The geology and mineralisation of the world-class Alpala porphyry copper-gold deposit, northern Ecuador

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ABSTRACT

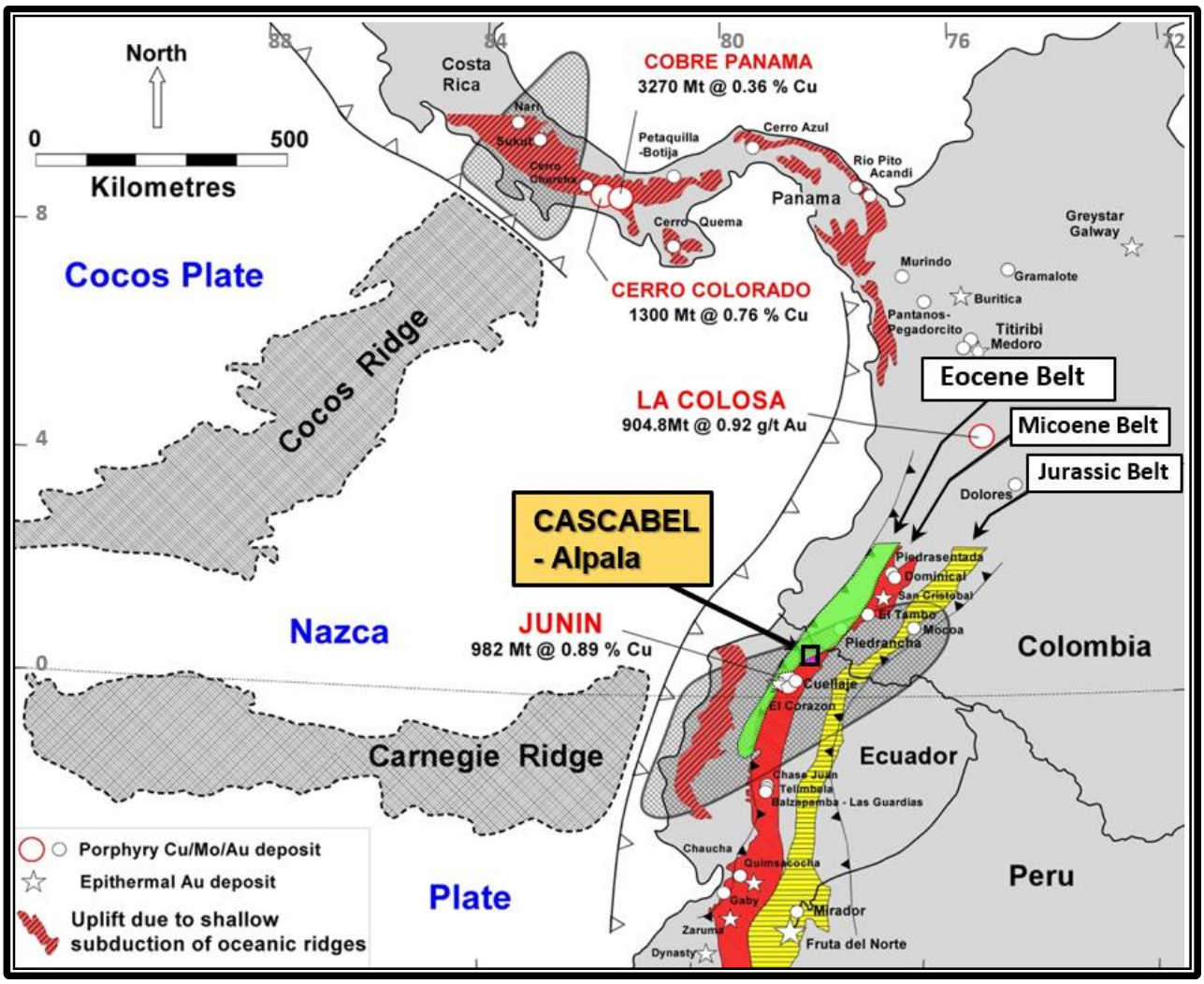
The recently discovered Eocene Alpala porphyry copper-gold deposit is located in the under-explored northern section of the Andean Copper Belt. The most recent resource estimate for Alpala (20 November, 2018) contains 2.95 Bt at 0.52% copper-equivalent (10.9 Mt Cu, 23.2 Moz Au, 79% Indicated) at a cut-off of 0.2% CuEq, which includes 420 Mt at 1.47% CuEq (3.8 Mt Cu, 12.3 Moz Au, 97% Indicated) at a cut-off of 0.9% CuEq. At a 0.45% CuEq cut-off, the deposit contains 960 Mt at 0.97% CuEq (6.1 Mt Cu, 16.2 Moz Au). The reported copper-equivalent values are calculated using the formula: CuEq (%) = Cu (%) + [0.63 * Au (g/t)], which equates to a $US 3.00 per pound copper and $US 1300 per troy ounce gold.

The recognition of geochemical zoning has assisted in drill-targeting within the deposit and tenement-wide exploration. This zoning is characterized by central Cu-Au; proximal Mo; proximal to distal Bi, Se and Te; and distal As, Mn and Zn. Within the Alpala deposit, variations of Au/Cu in drill-hole assist in the delineation of different intrusion stages.

The applications of the Anaconda method to geological mapping and drill-core logging have facilitated the identification of more than six major intrusion stages, a diagnostic vein sequence and sulphide-oxide mineral paragenesis that allows for the prediction of copper-gold grades. The most important indicators of high-grade include the presence of the early-stage causal intrusion(s), elevated porphyry-style vein abundance and an increased ratio of chalcopyrite to pyrite.

Radiometric U-Pb SHRIMP dates on zircons return 39.4 $\pm$ 0.6 Ma (2 σ) for the early-mineralisation quartz diorite intrusion and 38.7 $\pm$ 0.6 Ma (2 σ) for a late-mineralisation quartz diorite dike. A Re-Os date of molybdenite in a late-stage, sulphide-bearing anhydrite-quartz vein associated with quartz-sericite-pyrite alteration indicates 38.6 $\pm$ 0.2 Ma (2 σ). The age dates of the quartz diorite intrusions and late-stage molybdenite are not different in a statistical sense. Hence, the duration of the development of the Alpala porphyry system lies within the 2 σ error of the dating methods. This equates to a time-span of 800 ± 800 Ka (2 σ).

The sulphide mineral ore assemblages at Alpala are characterized principally by chalcopyrite, pyrite and bornite, which are similar to the main-stage to transitional-stage sulphide mineral assemblages present at Grasberg, Indonesia and the El Salvador and Portrerillos mines in northern Chile. The simple chemical formulas of the ore minerals at Alpala contribute to enhanced metallurgical recoveries and clean concentrates that lack any significantly deleterious elements.



Dr. Steve Garwin

Steve has more than 31 years of experience as an exploration geologist with large and small mining companies. He has participated in the gold and copper projects of more than 30 clients in over 18 countries. He worked with Newmont Mining for ten years, including two years as Chief Geologist in Nevada. Steve is a fellow of the Society of Economic Geologists, fellow of the Australian Institute of Geoscientists and a fellow of the Australian Institute of Mining and Metallurgy.

Steve is one of the leading authorities on porphyry, epithermal and Carlin-style mineralization in the circum-Pacific region. He has been involved in several, major exploration and mining projects, including the Batu Hijau porphyry mine in Indonesia, the mines of the Carlin and Battle Mountain Trends in Nevada, and the recently discovered world-class Alpala porphyry deposit in Ecuador.

Steve is an independent consultant based in Perth, Australia. He obtained his B.Sc. in geology from Stanford, M.Sc. from the University of British Columbia and Ph.D. (distinction) from the University of Western Australia. He is an adjunct research fellow at the Centre for Exploration Targeting at UWA and has authored and co-authored more than 40 scientific papers and abstracts. Steve is chief technical advisor to SolGold Plc. (SOLG:L and SOLG:TSX-V) and technical advisor to Japan Gold Corp (JG:TSX-V).