LITTLE EVA Cu-Au DEPOSIT, QUAMBY DISTRICT, QUEENSLAND

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LOCATION

The Little Eva Cu-Au Deposit is approximately 12 km N of the Dugald River Pb-Zn-Ag deposit at 20º08'51"S, 140º08'39"E (Figure 1); Cloncurry 1:250 000 sheet.

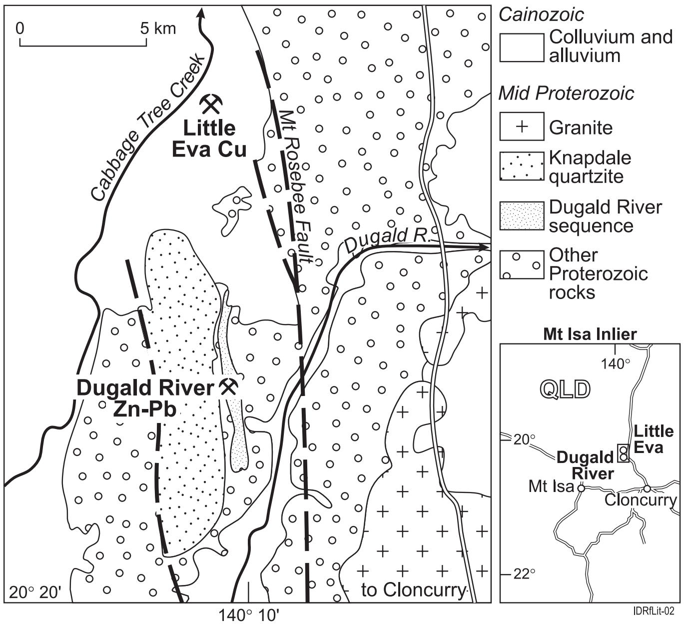

Figure 1. The geology around the Little Eva Cu Prospect, Queensland (after Wilson et al., 1976).

DISCOVERY HISTORY

This small deposit (previously known as Cabbage Tree Freehold) was discovered by conventional prospecting, which probably detected the green Cu carbonates in the lag, still visible today. In 1942 a small shaft (8 m) had been sunk and a production declared of 13 t Cu, 8 oz Ag and 4 oz Au. Recent drilling by Universal Resources has provided a preliminary resource estimate of 35 Mt at 0.46 Cu and 0.07 g/t Au with a high grade component of 8 Mt at 1.01% Cu and 0.12 g/tAu. The deposit is said to have a maximum vertical depth of 350 m (MiningNews.Net, December 2002).

PHYSICAL FEATURES AND ENVIRONMENT

The district has a dry savanna climate (Blake, 1987) with an average annual rainfall of 450-500 mm falling mainly in summer. An average of 28 days per year have a maximum of over 40ºC. Most of the area supports stunted eucalypts (3-8 m), some acacia scrub, scattered kurrajong trees and abundant spinifex and ephemeral grasses. The deposit is located on a narrow belt of eroded metamorphic rocks, covered by thin skeletal soils, with the alluvium of Cabbage Tree Creek to the NW and an extensive area of colluvium to the SE.

GEOLOGICAL SETTING

Little Eva (Figure 1) lies in the Corella Formation of the Eastern succession of the Proterozoic Mt Isa Block. The oldest rocks lie E of the Mt Rosebee Fault and consist of amphibolite facies metasediments intruded by the Naraku Granite (1754 ± 25 ma; Wyborn et al., 1988). To the W of the fault, the metamorphic grade is greenschist and the rocks young to the W. Close to Little Eva, the succession from E to W consists of pelitic metasediments with thin limestone layers, interlayered scapolitic limestones with calcareous, micaceous, quartzose metasediments and a podiform, cupriferous magnetite lens (Edwards, 1978). The massive lode of porphyroblastic scapolite-biotite granofels and feldspar-chlorite-epidote-amphibole granofels follows this. To the W are interlayered scapolitic limestones, calcareous, feldspathic, micaceous, quartzose metasediments and a magnetite lens.

REGOLITH

The Little Eva Prospect lies near the confluence of two braided river channels that drain the eastern and western sides of the Knapdale Quartzite, a ridge of low hills to the S (Figure 1). The prospect is sited on a gently inclined, undulating pediment that is covered by a veneer of colluvial sediments and ferruginous lithosols. Most of the Proterozoic rocks around Little Eva are obscured by i) extensive gravel plains on colluvium-alluvium, containing subangular to rounded quartzite clasts, ii) a sandy alluvium in the vicinity of Cabbage Tree Creek and, iii) where the basement rocks subcrop, by thin lithosols. The thickness of alluvium is estimated at 3-5 m; the colluvium is probably very thin, generally 1-2 m. The nearby Cabbage Tree Creek has incised to the Proterozoic basement in its bed. Relatively fresh bedrock is exposed close to the lower contact of the colluvium. There are two regolith regimes (Figure 2A) around the prospect, erosional and depositional; the depositional regime can be subdivided into one alluvial unit NW of the eroded basement and two colluvial units to the SE.

Erosional regime

Close to the Little Eva Prospect, the colluvium has been partly removed. Low outcrops of fresh Proterozoic bedrock and saprolite are largely mantled by a grey, carbonate-rich lithosol. This is overlain by a lag of quartz, quartzite and magnetite nodules. A narrow strip of erosional regime extends SW, along the eastern flank of Cabbage Tree Creek, and has been lightly incised by small streams. To the N and E, the Proterozoic rocks have been eroded into gently undulating country, characterized by scattered nodules of pedogenic carbonate.

A number of small pods of magnetite outcrop in the basement. They form small knob-like hills or low outcrops surrounded by a copious lag of black magnetite fragments on a red-brown soil. These pods are lenses of slightly weathered (oxidized) 'primary' magnetite, now altered to kenomagnetite probably due to lengthy exposure in the zone of weathering. The lag of slightly rounded nodules lacks cutans and their worn surfaces show small facets, crystal faces, quartz gangue and reddish, earthy patches, where oxidation is advanced.

Depositional regimes

Colluvial Units

To the SE, a veneer of colluvium, occupying a low plateau, hides the Proterozoic rocks. The colluvium may be subdivided into two. One unit has spinifex with sparse trees and tall, red-brown termitaria. It is mantled by a lag, rich in angular to subrounded quartzite clasts, quartzite cobbles, a few fragments of vein quartz and very minor, rounded magnetite pebbles, set in a red-brown, lithic, carbonate-free soil. This occupies very slightly higher parts of the landscape than the other colluvium-covered area.

The other colluvial unit occurs to the SE. There are fewer trees and this unit has numerous, elongated, shallow, grassy depressions (gilgai), underlain by grey-brown cracking clays, that are interspersed with slightly elevated areas underlain by yellowish colluvium and rimmed by spinifex. A lag of quartzite cobbles, vein quartz and rounded magnetite clasts occurs on a red-brown, lithic soil between the gilgai. In places, small, fresh, carbonate rocks, with calc-silicate minerals and malachite, outcrop within the 'gilgai', indicating a very thin cover of cracking clays. Coarse lag mantles both types of colluvium and contrasts with the fine soils that underlie them, suggesting an exogenous origin for the lag.

Alluvial Unit

The area to the NW, flanking Cabbage Tree Creek, is filled with grey-brown to red-brown alluvium and has a relatively linear SE boundary, suggesting infilling of alluvial sediments possibly against a small fault scarp. The bed of Cabbage Tree Creek has been graded slightly below the weathered Proterozoic basement. There is a thin basal conglomerate (0.2 m), of subangular to round clasts, overlying saprolite that is, in turn, overlain by flood-plain sands and silts.

Soil

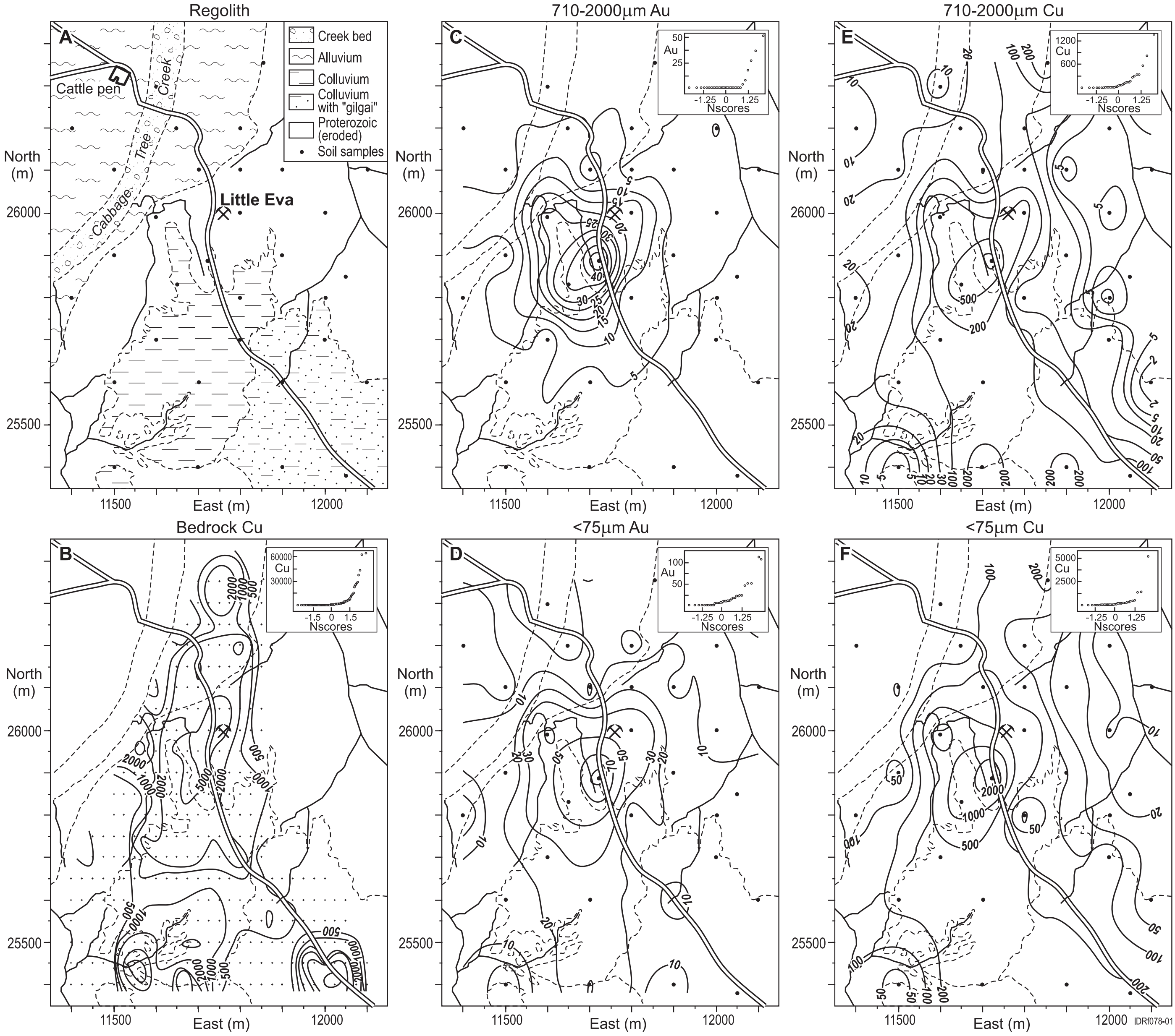

Figure 2. Regolith map of the Little Eva Cu Prospect (A). Bedrock Cu (B). Soil Au in the coarse (C) and fine (D) fractions. Soil Cu in the coarse (E) and fine (F) fractions. Sample points as dots.

On eroded basement

The carbonate-rich lithosols on the eroded basement are immature. The coarser fraction (710-2000 µm) contains fragments of primary rocks (granofels, limestone, vein carbonate) and weathered products (calcrete, magnetite nodules) in a dusty, carbonate-rich matrix. The finer fraction (75-250 µm) consists of mineral grains (amphibole, turbid plagioclase, microcline, epidote, quartz, biotite, hematite and magnetite).

On colluvium

The coarse fraction (710-2000 µm) of the carbonate-free soils on the colluvium consists of rounded to subrounded rock and mineral fragments, which are intensely stained with Fe oxides. The fine fraction (75-250 µm) consists of subangular to subrounded resistant mineral grains (quartz, microcline, magnetite, with minor chlorite, epidote and hornblende). Magnetite is extensively altered to kenomagnetite. Many grains are coated with Fe oxides. Rounding, staining, extensive alteration to kenomagnetite and dominance of resistant minerals implies extensive weathering in the source region and long transport distances. Some of the weathering may have occurred within the colluvium. The wide variety of rock fragments imply a variety of provenances.

On alluvium

The sandy fraction (710-2000 µm) contains dominantly rounded, water-worn grains of quartz and microcline of distant provenance and angular, more local grains of epidote, magnetite and granofels. The differences in materials ang grain shape indicate varied transport distances. The fine material (250-500 µm) is largely angular to subrounded relatively fresh mineral fragments. All fractions are carbonate free.

Soil grain size distribution

Grain size distributions of the soils are characteristic of their various geomorphological environments (Figure 3). The erosional regime (Figure 3A) has significant coarse and fine fractions with less in the 250-710 µm range, indicating a coarse population of rock and mineral fragments and a fine population of silt-clay weathered products. The soil on the colluvium (Figure 3B) consists mainly of fine materials (<75 µm). The alluvium (Figure 3C) has a mode at 75-250 µm of silty materials. These have a bell-like distribution, typical of hydraulic sorting in a slow flowing fluvial or overbank environment.

MINERALIZATION

Little Eva is a magmatic Fe oxide Cu-Au deposit, occurring within deformed and metamorphosed middle-Proterozoic sediments of the Eastern Succession of the Mt Isa Block. It is situated in the Mt Roseby corridor, a 3-4 km wide, north-trending, high strain zone which extends for about 40 km. This corridor is also host to Cu oxide and sulphide deposits and the Dugald River Zn-Pb-Ag deposit. The Little Eva mineralization is a hematite-rich breccia. Alteration is related to a felsic porphyry near the middle of the deposit. Copper-Au mineralization is greatest in hematite-rich areas and consists of chalcopyrite within low-temperature veins rich in calcite and quartz. There are four stages of alteration (Thomas, 1994); i) Na-K-Fe-Cl-O alteration (scapolite, amphibole, biotite and magnetite); ii) albitization (albite and chlorite); iii) K-feldspar and hematite; iv) late-stage veining and chalcopyrite mineralization with calcite and quartz. The host rocks are Fe-rich, with major element proportions similar to high-Fe tholeiites from Selwyn and elevated incompatible elements (La, Ce, Sm, Eu, Tb, Yb and Y), also consistent with a magmatic origin. Mineralizing fluids were of high salinity.

REGOLITH EXPRESSION

Bedrock
CRA Exploration investigated the Cu distribution in weathered bedrock by drilling. There is a north-striking anomalous band, about 300 m wide and over 1 km long, centred on the shaft, in the erosional regime, and this extends both 400 m to the N, under the alluvium of Cabbage Tree Creek, and 700 m to the S, under the colluvium. There are two strong peaks of 10 000-20 000 ppm Cu in the S. Most of the Cu anomaly is >2000 ppm but reaches 5000 ppm near the old shaft (Figure 2B). This substantial bedrock Cu anomaly formed the target for a subsequent orientation soil geochemical survey by CSIRO in late 1994 (Robertson, et al., 1995).

Soil
Early work by Nicolls et al., (1965) showed broad (150-300 m) total and cold extractable Cu anomalies (maxima 1000 and 100 ppm respectively) over the Little Eva deposit and its strike extensions. Although the anomaly was 'cut off' by the alluvium of Cabbage Tree Creek, there had been some dispersion at depth from drainage waters contaminated by the mine workings.

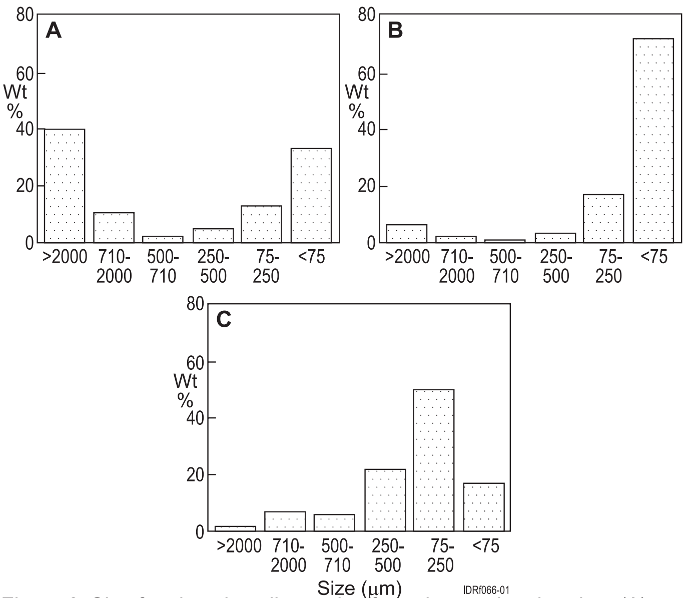

Figure 3. Size fractions in soil samples from the erosional regime (A), the colluvium (B) and the alluvium (C).

A soil pilot study (Robertson et al., 1995) showed that the widest ranges in composition occurred in the 710-2000 µm and the <75 µm soil fractions and these were selected for analysis and compared. Indicator elements for Little Eva mineralization are Cu and Au. Copper yielded similar results for both fractions although maximum abundances were five times greater in the fine fraction (compare Figures 2E and 2F). The erosional area near the Little Eva shaft is defined clearly by Cu in the fine fraction (Figure 2F) but the anomaly decreases by about an order of magnitude in passing into the colluvial environment where a subtle anomaly indicates the underlying bedrock anomalous trend of Figure 2B. There is no soil Cu anomaly in the area covered by alluvium, with Cu abundances close to detection (10 ppm).

Gold in the fine fraction also accurately targets the shaft area in the erosional regime with a bullseye anomaly (100 ppb), with a weak trend into the colluvium to the S (Figure 2D). The anomaly is similar but weaker (50 ppb) in the coarse fraction (Figure 2C) but there is no clear trend into the colluvium. It is possible to marginally improve the trend under the colluvium by weighting soil sample data from the colluvium by a factor designed to make the means of the two populations (erosional and depositional) approximately equal.

The mineralization in the erosional regime is also reflected by bullseye anomalies in Co (50 ppm) and V (300 ppm) against backgrounds of 20 and 150 ppm respectively probably indicating the magnetite-rich parts. There is no mineralization-associated response from Pb or Zn.

Drainage
Stream sediments are anomalous around Little Eva with cold extractable Cu exceeding 80 ppm (Nicolls et al, 1965). Some exceeded 500 m trains.

Geobotanical anomalies
Geobotanical anomalies coincide with all geochemical anomalies and may also occur in areas of transported cover where there is no geochemical response. These geobotanical anomalies are related to Cu toxicity and are characterised by *Tephrosia sp. nov*. and *Polycarpaea glabra* which are Cu tolerant. (Nicolls et al., 1965).

Termitaria and bioturbation
Bioturbation by soil mesofauna plays an important and active role in mixing soils in the near surface. Termitaria are an important feature of the landscape in areas mantled by colluvium at Little Eva. They have the capacity to carry fine soil particles (including clays and Fe oxyhydroxides which carry the geochemical signal) from the weathered basement, through thin colluvium and deposit them in the soil.

Contamination
Contamination of the soil by cattle feeds and licks occurs near a cattle-pen NW of Cabbage Tree Creek. The contaminants consist of salt, rock phosphate and gypsum, leading to strong anthropogenic anomalies in P, Zn and Yb.

DISPERSION MODEL

TBA

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SAMPLE MEDIA - SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Threshold (ppm)	Max anomaly (ppm)	Dispersion distance (m)
Bedrock	Au Cu	? ?	? ?	- 200	- 500	- 65 000	- ?<10
710-2000 µm soil on erosional regime	Au Cu	INAA XRF	0.005 10	<0.005 15	0.005 50	0.050 1370	20 10
<75 µm soil on erosional regime	Au Cu	INAA XRF	.005 10	0.010 50	0.020 200	0.053 5000	300 400
710-2000 µm soil on colluvium	Au Cu	INAA XRF	.005 10	<0.005 20	0.007 50	0.009 285	150 200
<75 µm soil on colluvium	Au Cu	INAA XRF	.005 10	0.010 150	0.020 250	0.025 510	150 200