **Dr Douglas R Mason**

SIGNED

for Mason Geoscience Pty Ltd

DATE **27 September 2002**

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SUMMARY

1. Rock Sample

- A single rock sample labelled 24/4/111 has been studied using routine petrographic and mineragraphic methods.

2. Brief Results

- *Primary rock type*

  - The rock formed as a fragmental acid volcanogenic rock of rhyolitic composition. Unsorted, matrix-supported lithic fragments of porphyritic rhyolite and crystal fragments of quartz, K-feldspar and trace zircon were deposited rapidly in a fine felsic matrix derived from the same rhyolitic source.

  - Primary massive rhyolite contained phenocrysts of quartz and feldspar in a fine-grained or glassy groundmass with trace acicular zircon.

- *Alteration*

  - The rock body was invaded by significant volumes of hydrothermal fluid in the presence of a directed stress regime. This may have occurred during a low-grade (greenschist facies) regional metamorphic event, possibly involving faulting to channel fluid flow.

  - Alteration of the rock generated a new assemblage dominated by quartz + sericite + Fe-carbonate, with minor pyrite + K-feldspar + trace rutile + chalcopyrite + sphalerite + native gold. Crystallisation of pyrite in lithic clasts, in matrix, and overprinting the clast/matrix boundaries confirms that the sulphide formed as part of the post-depositional alteration event. Foliation of the sericite, and development of coarser pyrite, quartz and Fe-carbonate in pressure shadows marginal to lithic fragments, confirms that the alteration assemblage developed synchronous with mild deformation. K-feldspar formed as fine-grained mosaics in the altered rhyolitic clasts, and represents recrystallisation of K-rich rhyolite rather than addition of K to a K-poor precursor clast.

  - Native gold of relatively high fineness formed as small inclusions in pyrite crystals. This has been observed only in pyrite-rich preferentially altered rhyolitic fragments. The close association between pyrite and gold confirms that deposition of gold occurred as part of coupled reactions between host rock and hydrothermal fluid.

1 INTRODUCTION

A single drill core rock sample labelled 24/4/111, composed of a smaller and a larger piece of quarter core, was received from Mr John Holliday (Newcrest Mining Limited – SE Australia Exploration, Cadia Project, via Orange, New South Wales) on 16 September 2002.

Particular requests were:

i) To prepare a polished thin section of the sample, preferably from the freshly sawn surface of the smaller piece of core.

ii) To provide a petrographic description, comparing and contrasting the alteration in mid-dark grey clasts and creamy yellow host rock.

iii) To provide comments on the style of mineralisation.

The results were provided by email to Mr Holliday on 21 September 2002, when it was confirmed that photomicrographs should be included to illustrate overprinting of clast margins by pyrite, and the occurrence of native gold in pyrite. This report contains the full results of this work.

2 METHODS

The two pieces of drill core were examined in hand specimen. A thin section area was marked on the freshly sawn surface of the smaller piece of core. A polished thin section was obtained from an external laboratory (Pontifex & Associates Pty Ltd, Rose Park, South Australia).

At Mason Geoscience Pty Ltd conventional transmitted and reflected polarised light microscopy was used to prepare the combined petrographic and mineragraphic description. A small number of colour photomicrographs were included with the descriptions to illustrate particular mineralogical and microtextural features.

3 PETROGRAPHIC DESCRIPTION

The combined petrographic and mineragraphic description is provided in the following pages.

SAMPLE : 24/4/111 (Quarter-core rock sample)

SECTION NO : 24/4/111

HAND SPECIMEN : The drill core sample represents a coarse fragmental rock, composed of pale to medium grey lithic fragments of rounded to subangular shapes and ranging from several millimetres to ~2 cm in size, scattered through a moderately foliated pale grey matrix with faint yellowish tinge.

ROCK NAME : Schistose sericite-carbonate-pyrite(-gold) altered meta-rhyolitic fragmental volcanic rock

PETROGRAPHY AND MINERAGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol %	Origin
Sericite-pyrite altered rhyolitic volcaniclastic rock		
Quartz	25	Crystal fragments
K-feldspar	5	Crystal fragments
Zircon	Tr	Crystal fragments
Lithics (quartz, K-feldspar, albite, pyrite)	30	Lithic fragments
Felsic mosaic (mainly quartz)	24	Alteration (after matrix)
Sericite	12	Alteration (after matrix)
Carbonate (Fe-carbonate)	2	Alteration
Quartz (spheroids)	Tr	Alteration (devitrification)
Pyrite	<1	Alteration (after clasts, matrix)
Chalcopyrite	Tr	Alteration (inclus. in pyrite)
Sphalerite	Tr	Abundant (inclus. in pyrite)
K-feldspar-quartz-pyrite(-gold) altered rhyolitic clast		
Quartz	10	Crystals (?phenocrysts)
Zircon	Tr	Crystals
K-feldspar	36	Alteration (after groundmass)
Quartz	35	Alteration (after groundmass)
Pyrite	5	Alteration
Sericite	12	Alteration (after ?feld. phenocrysts)
Carbonate (?Fe-carbonate)	Tr	Alteration
Rutile	Tr	Alteration
Native gold	Tr	Alteration (inclus. in pyrite)

In polished thin section, this sample displays a coarse matrix-supported, non-sorted fragmental texture, with relict porphyritic rhyolitic igneous textures in larger lithic fragments, all of which has been overprinted by a syndeformational alteration event.

Sericite-pyrite altered rhyolitic volcaniclastic rock contains relatively large subrounded to subangular rhyolitic lithic fragments (see description below) and crystal fragments in a finer-grained foliated matrix.

Crystal fragments are moderately abundant and range widely in size from ~0.1 mm up to ~2 mm. Quartz forms clear angular fragments and equant subhedral crystals, and K-feldspar forms subhedral blocky crystals and angular crystal fragments that display incipient replacement by minor carbonate grains. Zircon occurs as uncommon but relatively large crystal fragments.

The matrix is dominated by quartz and sericite. Quartz occurs as small equant anhedral grains that form a mosaic of alteration origin. Sericite forms small flakes whose preferred orientation defines a foliation that wraps around the crystal and lithic fragments. Although distributed throughout the matrix, the sericite tends to be concentrated in indistinct wispy folia aligned in the trace of the foliation. Uncommon ovoid bodies of quartz ~0.4 mm in size appear to represent devitrification of precursor glass.

Pyrite occurs mostly as small cubic crystals in altered lithic fragments (see below), but some pyrite also occurs disseminated through the altered matrix. The observation that pyrite forms small crystals in lithic fragments, overgrowing lithic fragment margins, and disseminated in nearby matrix areas confirms that the pyrite formed as part of an overprinting alteration event, not as pre-depositional alteration of lithic fragments.

Carbonate occurs in minor amount as ragged granular aggregates scattered sparsely through the rock, as small replacement patches in some K-feldspar crystals, and also in granular aggregates concentrated in indistinct veins that 'climb' through the foliation. The strong double refraction, pale off-yellow colour, and local ferruginous staining in response to weathering suggest that the carbonate is Fe-bearing, possibly ferroan dolomite or ankerite.

Tiny ragged grains of chalcopyrite and sphalerite occur as inclusions in larger pyrite aggregates.

K-feldspar-quartz-pyrite(-gold) altered rhyolitic clast retains its primary porphyritic igneous texture. Equant euhedral quartz crystals (phenocrysts) ~0.2-1.5 mm in size are sparsely scattered through the rock. Larger blocky feldspar phenocrysts up to ~3 mm in size have suffered complete replacement by fine-grained dense sericite mats. Uncommon small blocky carbonate crystals and aggregates are sparsely scattered through the clast.

Most of the rock is composed of a fine-grained to 'snowflake-like' felsic mosaic, which appears to represent alteration of a primary ?glassy groundmass. Small pyrite crystals are liberally sprinkled through the felsic matrix: they are abundant in some clasts, but are virtually absent from others. The pyrite crystals are quite small (tens of microns up to ~0.1 mm in size), but are somewhat larger (up to ~0.2 mm) near the clast margins, in nearby fragmental matrix, and in pressure shadows marginal to the lithic clasts.

A single grain of native gold has been observed as an inclusion within a small pyrite crystal. The native gold displays a golden yellow colour, suggestive of relatively high fineness (ie low Ag content).

Zircon occurs as rare small acicular prisms (magmatic quench origin).

Rutile occurs in trace amount as tiny granules in small altered primary crystal sites (?Fe-Ti oxide).

INTERPRETATION :

This sample is considered to have formed as a fragmental acid volcanogenic rock. It was originally composed of quartz-feldspar-phyric rhyolitic fragments and crystal fragments (quartz, K-feldspar, rare zircon) in a fine-grained matrix probably composed of comminuted felsic volcanic materials including ?glass. Devitrification may have commenced shortly after deposition.

Subsequent hydrothermal alteration generated a new assemblage dominated by quartz + sericite + Fe-carbonate, with minor pyrite + K-feldspar + trace rutile + chalcopyrite + sphalerite + native gold. The alteration formed in response to invasion of the rock by significant volumes of hydrothermal fluid, most probably synchronous with deformation. This resulted in moderately strong foliation of sericite in the altered matrix, and also generated slightly coarser-grained pyrite, quartz and carbonate in pressure shadows at margins of lithic clasts, and concentrations of carbonate along indistinct veins that climb through the foliation at an acute angle.

Sulphides (mainly pyrite) formed throughout the rock, but formed most abundantly in some lithic clasts where they crystallised as small disseminated euhedral crystals. Fine-grained K-feldspar formed as part of the alteration of the lithic clasts, and this provides a point of difference with altered matrix which lacks K-feldspar. The K-feldspar is not considered to represent addition of K to the rhyolitic fragments, but simply represents a stable K-bearing phase arising from alteration of the primary K-rich rhyolitic fragment. Native gold formed as small inclusions in some of the pyrite crystals. The association of gold and pyrite suggests that coupled reactions between fluid and rock were responsible for synchronous pyrite-gold crystallisation, and relatively dense formation of pyrite in lithic fragments suggests that they were more reactive sites than matrix.

Microtextural observations indicate that the alteration assemblage formed whilst a mild directed stress regime was applied to the rock. This regime might have developed in response to a low-grade regional metamorphic event, possibly including localised faulting to control and enhance fluid flow. The ultimate origin of the fluid remains unknown from study of the single sample.

Subsequent weak weathering effects have generated traces of goethite after the Fe-carbonate phase.

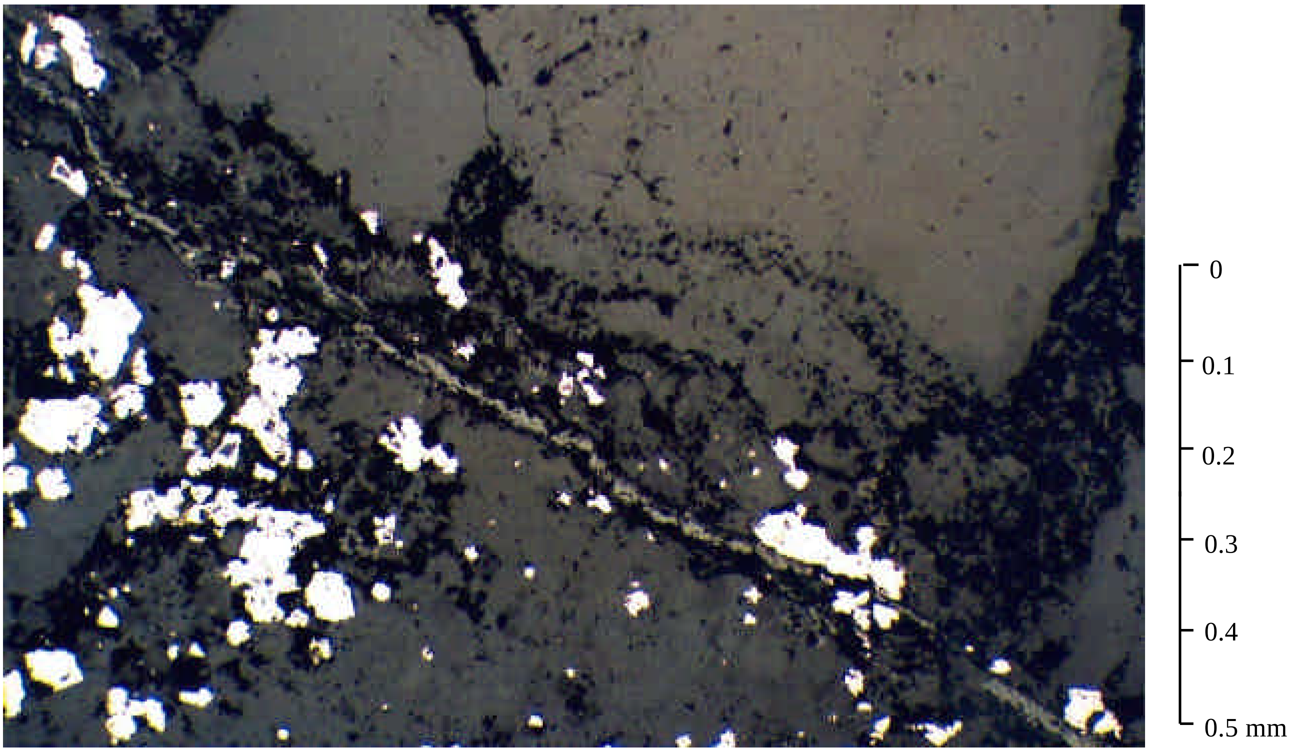

PLATE 1: SAMPLE 24/4/111 (Reflected plane polarised light, x10, Film 1 / Frame 9)
This view illustrates the development of alteration pyrite (small euhedral white crystals) in both altered lithic fragment (bottom left) and adjacent matrix. Note the edge of the clast is oriented NW-SE diagonally across the field of view, and is marked by a thin rim of goethite (slightly paler grey line) of weathering origin.

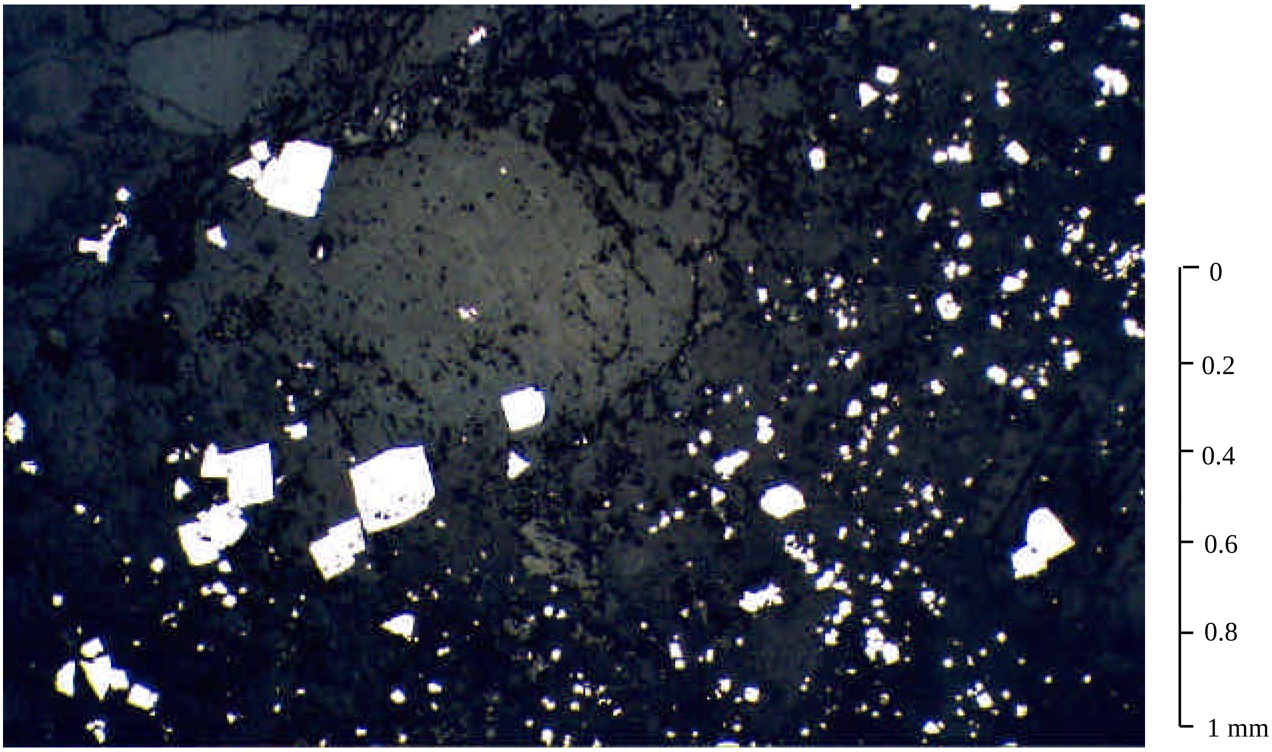

PLATE 2: SAMPLE 24/4/111 (Reflected plane polarised light, x5, Film 1 / Frame 10)
This view illustrates the development of alteration pyrite (small white crystals) in both altered lithic clast (right) and in enclosing matrix (left). The larger pyrite crystals at left are actually developed in a pressure shadow marginal to the lithic clast (also see PLATE 3).

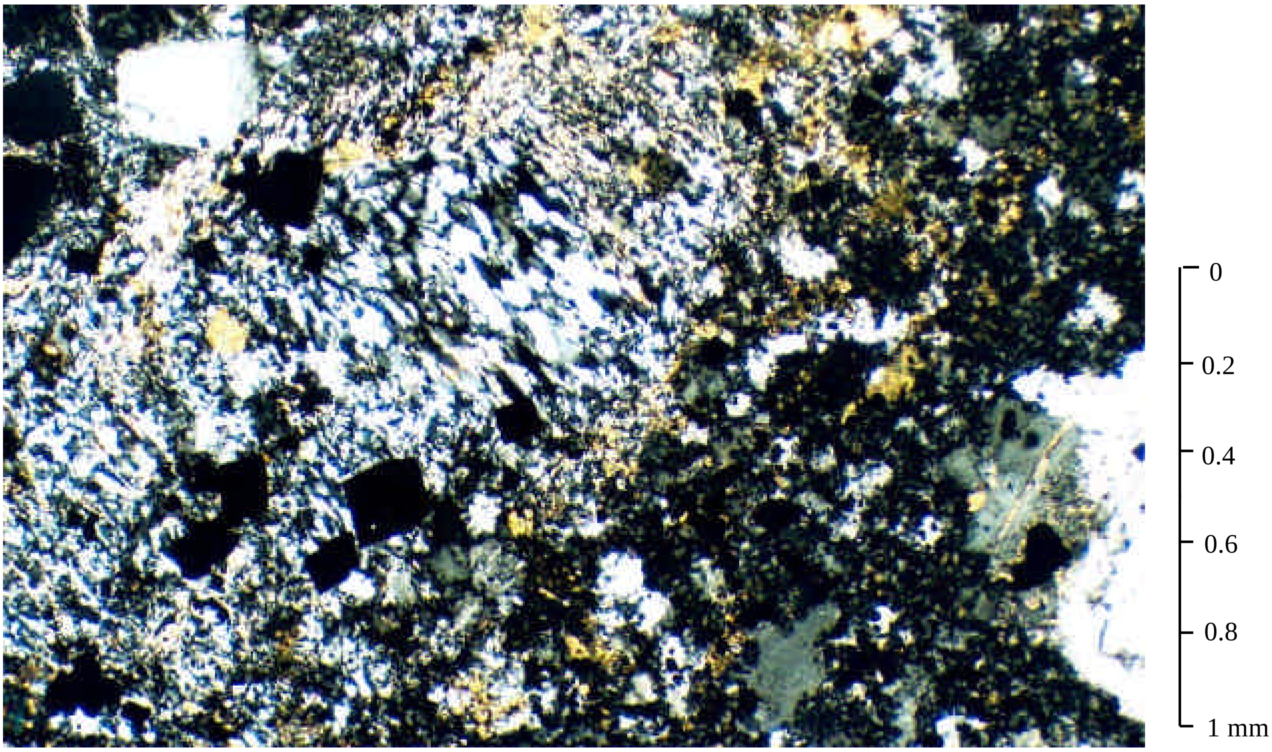

PLATE 3: SAMPLE 24/4/111 (Transmitted light, crossed polarisers, x5, Film 1 / Frame 11)
A pressure shadow (upper left) has developed at the margin of a large lithic clast (lower right). Note the lineation of the quartz (white to grey) oriented NW-SE, which confirms development of the alteration minerals during application of a directed stress regime. The pressure shadow is composed of quartz, pyrite (small black cubes, also see PLATE 2 above), and minor fine sericite and calcite.

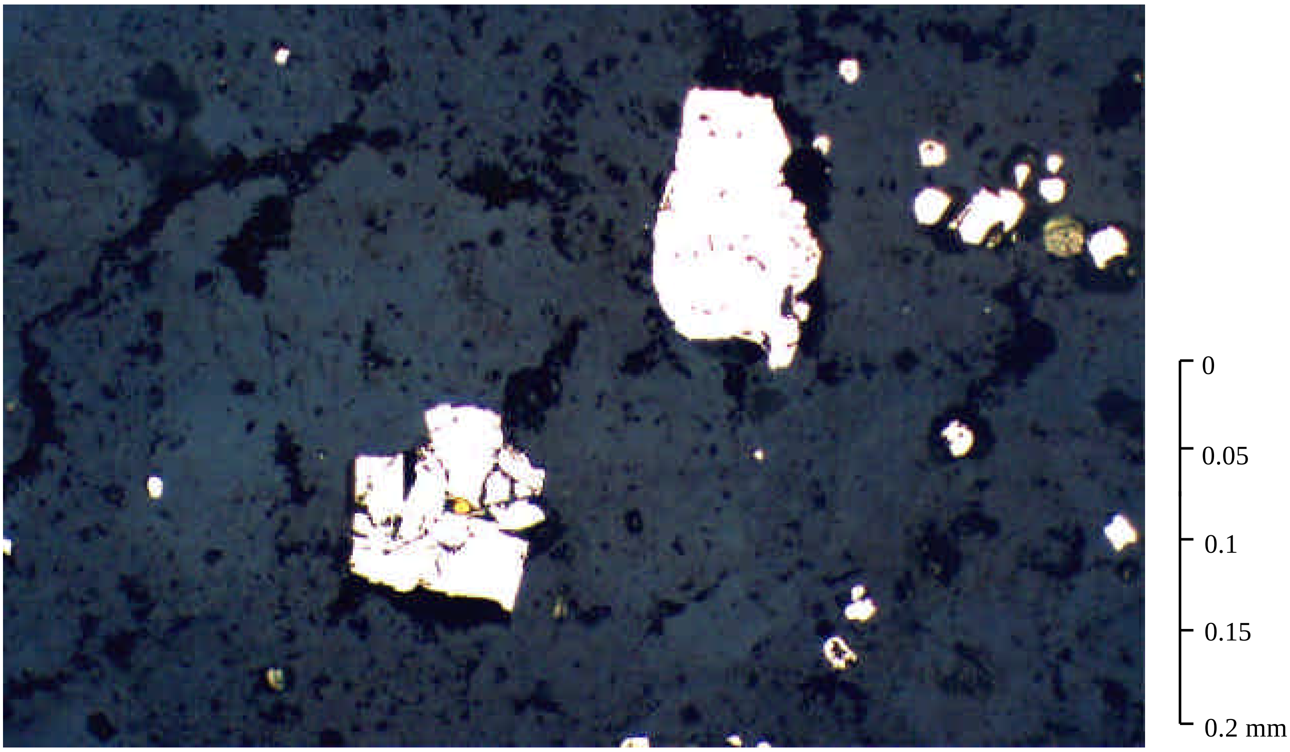

PLATE 4: SAMPLE 24/4/111 (Reflected plane polarised light, x20, Film 1 / Frame 13)
This view illustrates the occurrence of native gold (yellow) as a small inclusion within a pyrite crystal (lower centre). This view was taken from within an altered lithic clast, where pyrite is most abundant.