LITTLE EVA Cu–Au DEPOSIT, QUEENSLAND

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INTRODUCTION

The Little Eva Cu–Au deposit is situated approximately 12 km north of the Dugald River Pb–Zn deposit (Figure 1) at 20º08'51"S, 140º08'39"E within the CLONCURRY (SF54-02) 1:250 000 map sheet area. The deposit occurs in a narrow belt of eroded metamorphic rocks, which is covered by thin skeletal soils. Alluvium of Cabbage Tree Creek and an extensive area of colluvium occur to the northwest and the southeast of the deposit, respectively (Figure 2).

PHYSICAL SETTING

Geology

Little Eva lies within the Corella Formation of the Eastern Succession of the Proterozoic Mt Isa Block. The oldest rocks lie east of the Mt Rosebee Fault and consist of amphibolite facies metasediments intruded by the Naraku Granite (Figure 1). To the west of the fault, the metamorphic grade is greenschist and the rocks young to the west.

In the immediate vicinity of Little Eva, the Proterozoic succession consists of pelitic metasediments with thin limestone layers, scapolitic limestones interlayered with calcareous, micaceous, quartzose metasediments, and a podiform, cupriferous magnetite lens of the Eastern Carbonates (Edwards, 1978). The massive granofels of the lode follows this.

Geomorphology

The Little Eva deposit 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 south of Little Eva (Figure 1). The deposit occurs on a gently inclined undulating pediment that is covered by a veneer of colluvial sediments and ferruginous lithosols.

The Proterozoic rocks around Little Eva are widely obscured by extensive gravel plains of colluvium–alluvium containing subangular to rounded quartzite clasts, sandy alluvium in the vicinity of Cabbage Tree Creek, and thin lithosols where the basement rocks occur. The thickness of alluvium is estimated to be 3–5 m, whereas the colluvium is probably very thin, generally 1–2 m.

Exposures of relatively fresh Proterozoic bedrock occur in the bed of Cabbage Tree Creek (Figure 2). The regolith around Little Eva comprises two main regimes — erosional and depositional, with the depositional regime containing one alluvial and two colluvial units (see below).

Climate and vegetation

The Quamby district has a dry savanna climate (Blake, 1987) with an average annual rainfall of 450–500 mm, occurring mainly between November and March. An average of 28 days per year have a maximum temperature of more than 40ºC. Most of the area supports stunted eucalypts (3–8 m), acacia scrub, scattered kurrajong trees and abundant spinifex and ephemeral grasses.

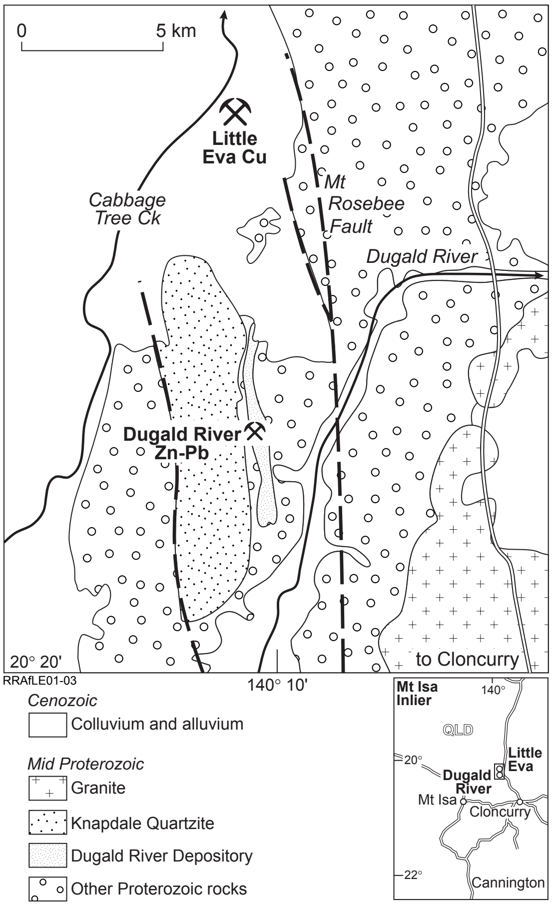

Figure 1. Location and regional geological setting of the Little Eva Cu–Ag deposit. (after Wilson *et al*., 1976)

REGOLITH–LANDFORM RELATIONSHIPS

Erosional regime

In the area of Little Eva, the colluvium has been largely removed and low outcrops of fresh Proterozoic bedrock and saprolite are generally 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 southwest, along the eastern flank of Cabbage Tree Creek (Figure 2). To the north and east of Little Eva, the Proterozoic rocks have been extensively eroded into gently undulating country, characterised by scattered nodules of pedogenic carbonate.

Pods of magnetite within the Proterozoic basement form small knob-like hills or low outcrops, surrounded by a copious lag of black magnetite fragments on a red-brown soil.

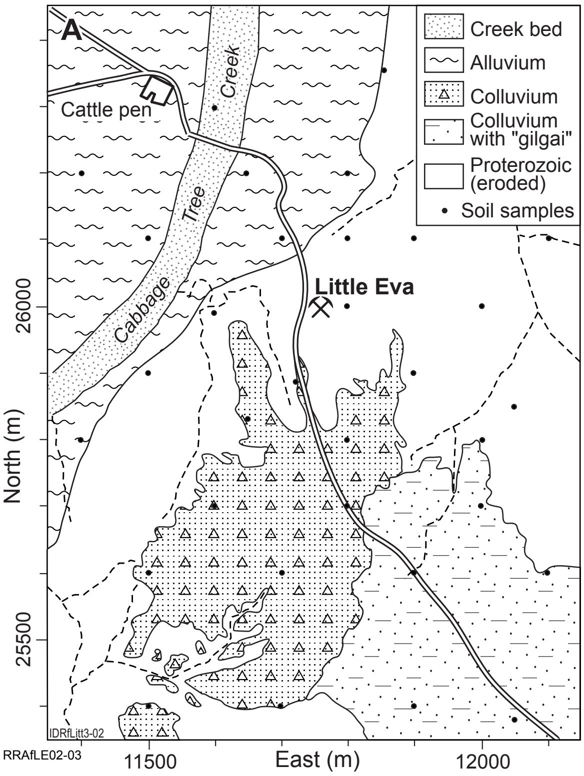

Figure 2. Regolith map of the Little Eva area. (after Robertson *et al*., 1995)

Depositional regime

The depositional regime consists of two colluvial units and one alluvial unit situated to the southeast and northwest of Little Eva, respectively (Figure 2).

The colluvium forms a low plateau over the Proterozoic basement rocks. One type of colluvium supports spinifex with sparse trees and tall, red–brown termitaria, and is mantled by a lag of abundant angular to subrounded quartzite clasts, common fragments of vein quartz and very minor, rounded magnetite pebbles, all set in a red–brown, lithic, carbonate-free soil.

The second colluvial unit occurs further to the southeast of Little Eva and occupies slightly lower parts of the landscape than the other type of colluvium (Figure 2). The unit supports fewer trees and is characterised by numerous, elongated, shallow, grassy depressions underlain by grey–brown cracking clays (gilgai), interspersed with slightly elevated areas underlain by yellowish colluvium and rimmed by spinifex.

Alluvium predominates in the area to the northwest of Little Eva and is commonly exposed in the bed of Cabbage Tree Creek (Figure 2). The relatively linear southeast boundary of Cabbage Tree Creek suggests deposition against a small fault scarp. The bed of Cabbage Tree Creek also exposes weathered Proterozoic basement.

REGOLITH CHARACTERISTICS

Eroded Proterozoic basement

The relatively fresh rocks of the Proterozoic basement (granofels and carbonates) are largely obscured by an immature, pale brown carbonate–rich lithosol. 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). Lag over the Proterozoic basement comprises angular vein quartz, subrounded quartzite and round magnetite clasts.

Small pods and lenses of resistant ‘primary’ magnetite protrude through the soil. These shed a lag of slightly rounded nodules that lack cutans. Worn surfaces show small facets and crystal faces, quartz gangue and reddish, earthy patches, where oxidation is advanced. Variable quantities of magnetite occur within the soil, and within the lag on erosional and depositional regimes.

Colluvium

No exposures were available to determine the depth of the colluvium, but it is estimated to be thin (1–2 m). The colluvium is mantled by a lag containing abundant angular to subrounded quartzite clasts, common fragments of vein quartz, and very minor rounded magnetite pebbles. This material lies on a red-brown, lithic, carbonate-free soil. The soil coarse fraction (710–2000 µm) 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, and magnetite, with minor chlorite, epidote and hornblende). Magnetite is extensively altered to kenomagnetite. Many grains are coated with Fe oxides. Red–brown termite mounds characterise the colluvial areas.

The southernmost colluvium (Figure 2) comprises slightly elevated areas of red–brown lithic soil with a lag of quartz, quartzite cobbles and magnetite clasts on which spinifex, bushes and small eucalypts grow. These are interspersed with slightly lower, linear tracts of lag-free, dark brown cracking soil on which grasses grow. In places, small, fresh, Proterozoic carbonate rocks, with calc-silicate minerals and malachite, outcrop within the ‘gilgai’, indicating a very thin cover of cracking clays.

Alluvium

The banks of Cabbage Tree Creek consist of grey–brown to red–brown alluvium. Where the bed of Cabbage Tree Creek has been incised, there is a thin basal conglomerate (0.2 m) of subangular to round clasts, overlying saprolite. Floodplain sands and silts in turn overlie the conglomerate. The coarser sand fraction of this material (710–2000 µm) dominantly contains rounded, water-worn grains of quartz and microcline of distant provenance and angular, more locally-derived grains of epidote, magnetite and granofels, indicating a variety of transport distances. The finer sand material (250–500 µm) comprises largely angular to subrounded, relatively fresh mineral fragments. The alluvium

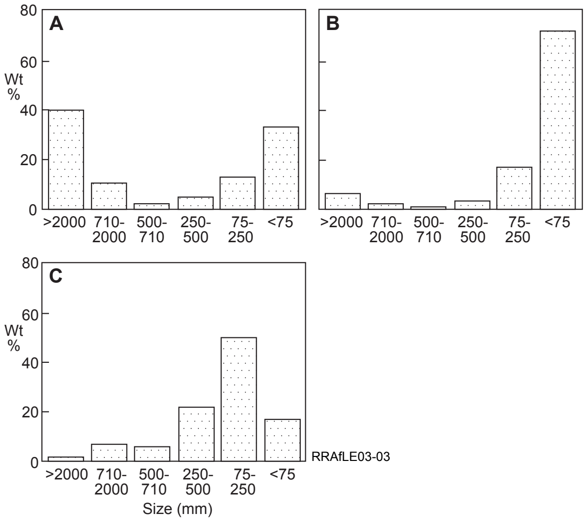

Figure 3. Particle size distributions of soils from erosional, colluvial and alluvial regimes at Little Eva.

and the soils on it are carbonate free.

Soils

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 fewer grains in the 250–710 µm range, indicating a coarse population of rock and mineral fragments and a fine population of silt–clay weathering products. The soil on the colluvium (Figure 3B) consists mainly of fine materials (<75 µm). The alluvium (Figure 3C) has a mode of 75–250 µm grains with a bell-like distribution, typical of hydraulic sorting in a slow flowing fluvial or overbank environment.

REGOLITH EVOLUTION

Basement and colluvium

Weathering of the Proterozoic rocks around Little Eva probably occurred during the Tertiary (Anand *et al*., 1997; Vasconcelos, 1998) when saprolites were developed in all but the most resistant rocks. This was accompanied by mechanical degradation of the weathered profiles and the shedding of abundant quartz and quartzite-rich colluvial material onto pediments. Important sources of this colluvium are the Knapdale quartzites and neighbouring materials (granofels and magnetite pods). Rounding, staining, extensive alteration of magnetite to kenomagnetite, and dominance of resistant minerals implies intensive weathering in the source region and, for some materials, long transport distances. Weathering may have continued within the colluvium. The wide variety of rock fragments implies a variety of provenances. Coarse lag mantles both types of colluvium and contrasts with the fine soils that underlie some of them, suggesting an exogenous origin for at least some of the lag. Gilgai probably developed in these colluvia late in the process and are probably related to calcareous bedrocks and the onset of arid conditions with conditions of restricted groundwater flow.

Alluvium

Rounded, water-worn grains of quartz and microcline of distant provenance, and angular, more locally-derived grains of epidote, magnetite and granofels dominate the sandy fraction of the alluvium. The finer material (250–500 µm) is largely angular to subrounded relatively fresh mineral fragments. The alluvium is a relatively young material with indications of varied transport distances. Its size distribution suggests hydraulic sorting in a slow moving overbank environment.

Termitaria and bioturbation

Bioturbation by soil mesofauna, and by termites in particular, 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 where they have the capacity to carry fine soil particles (clays and Fe oxyhydroxides) and the geochemical signal from the weathered basement, through thin colluvium and deposit them in the soil.

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