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COMMENTS ON THE

EXPLORATION MODEL

IN USE AT THE

STAVELY PORPHYRY PROJECT,

WESTERN VICTORIA

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September 2017

SUMMARY

A brief review of existing drill core at Thursdays Gossan was carried out in order to comment on the exploration model in use by Stavely Minerals to plan the next drill programme, which suggests 'above-porphyry' features provide targets for porphyry Cu mineralisation at depth. Therefore several 'above-porphyry' features have been considered as:

Stavely Minerals have correctly defined D veins as those typical of settings marginal to porphyry Cu intrusions and which provide quality vectors to porphyry Cu mineralisation at depth. While two populations include early Mo and later pyrite sets, the numerous high quality pyrite veins represent excellent exploration vectors.

Pebble dykes identified in drill core are also typical above porphyry environments and are locally cut by D veins, as recognised elsewhere.

Pyrite D veins in drill hole DDH STRC19D are overprinted by an oxidised mineral assemblage dominated by chalcocite with lesser bornite and also haematite including specularite. The Cu-rich ore fluid responsible for this is mineralisation interpreted to have been derived from a deeper porphyry source and is typical of fluids which evolve to deposit in high sulphidation epithermal ores at higher crustal levels in polyphasal porphyry terrains .

Although the final 3 dimensional analysis of the patterns of prograde and retrograde hydrothermal alteration are awaited, alteration assemblages recognised to date are typical of an above porphyry setting.

A dilatant flexure discernible on the data to hand provides a possible setting for the emplacement of a vertically attenuated porphyry intrusion.

In <u>conclusion</u> the Stavely Minerals exploration model is of merit and the buried porphyry target should be tested with a priority A by progressively deeper inclined drill holes bored from SW to NE.

INTRODUCITON

At the request of Chris Cairns 2 days were spent at the Stavely porphyry Cu-Au exploration project in western Victoria in a review of the exploration model which will be used to plan the next drill program (figures 1 & 2).

Priority

Exploration projects are rated with priorities to proceed with the planned work program to take them to the next decision point. Any such a grading might include a number of projects at widely differing stages of evaluation, some with substantial data bases, while others might be unexplored, but may display considerable untested potential. Priorities are based upon the data to hand at the time of inspection, and are subject to change as increased exploration provides improved and additional data. Projects are categorised as:
A – Of highest interest such that the proposed exploration program should be carried out immediately. However, early stage projects with untested potential might be rapidly down graded from this stage by completion of the planned work program.
B – Of some interest and should be subject to further work if funds are available, often with smaller components of continued exploration expenditure than higher priority targets.
C – Of only little interest and subject to further work at a low priority if funds are available, but not to be relinquished at this stage.
D – Of no further interest and can be offered for joint venture or relinquished.

EXPLORATION MODEL

The geological model in use by Stavely Minerals to plan the next drill program at Thursdays Gossan is based upon the argument that the presence of "above-porphyry" features identified in existing drill holes provide vectors towards a target for porphyry Cu-Au mineralisation at depth. This review therefore comments on a target identified in the vicinity of the major fault contact between the (western) volcano sedimentary sequence and (eastern) ultramafic rocks where abundant D veins have been recognised (figures 1 & 2). Such a target lies below the low angle syn-mineral low angle fault which has been difficult to penetrate in many drill tests.

EXPLORATION VECTORS

The features commonly used to vector towards porphyry mineralisation and under consideration here include:

- D veins.
- Pebble dykes.
- Overprinting evolved porphyry-related ore fluids.
- Zoned prograde and overprinting retrograde alteration.
- Metal zonation.
- Structural control to porphyry localisation.

Porphyry D veins

Porphyry D veins were first described by Gustafson and Hunt (1975) from the El Salvador, porphyry Cu deposit in Chile, where they are recognised within the overlying wall rocks and were interpreted to have developed late in the paragenetic sequence of hydrothermal events. Those workers defined D veins as containing high proportions of pyrite with lesser chalcopyrite, bornite, enargite, tennantite, sphalerite, galena with minor quartz and local anhydrite. Distinctive sericite alteration halos may grade to more marginal kaolinite. Porphyry-related D veins are equivalent to low sulphidation (deep) epithermal quartz-sulphide Au $\pm$ Cu veins classified by Corbett and Leach

(1993-1998). Whereas the Gustafson and Hunt classification grades outward from a porphyry, the Corbett and Leach classification grades downward from the epithermal environment. In recent times D veins are often divided into two packages, the low sulphidation group dominated by pyrite-chalcopyrite and high sulphidation veins dominated by enargite. Many D veins are expected to exploit structures within porphyry wall rocks and have been deposited from hydrothermal fluids derived from the same magmatic source at depth that might generate vertically attenuated polyphasal locally mineralised porphyry Cu intrusions at an apophysis. Other D vein lodes display structural patterns more consistent with a derivation from an actual spine-like porphyry Cu intrusions. Many D veins are worked as epithermal Au (+Cu) mines and near surface supergene Au enrichment is exploited by artesian miners. Consequently, strong populations of D veins might vector towards a mineralised porphyry Cu intrusion at depth.

An analysis of D veins associated withe the Thursdays gossan porphyry by Stavely Minerals geologists has identified two prominent types as: Mo-rich, and pyrite dominant with anomalous Cu-Au. One specimen noted in this review (photo 1) of a pyrite-dominant D vein cutting a Mo D vein supports the Stavely Minerals interpretation that the pyrite veins are younger than the Mo veins. This drill core inspection has identified many quartz-pyrite veins typical, in this author's experience, of D veins, or low sulphidation (deep) epithermal quartz-sulphide Au ± Cu veins, as illustrated in photos 2 and 3. A number of the D veins inspected in this review lie within fault zones with protracted histories of activity and so have been crushed to a mass of pyrite grains.

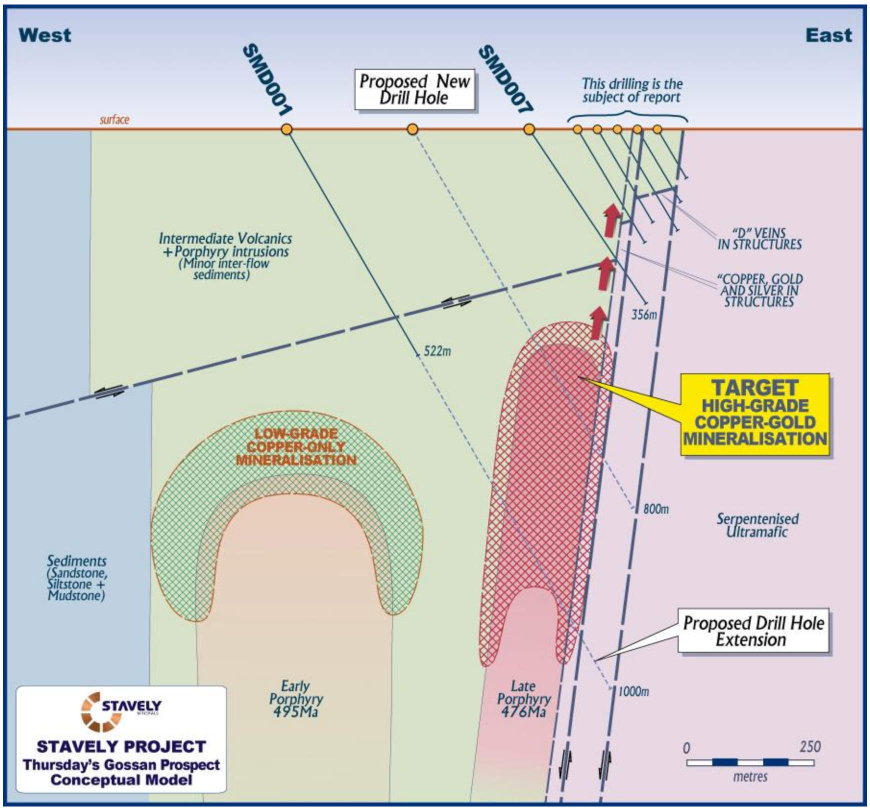

Figure 1. Stavely Minerals model that suggests two porphyry events are discernible and that a porphyry Cu-Au target lies at depth in the vicinity of Ultramafic Contact Fault.

Pebble dykes

Pebble dykes (Farmin, 1934; Bryner, 1961; Cornelius, 1967; Gustafson and Hunt, 1975) typically exploit linear pre-existing structures at near porphyry crustal levels and comprise rounded transported clasts in a polymictic clast-rich breccia and result from the rapid degassing of depressurised volatiles which vent up structures from cooling magmatic source bodies at depth. In these settings clasts rising rapidly up the narrow structure become rounded by milling, aided by hypogene exfoliation during depressurisation. While the common definition of pebble dykes is a clast supported breccia from which finer grained rock flour material has been winnowed out during transport, considerable matrix is also recognised in some examples, such as the 0-80% cited by Baldwin et al. (1978) for the pebble dykes which transect the Panguna Porphyry Cu deposit, Papua New Guinea. Pebble dykes might also emanate from the same magmatic source at depth as that which is responsible for the development of D veins in the apophysis (Panguna, Papua New Guinea; El Salvador, Chile) as well as the porphyry developed in the apophysis. Pebble dykes are interpreted by Gustafson and Hunt (1975) to form late in the El Salvador paragenetic sequence along with D veins and are commonly overprinted by D veins (Bilimoia, Corbett et al., 1994). Although some pebble dykes at Stavely are consistent with the definition of a pebble dykes as dominated by milled transported clasts from which the milled matrix has been winnowed (photo 4), matrix-rich magmatic hydrothermal breccias are also likened to pebble dykes (photo 5). Brecciation is very common in the permeable sedimentary rocks close to the Ultramafic Contact Fault. Some cases of D veins cutting pebble dykes are also recognised at Stavely (photo 6), similar to elsewhere.

Overprinting oxidising fluids

A typical quartz-pyrite D vein at the faulted contact between the western hanging wall volcano sedimentary sequence and eastern ultramafic rocks (the Ultramafic Contact Fault) is overprinted by a later more oxidised mineral assemblage in DDH STRC19D at about 148-155m (photos 7-12). Quartz-pyrite is cut by a chalcocite matrix breccia with quartz-pyrite clasts (photo 8), which appears to progressively contain increased bornite (photos 9 & 10), and then varies to silica-haematite alteration (photo 11), grading to specular haematite (photo 12) closest to the Ultramafic Contact Fault. The chalcocite ores yielded an ore grade of 5.2% Cu, 1.9 g/t Au and 128 g/t Ag. Several individual chalcocite-bornite fluidised breccias cut the pre-existing quartz-pyrite D vein. The adjacent wall rock alteration up hole appears as sericite while any wall rock within the mineralised structure is replaced by kaolin. Curiously, the chalcocite-bornite mineralisation is locally accompanied by textural destruction reminiscent of vughy silica recognised in high sulphidation epithermal Au deposits (photos 10 & 13). However, no alunite-pyrophyllite alteration typical of advanced argillic alteration minerals associated with high sulphidation epithermal Au deposits was recognised in the volcanic or ultramafic wall rocks in DDH STRC19D, although these acidic alteration mineral assemblages are recognised elsewhere in this portion of Thursdays gossan.

It is interpreted the oxidising fluid which cuts the earlier D vein has deposited late stage hypogene chalcocite as recognised in other porphyry deposits (Cadia East & Goonumbla, Corbett and Leach,1998) and locally occurs with advanced argillic alteration (Dizon, Philippines, Corbett and Leach, 1998; Resolution porphyry, Arizona, Hehnka et al., 2012). Thus, the hydrothermal fluid which has deposited chalcocite is typical of a magmatic fluid which might evolve during the rise to a higher crustal level of a magmatic fluid to form a hot acidic fluid recognised as responsible for the development of advanced argillic alteration by reaction with the wall rocks as part of high sulphidation epithermal Au deposits. The presence of vughy silica is consistent with this fluid evolution. A similar chalcocite-covellite cap to the Golpu porphyry in Papua New Guinea developed by the overprinting of the evolving acidic fluid responsible for the development of the Wafi high sulphidation epithermal Au deposit up-dip from the porphyry.

Importantly, some additional source of Cu would be required at depth to produce the mineralised chalcocite in drill hole DDH STRC19D and this source might represent a porphyry Cu target at depth.

Zoned hydrothermal alteration

At the time of writing collation of the spectral alteration data into a three dimensional model remains in progress. The drill cores examined in this review are characterised by:

- Surficial clay alteration of interpreted supergene origin which collapses to the base of oxidation and so typically occurs above the supergene Cu blanket, as might be expected.
- The supergene Cu blanket is expected to form by the replacement of hypogene primary sulphide minerals within the transition zone and extending downwards to replace hypogene sulphides.
- Strong collapsing phyllic alteration overprints much of the prograde alteration and evolves to contain clay alteration, especially within some permeable volcano sedimentary rocks.
- Several occurrences of pyrophyllite close to the Ultramafic Contact Fault are all indicative of some development of an advanced argillic alteration assemblage typical of that which might be expected if the oxidising fluids described above were to evolve to a high sulphidation epithermal Au deposit.
- Deep intersections of hypogene kaolin alteration may be derived from the progressive cooling and neutralisation of hot acidic waters which might be expected to produce wall rock sericite alteration. The overprinting of phyllic by argillic alteration is termed SCC (sericite-clay-chlorite) alteration in some geological literature.
- Minor propylitic alteration characterised by magnetite-epidote is consistent with a setting distal to an intrusion source.

These alteration assemblages are all typical of an “above-porphyry” environment.

Metal zonation

A porphyry Cu-Au deposit at depth might be Au-Cu rich if bornite represents the main Cu species and grade to Cu>Au bearing in the presence of chalcopyrite as the main Cu suite. While Mo might occur with Cu-Au with porphyry ore, in many porphyry deposits there is a disconnect in time and space between Cu and Mo, and Mo occurs outside the Cu zone. In these settings Mo may be locally used as a vector towards buried porphyry mineralisation.

The oxidising chalcocite-bornite mineral assemblage may evolve to higher crustal level enargite in a high sulphidation epithermal Au environment. Here enargite ores will be As and locally Sb bearing.

In a low sulphidation epithermal Au environment chalcopyrite-dominant porphyry Cu ores might evolve at higher crustal levels to become Zn-Pb (sphalerite-galena) anomalous and host As, Sb and Hg at highest crustal levels associated with a variety of minerals such as arsenean pyrite and tennantite-tetrahedrite. Minor low temperature white (low Fe) sphalerite at Stavely has probably been deposited following uplift and erosion, as also interpreted for Copper Hill, Australia (Hayward et al., 2013).

Structure

Many porphyry deposits are emplaced into dilatant structural settings such as splay faults at depth which may pass upwards to flexures within the negative flower structure model. In the region under consideration here, structures of the Ultramafic Contact Fault are traced at about 320^{o} between cross sections, whereas the structural grain of the district trends more to the NNW. A possible flexure apparent on the magnetic data (figure 2) is consistent with a sinistral sense of movement on the NNW structures during mineralisation, a trend recognised throughout the Lachlan Orogen (Corbett and Leach, 1998; Corbett, 2012).

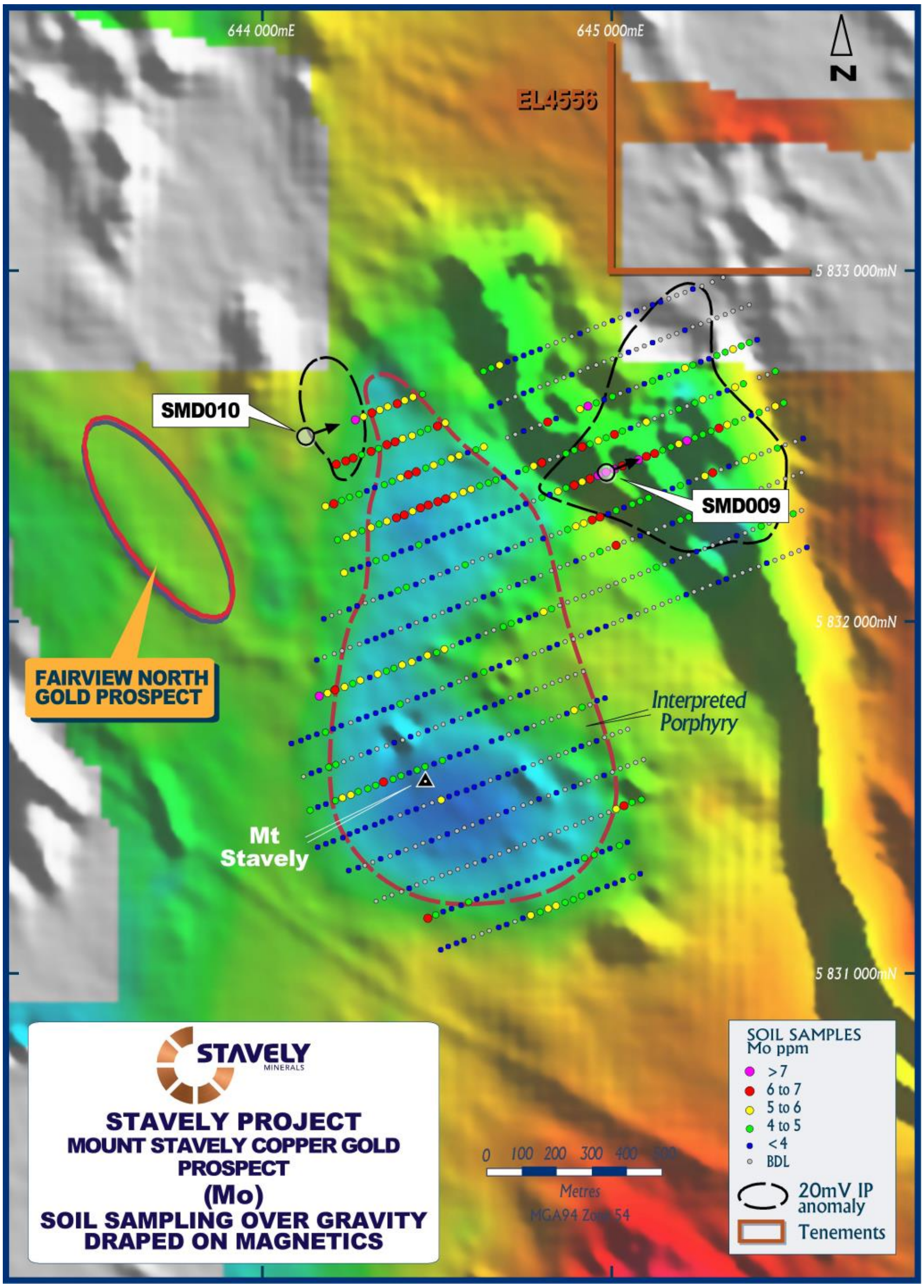

Figure 2. Stavely Minerals data showing a possible flexure in the vicinity of SMD009 in the structural grain interpreted to have formed by a component of sinistral strike-slip deformation on the NNW structural grain of the district.

CONCLUSION

Features recognised in the drill core examined are typical of those which might be expected above more deeply buried porphyry Cu deposits. The numerous well developed quartz-pyrite D veins provide greatest encouragement that a porphyry might occur at depth and the high Cu chalcocite breccia suggests such a body may be Cu-bearing. Hydrothermal alteration is similarly typical of an above-porphyry environment. A NW trending flexure within the generally NNW trending structural grain might provide a dilatant locus for porphyry emplacement.

The proposal by Stavely Minerals to bore deeper drill holes in this area is ranked with a priority A.

RECOMMENDATIONS

The proposed target for Cu-Au porphyry mineralisation should be tested with a priority A. An initial drill test should be bored at say, 100 metres below the deepest intersection to date and then any mineralisation followed to depth with deeper drill holes.

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Photo 1 Porphyry D vein which comprises the early Mo-rich D vein at the margins and later cross-cutting central pyrite-dominant D vein in the centre, DDHSMD6, 173.7m.

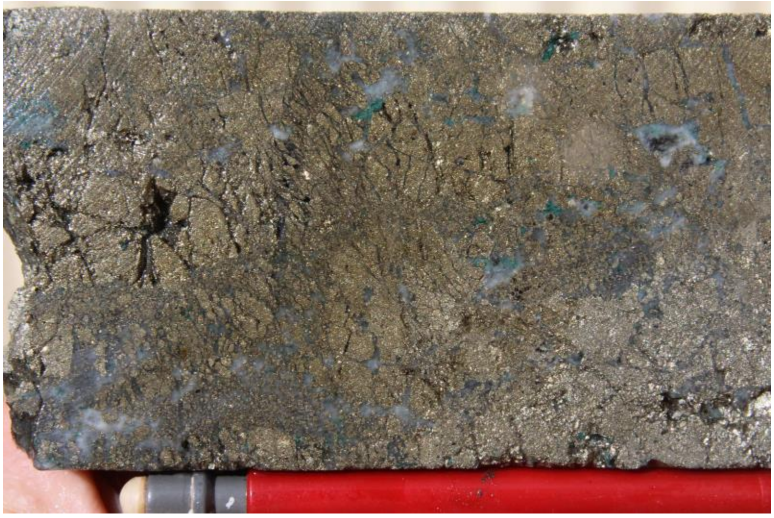

Photo 2 Typical quartz-pyrite D vein characterised by coarse crystalline pyrite, white quartz, (with an incorrect blue tone in this photo) and minor green micas which contain Cr derived from ultramafic rocks - DDHSTRC5D, 135.4m.

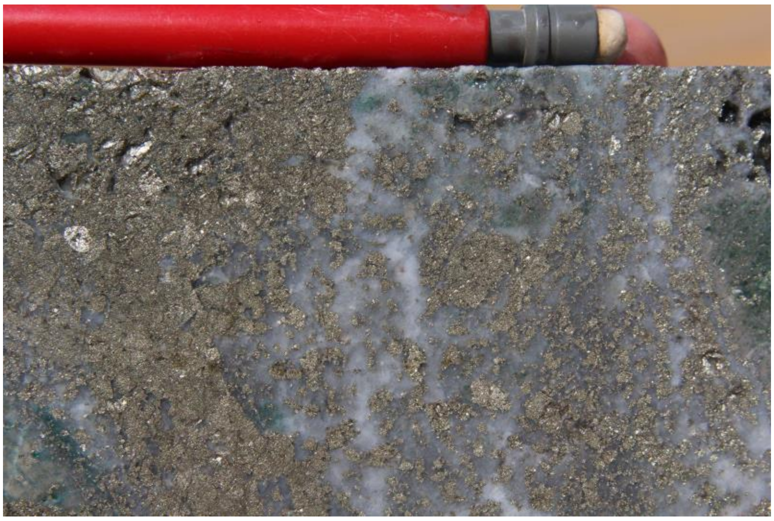

Photo 3 Typical quartz-pyrite D vein characterised by coarse crystalline pyrite and white quartz, DDH STRC19D, 148m.

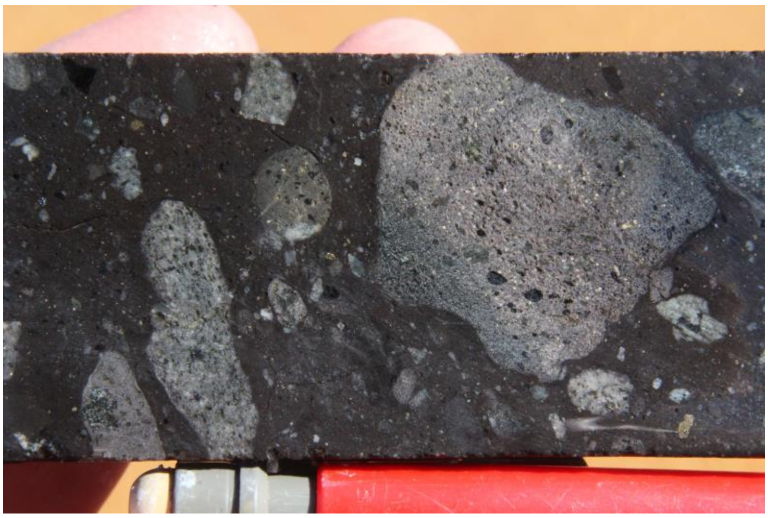

Photo 4 Stavely pebble dyke characterised by rounded milled clasts in a pyrite altered rock flour matrix, DDH SMD9.

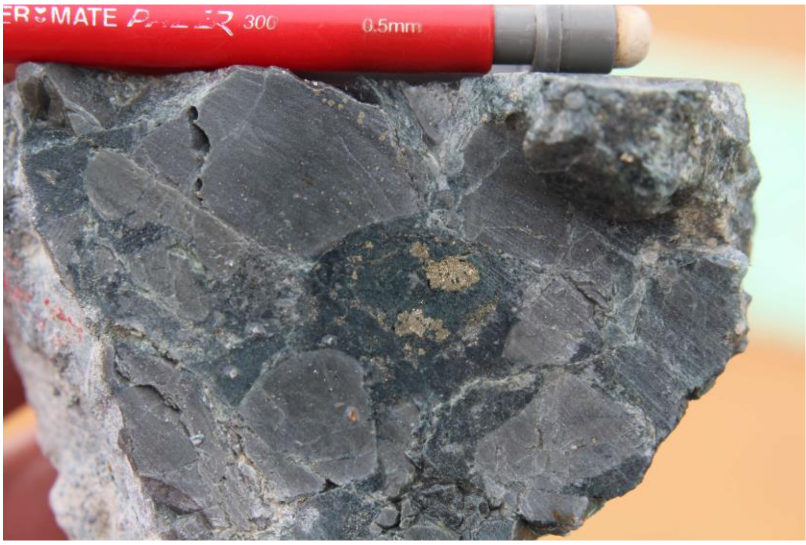

Photo 5 Stavely pebble dyke with altered clast, DDH STRC3D, 163.5.

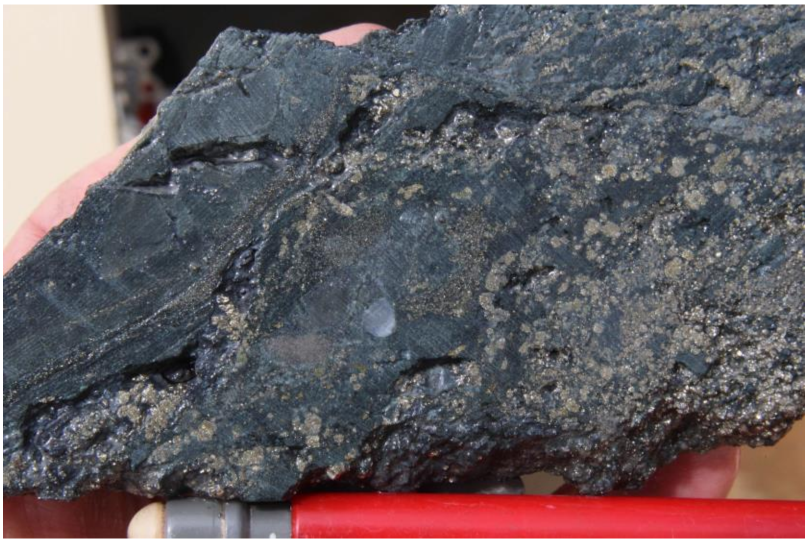

Photo 6 Stavely pebbly dyke cut by pyritic D vein, DDH STRC5D, 170.8m.

Photo 7 Quartz-pyrite vein (left) cut by chalcocite matrix breccia (right) with pyrite clasts, DDH STRC19D, 151.4m.

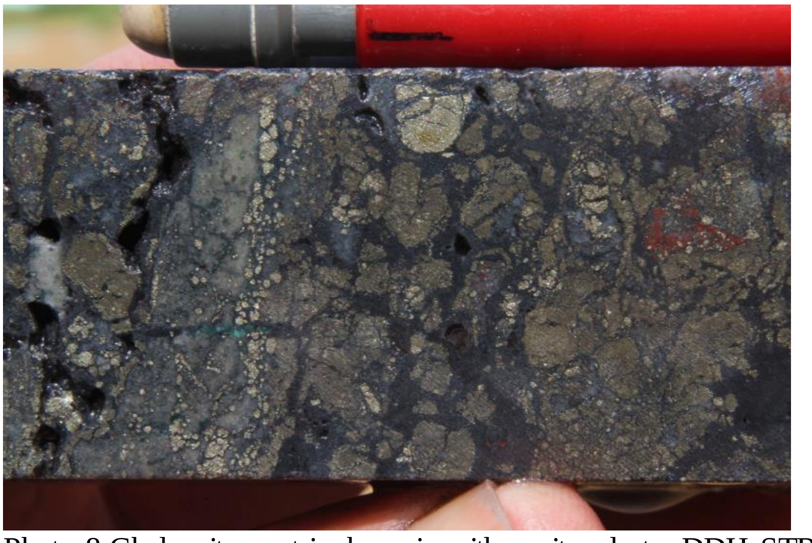

Photo 8 Chalcocite matrix breccia with pyrite clasts, DDH STRC19D, 151.4m.

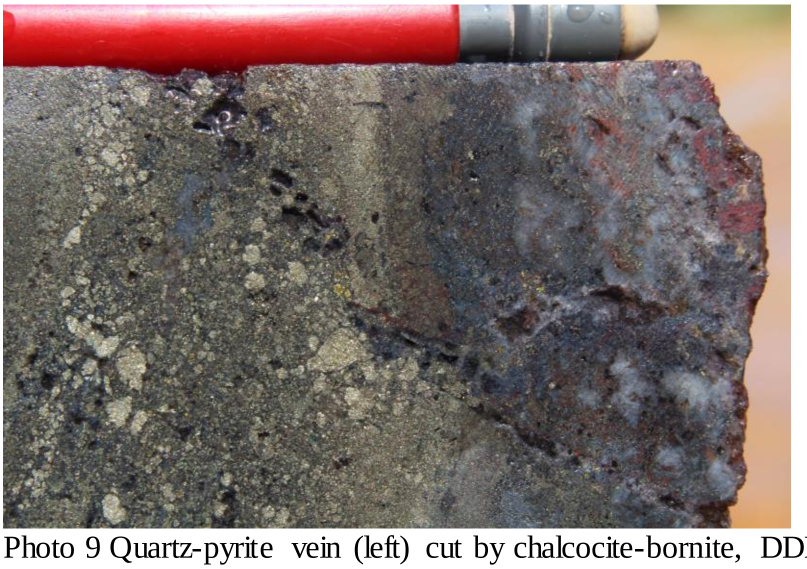

Photo 9 Quartz-pyrite vein (left) cut by chalcocite-bornite, DDHSTRC19D, 154m.

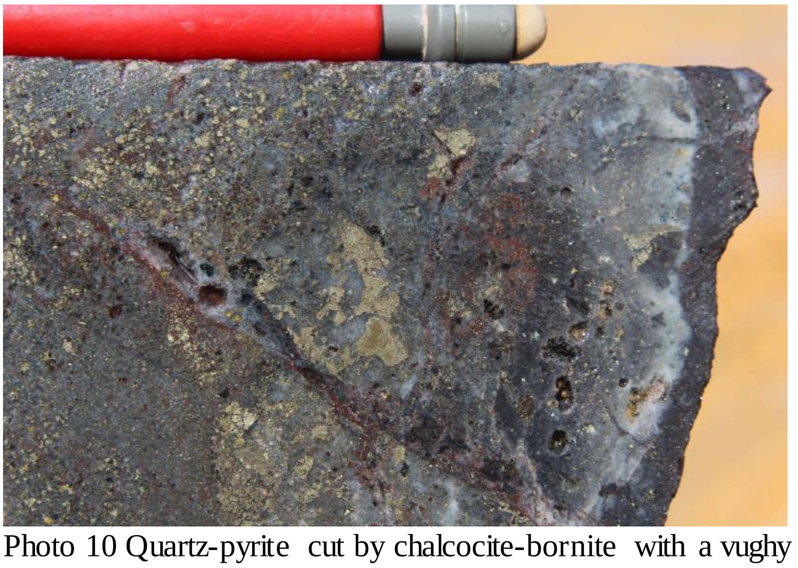

Photo 10 Quartz-pyrite cut by chalcocite-bornite with a vughy texture DDH STRC19D, 154m.

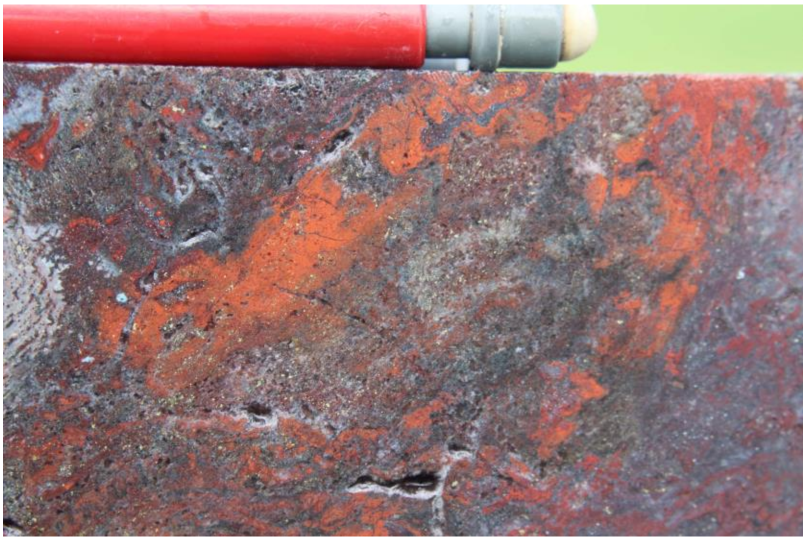

Photo 11 Silica-haematite overprints original quartz-pyrite D vein, DDH STRC19D, 151.8m.

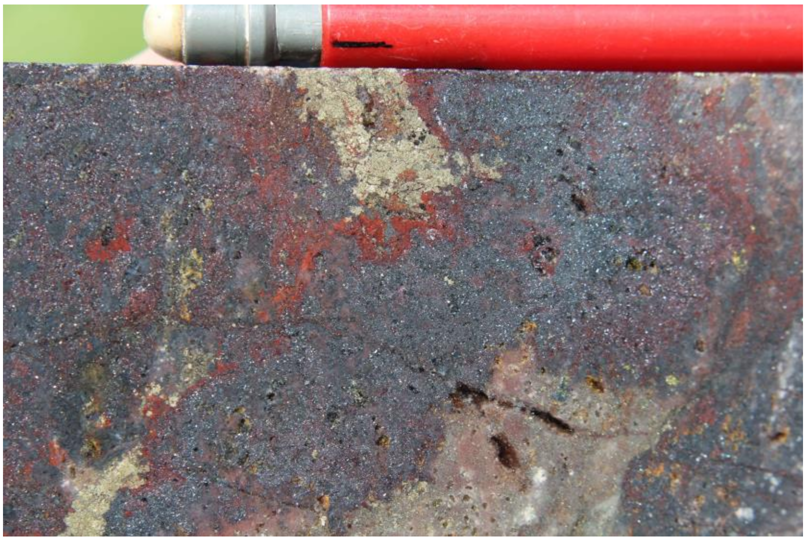

Photo 12 Specular haematite overprints original quartz-pyrite D vein, DDH STRC19D, 155m.
155.

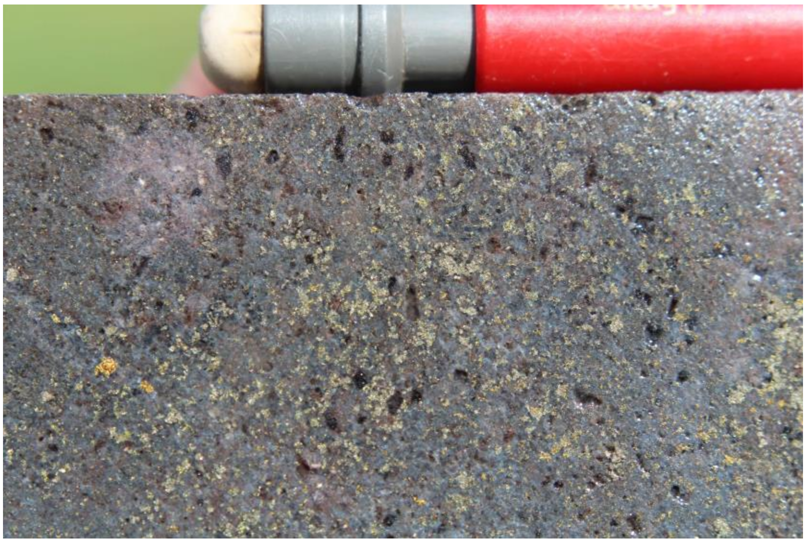

Photo 13 Vughy silica texture within chalcocite-bornite alteration, DDHSTRC19D, 154.5m.