The Sams Creek Porphyry Gold Deposit, Northwest Nelson, New Zealand

P V M Angus[1], R Jongens[2], Yu Nazimova[3], M J McCulloch[4] and G Ryan[3]
[1]MOD Resources Ltd, 18 Princes St, Dunedin. Email: paul.angus@xtra.co.nz
[2]Anatoki Geoscience Ltd. Email: richard.jongens@gmail.com
[3]NZ Exploration Ltd. Email: jul_nz@yahoo.com and pacificgeological@hotmail.com
[4]Golder Associates NZ Ltd, 105 Montgomery Square, Nelson. Email: mmcculloch@golder.co.nz

INTRODUCTION

Sams Creek mineralisation is contained within a hydrothermally altered peralkaline granite porphyry dyke that intrudes Early Paleozoic metasediments (Tulloch, 1992). The dyke is up to 60 m thick and can be traced for over 7 km along strike. The dyke generally dips steeply to the north (~60º) with gold mineralisation extending down dip for at least 1 km and is open at depth. A resource of 1.0 Moz of gold has been estimated at the Main Zone (Golders, 2012) which comprises an 800m section of the Sams Creek Dyke, highlighting the potential for a significant increase in the known gold resource.

The porphyry dyke is variably mineralised and has been modified by at least four alteration / mineralisation phases. The first stage of alteration (Stage I) is represented by a magnetite–ankerite±biotite assemblage (Figure 1a). The occurrence of the early stage alteration minerals, magnetite and biotite, is similar to the magnetite + biotite alteration found in many calc-alkaline and alkaline porphyry Cu–Mo–Au deposits, where it represents an early high temperature stage (Brathwaite and Faure, 2004).

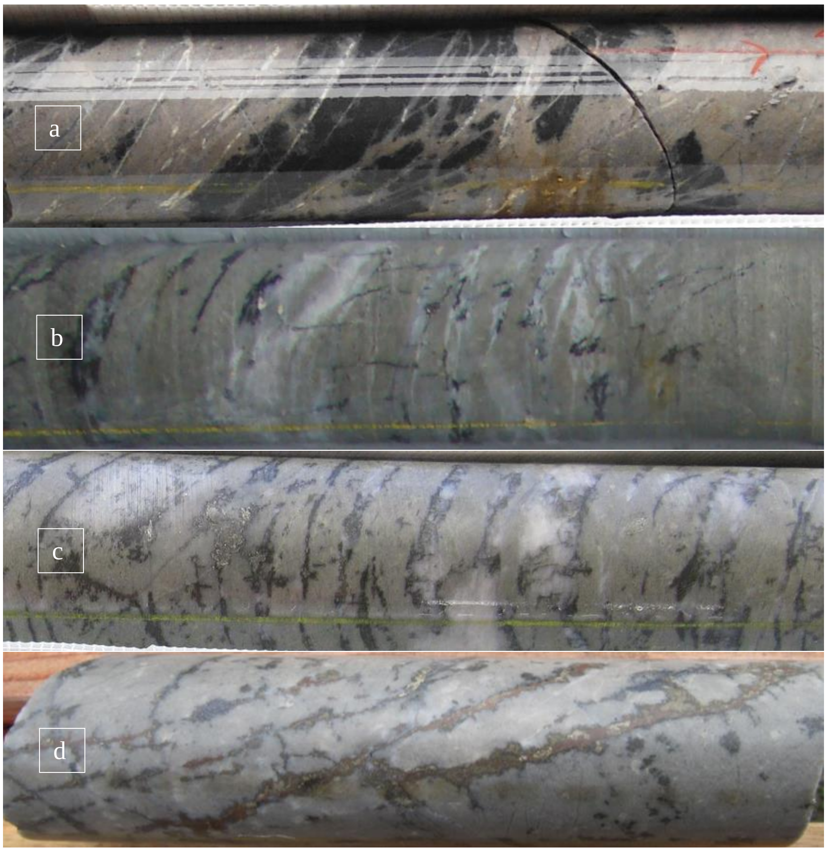

FIG 1 - Sams Creek Porphyry Dyke: a) Stage I magnetite–ankerite±biotite alteration, b) Stage II quartz±pyrite, c) Stage III arsenopyrite±pyrite veins, d) Stage IV base metal veins.

The second stage of alteration/mineralisation (Stage II) consists of thin quartz, pyrite, quartz-pyrite, or quartz–albite veinlets, which contain no gold (Figure 1b).

Stage III mineralisation consists of irregular to planar gold-bearing arsenopyrite-pyrite±quartz veins (Figure 1c), which form sheeted and local stockwork vein complexes that generally dip to the SE and form moderate-high grade gold zones (Figure 2). Veins vary in thickness from <1 to 15mm. Thirteen 'ore' minerals have been identified within the mineralised zones. Arsenopyrite is the most abundant (~85%) followed by pyrite (~10%), while the remaining ten minerals (gold, zircon, ilmenite, sphalerite, chalcopyrite, molybdenite, galena, marcasite, pyrrhotite, rutile and graphite) accounts for 5%. Wolframite was also recognised in one sample (Brathwaite, 2012).

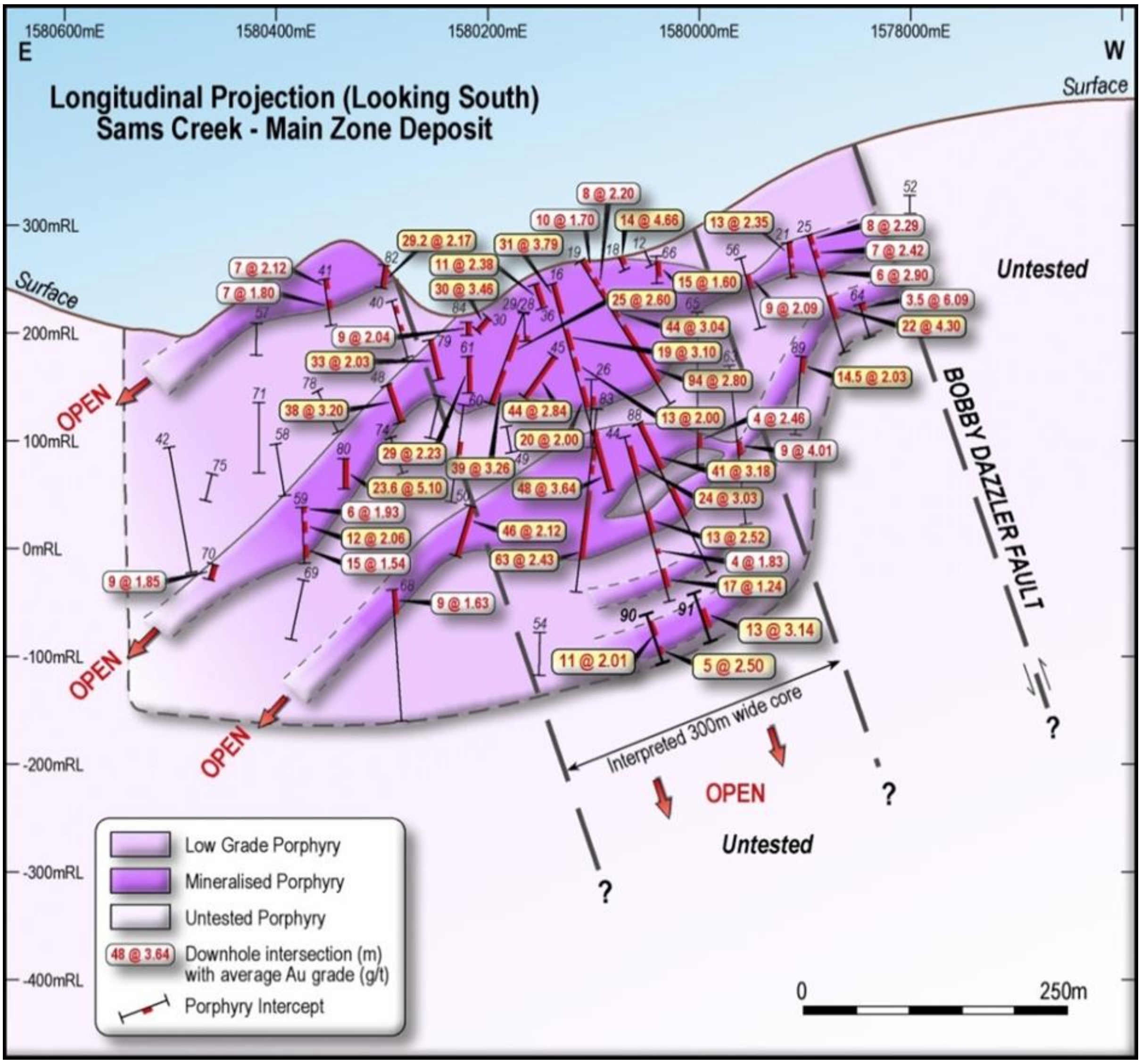

FIG 2 - Sams Creek longitudinal projection looking south showing downhole intercepts.

Two generations of gold are recognized (Nazimova, 2012). The first (Gold-1) occurs as minor disseminations (1-3 µm) of gold in pyrite and arsenopyrite, and is characterised by a relatively high degree of purity (average 85% Au, 15% Ag). Gold-1 produced only anomalous gold values ranging not more than tenths of g/t. The bulk of the gold was introduced during a second gold mineralising pulse (Gold-2), together with galena and chalcopyrite, filling microfractures in arsenopyrite. Gold-2 is much coarser (up to 20 µm) and less pure (average 70% Au and 30% Ag) than Gold-1. Small grains (5-20 µm) of hydrothermal zircon were found in association with Gold-2.

In some of the recent deeper drillholes the Stage III arsenopyrite veins have been cut by Stage IV base metal veins up to 15 mm thick (Figure 1d). These veins contain galena, sphalerite, chalcopyrite and pyrite (Angus, 2013). From the analytical data it appears that these veins don't contain significant gold if any, and appear to dip steeply to the SW orthogonal to the Stage III auriferous veins. However, some very high grade gold grades (10-18 g/t Au) are located in the vicinity of these base metal veins.

Three major deformation events are recognised in the metasedimentary rocks of the Main Zone and surrounding area (Jongens, 2013). The first, D1, is represented primarily by a S1 slaty cleavage subparallel to bedding and some indirect evidence of recumbent folding. D2 is the most prominent of deformations and is recognised by a widespread mesoscale and macroscale folding (F2) of bedding. An associated axial planar slaty-like crenulation cleavage (S2) is ubiquitous throughout the prospect. F2 folds have gently SSE-plunging axes, east-dipping axial planes, and westerly vergence. From east to west, F2 increases in tightness and become overturned towards the west. D3 is represented by a widespread but often difficult to see crenulation cleavage (S3) and rare F3 gentle folds. S3 is NE to ENE-striking, dipping SE. Folds on bedding reference surfaces plunge towards the east or southeast.

Stereographic analysis of the Stage II and Stage III vein orientations, measured in both drill core and outcrop, demonstrate a strong NE to ENE trend, dipping to the southeast (Jongens, 2013). This orientation is sub-parallel to F3 axial planes and S3 crenulation cleavages indicating a strong relationship between the veining in the dyke and D3 deformation.

A D3 folding model of Stage II and Stage III vein formation is proposed whereby the Sams Creek granite dyke, as a competent unit, buckles within a far less competent argillitic-dominated host rocks. This buckling leads to gentle open F3 folds with veins preferentially forming in the tension gashes of the fold hinge area and within incipient boudin necks of the extending fold limbs. These incipient boudin necks are sub-parallel to the fold hinges, and the higher concentrations of veining in these two areas results in NE plunging mineralised shoots as shown in Figure 3. These shoots are up to 35 m wide and 100 m high separated by narrower zones of lower grade gold mineralisation.

This interpretation indicates that the gold mineralisation of the Sams Creek Dyke occurred during D3 deformation. Regional timing constraints bracket D3 to the Cretaceous (Jongens, 2013), suggesting mineralisation also occurred at this time. This is at odds to the currently accepted Carboniferous (~319 Ma) age for dyke emplacement (Tulloch and Dunlap, 2006), as it is unlikely that dyke IRGD mineralisation took place 200 Ma after it was emplaced. However, recent U-Pb dating of primary zircons from both the dyke and hydrothermal zircons (Philips, 2013) from Stage III mineralised veins indicates an upper Early Cretaceous age for both dyke emplacement (109 ± 9 Ma) and the main gold bearing hydrothermal event (114 ± 6 Ma). The error limits on these ages overlap indicating that emplacement of the dyke and gold mineralisation occurred at a similar time, and is compatible with the folding model proposed.

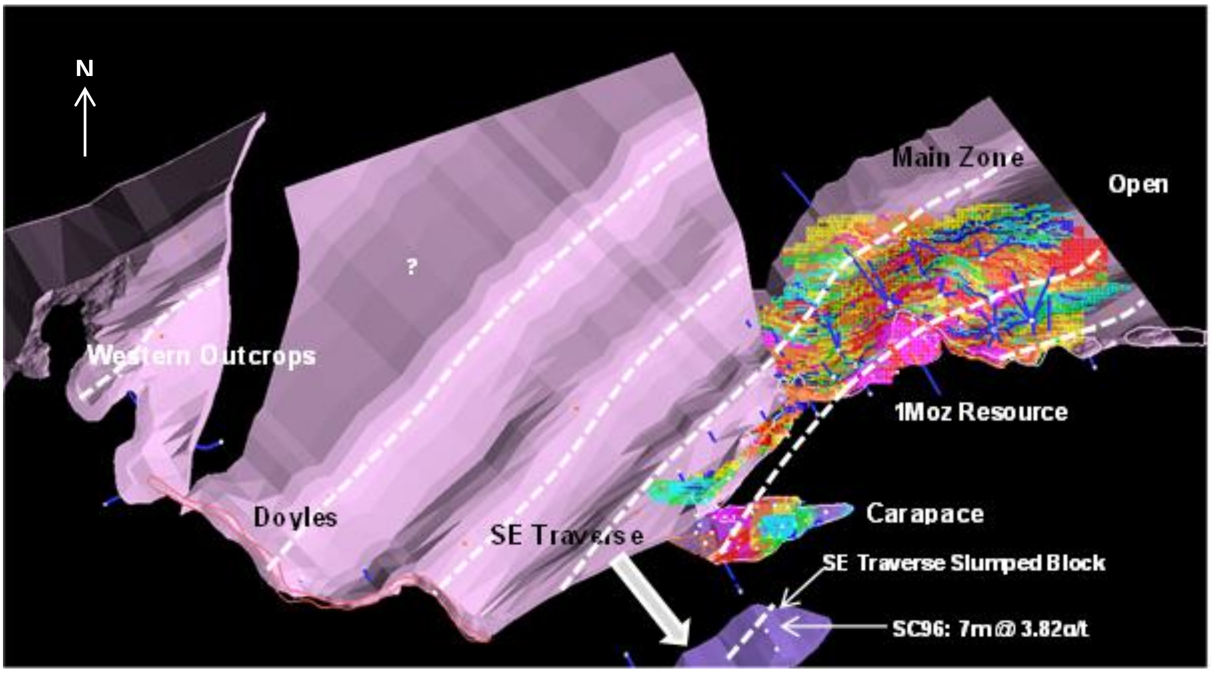

FIG 3 - Sams Creek Dyke 3D projection (pink) showing NE trending F3 fold axis (white dotted lines), drillholes (blue lines) and the resource block model (green = low grade - magenta = high grade).

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