The geology and exploration footprint of the Cobre Panamá porphyry copper deposits

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The Cobre Panamá project comprises a cluster of porphyry copper orebodies that collectively contain measured and indicated resources of 3.27 Gt @ 0.36% Cu, 0.06 ppm Au, and 70 ppm Mo, among a global resource of ~6.5 Gt (~2.5 km³) of mineralised rock. Tropical regolith and forest cover conceal much of the surface footprint of the deposits, associated intrusions and peripheral alteration. Numerous organisations have explored the area since its discovery as a broad drainage chemical anomaly during a 1968 United Nations Development Program regional survey. Here we report the current understanding of the deposit, based on integration of historical work and recent exploration conducted by FQM, with emphasis on the delineation of the system and deposit footprints in exploration datasets.

The porphyry copper deposits at Cobre Panamá are unusual in that the base metal distribution defines a series of moderately dipping tabular zones rather than more classical upright bulbous or inverted cup-like forms. This is interpreted as a primary feature of the deposits, which formed during emplacement of a multiphase porphyritic dyke swarm along a pre-existing moderately to shallowly-inclined reverse fault zone. The dykes are cogenetic with the Petaquilla batholith; one of the largest of a series of Early Oligocene dacitic plutons that intruded an Eocene subaqueous mafic island arc package following collision of oceanic plateaux with the arc. Early vein geometries locally mimic the overall dyke orientation although later hydrothermal and magmatic stages are more steeply dipping. These relationships imply that mineralization mostly occurred during compression, with a syn-late-mineral switch to transpressional conditions. Post mineral extensional faulting had the effect of arranging the main stage stockworks within a narrow range of elevation. The upper, epithermal levels of the hydrothermal systems were mostly removed by erosion and the present incised but modest terrain fortuitously exposes the high temperature alteration and attendant sulfide-bearing stockwork of all but one of the known deposits.

The mappable footprint is restricted to the central part of each deposit because of limited outcrop and intense weathering. The regolith is mostly residual, and surface chemistry defines a much broader footprint. Soil chemistry is systematically zoned from proximal assemblage Cu-Mo-(Au-Sn), outward through a halo of elements related to primary pyrite distribution. The proximal anomalies map the location and footprint of the deposits from which epithermal levels have been eroded, while the distal haloes amalgamated to yield a near continuous soil chemical anomaly covering more than 40 square kilometres. Soil chemistry also accurately maps the distribution of intrusions and suggests a mappable stratigraphy in the host volcanic package. Airborne radiometrics also map the intrusive rocks as well as the proximal phyllitic alteration zones as
potassic anomalies that contrast with the basaltic substrate. The magnetic response of the deposits are variable. Some are associated with subtle magnetic lows, whereas others are more ambiguous.

The interplay of structural evolution and geomorphology at Cobre Panamá has yielded an unusually broad surface exposure of mineralized rock that is most clearly defined by surface chemistry despite intense weathering.