DEPOSIT DESCRIPTION

Antapacay Porphyry Copper-Gold Project - Peru

Bart Stryhas, BHP, October 2000

The Antapacay project is a medium sized, moderate to high grade, hypogene porphyry copper-gold deposit with associated exoskarn mineralisation developed in carbonate host rocks on its margins. The project is located in the Andahuaylas-Yauri copper skarn belt on the Altiplano of southern Peru at 4100 m above sea level, some 256 km from Cusco to the NNW and 255 km from Arequipa to the SSW. Mineralisation occurs about two centres of Tertiary age intrusives, Antapacay North and Antapacay South, that have been emplaced within a package of Cretaceous carbonates and clastic sediments belonging to the Ferrobamba and Mara Formations respectively. The deposit is concealed beneath 5-50 m of late Tertiary andesitic volcanic and Quaternary colluvial cover which is displaced by a northerly trending normal fault zone that increases the thickness of cover to 160 m in the east.

Although outcropping high grade skarn mineralisation located at Atalaya on the northwest margin of the southern porphyry cluster has been mined sporadically since the 1930's, the Antapacay porphyry centres were not discovered by BHP until late 1998 / early 1999. The discovery was the result of persistent step out drilling of coincident ground magnetic and EM anomalies. ATA-20, the 8th hole drilled, was the first to intersect significant porphyry style mineralisation in what is now the northern porphyry centre and the larger southern porphyry cluster was not discovered until hole ATA-036, the 27th hole, was drilled. A ground IP survey which was completed as drilling proceeded was important in delineating the extent of disseminated mineralisation and locating further drill holes. The combined Antapacay North and Antapacay South resource is currently estimated at 420 million tonnes @ 0.82 % Cu and 0.15 g/t Au (7.58 billion pounds Cu, 2.03 million ounces Au) and the mineable ore resource at 285 million tonnes @ 0.95 % Cu and 0.19 g/t Au. This is based on approximately 66,000 m of drilling in 189 diamond and reverse circulation drill holes with a spacing of approximately 90 meters. Mineralisation is still open at depth, to the north at Antapacay South and to the northeast at Antapacay North.

Mineralisation in both the smaller Antapacay North and larger Antapacay South deposits occurs about centre of Tertiary age, quartz-monzonite, monzonite, monzodiorite andesite, granodiorite and dacite porphyry intrusives that have been emplaced within Tertiary Diorite and Cretaceous carbonate and clastic sediments. Early syn-mineral quartz monzonite, monzonite and monzodiorite porphyries are stock like bodies with only minor chilling developed on their margins. Latter syn-mineral andesite porphyry intrusives occur as north-west trending dykes that are autobrecciated, contain numerous wall rock inclusions and have well developed chilled margins. Flow banding imparted by textural variations and flow alignment of phenocryst phases is also well developed in the latter syn-mineral intrusive bodies. Post-mineral monzodiorite, granodiorite and dacite porphyry dykes cut the earlier mineralised intrusives.

The most important host rocks in the South are the syn-mineral quartz monzonite and monzonite porphyries while in the North the pre-mineral diorite and syn-mineral quartz monzonite, monzodiorite and andesite porphyries are the principal hosts to mineralisation. Biotite-magnetite alteration after primary mafic phases, groundmass and in early veins is strongly developed in the pre-mineral diorite and syn-mineral quartz-monzonite and monzonite porphyries in both the North and South. Subordinate K-feldspar alteration is also present primarily in vein envelopes. This stage of potassic alteration is accompanied by disseminated, fracture and vein controlled chalcopyrite, bornite, hypogene chalcocite and molybdenite mineralisation. High grade zones of intense stockwork veining and quartz alteration are developed in the diorite, quartz monzonite, monzonite and monzodiorite porphyries in both the North and South. Early stage quartz dominant veins with and without k-feldspar alteration envelopes are cut by sulfide dominant veinlets. These veinlets are in turn cut by zoned sulfide-quartz veins that commonly have comb textured quartz and sulphides in a central selvage or

along the vein margin. Potassic alteration is overprinted by partial chlorite-kaolinite alteration accompanied by chalcopyrite mineralisation of both primary and secondary mafic sites and incipient kaolinite-calcite alteration of plagioclase. Biotite veins cut pervasive chlorite alteration distal to the mineralised centres.

Gold occurs in the centre of the northern porphyry centre hosted by the diorite and syn-mineral porphyries. In the South gold is also central and deep in the system occuring within the zones of intense stockwork veining and alteration developed in the syn-mineral porphyries. The earliest quartz monzonite intrusive is also host to significant molybdenite mineralisation in the South.

Skarn is developed on the margins of both the northern and southern porphyry centres but is only a minor component of the overall resource. Variable chlorite-anorthite-epidote-garnet-pyroxene endoskarn is developed in both the porphyries and diorite while garnet-pyroxene-magnetite-chalcopyrite-bornite-chalcocite exoskarn is developed in the calcareous host rocks. The exoskarn commonly hosts high grade copper and sometimes gold mineralisation.
The southern porphyry centre is cut by a west-northwest trending, post-mineral, dacite dyke. Post mineral diatreme breccia bodies associated with emplacement of late monzodiorite porphyry intrusives cut both the northern and southern porphyry clusters. Alteration in the diatreme breccia bodies and the associated intrusives is primarily pyrite-chlorite-calcite-kaolinite. Calcite and latter gypsum-anhydrite veins cut all previous vein types. Late Andesite Dykes inferred to be feeders of the late Tertiary andesitic volcanic cover sequence cut all previously described porphyries and the diatreme breccia bodies.

A zone of leaching preserved beneath the andesitic cover is commonly 10-30 m thick but locally oxidation is deeply developed within late, northerly trending fault zones that displace the cover sequence. In both the North and the South, a zone of "perched" native copper-azurite-chrysocolla-tenorite-cuprite-malachite oxide mineralisation 10-30 m thick is developed above the centres of the two systems on horst blocks between these faults. The combined northern and southern oxide resource is approximately 12 Mt @ 0.38 % Cu. A thin, incipiently developed zone of secondary "sooty' chalcocite underlies the leached and oxide zones but is not economically significant. Anhydrite and gypsum have been leached from the upper parts of the deposits with this style of veining generally occurring from 380-400 m below the surface. The alteration and mineralisation observed at Antapacay is similar to that at other porphyry copper deposits except that the intrusives have a much less potassic, more sodic primary composition which has influenced the composition of the observed alteration assemblages. Antapacay is intermediate between the typical potassic quartz-monzonite systems that have early stage k-feldspar and biotite alteration followed by latter destructive quartz-sericite-pyrite alteration, and diorite systems that have early stage secondary biotite overprinted by late stage chlorite alteration and lack abundant pyrite. The system is high in S as evidenced by coexisting chalcocite-bornite-chalcopyrite and has a high oxidation fugacity, as implied by the abundant magnetite, biotite and chlorite and lack of pyrite until late in its evolution.