WHIM CREEK Cu-Zn-Pb DEPOSIT, PILBARA, WA

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LOCATION

The Whim Creek deposit is about 120 km E of Karratha and 1 km SW of the Whim Creek Hotel at 20°50'50"S, 117°49'40"E; Roebourne 1:250 000 sheet (SF 50-3).

DISCOVERY HISTORY

Oxidized copper mineralization has been mined at Whim Creek since 1889. Although there is contamination from early mining, there have been several soil and stream sediment geochemical surveys since 1965, to identify its geochemical signature and to test for geochemical dispersion in soils (Chisholm, 1983). Other geochemical surveys have included investigations of elemental associations in the ore horizon and its host rocks, and a comparative semi-quantitative analysis of the primary ore and overlying gossan (Nickel, 1982).

PHYSICAL FEATURES AND ENVIRONMENT

Whim Creek is within an arcuate, strike controlled range of low hills

GEOLOGICAL SETTING

The Whim Creek deposit lies within the Archaean Whim Creek Belt. This outcrops as a NE trending range of hills and consists of 1000-1500 m of rhyolitic-dacitic rocks and overlying fine- to coarse-grained felsic volcaniclastic and epiclastic rocks of the Mons Cupri Volcanics. The felsic volcanic pile is conformably overlain by 200-400 m of the well-laminated Rushall Slate, which has in-filled a small depocentre on the N flank of a domal felsic volcanic centre. These formations are unconformably overlain by up to 2000 m of basaltic and ultramafic volcanic and intrusive rocks of the Louden Volcanics and tholeiitic basalt-andesite lavas of the Negri Volcanics (Smithies, 1998; Collins and Marshall, 1999).

REGOLITH

The Whim Creek area was originally blanketed by a vast Cretaceous- Tertiary peneplain, the Hamersley Surface (Campana et al., 1964; Hickman, 1983). Subsequent erosion has completely removed this peneplain and its underlying weathered profile, leaving the Whim Creek volcanic belt as a low range of hills. Although a residual profile is not preserved, the Whim Creek ore body is a remnant of the palaeoweathered profile with a well-developed gossan/oxide zone above primary sulphide mineralization (Reynolds et al., 1975; Nickel, 1982).

MINERALIZATION

Sediment-hosted VHMS Cu-Zn-(Pb-Ag) mineralization at Whim Creek is confined to a single conformable horizon 150-200 m above the base of the Rushall Slate. The ore horizon can be traced for at least 5 km around the nose and along the limbs of a NE plunging syncline-anticline couplet (Figure 1). For most of its strike, the ore horizon is 0.5 m thick but thickens sharply to 10-15 m at the Whim Creek deposit where base metal mineralization outcrops over a strike of 600 m. Another, smaller lens in the same ore horizon outcrops as a gossan at the Rushall Prospect, about 1 km E of Whim Creek. The Whim Creek deposit originally contained at least 3.4 Mt of sulphide ore at 1.6% that are generally 50-60 m above sea level and attain a maximum of about 80 m. This low range is on the S edge of a vast plain that extends across granitic terrain to the coast. The plain reaches a maximum elevation of 25-30 m above sea level, where it laps onto the range. The climate is semi-arid with average daily maximum temperatures of 26-40°C and an average annual rainfall of about 300 mm. Most rainfall is in summer from thunderstorms and cyclones. There are about 25 rain days per year, so the regolith above the water table is dry for most of the year. Whim Creek has a mean annual evapotranspiration of about 350 mm and a potential evapotranspiration of about 1700 mm, so vegetation is sparse and restricted to drought resistant grasses and shrubs.
Cu, 1.3% Zn, 0.2% Pb and 8.6 g/t Ag (Collins and Marshall, 1999). However, it has only been mined for oxidized copper ore (9930 t Cu produced). Current reserves of leachable oxide ore are 2.5 Mt at 1.3% Cu (Straits, 2003).

Primary ore consists of pyrite, pyrrhotite, chalcopyrite and sphalerite with minor galena, magnetite and arsenopyrite, and traces of argentiferous tetrahedrite, bismuth, bismuthinite, galenobismutite, cassiterite, stannite, cobaltite, ullmanite, meneghinite, bournonite, emblectite, tueckeite and rutile (Nickel, 1982; Black, 1998). The ore varies from stratiform lenses of massive and laminated sulphides to stockwork veins and sulphide-cemented microbreccias to disseminated sulphides (Marston, 1979). An upper zone of pyrite with sphalerite and minor galena overlies a lower zone dominated by massive and disseminated pyrite, pyrrhotite and chalcopyrite. Although Whim Creek is a proximal deposit (Collins and Marshall, 1999) and some of the Rushall Slate close to the ore shows intense chlorite alteration, a primary alteration halo has not been identified.

Supergene enrichment is characterized by abundant chalcocite and covellite that have replaced chalcopyrite and pyrite by secondary sphalerite (Nickel, 1982; Black, 1998). Supergene sulphides first occur at about 30 m below surface, just about the current pyrite by secondary sphalerite (Nickel, 1982; Black, 1998). The upper gossanous part of the oxide zone consists of goethite and hematite, residual quartz and kaolinite with abundant malachite, minor azurite, chrysocolla and traces of native Cu, cuprite and chalcocite (Koehler, 1974; Marston, 1979). There are several secondary Pb minerals, pseudomorphing galena, but no secondary Zn minerals. Residual grains of cassiterite are common throughout the oxidized zone and sulphide inclusions are preserved in quartz (Nickel, 1982).

The mineralogy of the primary ore and the gossanous oxidate ore indicate that, in addition to Cu, Pb and Zn, several other elements (Sn, Bi, As, Au, Ag, Mo and Sb) should be pathfinders for a Whim Creek deposit. They are all enriched in the oxide ore relative to the host Rushall Slate (Table 1). The erratic distribution of secondary minerals within the oxide zone is reflected in the wide compositional range for many elements in gossanous ore. Some of the observed enrichments in gossan, in comparison with the primary ore, may be only relative, due to loss of other components during weathering (Nickel, 1982), whereas some elements, such as Zn, Ni, Co and Mn, appear to be depleted in gossan (Table 1). In contrast, Ba, Sr and Mn, which may have been leached from the gossan during weathering, are depleted in the gossan relative to the Rushall Slate (Table 1). Immobile elements, (Cr, Ti, V, Nb, La and Th) also appear to be depleted in the gossan but this may be due to their low initial abundances in the primary ore (see Nickel, 1982).

Soil
A regional soil sampling survey in 2000 tested the effectiveness of Regoleach as a soil geochemical technique. Regoleach is a proprietary technique developed by ALS Laboratories and is one of the stronger digestion used for partial extractions. The survey covered an area of about 24 km² that included Whim Creek and the nearby Mons Cupri deposit (see Collins et al., 2004). Samples were collected at 100 m intervals along N-S grid lines 500 m apart, and analysed by Regoleach for Cu, Pb, Zn, Ag, As, Sb, Bi, Mo, Te, Ni, Au and Hg and Cr (Table 2). Two lines pass over Whim Creek (Figure 1): line 586 000mE (AMG) passes over the surface exposure of the Whim Creek deposit, and line 586 500mE includes the ore horizon to the E of the main deposit on the S limb of the Whim Creek syncline. Both lines pass over the stratigraphic position of the ore horizon on the N limb of the syncline (Figure 1). Profiles from each line are presented in Figures 2 and 3. In most cases the soil geochemical profiles are apical and give single point anomalies, which is a consequence of the 100 m sampling and limited dispersion within the thin soil.

The Whim Creek deposit has a distinct multi-element soil geochemical anomaly (Figure 2). This has (i) strong enrichment in Cu, Pb, Ag, Au, As, Bi, Mo and Sb (as expected from the gossan mineralogy), (ii) no enrichment in Zn, despite up to 1% Zn in the gossan (Table 1) and (iii) apparent depletion in Cr, Ni (Figure 2), Co and Te. As Cr is one of the elements depleted in the gossan relative to primary ore, other immobile elements such as Ti, V, La and Nb may also be depleted in the soil over Whim Creek (see Table 1). In contrast, Sn would be expected to be enriched in soil because it is enriched in gossan relative to the host Rushall Slate.

On the S limb of the syncline, along strike from the Whim Creek deposit (586 500mE; Figure 1), soil derived from the ore horizon is strongly anomalous in Cu, As, Bi, Sb and Hg, and moderately anomalous in Pb, Ag, Au and Mo (Figure 3). This is similar to but of lower magnitude than the Whim Creek anomaly. On the N limb of the syncline, the soil at the ore horizon position is anomalous in Cu, Pb, Ag, As, Mo, Zn and Hg and Sb. As (Figure 2) but less so. Further E, along the N limb of the syncline, the ore horizon is only moderately anomalous in Hg and weakly anomalous in Sb and Bi (Figure 2). Although soil from the ore horizon, along strike from the Whim Creek deposit, is anomalous in a similar suite of elements to soil derived from gossanous ore, it is not similarly depleted in Cr, Ni, Co and Te (see Figures 2 and 3).

Anthropogenic soil anomalies
Two soil anomalies may be attributed to contamination by early mining. A broad, multi-element anomaly at the N end of line 586 500mE (Figure 3) is underlain by colluvium-alluvium derived, in part, from the Whim Creek ore horizon but also from early mining activity and an ore processing plant. A strong Cu, As, Ag, Mo anomaly, with depletion in
Cr, Ni, Co and Te, similar to that caused by the Whim Creek deposit is about 500 m from the N end of both lines (Figures 2 and 3) in transported regolith. The anomaly straddles the old Balla Balla and Roebourne road and was caused by shipments of Whim Creek ore.

In summary, Whim Creek-style Cu-Zn-(Pb-Ag) primary mineralization and its oxide ore have a prominent multi-element geochemical signature dominated by Cu, Pb, Zn, Sn, Au, Sb, Bi, Ag and As compared with the pelitic host. The most effective pathfinder elements for soil geochemistry are Cu, Pb, As, Au, Bi, Sb and Sn, with depletion in Cr, Ni, Co and Ti. There is limited dispersion of anomalous metals within a thin, discontinuous, poorly developed eluvial-colluvial soil; hence close-spaced soil sampling is essential for effective exploration. Anomalous Hg may be used as an indicator of the ore horizon, along strike from a deposit.

REFERENCES


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REFERENCES


