ELOISE Cu-Au DEPOSIT, CLONCURRY DISTRICT, QUEENSLAND

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LOCATION

The Eloise Cu-Au Deposit is approximately 60 km SE of Cloncurry at 20º57'30"S, 140º58'40"E (Figure 1); Cloncurry SF54-02 1:250 000 sheet.

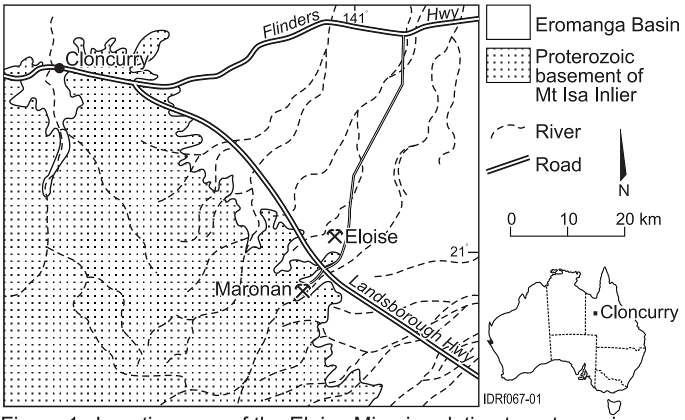

Figure 1. Location map of the Eloise Mine in relation to outcropping Proterozoic rocks and the Eromanga Basin.

DISCOVERY HISTORY

Eloise was discovered by regional and local aeromagnetic, ground magnetic and electromagnetic surveys and subsequent drilling by BHP Minerals Exploration (Brescianini *et al.,* 1992; Skrzeczynski, 1993).

PHYSICAL FEATURES AND ENVIRONMENT

The mine is situated on rolling plains underlain by sediments of the Eromanga Basin. The plains consist of alluvial river terraces and fluvial ridges with a relief of generally less than 10 m. To the SW, in the foothills of the Selwyn Range, the rugged Proterozoic Mt Isa Inlier outcrops 150 m above the plain. Major streams that flow intermittently after significant rains (Williams and Fullarton rivers) are sourced from the eastern flank of the Selwyn Range and drain NE, ultimately into the Gulf of Carpentaria.

The climate is tropical, monsoonal and semi-arid, with an erratic annual summer rainfall of about 380 mm. Sparse bushes of eucalypt and spiky hummocks of spinifex cover much of the Proterozoic, whereas the N and E parts have been cleared for grazing, particularly the black soil plains, where grasses flourish.

GEOLOGICAL SETTING

Eloise lies on the margin of the Eromanga basin, close to the exposed part of the Eastern Fold Belt of the Mt Isa Inlier (Figure 1). The inlier runs predominantly N-S and consists mainly of folded and eroded Proterozoic metasediments and metabasalts of the Soldiers Cap Group. Mineralization in these rocks occurs along major faults and shears. The exposed Proterozoic is sporadically capped with remnant, flat-lying, late Jurassic to early Cretaceous fluvial sediments (Gilbert River Formation), mainly in the headwaters of the Fullarton, Cloncurry and Bustard rivers.

The Eloise deposit is buried under 50-70 m of Cretaceous sediments of the western margin of the Eromanga Basin (Figure 2) which incorporate early Jurassic, continental, fluvial, swamp and lake facies sediments (Senior *et al.,* 1978). A marine transgression from the N and NW in the Early Cretaceous deposited thick mudstones, siltstones and sandstones of the Willumbilla Formation, capped by thin beds of Toolebuc Formation limestone. Much of the upper limestone has been eroded and Tertiary and Cainozoic fluvial sediments have been deposited and since weathered.

REGOLITH

Little pre-Cretaceous weathering is preserved, so that Proterozoic rocks, intersected by diamond drilling, are fresh, except at and near the unconformity, where there is very weak weathering to saprock (Li Shu and Robertson, 1997). Any weathering rind was eroded almost as quickly as it formed and the unconformity quickly sealed by thick (50-150 m), impermeable Cretaceous sediments (Figure 2). This differs markedly from the state of the Proterozoic immediately beneath the Tertiary and Quaternary fluvial sediments, nearby at Maronan (Figure 1; Robertson *et al.*, 1997), where the Proterozoic rocks are deeply weathered to several tens of metres.

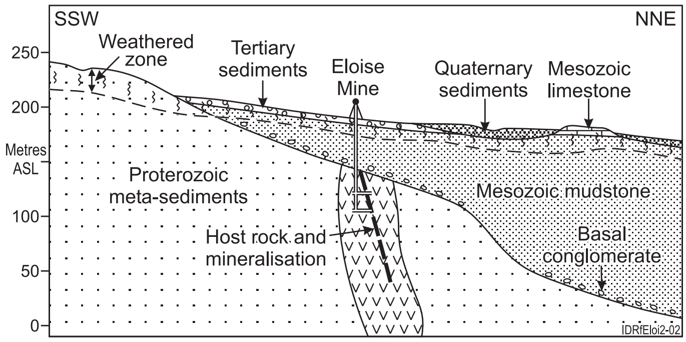

Figure 2. Generalized section through the Eloise environment showing Proterozoic basement partly covered by a wedge of Mesozoic rocks, in turn partly covered by Tertiary and Quaternary fluvial deposits.

Around Eloise, the Cretaceous sediments are buried beneath Tertiary and Quaternary fluvial sediments (Figure 2). However, they are exposed as deeply weathered saprolites of mudstones in gullies and shallow pits. The fluvial sediments (2-8 m thick) consist of well-rounded gravel and coarse sand derived from recognisable Proterozoic rocks. Their top part is generally slightly ferruginous and the surface is covered by brown and black soil, strewn with a lag of pebbles and ferruginous pisoliths. These materials were deposited by the ancestral Fullerton River that later changed its course to the E. The Tertiary sediments form fluvial ridges and high river terraces. Quaternary alluvium, in the lower part of the landscape, has built plains and low river terraces directly over Mesozoic sediments. Deposition and redistribution of these post-Mesozoic sediments has formed the rolling plains at Eloise. Where the material is fine and poorly drained, black smectitic soils have developed.

MINERALIZATION

Eloise has an indicated reserve of 3.2 Mt at 5.8% Cu, 1.5 g/t Au and 19 g/t Ag. It is hosted by greenschist-metamorphosed metasediments and metabasic rocks with major retrograde shears in which early hornblende-biotite-quartz assemblages occur. They were overprinted by chlorite-muscovite-pyrrhotite-chalcopyrite±calcite±magnetite and, later, by calcite-chlorite-quartz±pyrite assemblages during subsequent brittle deformation (Baker, 1994).

Locally, the host rocks consist of N-striking metapelites, amphibolites, psammitic quartz-biotite schists, quartz-muscovite schists and a meta-arkose. The two main orebodies (western 'Elrose Lode' and eastern 'Levuka Lode') lie within meta-arkoses and biotite schists parallel to and between the major shears. These rocks have been cut by the reverse Median fault with a 40-60° westerly dip. This fault, which thickens with depth from 15 to 30 m, consists of a breccia of silicified host rocks in a matrix of calcite, chlorite and quartz, with minor pyrite and chalcopyrite. The later Middle Fault displaces the Median Fault. As a result of the faulting, the southern part of the deposit is cut off and concealed beneath a wedge of barren Proterozoic metamorphic rocks. Here, mineralization in the fault is the only way by which a geochemical signal could reach the Proterozoic-Cretaceous unconformity.

REGOLITH EXPRESSION

To date, exploration in the Eromanga and Carpentaria basins has been by investigation of geophysical targets by drilling. The Mesozoic cover has presented a considerable challenge. Li Shu and Robertson

(1997) determined the linked geomorphic and sedimentary histories of this region and, using this framework, investigated opportunities for using geochemistry in this difficult environment. The most promising geochemical target is the Proterozoic-Cretaceous unconformity, marked by a thin, discontinuous layer of gravelly sand and conglomerate, sealed in by a thick mass of semi-pelitic to pelitic sediments. The basal, high-energy sediments developed on and from the basement might be expected to retain dispersions from any parts of the Eloise deposit that were exposed in Cretaceous times.

Palaeotopography

The palaeotopography of this unconformity was obtained from mine and broad-scale (>1 km) water bore drilling (Figure 3). The Eromanga Basin deepens to the NE. The gradient of the unconformity, close to the mine (Figure 3A), is slight (1:1250) but there appears to be a much steeper slope (1:100) about 3 km NE, suggesting a scarp (Figure 3B).

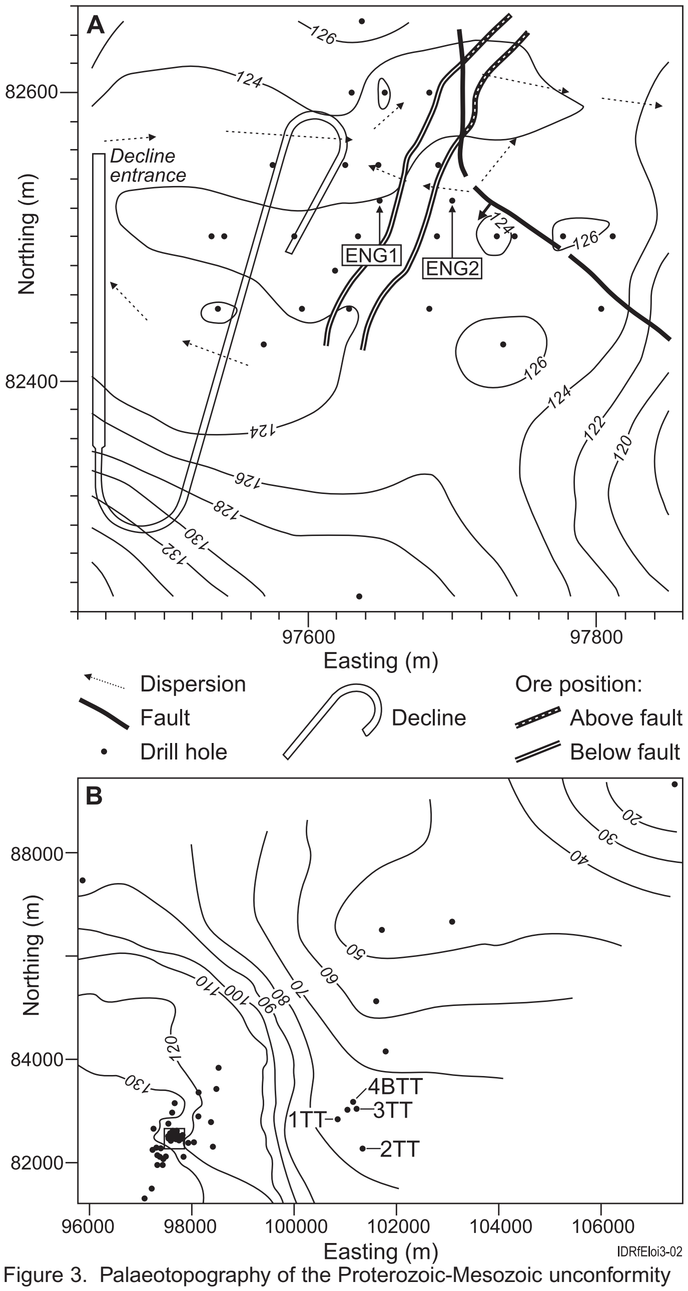

Figure 3. Palaeotopography of the Proterozoic-Mesozoic unconformity as determined from drilling. Detailed palaeotopography (A) around Eloise showing drill sites, sampled drillholes and the main decline. Regional palaeotopography around Eloise and to the NE (B) as determined from more sparse water bore drilling. The location of Figure 4A is also shown as a box.

The local map (Figure 3A) is well controlled by mine drilling. Together, these palaeotopographic maps indicate an arcuate gully to the E and NE, draining towards the upper edge of the scarp. Dispersion from the mineralization that outcrops at the unconformity N of the Median Fault would have been largely carried E, down the scarp. However, some leakage from the Median Fault could have dispersed W to the arcuate palaeodrainage (see arrows in Figure 3A). Geotechnical drillhole ENG2 is the nearest to the fault; drillhole ENG1 is more distant. The point where the decline intersected the unconformity is more distant still and is probably up-slope of any point where mechanical dispersion from the Eloise mineralization or from the Median Fault subcrops could have entered the palaeodrainage.

Geochemical investigation

Cretaceous rocks below the casing of the decline and core from two geotechnical diamond drillholes (ENG1 and ENG2) were sampled, concentrating on coarse sediments (gritty mudstone and basal conglomerate) close to the unconformity (Figure 4). These sites comprised a proximal data set and were compared to distal hydrological diamond drilling, about 3 km from the mine, where sampling also concentrated on high-energy sediments near the unconformity.

Near the mine, coarse, high-energy Cretaceous sediments are anomalous in Cu (75 ppm), Au (90 ppb) As (125 ppm) and, weakly, in Sb (0.7 ppm) at or very close to the unconformity in diamond drillholes ENG1 and ENG2 (Figure 4). There are no anomalies in the decline or in the upper parts of the Cretaceous stratigraphy (Figure 4).

Three km from the mine, there is a small Cu anomaly (80 ppm) at the upper surface of the basal sandstone in diamond drillhole 1TT about 2.5 m above the unconformity. There are very weak Au anomalies in 2TT (57 ppb at the sandstone base and 26 ppb in a thin conglomerate 0.3 m above the unconformity). Arsenic and Sb anomalies (102 and 1.5 ppm respectively) also occur in drillhole 4BTT in sandstones and conglomerates 1.3 m above the unconformity.

Conclusions

The degree of weathering below the unconformity is minimal so weathering-related dispersion in the basement is also minimal. There is no dispersion into the upper parts of the Cretaceous sediments. Here, thick Cretaceous cover at Eloise presents an effective barrier to geochemical exploration.

Apart from the mineralization itself, the most promising geochemical target at Eloise is the Proterozoic-Cretaceous unconformity. This is a thin and probably discontinuous layer of high-energy sediments developed on, and from erosion of, the basement. It appears to retain a down-slope mechanical or hydromorphic dispersion from the Eloise mineralisation that was detected in some of the drilling. Dispersion may extend about 100 m from the mineralization or from mineralized faults (Figure 5B). Drilling 3 km distant from the mine also indicated some anomalies, notably just above the unconformity, at sites located directly down-slope from Eloise. Early sediments infilling the area down-slope are anomalous (Figure 5A).

Sampling to detect down-slope mechanical dispersion of Cu, Au, As and Sb in coarse sediments at the Proterozoic-Mesozoic unconformity seems a valid prospecting method in areas of unweathered or slightly weathered Mesozoic cover. It could be used conveniently and cheaply in conjunction with drilling of magnetic basement targets to detect a near miss. The palaeotopography governs the direction of dispersion and needs to be thoroughly understood.

DISPERSION MODEL

TBA

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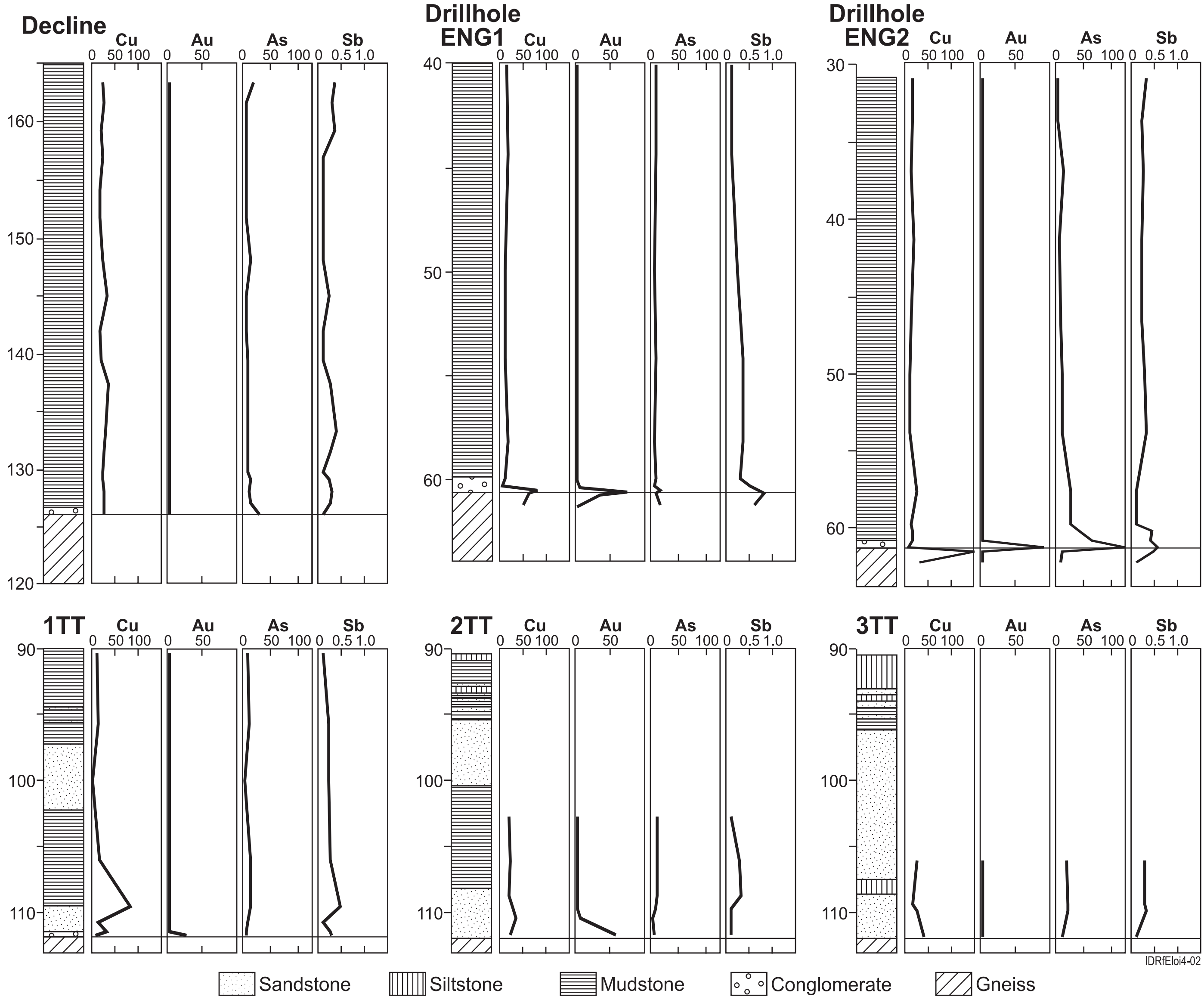

Figure 4. Geochemistry of the decline below the concrete casing, the geotechnical drilling and water bore drilling (boreholes 1TT, 2TT and 3TT).

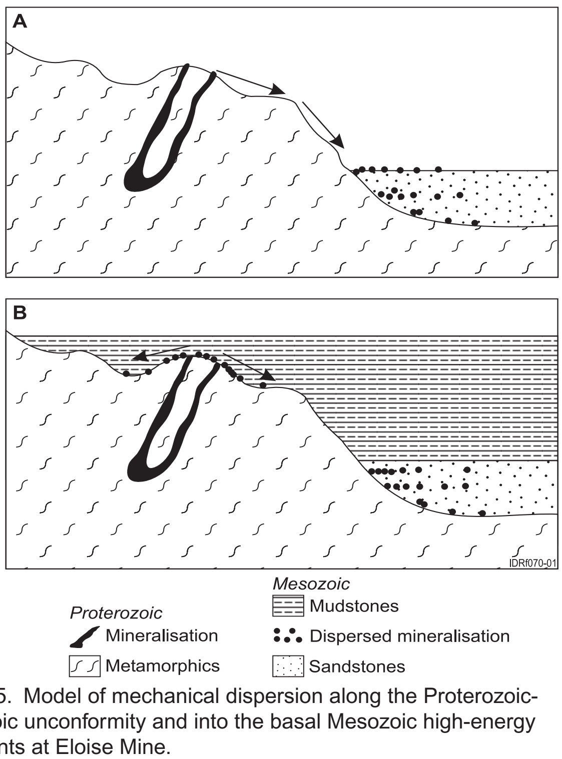

Figure 5. Model of mechanical dispersion along the Proterozoic-Mesozoic unconformity and into the basal Mesozoic high-energy sediments at Eloise Mine.

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SAMPLE MEDIUM - SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Threshold (ppm)	Max anomaly (ppm)
Coarse, basal, high-energy sediments	Cu, Au, As, Sb	Au, As Sb by INAA Cu by XRF	Au 5 ppb As 1 ppm Sb 0.2 ppm Cu 10 ppm	Au <5 ppb As 10 ppm Sb 0.2 ppm Cu 15 ppm	Au 15 ppb As 20 ppm Sb 0.35 ppm Cu 30 ppm	Au 90 ppb As 125 ppm Sb 1.4 ppm Cu 160 ppm