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OPEN FILE REPORT SERIES

SURFICIAL GEOLOGY AROUND THE ELOISE Cu-Au MINE AND DISPERSION INTO MESOZOIC COVER FROM THE ELOISE MINERALISATION, N.E. QUEENSLAND

Li Shu and I.D.M. Robertson

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(CSIRO Exploration and Mining Report 405R / CRC LEME Report 56R, 1997. 2nd Impression 2002.)

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CRC LEME is an unincorporated joint venture between CSIRO-Exploration & Mining, and Land & Water, The Australian National University, Curtin University of Technology, University of Adelaide, University of Canberra, Geoscience Australia, Bureau of Rural Sciences, Primary Industries and Resources SA, NSW Department of Mineral Resources-Geological Survey and Minerals Council of Australia.
Headquarters: CRC LEME c/o CSIRO Exploration and Mining, PO Box 1130, Bentley WA 6102, Australia

CSIRO/CRC LEME/AMIRA PROJECT P417
GEOCHEMICAL EXPLORATION IN REGOLITH-DOMINATED TERRAIN, NORTH QUEENSLAND 1994-1997

In 1994, CSIRO commenced a multi-client research project in regolith geology and geochemistry in North Queensland, supported by 11 mining companies, through the Australian Mineral Industries Research Association Limited (AMIRA). This research project, "Geochemical Exploration in Regolith-Dominated Terrain, North Queensland" had the aim of substantially improving geochemical methods of exploring for base metals and gold deposits under cover or obscured by deep weathering in selected areas within (a) the Mt Isa region and (b) the Charters Towers - North Drummond Basin region.

In July 1995, this project was incorporated into the research programs of CRC LEME, which provided an expanded staffing, not only from CSIRO but also from the Australian Geological Survey Organisation, University of Queensland and the Queensland Department of Minerals and Energy. The project, operated from nodes in Perth, Brisbane, Canberra and Sydney, was led by Dr R.R. Anand. It was commenced on 1st April 1994 and concluded in December 1997. The project involved regional mapping (three areas), district scale mapping (seven areas), local scale mapping (six areas), geochemical dispersion studies (fifteen sites) and geochronological studies (eleven sites). It carried the experience gained from the Yilgarn (see CRC LEME Open File Reports 1-75 and 86-112) across the continent and expanded upon it.

Although the confidentiality period of Project P417 expired in mid 2000, the reports have not been released previously. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authority to publish these reports. It is intended that publication of the reports will be a substantial additional factor in transferring technology to aid the Australian mineral industry.

This report (CRC LEME Open File Report 135) is a second impression (second printing) of CSIRO, Division of Exploration and Mining Restricted Report 405R, first issued in 1997, which formed part of the CSIRO/AMIRA Project P417.

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PREFACE AND EXECUTIVE SUMMARY

The CRC LEME-AMIRA Project 'Geochemical exploration in regolith-dominated terrain of North Queensland' (P417) has, as its overall aim, to substantially improve geochemical methods of exploring for base metals and gold deposits under cover or obscured by deep weathering. The research includes geochemical dispersion studies, regolith characterisation, dating of profiles and investigation of regolith evolution.

The area around Eloise is on the margin of the Eromanga Basin where the Proterozoic metamorphic rocks of the Mt Isa Inlier have been partly covered with Mesozoic and Cainozoic sediments. This has provided some considerable challenges to geochemical exploration; exploration to date in the Eromanga and Carpentaria basins has been by investigation of geophysical targets by drilling. The intent of this study was to determine the geomorphic and linked sedimentary history of this region and, using this framework, to investigate a number of opportunities for using geochemistry in this difficult environment.

This area has had a complex history of erosion and deposition. Fluvial and deltaic sediments were deposited in the Jurassic and Early Cretaceous in what is now the headwaters of the Cloncurry, Bustard and Fullarton rivers; remnants of these now form mesas on the Proterozoic basement. Marine deposition covered the Eloise mineralisation with 50-150 m of mudstones. After marine regression, a veneer of Tertiary fluvial sediments was deposited on the Mesozoic sediments. Incision since the Early Cretaceous has left erosional terraces, plains, higher river terraces and lower river terraces on which plains of black and brown soil have developed.

Geochemical investigation of coarse sediments at or just above the virtually unweathered Proterozoic-Mesozoic unconformity gave the most promise for detection of a 'near-miss' situation when investigating geophysical targets by drilling. There were indications of limited mechanical dispersion (<100 m) of Au, Cu, As and Sb down slope from mineralisation or fault leakage. There may also be some fluvial concentrations just above the unconformity, more distant from mineralisation but also down slope. An understanding of the palaeotopography of the unconformity is essential to interpreting this data.

This report is one of three. CRC LEME Report 45R covers the alluvial landscapes of the Maronan area. CRC LEME Report 57R deals briefly with dispersion at the Maronan Prospect.

R.R. Anand
Project Leader

I.D.M. Robertson
Deputy Project Leader

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ABSTRACT

The area around Eloise is on the margin of the Eromanga Basin where the Proterozoic metamorphic rocks of the Mt Isa Inlier have been partly covered with Mesozoic and Cainozoic sediments. This has presented a considerable challenge to geochemical exploration in the region. To date, exploration in the Eromanga and Carpentaria basins has been by investigation of geophysical targets by drilling. The intent of this study was to determine the geomorphic and linked sedimentary history of this region and, using this framework, to investigate a number of opportunities for using geochemistry in this difficult environment.

There has been a complex history of erosion and deposition during the Mesozoic and Tertiary. In the Late Jurassic and Early Cretaceous, fluvial and deltaic sediments of the Gilbert River Formation were deposited in broad valleys which later became mesas on the Proterozoic basement in the catchments of the Cloncurry, Bustard and Fullarton rivers to the southwest of the study area. Subsidence of the Eromanga Basin and marine transgression in the Cretaceous covered the Eloise area with mudstones and limestones 50-150 m thick, concealing the mineralisation in the Proterozoic basement.

The ancestral Fullarton River later deposited 5-8 m of Tertiary fluvial sediments on the Mesozoic. Since the Early Cretaceous, incision has created erosional terraces, plains, higher river terraces and lower river terraces. The Tertiary fluvial sediments were slightly ferruginised and mottled and brown soil was developed on them. Kaolinite of the brown soil has been partially converted to smectite, forming patches of black soil on the higher terrace, where the fine-grained sediments are water retentive. Black soil has developed on the lower river terrace, forming extensive black soil plains.

Thick Cretaceous cover at Eloise presents an effective barrier to geochemical exploration. Apart from the mineralisation, the most promising geochemical target at Eloise is the Proterozoic-Cretaceous unconformity. This consists of a thin and probably discontinuous layer of coarse sediments developed on and from erosion of the basement which might retain a mechanical or hydromorphic dispersion from the Eloise mineralisation. The palaeotopography of the unconformity was reconstructed from distant water bores and near mine drilling. Sampling of the decline and geotechnical and water bore drilling indicated no dispersion into the Mesozoic but there were indications of mechanical down-slope dispersion along the unconformity. Mechanical dispersion at the unconformity around Eloise may have extended about 100 m from the mineralisation or from mineralised faults. Drilling 3 km distant from the mine indicated some small anomalies, notably just above the unconformity. This site appears to have been located directly down the palaeo-slope from Eloise and early sediments infilling this area were, therefore, slightly anomalous.

Investigation of mechanical dispersions of Cu, Au, As and Sb in coarse sediments at the Proterozoic-Mesozoic unconformity seems to be a valid prospecting method in areas of unweathered or slightly weathered Mesozoic cover. The form of the palaeolandscape governs dispersion directions so this needs to be thoroughly understood.

1. INTRODUCTION

1.1 THE ELOISE MINERALISATION

The Eloise Cu-Au Mine lies 60 km south-east of Cloncurry at 20°57'30"S, 140°58'40"E (Figure 1) and 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. Mineralisation is associated with major retrograde shears in which early hornblende-biotite-quartz assemblages occur. This was overprinted by chlorite-muscovite-pyrrhotite-chalcopyrite±calcite±magnetite assemblages and, later, by a calcite-chlorite-quartz±pyrite assemblage during subsequent brittle phase deformation (Baker, 1994). The deposit and its Proterozoic host rocks are buried beneath 50-70 m of Mesozoic cover of the Eromanga Basin and by 5-7 m of Tertiary-Quaternary alluvium. It was discovered by regional and local aeromagnetic, ground magnetic and electromagnetic surveys and by subsequent drilling by BHP Minerals Exploration (Brescianini *et al.,* 1992; Skrzeczynski, 1993). AMALG Resources NL initiated mining at Eloise in late 1995 and offered the opportunity for this study.

Locally, the host rocks consist of north-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 a reverse fault with a 40-60° westerly dip, the Median Fault. This fault thickens with depth from 15-30 m. It consists of a breccia of silicified host rocks in a matrix of calcite, chlorite, quartz with minor pyrite and chalcopyrite. A later fault, the 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 metamorphics (Figure 2). Here, mineralisation in the fault is the only way by which a geochemical signal could reach the Proterozoic-Cretaceous unconformity.

1.2 REGIONAL SETTING

The mapped study area around the mine is about 21 x 34 km and consists of undulating plains, river terraces, fluvial ridges and bedrock outcrops. The undulating alluvial plains dominate and have a relief generally of less than 10 m. There are some low hills in the southwest and the terrain there is comparatively rugged due to stream incision.

Geologically, the study area is located to the east of the Eastern Fold Belt (Figures 1 and 3A). This runs predominantly north-south and consists mainly of Proterozoic rocks capped, in places, with remnants of Late Jurassic to Early Cretaceous fluvial sediments (the flat-lying Gilbert River Formation shown in Figure 3A). In the modern landscape, these Jurassic-Cretaceous sediments are distributed mainly in the headwaters of the Fullarton, the Cloncurry and the Bustard rivers; they probably once covered a much larger area, overlapping onto some of the Eastern Fold Belt in the pre-Tertiary. Folding and faulting in the Eastern Fold Belt occurred prior to deposition of the Gilbert River Formation; patches of Mesozoic sediments on the Cloncurry Fault seem unaffected by its movements (Figures 3A and 3C), although it is reported that the Mesozoic land surface has been displaced up to 180m, based on an examination of topographic maps (Grimes, 1972). The fluvial sediments, now occurring as mesas at the top of the modern landscape, vary in elevation from 480 m above m.s.l., on the Selwyn Range, to 300 m about 35 km to the south and 60 km to the north of the range. They are now about 150-200 m above the pediment immediately to the east of the Mount Isa Inlier. These data assist interpretation of landscape evolution of the study area.

The Eloise area lies on the western margin of the Eromanga Basin (Figure 4A). The sediments were of braided stream, meandering river, swamp and lake facies. Sedimentation was initiated in the Early Jurassic and continued to the Early Cretaceous (Senior *et al.,* 1978). A marine

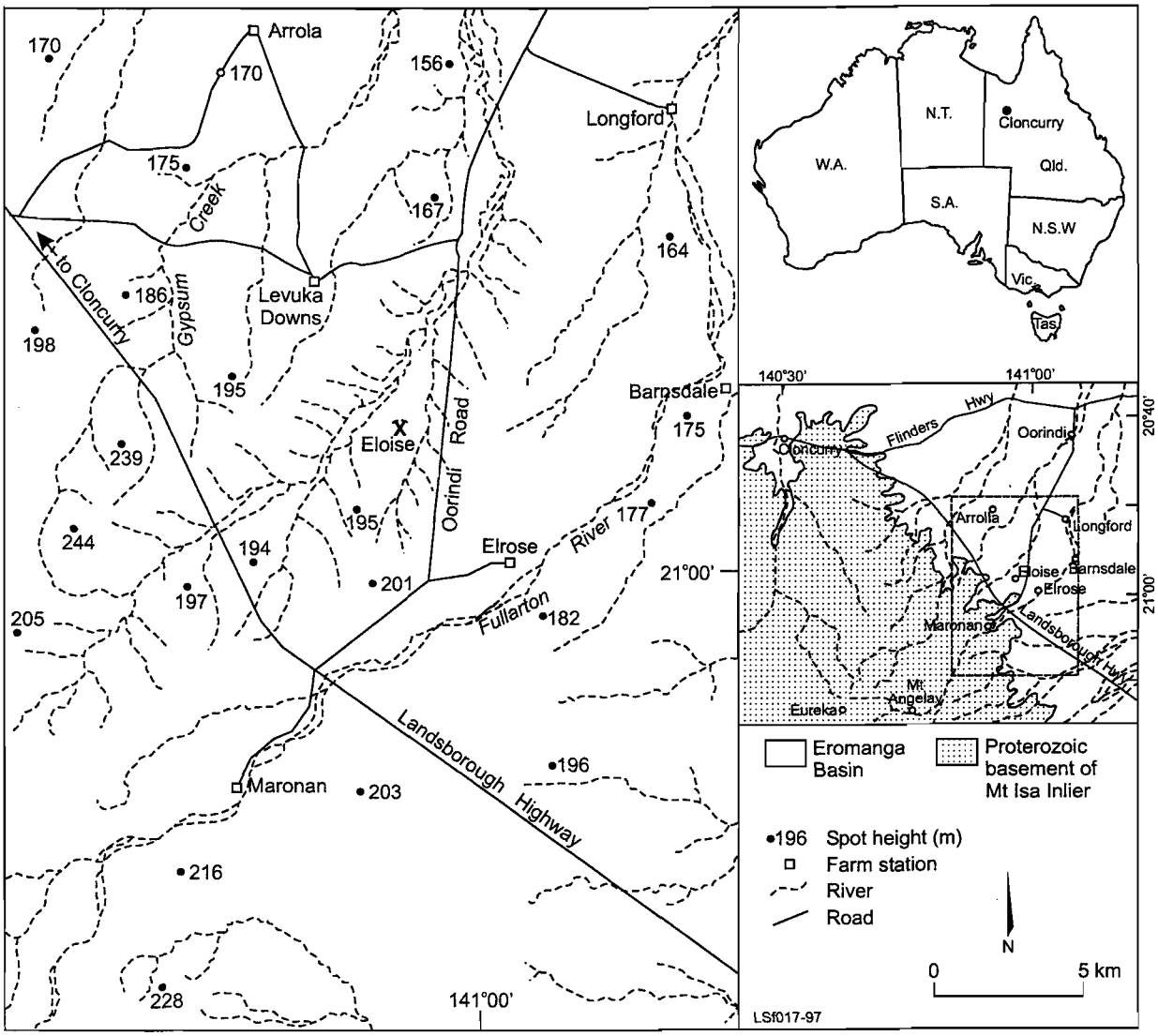


Figure 1. Location of the Eloise area in Northwest Queensland. This study area is on the eastern margin of the Mt Isa Inlier in the south-west. The remaining undulating terrain is inclined north-east, as indicated by the rivers and spot heights.

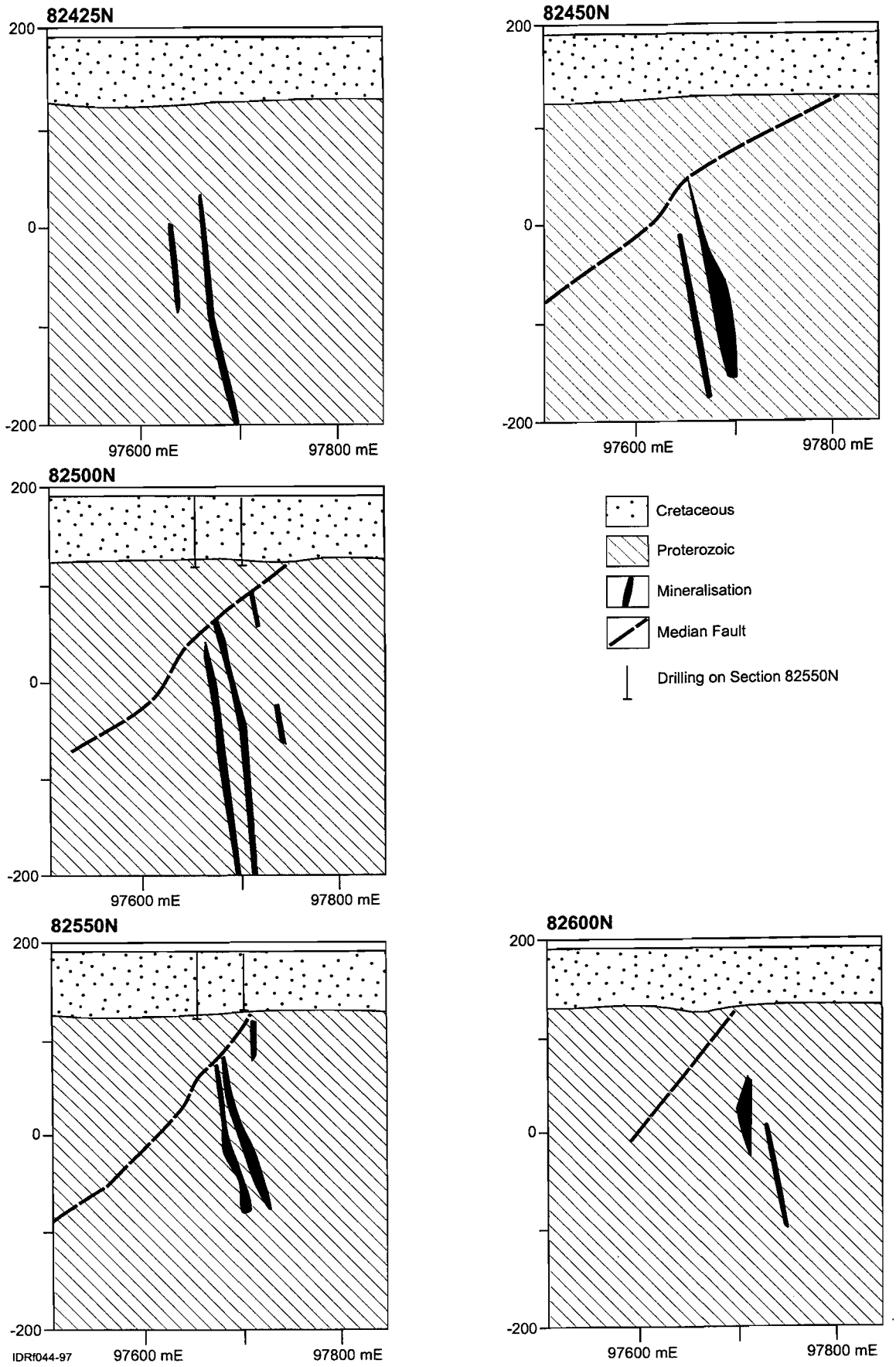


Figure 2. A sequence of east-west sections through faults and mineralisation at Eloise Mine, northwest Queensland. The Proterozoic basement is covered by 70 m of Mesozoic mudstones, Tertiary fluvial sediments and soil. Mineralisation is progressively cut off by the south-west dipping, curvilinear Median Fault. The locations of geotechnical diamond drillholes ENG1 and ENG2 are also shown projected onto sections 82500 and 82550N, between which they lie.

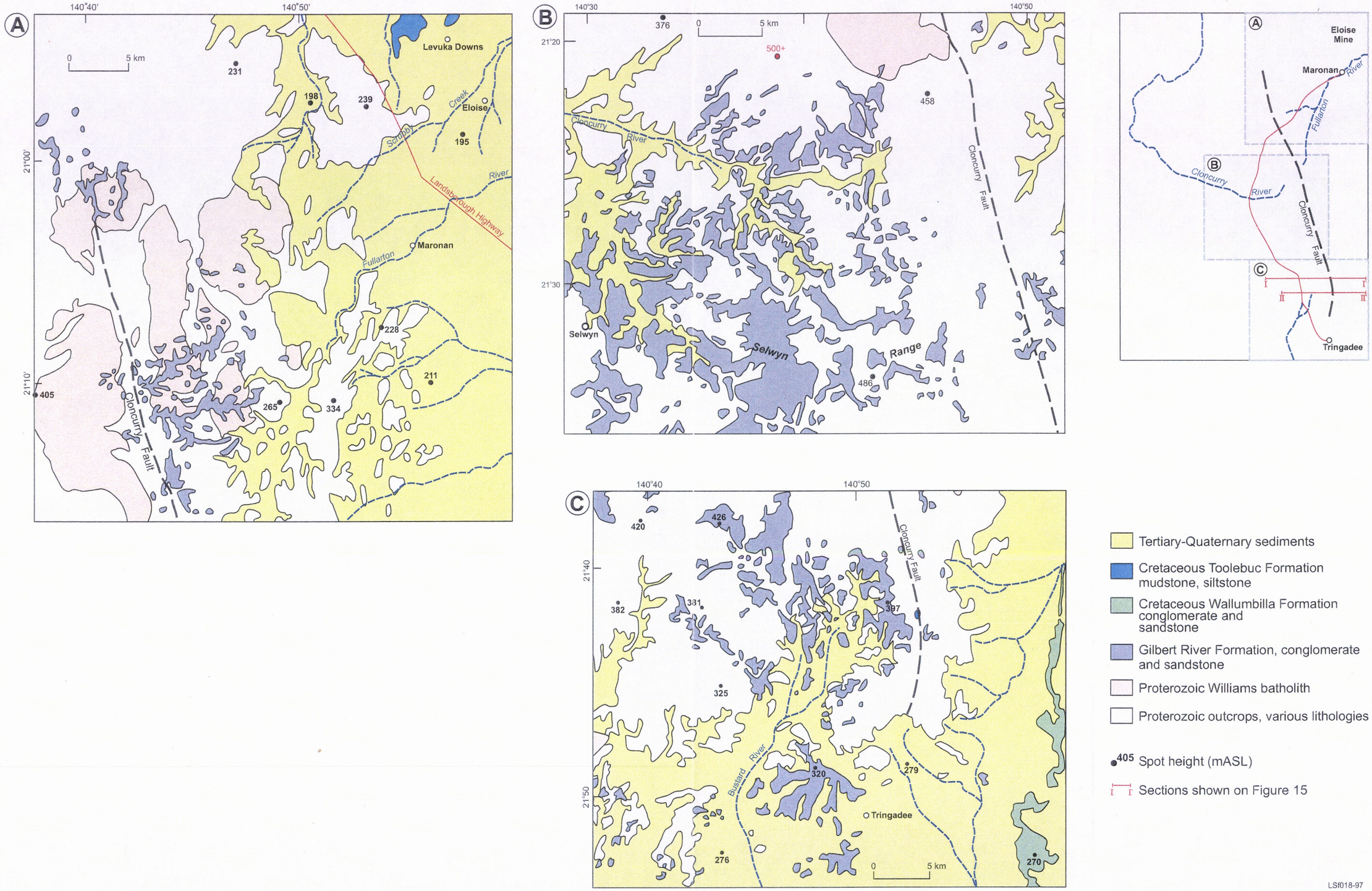


Figure 3. Distribution of the Late Jurassic to Early Cretaceous of the Gilbert River Formation around part of the Eastern Fold Belt of the Mount Isa Inlier, simplified from Blake et al., (1983). (A) Mesozoic sediments preserved as hill cappings at 260-400 m above m.s.l., in the headwaters of the Fullarton River, (B) at 380-460 m on the Selwyn Range and (C) down to 260 m south of the Range. The sediments are undisplaced by the Cloncurry Fault (B and C).

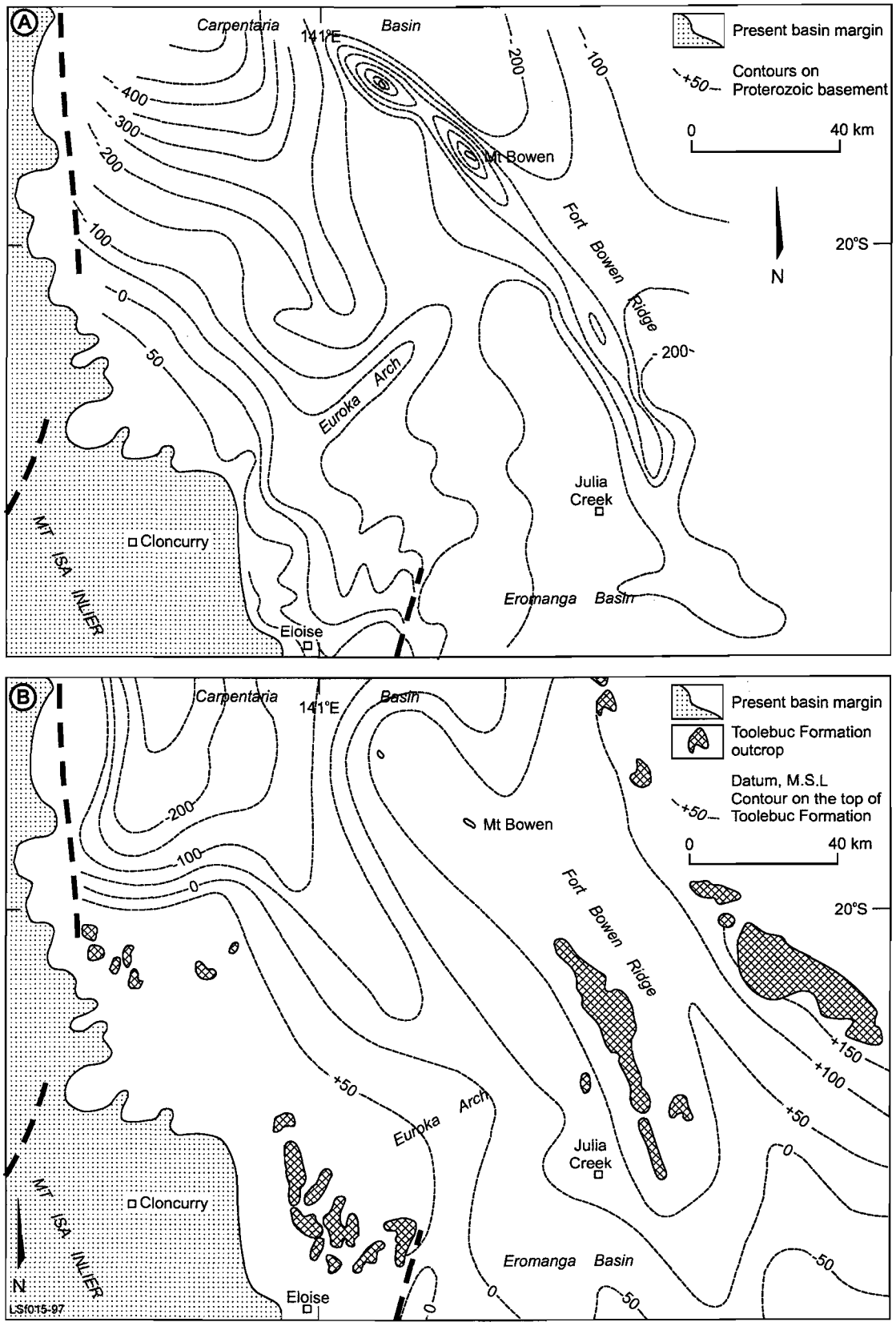


Figure 4. Basement structure of the junction between the Eromanga and Carpentaria basins (A) and contours of the top of the Toolebuc Formation (B). The Eloise Mine is on the margin of the Eromanga Basin (A) but close to the Euroka Arch. The Toolebuc Limestone was deposited at the end of the Early Cretaceous and remnants of this crop out in the modern landscape (B).

transgression from the north and northwest of the basin took place in the Early Cretaceous when deposition in marginal marine environments superceded continental sedimentation.

Geomorphologically, the southwestern part of the area consists of the foothills of the Selwyn Range which stands immediately to the west and about 150 m above the plains; the eastern and northern parts of the area are rolling plains constructed of sediments on the western margin of a Mesozoic basin, derived from the Range. Major streams, of intermittent flow, such as the Williams and Fullarton rivers, are sourced in the eastern flank of the Range and drain northeast, ultimately into the Gulf of Carpentaria.

The climate is tropical, monsoonal and semi-arid, with an annual rainfall of about 380 mm, falling largely between November and April. Variations in rainfall are marked, ranging from 500 mm in some years to less than 200 mm in others (Bureau of Meteorology, 1975 and 1977). Major drainages flow only after significant rains. At Cloncurry, to the northwest of the study area, average daily temperatures range from 10-24°C during July to 24-38°C in November to January.

Sparse bushes of eucalypt and spiky hummocks of spinifex cover much of the southwestern part of the area. The northern and eastern parts have been cleared for grazing, particular the black soil plains. Grasses grow well on black soil but less well on brown soil with a lag of fluvial gravel. This makes it possible to delineate the distribution of black and brown soils by their vegetation patterns on aerial photographs.

1.3 WORK PROGRAM

Field work was undertaken in the middle of December 1995, including regolith mapping, surface material and core sampling and geomorphic and sedimentological observations. This was followed by multi-element geochemical and some mineralogical analysis of the samples collected. The specific objectives were to understand (i) landscape evolution of the area, (ii) regolith development and characteristics, and (iii) geochemical dispersion, if any, into the Mesozoic and younger overburden. In addition, dispersions around the Maronan Prospect were briefly investigated and reported separately (Robertson *et al.*, 1997) and the alluvial landscapes of the Maronan area was investigated (Jones, 1997).

2. GEOLOGY AND STRATIGRAPHY

The simplified geology and stratigraphy of the Eloise area are shown in Figure 5. Basement rocks underlying the study area are Proterozoic meta-sediments and meta-basalts of the Soldiers Cap Group, part of the Maronan Supergroup. They include schist, gneiss, quartzite and amphibolite (Blake *et al.*, 1984). The rocks have been folded and faulted, are steeply dipping, and have a northerly regional structural trend. Mineralisation occurs along major faults and shears in the Proterozoic rocks which provided access to mineralising fluids.

Lag fragments of weathered Proterozoic rocks, occur as a veneer on residual soil in the southwest and the west. Here, the surface is flat and is at a similar level to the interfluve ridges to the northeast in the landscape. This suggests that intensive erosion took place in the southwestern corner of the study area while sediments were deposited to form the ridges in the north and east. Subsequently, the southwestern portion of the study area has been erosional.

The Proterozoic rocks underlying the Eloise area are almost entirely covered by a sequence of Mesozoic siltstone, mudstone and minor limestone of the Rolling Downs Group, except in the southwestern corner of the area. The unconformity indicates a long period of erosion. A thin layer of coarse conglomerate marks the unconformity between the Proterozoic metamorphic rocks

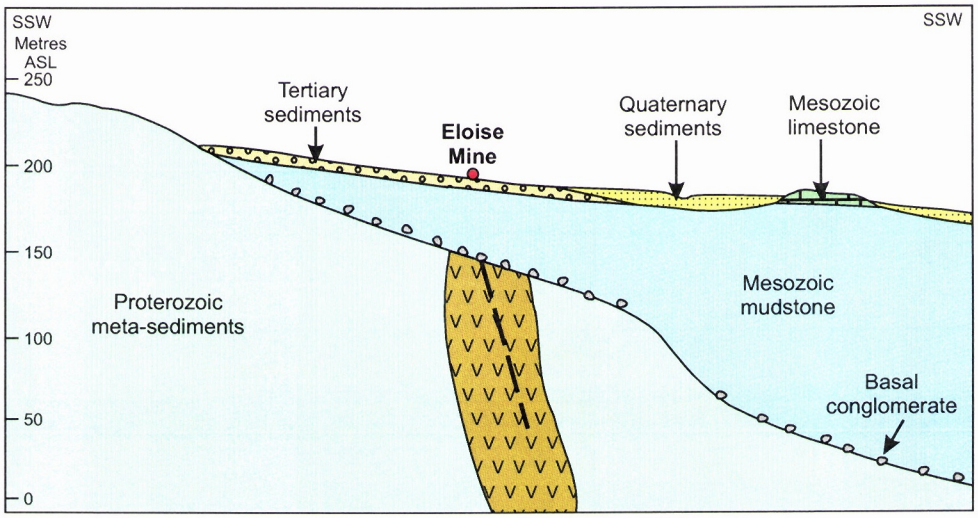


Figure 5. Generalised stratigraphy of the Eloise area showing the Proterozoic basement metapsammites and metapelites (yellow) and mineralised and faulted amphibolites. These have been eroded. At the base of the Mesozoic mudstones lies a thin layer of high energy sediments; at the top are remnants of Mesozoic limestone. The Mesozoic sediments, in turn, have been eroded and Tertiary and Quaternary fluvial sediments have been deposited as higher and lower river terraces respectively.

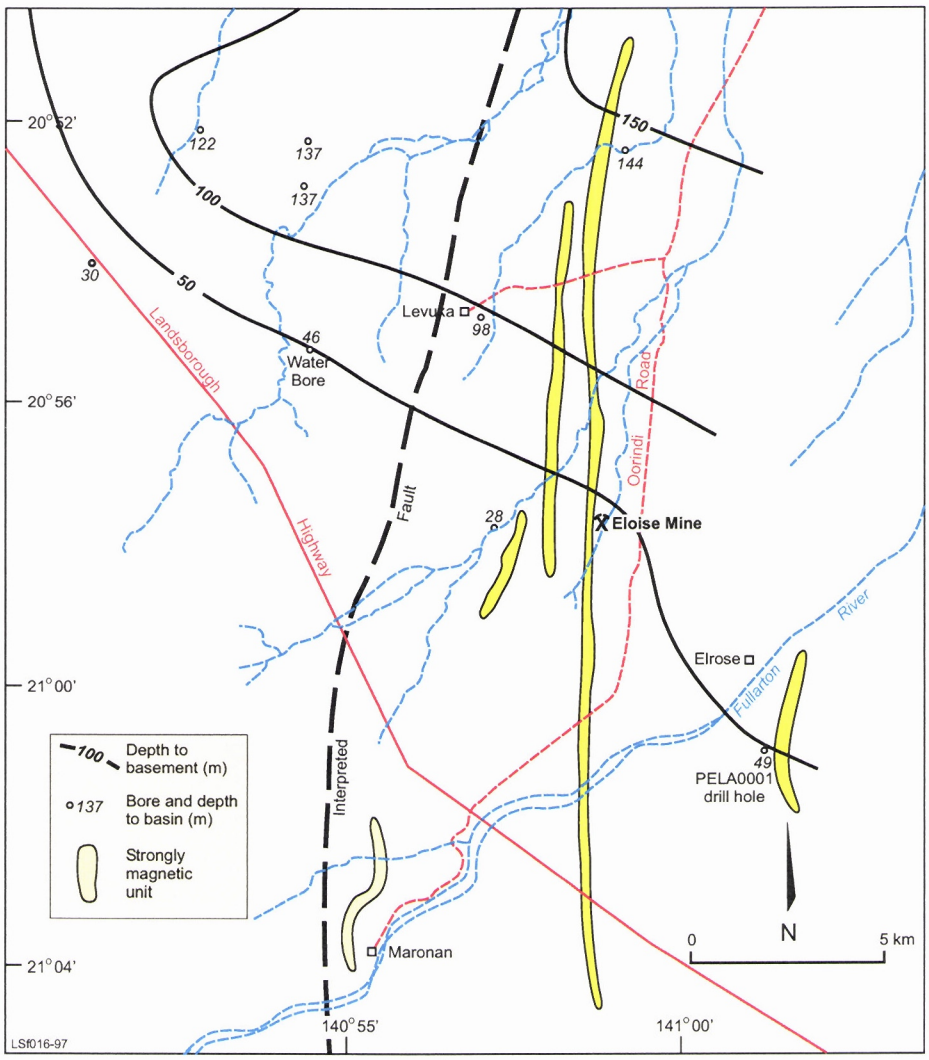


Figure 6. Depth to Proterozoic basement and the strongly magnetic units around Eloise and Maronan (modified from Komyshan, 1993).

FIGURE 7

A Remnants of the Toolebuc Formation. A thin layer of Early Cretaceous limestone has been eroded into slabs (CL), to form an erosional terrace (TC). Calcareous soil (CS) is now developed on the Mesozoic mudstone which was formerly capped by limestone. A lower river terrace (LC) is hidden below the skyline. Longford Station. AMG 501550 mE, 7690640 mN.

B A fossil ichthyosaur from the Mesozoic limestone of the Eloise area showing teeth (TH), orbit (OR) and probable cervical vertebrae (VB). Collected by the Muller family of Maronan Station.

C Numerous fossil belemnites from the Mesozoic limestone of the Eloise area showing the guard (GA) and phragmacone (PH) found in the Toolebuc Formation to the east of Arrolla homestead by the Muller family of Maronan Station. These fossils indicate an Early Cretaceous age for the mudstones and limestones.

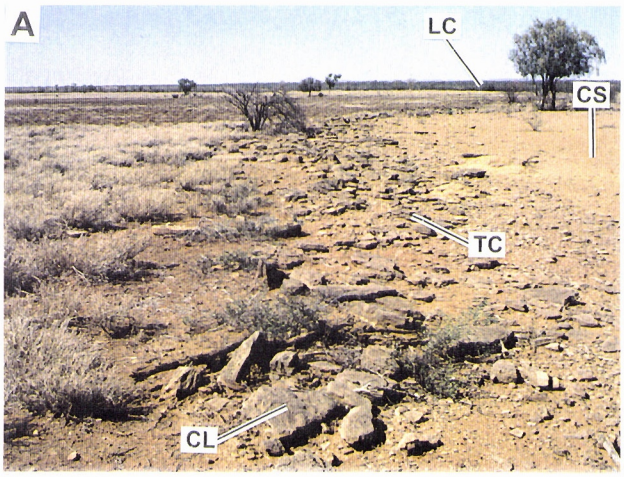
D River sediments on the higher terrace at the tailing dam of the Eloise Mine. The lower, grey part of the profile is weathered Mesozoic mudstone (MM), overlain by crossbedded channel deposits (CD). The upper part of the profile is a chocolate-coloured soil (SO), developed in relative fine sediments, in the process of transforming from brown to black. Detail is shown in Figure 7E. AMG 497564 mE, 7683063 mN.

E Detail of river sediments in Figure 7D. Note carbonates (CA) accumulated in the river sediments. The sandstones rest unconformably on Mesozoic mudstone (MM). Eloise Mine.

F River sediments on the higher terrace at the tailing dam of the Eloise Mine. The lower, grey part of the profile is weathered Mesozoic mudstone (MM), overlain by crossbedded channel deposits (CD). The upper part of the profile is a chocolate-coloured soil, developed in relative fine sediments, in the process of transforming from brown to black. Detail is shown in Figure 7G. AMG 497564 mE, 7683063 mN.

G Detail of river sediments in Figure 7F. Tertiary river sediments (RS) overlie weathered Mesozoic mudstones (MM) with an irregular contact (IC). A pocket of coarse quartz and quartzite gravel (QG) marks the onset of Tertiary sedimentation and their roundness indicates a significant transport distance. AMG 497564 mE, 7683063 mN.

H Weathering on an erosional terrace. Micaceous schist (MS) protrudes from the ground. A very thin, brown, lithic soil has formed on the terrace (LS), with numerous termitaria (TM). A quartz vein (QV) outcrops in the background, shedding a lag of quartz fragments (QL). Two km west of Eloise Mine.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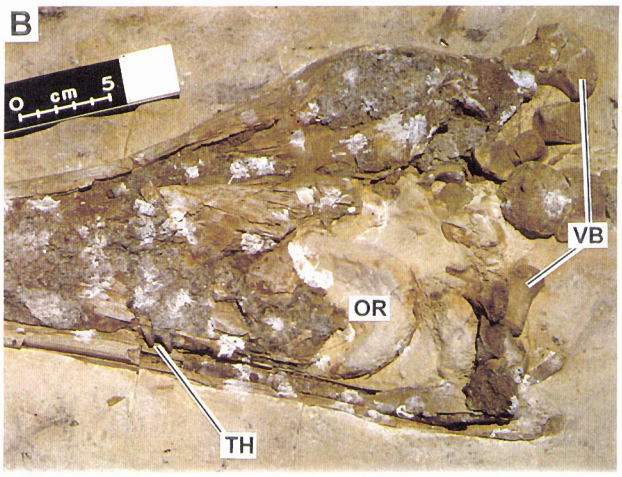
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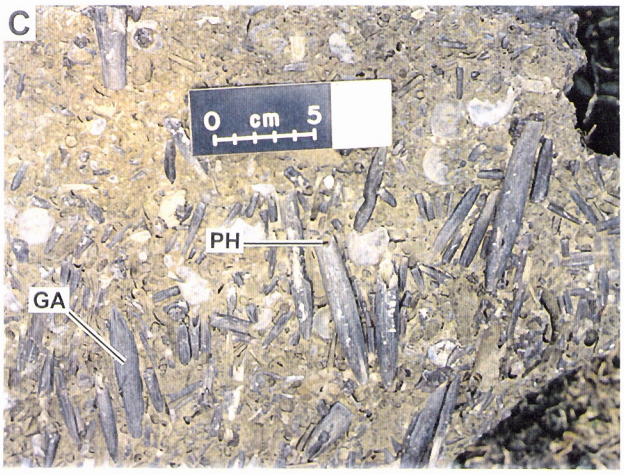
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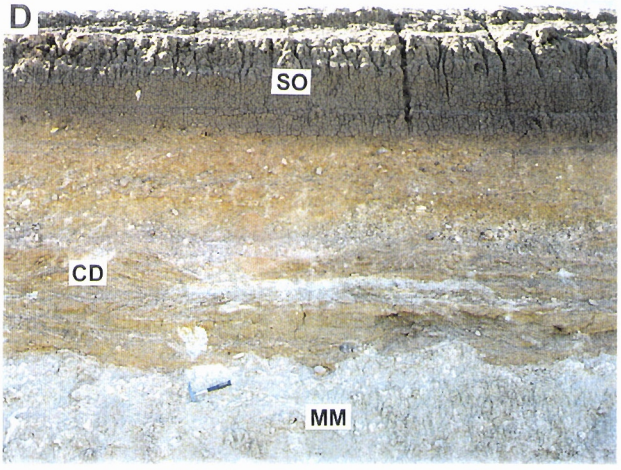
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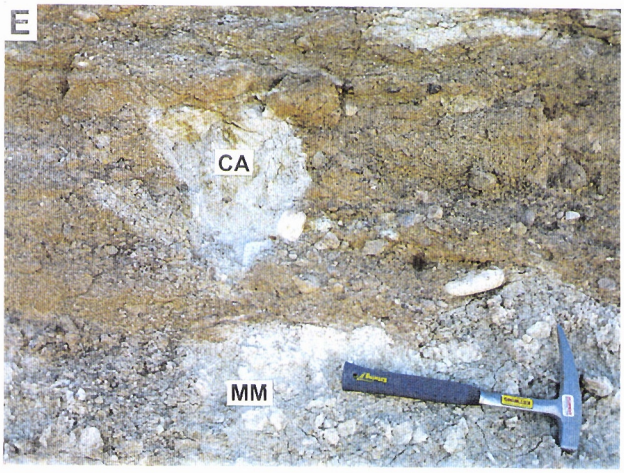
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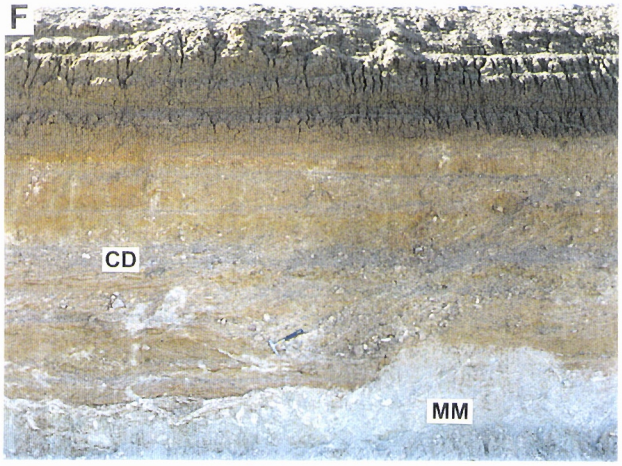
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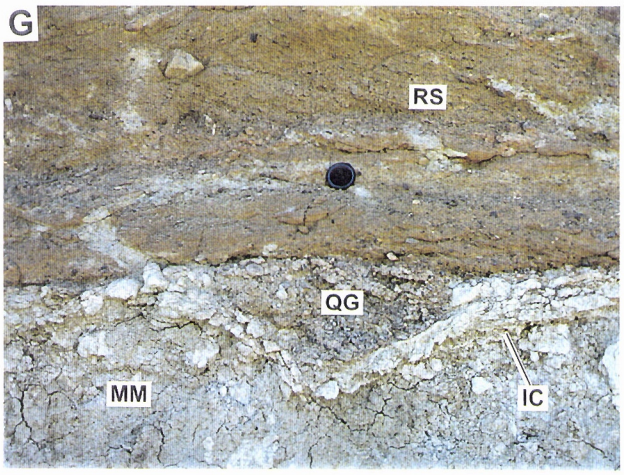
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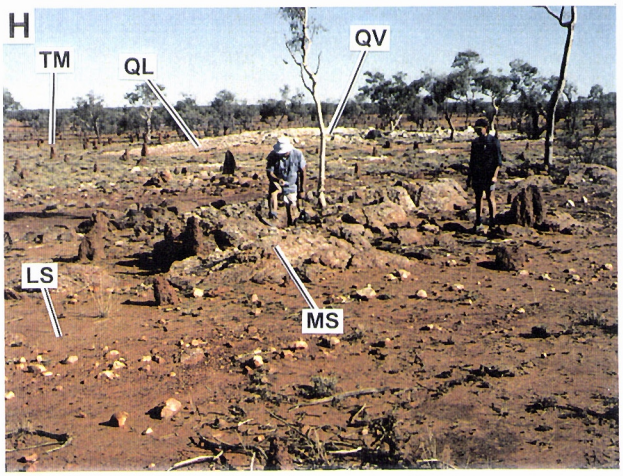
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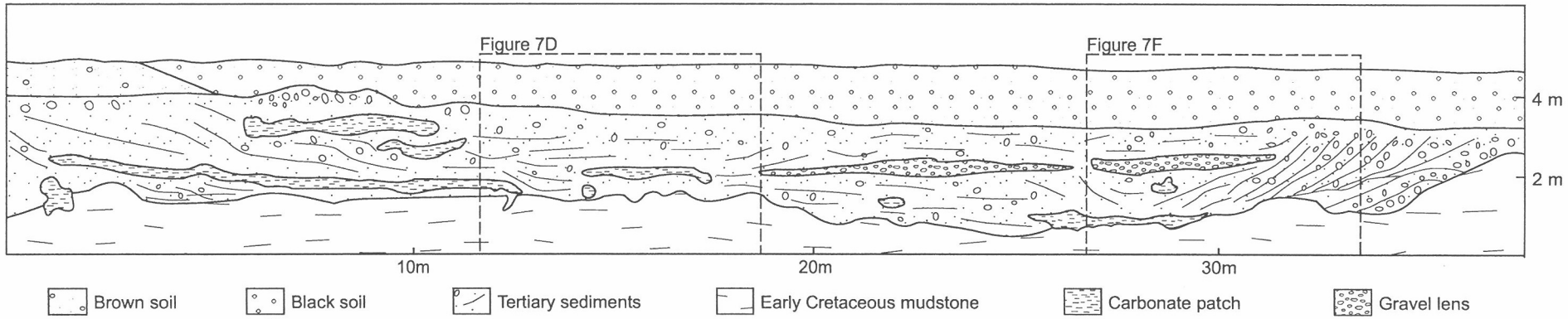


Figure 8. Tertiary sediments over weathered Mesozoic mudstone at Eloise tailings dam pit. Cross-bedding and coarse, rounded gravel beds above the mudstone indicate a channel deposit overlain by coarse sands. These, in turn are covered by clays, where brown and black soils have developed.

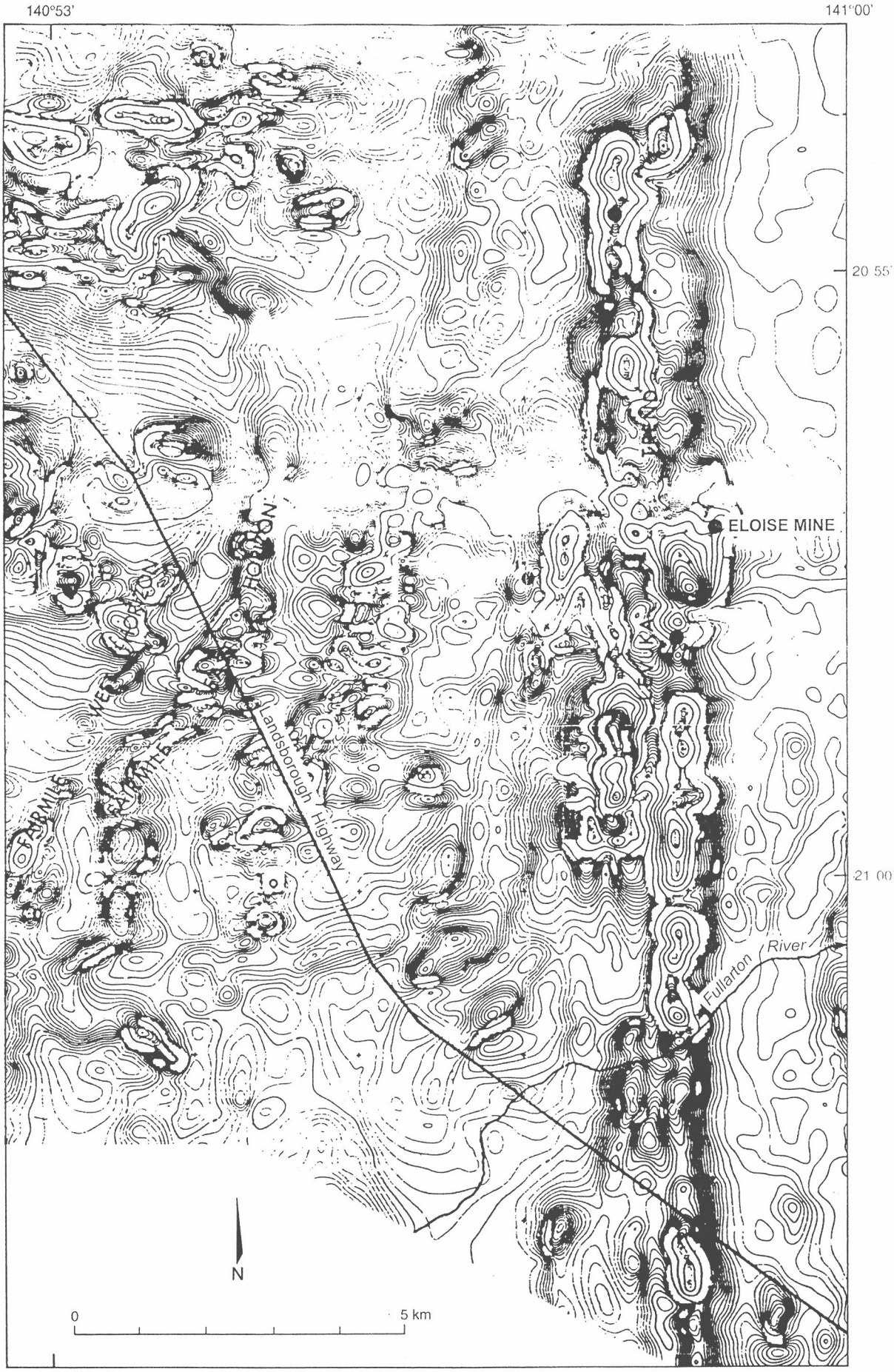


Figure 9. Contoured aeromagnetic data around the Eloise Mine (after Sandl *et al.*, 1991).

and the Mesozoic sediments and suggests an extended period of erosion prior to the onset of marine sedimentation. The Proterozoic rocks beneath the unconformity are all remarkably fresh (weathered to saprock at most).

The Mesozoic sediments vary in thickness of 1-2 m in the south to greater than 150 m, 10 km north of Eloise (Figure 6; Komyshan, 1993). At the Eloise Mine, the Mesozoic sequence ranges from 50-70 m thick, and thickens towards the northeast. Arenaceous sediments, dominantly mudstone, siltstone and sandstone of the Wallumbilla Formation represent a shallow marine environment and are capped in the northern and northeastern parts of the area by thin beds of limestone of the Toolebuc Formation. Much of the limestone has been eroded but there are remnants of the limestone scattered to the north and northeast of Eloise Mine (Figure 7A). Various fossils found in the mudstone and limestone, such as belemnites (Figure 7C), small bivalves, ichthyosaur remains (Figure 7B), shark teeth and ammonites, indicate an Early Cretaceous age.

Remnants of limestone on a former river terrace, as well as limestone-capped hills, are indicative of erosion of the Mesozoic sediments. Where covered by Tertiary and recent alluvium, the Mesozoic sediments, exposed by open test pits and gully exposures, have been weathered to saprolites. There is no way of determining if the weathering took place prior to or after deposition of the Tertiary sediments.

In most parts of the area, the upper portion of the Mesozoic sediments has been removed by erosion, leaving room for later deposits. Fluvial sediments, 2-8 m thick, with a large proportion of rounded gravels in a matrix of coarse sand, derived from various types of Proterozoic bedrock, overlie Mesozoic mudstone and are generally referred to as Tertiary sediments (Figures 7 D-G and Figure 8). The top part of the material is generally ferruginous, brown to red and its surface is mantled with a lag of pebbles and ferruginous pisoliths. The materials were deposited in former channels of a major river, probably the ancestral Fullarton River but, later, this river changed its course to the east. The Tertiary sediments form either fluvial ridges or high river terraces.

Quaternary alluvium, in the lower part of the landscape, has built up plains directly over Mesozoic sediments. Deposition and redistribution of these post-Mesozoic sediments has formed rolling plains at Eloise. Where the material is fine, due to facies changes from overbank deposition, and poorly-drained, black soil is developed. In some places, the fine facies of the Tertiary sediments occurs under coarse sand and gravel and has been mottled (Figure 14C).

The basement geological structure of the area is concealed by Mesozoic sediments and is not visible at surface. An aeromagnetic survey by BHP Minerals Exploration highlighted a north-trending magnetic ridge through the Eloise Mine area (Figure 9), which is consistent with the regional structural trends. The magnetic units have been found by drilling to be relatively unaltered amphibolites and magnetite-rich psammites (Brescianini *et al.*, 1992; Komyshan, 1993). Baker (1994) provided details of basement faults but these do not intersect the Mesozoic overburden.

3. DISCUSSION OF PREVIOUS WORK ON LANDSCAPE EVOLUTION

There has been little geomorphological research in the Eloise area, although there has been substantial geological and geophysical investigation by BHP Minerals Exploration and other exploration companies in the last decade. Landscape observations have been mentioned only incidentally in annual reports and there have been no regolith studies, prior to the present study, of which the authors are aware.

There has been exploration in the area for uranium deposits and base metals by ERA South Pacific, BHP-UTAH, Shell and Aberfoyle Resources from 1977-1991. There have been detailed

magnetic and radiometric surveys, pattern drilling, bedrock and stream sediment sampling (Baker 1994; Brescianini *et al.*, 1992; Komyshan, 1992 and 1993; Sandl *et al.*, 1991).

Twidale (1956 and 1966) recognised three major erosion surfaces in the Leichhardt-Gilbert area of NW Queensland. These were:- (i) A high plateau (pre-middle Mesozoic) of the Isa Highlands and the Cloncurry Plain, (ii) the undulating plateau of the Isa Highlands (Early to Middle Tertiary), and (iii) the Julia Plain and Wondoola Plain (Late Tertiary-Quaternary). On his geomorphological map of the region, the Eloise area was classified as rolling and undulating plains of erosion, and formed parts of the Cloncurry Plain and the Julia Plain. Twidale's concept of erosion surfaces was followed by Grimes (1972, 1980a) who proposed a dozen surfaces for Queensland. In particular, Grimes (1980b) adopted a concept of cyclic development for the region of the Carpentaria and the Eromanga Basins, including the Eloise area, and recognised three cycles, each commencing with uplift, followed by similar sequences of erosional, depositional and weathering events.

Studies of erosion surfaces and development of cyclic concepts bought about the first understanding of a regional landscape with simplified interpretations of means by which the landscape evolved. However, one must be cautious about identifying land surfaces as different workers have differing perceptions of them. For instance, the Late Jurassic to Early Cretaceous sediments in the Eastern Fold Belt are identified as an erosion surface by Twidale (1966) and Grimes (1972). The actual level of the sediments in the landscape ranges from 486 m (Figure 3B) to 252 m (Figure 3A). Within the Julia Plain, which makes up most of the Eloise area, most of the landforms of this so-called surface are much more diverse than the simplistic concept of erosion surfaces would allow. Most areas of the plain are depositional, as discussed below. In contemporary geomorphology, there are few case studies of land surfaces and still less in the literature which have been successful in guiding mineral exploration.

Twidale (1966) examined river patterns in northwest Queensland and recognised a recent change in habit from meandering to braided. He attributed this to uplift of the Selwyn Upwarp in the Late Pleistocene and Early to Middle Holocene. However, some fundamental points in his study are controversial. Firstly, a river may be broadly braided but, in detail, be meandering. On aerial photographs, representing a large drainage system, it can be seen that the present channels are still meandering; there is no evidence for a change in river habit in these cases. Moreover, northwest Queensland is subject to sporadic flooding when most abandoned channels of a meandering river would be reactivated. A change from meandering to braided habit is not due to increased rainfall, increased channel gradient or to tectonic upwarping in this case. Furthermore, Twidale (1956 and 1966) noticed a recent fall in sea level but believed the knickpoint caused by the fall has migrated upstream only about 64 km and remained there.

Twidale's model (1966) of a single migrating knickpoint is too simplistic; in actuality, a single knickpoint, which resulted from sea-level lowering could break into several knickpoints which migrate upstream, their positions influenced by local lithologies. If this occurred, the change in river habit, as claimed, might be attributed to increased channel gradient but not to upwarping in the headwaters of the rivers.

4. LANDFORMS

Regionally, the landscape of the Eloise area consists of a variety of landforms (see separate regolith map). Extensive alluvial plains and flat-lying erosional terraces give the impression of an undulating plain (Figure 10). There are both erosional and depositional landscapes. At the headwaters of Scrubby and Gypsum Creeks, to the southwest of the Landsborough Highway and in the southwestern corner of the study area, erosion has predominated. Materials eroded from the southwest have been carried to and deposited on low floodplains in the northeast, forming alluvial plains and other related landforms. Details are given below.

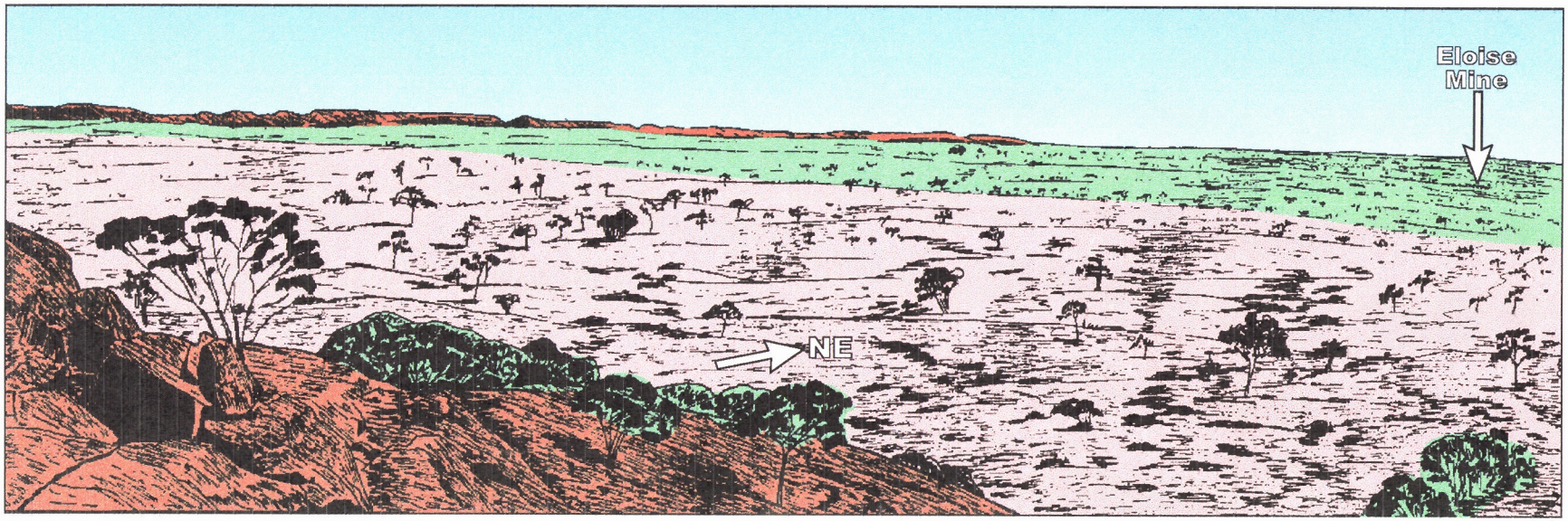


Figure 10. Sketch of the landscape around the Eloise Mine. The granite hill in the foreground (orange) and the low hills in the background to the left mark the eastern margin of the Mt Isa Inlier. Proterozoic rocks form an erosional terrace (pink; middle ground) and alluvial material (green) has formed in extensive, undulating plain on which the Eloise Mine is situated.

4.1 LOW HILLS

Proterozoic rocks form low hills in the southwestern corner of the area, generally to the west of the Landsborough Highway (Figure 1). They form foothills to the Eastern Fold Belt and provide the source of headwaters of many creeks. Erosion has occurred to form hills of bedrock and saprock about 20-50 m above the surrounding plains.

At the headwaters of Gypsum Creek, there are low hills with flat tops at a similar level to a higher river terrace around the Eloise Mine. Rounded river gravels occur in a thin layer of sandy, lithic soil on Proterozoic saprock. Many small creeks have incised the surface, leaving low hills. Further south, there are some isolated, north-trending hogbacks on steeply dipping phyllite, shale, gneiss and amphibolite; cuestas have formed on gently inclined basement strata.

4.1.1 Erosional terrace

Adjacent to the low hills is an erosional terrace with a flat surface at a similar level to the higher terrace of the Fullarton River. It is a planated surface with little colluvial or alluvial material and only a veneer of brown sandy soil mixed with lithic fragments (Figure 7H). Proterozoic bedrock (micaceous gneiss with a steeply inclined foliation) has been weathered and protrudes from the ground.

To the north and northeast of the Eloise Mine, Early Cretaceous limestone and mudstone form an erosional terrace, which is on the same but projected gradient as the higher river terrace around the Eloise Mine. From its distribution, the limestone must have covered a much larger area than that indicated by its present outcrop, so much has been removed by a long period of erosion. The limestone terrace appears to have been removed by fluvial erosion, possibly assisted by karstification. At present, much of the surface limestone is broken into slabs which are scattered on the mudstone (Figure 11A). Given extensive erosion in another one million years, the limestone float would be largely removed by then, which would make it very difficult to reconstruct the landscape.

4.1.2 Erosion plain

An erosion plain is well developed on both sides of the Fullarton River in the southwestern corner of the study area (Figure 11B). Subaerial erosion, aided by fluvial denudation, has reduced the land surface by weathering, mass wasting and overland flow, facilitated by the washing action of flooded streams. Quartz veins, amphibolites, shales and micaceous gneisses all have been planed to the same level as the lower river terrace of the Fularton River. Fragments of Proterozoic rocks are scattered on the surface but there is very little soil developed, indicating that the erosion is very recent. Morphologically, it provides an analogue to the formation of the erosional terrace over Proterozoic outcrops at the height of the higher river terrace.

4.1.3 River terrace

Where river channels are incised, former floodplains become river terraces. The Eloise Mine is on such an old terrace of the Fullarton River, which has shifted its course further to the east subsequently. This terrace is about 9 km wide, 14 km long and 15 m above a lower terrace adjacent to the present river channel. It has a gradient of 1:476 and has a similar surface level to erosional terraces both on Proterozoic rocks to the southwest and on Mesozoic mudstone to the northeast.

River sediments, consisting of coarse sand and rounded gravel, were deposited on the Mesozoic mudstone to form this terrace. In general, imbricated gravel and cross-bedded coarse sand form the lower part of the profile, sand and fine material form the upper part (Figure 12A), typical of channel deposition and floodplain sedimentation. When the terrace was formed, the river was

FIGURE 11

A An erosional terrace showing slabs of Cretaceous limestone (CL) with some concretions (CR), viewing southwest, towards Eloise Mine. In the background, beyond the remnants of limestone, is the lower river terrace (TC). AMG 501800 mE, 7690100 mN.

B Angular fragments of green Proterozoic amphibolite on an erosion plain in a very thin lithic soil (SL), southwest of Maronan. This flat surface is at the same level as the lower terrace of the Fullarton River (TC). Maronan Station. AMG 488861 mE, 7667848 mN.

C Large cracks (CR) developed in the smectitic black soil of a gilgai on the lower river terrace. Elrose Station. See bottom left of air photo in Figure 14G for location.

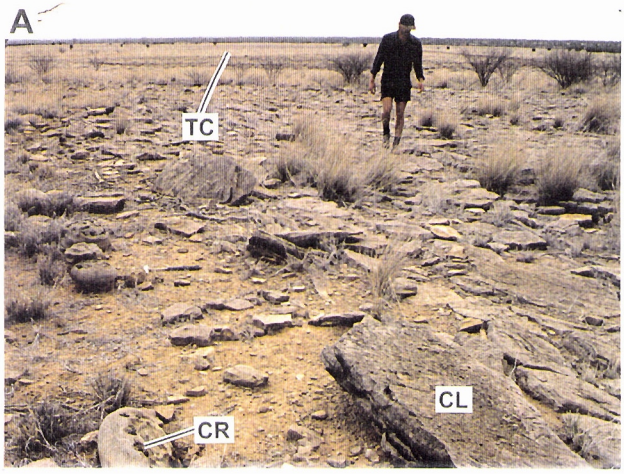
D An aerial view of minor rises (MR) on the lower terrace (LT) at the bend of Gypsum Creek (GC), consisting of a lag of river gravel and coarse sand. An erosional terrace of Cretaceous limestone (CL) lies 3-4 m above the lower terrace. Arrola Station.

E Fragments of fresh micaceous schist (MS) and quartz (QZ) in very thin, brown, lithic soil (LS) in the foreground and an outcropping lens of broken white quartz (QV) forming a low hill, suggesting a long period of erosion. AMG 488870 mE, 7677670 mN.

F Steeply inclined micaceous schist (MS) has been weathered to thin blades protruding from the ground in a thin, lithic soil (LS). Weathering on the slope of a low hill, south west of Maronan. AMG 488149 mE, 7668110 mN.

G Weathered slabs (SL) and concretions (CR) of relict Mesozoic limestone and carbonate sandstone on a mudstone erosional terrace, northeast of Eloise.

H Calcareous soil developed where Cretaceous limestone has been removed. Limestone remnants (LR) on the left middle ground mark an erosional terrace; the chocolate coloured calcareous soil (CS) makes up the lower river terrace. AMG 501609 mE, 7690776 mN.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CL
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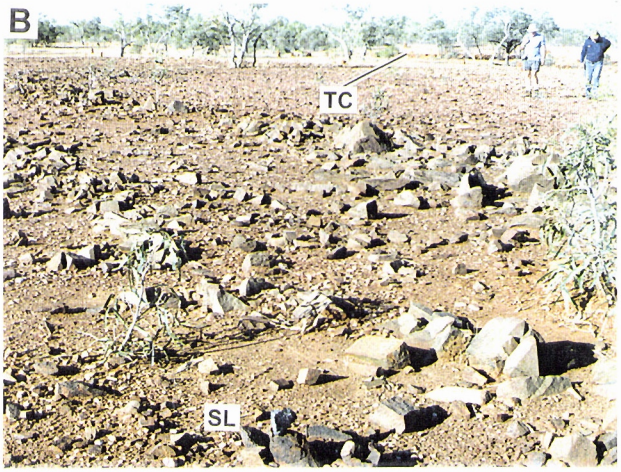
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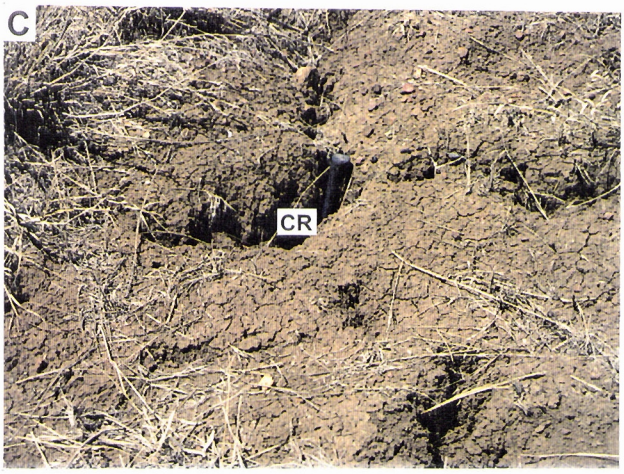
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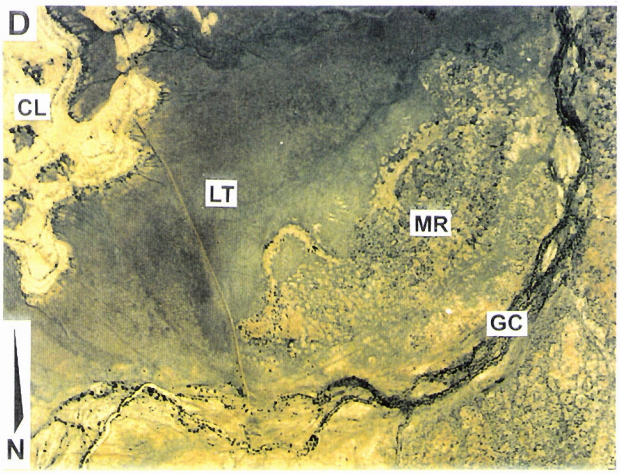
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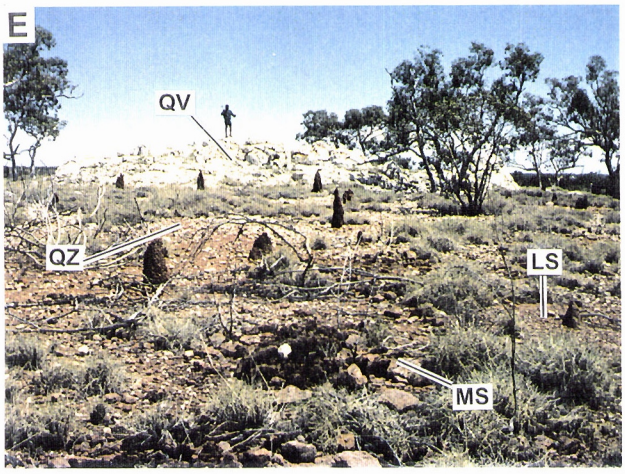
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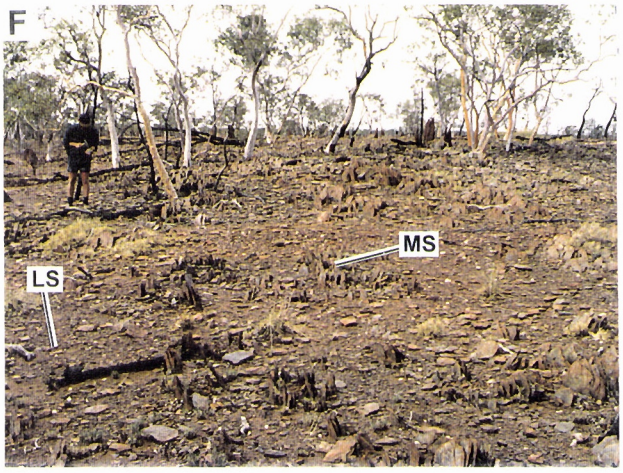
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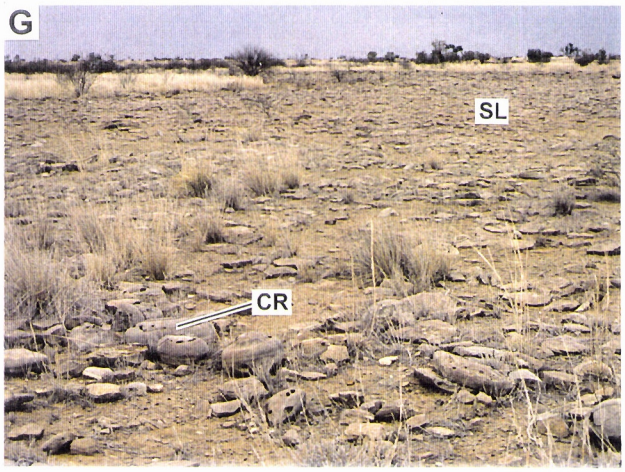
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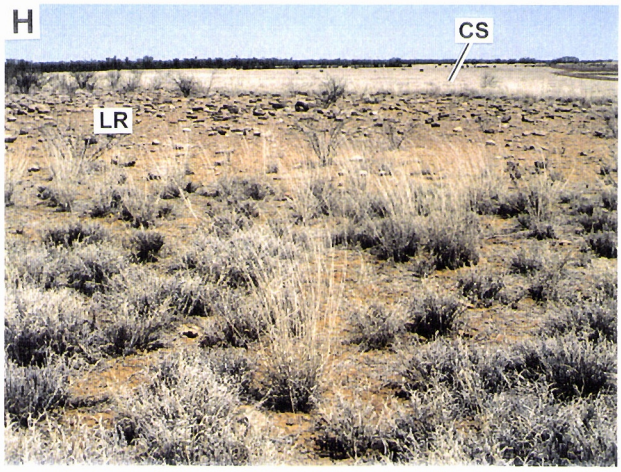

H
CS
LR

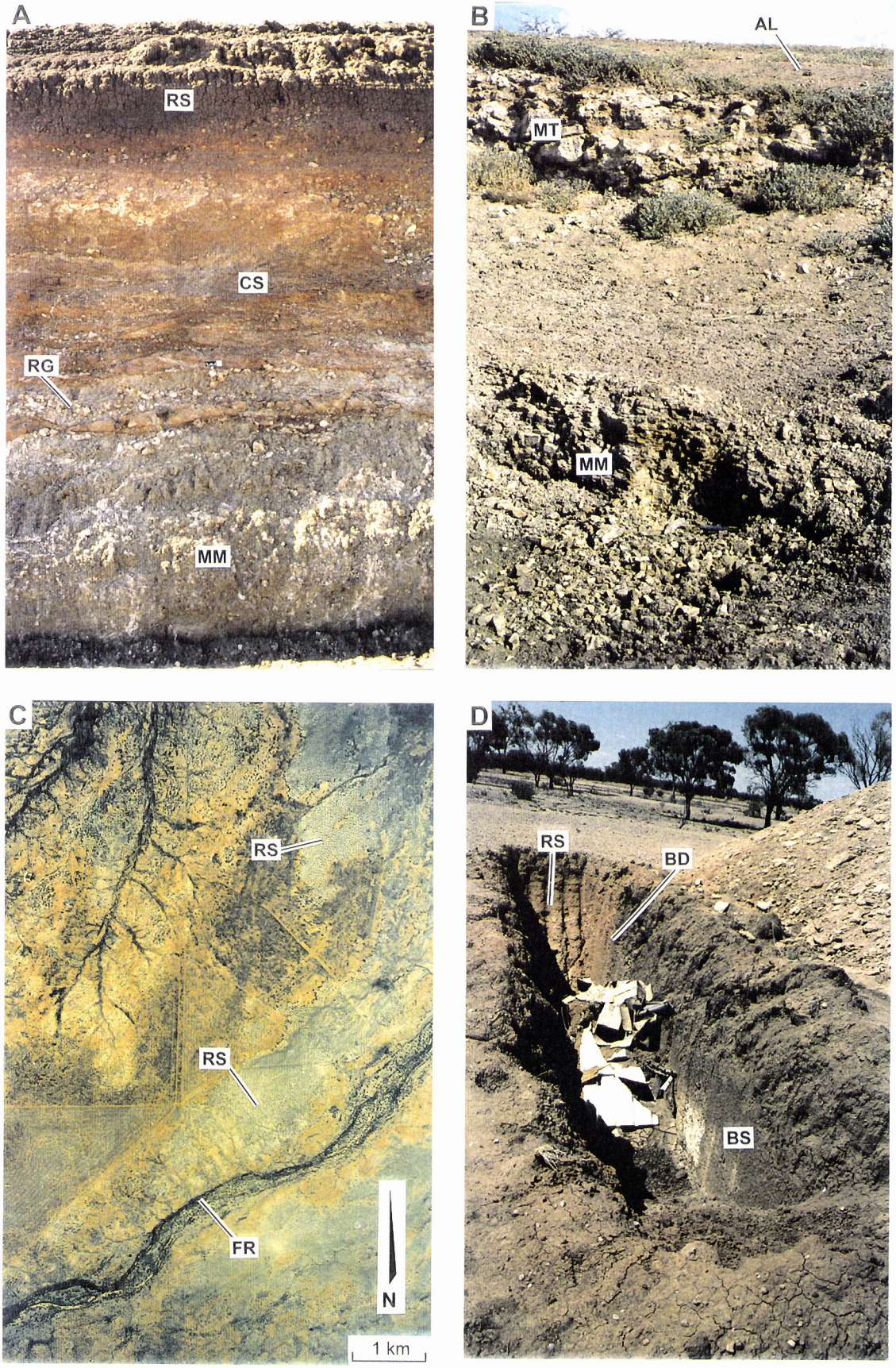
FIGURE 12

A A tertiary fluvial deposit over Mesozoic sediments at one of the open test pits at Eloise Mine. The lower part is grey, weathered Mesozoic mudstone (MM). The Tertiary sediments consist of crossbedded, coarse sands (CS) and river gravels (RG) overlain by a relatively fine sediment in which brown soil (RS) is developed. AMG 497564 mE, 7683063 mN.

B A close up of thin alluvium (AL) over Cretaceous mudstone (MM) exposed at a dam on the lower river terrace. The top of the mudstone (MT) is weathered and rich in carbonates. Two km south of Elrose homestead. AMG 501549 mE, 7674644 mN.

C An aerial view of a very fine, ribbed or spotted alternating distribution of brown and black soils (RS). The soil pattern is oriented towards the Fullarton River (FR) on the lower terrace between the track intersection and the River. In the up right corner, it lacks a pattern on the higher terrace. Elrose Station.

D A patch of black soil (BS) surrounded by brown soil (RS) on the higher river terrace exposed in a test pit at Eloise. Notice the boundary (BD) between black soil and brown soil. AMG 497577 mE, 7683428 mN.


A
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CS
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MM
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AL
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C
RS
RS
FR
N
1 km
D
RS
BD
BS

much broader and carried much more coarse sediment than at present, as seen from the grain sizes of the gravel and cross-bedded sediment exposed in pits at the Eloise Mine.

The higher terrace once comprised a former floodplain with incorporated point bars, scrolls and abandoned channels. Overbank deposits, laid down in times of flood, covered all this with fine sand and clay, forming an area of low relief and gentle gradients. This indicates that the river channel, which created this higher terrace, has shifted its position.

The Tertiary sediments, which are about 7 m thick at the Eloise Mine, thin out to the southwest and merge into an erosional terrace. This change is not apparent in the slope morphology, as there are no noticeable breaks in slope. To the north, east and south, however, this terrace has been removed by late erosion so that it is now bounded by a slope break which is about 3-5 m high in places and descends progressively to a lower river terrace.

The lower river terrace, about 4-5 m above the modern stream channels, is the former floodplain of the Fullarton River and its tributaries, formed after the river incised the Mesozoic mudstone and shifted its course to the east, away from the high river terrace. Normal flood water is now accommodated in a channel-floodplain assemblage, and generally does not reach the lower terrace. Peak floods, however, may reactivate abandoned river courses on the lower terrace.

The lower terrace consists largely of a very thin alluvium on the Mesozoic mudstone. At Levuka Downs, excavations for a dam exposed the mudstone covered by less than 2 m of fluvial sediments in which a black soil is developed. At another dam site, about 2 km south of Elrose, the mudstone almost outcrops (Figure 12B).

Black soil is well developed in the alluvium, forming a black soil plain, which extends beyond the study area. Development of black soil in the Eloise area is closely associated with availability of fine particles and poor drainage (discussed further in section 6.3).

4.1.4 Fluvial ridges

There are some ridges about 1-2 m high developed on black soil plains. They range in length from a few hundreds of metres to many kilometres and occur in broken lines. Rounded clasts (20-150 mm), occurring in a matrix of coarse sand, form the ridges that were once former river channels. Later erosion has removed the fine material from the coarse components which now stand out as ridges. Rivers of this region are subject to periodic flooding so natural levees line major channels. Where the channels have been abandoned and the fine material has been removed from these levees, coarse sands and gravels are left as ridges on the black soil plains.

4.1.5 Gilgai

Gilgai, common on black soil plains around the Eloise Mine, form an undulating micro-relief of shallow depressions (Figure 11C). They seem to have developed by differential expansion and contraction of clay-rich (smectitic) soils due to seasonal changes in moisture content, leading to a churning action. Expansion of the soil pushes gravel up the profile; gravel rims to the depressions are common (see Ollier, 1966; Paton, 1974; Beckman *et al.,* 1981, Thompson and Beckman, 1982).

4.1.6 Minor rises on alluvial plains

Minor rises, 2-3 m above the surroundings, occur on the black soil plains. In places, these are remnants of fluvial ridges but, in others, they are erosional remnants of Mesozoic mudstone. The latter may have been derived from a former erosional terrace and was probably capped by a thin layer of limestone, as is the present erosional terrace on the Mesozoic mudstone. Weathering and stripping have removed the top of the terrace and left the lower part as a minor rise. In other

places, most of the fluvial ridges have been eroded, leaving patches of gravel on the plains as minor rises (Figure 11D).

After a significant time, fine material and sand are generally washed away. As neither the former channel bed deposit nor the sediments of the levee have uniform gravel distributions, those parts of a fluvial ridge containing less gravel are more readily removed by sheetwash or overland flow than those parts consisting largely of gravel. This has produced minor rises lacking any obvious pattern.

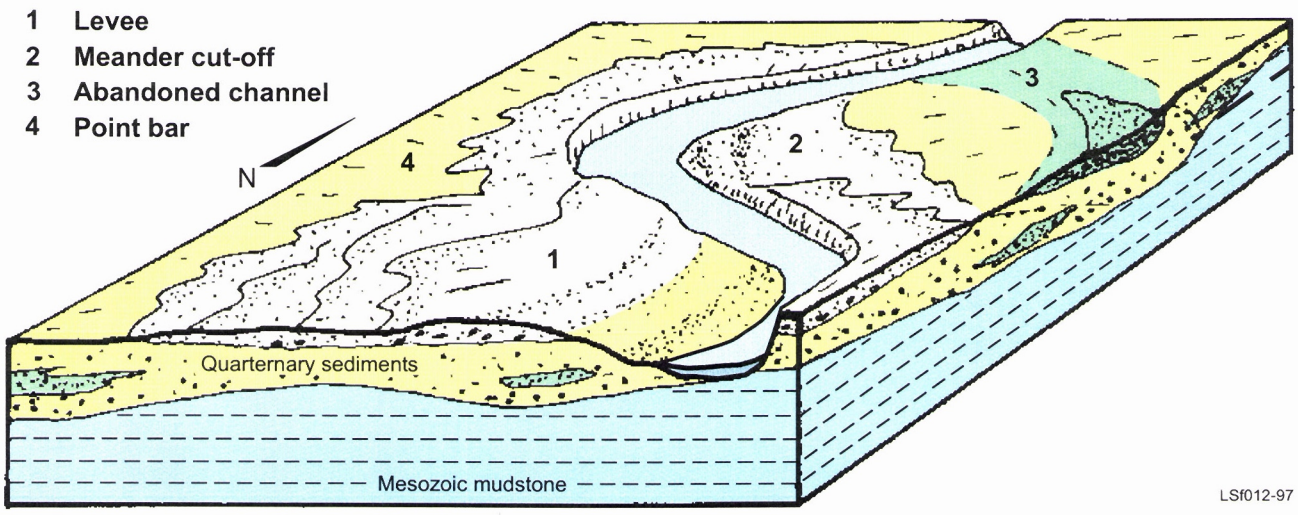


Figure 13. Levees built up by the Fullarton River. A flood plain of Quaternary fluvial sediments (4) lie on a basement of eroded Mesozoic mudstones. Incision and meandering of the Fullarton River has left abandoned river channels (3) and a meander cut-off (2). Periodic flooding has left overbank deposits building up levees (1).

4.1.7 Levees

The Fullarton River lies between levees 2-3 m high and 5-10 m wide (Figure 13). Outside these levees there are strips of a modern floodplain. This is common in other major streams, such as the Williams River and Gypsum Creek. Though the study area is semi-arid, streams are subject to flooding as rain occurs as spasmodic but torrential events when flood water may overtop river banks. Here, the velocity of the water decreases away from the main channels and sediments are deposited outside the main channels which gradually build up levees. Away from the channels, the grain size of the sediments decreases and the levees coalesce with floodplains.

4.1.8 Stream channel

The Eloise area has two types of stream channel; meandering channels and braided channels. Upstream from the study area, the major streams have bedrock-confined channels but, upon entering the study area, the channel characteristics change. Major streams, like the Fullarton and the Williams rivers, have meandering channels but Scrubby Creek, throughout the Eloise Mine area, has braided channels. The modern Fullarton River, downstream from Maronan, meanders through black soil plains and its main channel is floored by Mesozoic mudstone. Inside the main channel, sand bars are well developed, forming many sub-channels. During floods, the bars are submerged and may even be washed away, but new bars are formed at low stage. Where a flood breaks the levee, the river can form a new channel and change its course. At present, the Fullarton River has a few sections in which recently abandoned channels are, in places, reactivated during

flooding. Downstream from Barnsdale station, a meander scroll is clearly shown on a satellite image.

Scrubby Creek has a braided main channel with dendritic tributaries. This planform is unrelated to upwarping, as suggested by Twidale (1956), but is closely related to the substrate. Scrubby Creek has formed on the higher terrace of the former Fullarton River, all channels and tributaries upstream from the Oorindi Road (see Figure 1) are developed in unconsolidated Tertiary sediments which facilitate changes in stream course and the formation of dendritic tributaries.

5. REGOLITH UNITS

Twelve regolith mapping units have been recognised in this study (see separate regolith map). These regolith units were grouped into saprock and colluvium-alluvium, based on the nature of the regolith materials and geomorphological settings. This may be erosional, with extensive rock outcrop, or depositional (dominated by several metres of Cainozoic sediment). As a regolith unit may be associated with various landforms, the actual regolith-landform units may be more than the number of regolith units.

5.1 SAPROCK

5.1.1 Saprock on Proterozoic rocks

The southwestern part of the area has been erosional for a prolonged period, as the ancient sea level marked by Early Cretaceous limestone and calcareous concretions is below the erosional plain. Any weathering products have been removed by erosion in time, so no ferruginous saprolites or duricrusts have had an opportunity to form. In this regolith unit, fragments of bedrock are common; quartz has been dispersed at the surface from veins and pods to form a quartz lag (Figure 11E). Steeply inclined mica schists protrude from the ground as serrated outcrops (Figure 11F). The saprock forms low hills and has little soil on it, indicating active erosion.

5.1.2 Saprock on Mesozoic limestone

Weathering since the Mesozoic has broken the Cretaceous limestone into rock slabs with isolated carbonate-sandstone concretions (Figure 11G). Soil has developed on the mudstone beneath the limestone. On aerial photographs, the areas of broken limestone slabs has a ring-pattern and mudstone under the limestone is partly exposed. The limestone is more resistant to erosion than mudstone so it forms an erosional terrace surrounded by eroded mudstone.

5.1.3 Calcareous soil on saprock

Calcareous soils are developed on the Mesozoic mudstone where limestone has been removed (Figure 11H). Its distribution is closely associated with remnants of limestone and it forms a transition from the erosional terrace to the black soil plains. As the limestone is very thin, the soil is developed on the terrace; small fragments of limestone occur in the soil. Generally, this calcareous soil is developed on mudstone around erosional terraces but forms part of the black soil plains. Gullies expose the dark, chocolate-coloured soil which is generally less than 1 m thick and reacts with dilute HCl.

5.1.4 Non-ferruginous lithic soil on saprock

A veneer of lithic soil occurs on Proterozoic saprock both on the slopes of low hills and on erosional terraces. As weathered bedrocks protrude from the ground, the soil has not formed a continuous blanket and its distribution is rather patchy; it is generally a few tens of millimetres in thickness, yellowish to light brown and gravelly to sandy. There is little ferruginisation, although

FIGURE 14

A A lag of ferruginous saprolite fragments (FS) on a red, sandy, lithic soil (LS) forming an erosional terrace, west of Eloise. A lag of finer quartz fragments (QL) occurs among the saprolitic lag. Evuka Downs.

B A mixture of brown, lithic soil (LS) with a lag of coarse river gravel (RG) occurs on the higher river terrace, Evuka Downs. AMG 496936 mE, 7689821 mN.

C A brown soil (BS) developed in sandy clay (SC) on river gravels (RG) of a typical flood plain deposit forming the higher terrace of the Fullarton River. The matrix of the gravels is mottled (MT) and this overlies Mesozoic mudstone (MM) which is slightly mottled. About 2 km south of Eloise Mine. AMG 498631 mE, 7680703 mN.

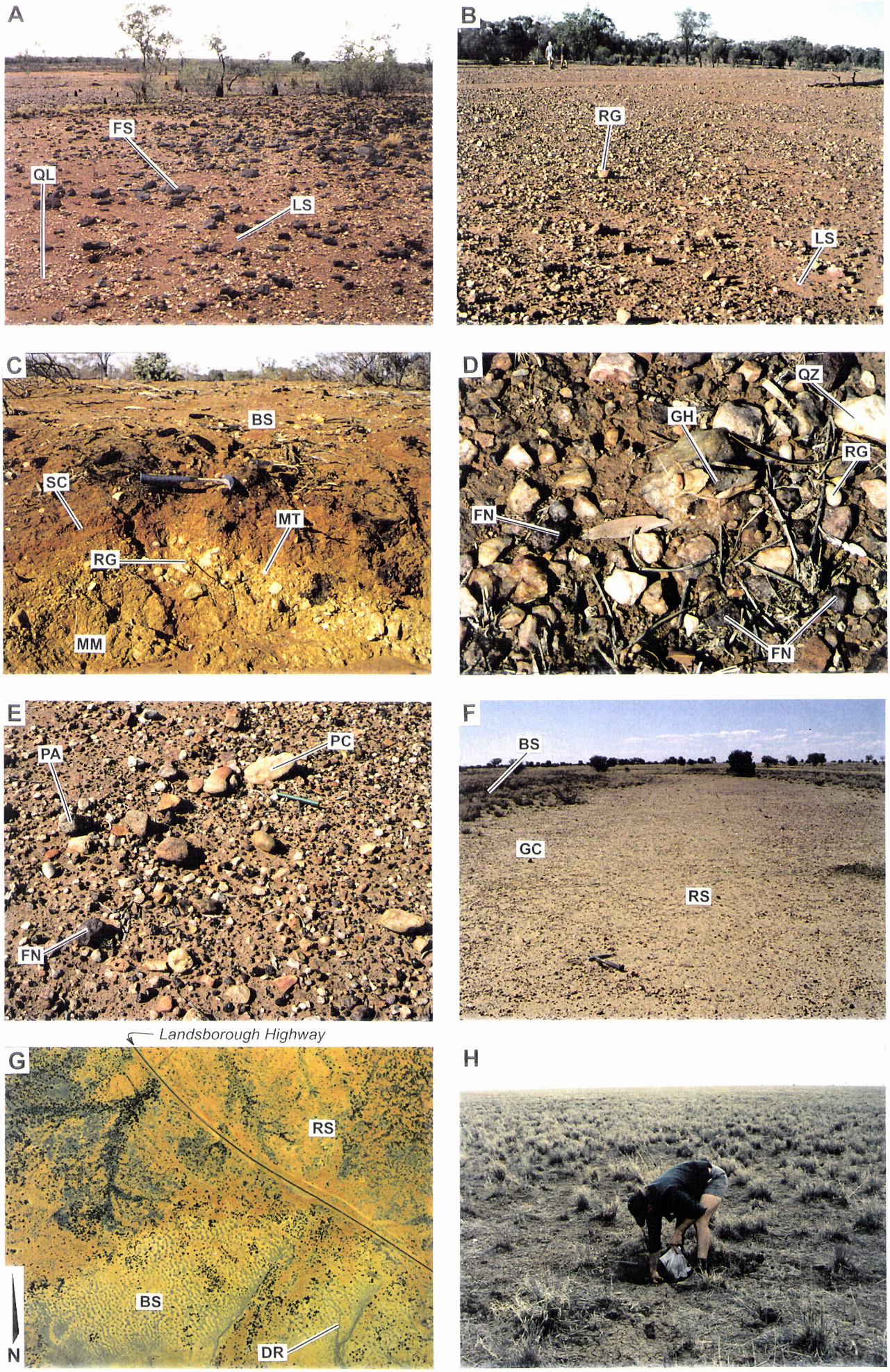
D Quartz fragments (QZ), river gravel (RG) and ferruginous nodules (FN) on the higher river terrace with a grasshopper (GH) for scale. Evuka Downs, 1.5 km northeast of the homestead. AMG 496864 mE, 7689888 mN.

E A polymictic lag of river gravel including ferruginous nodules (FN), Proterozoic quartzite (PC) and amphibolite (PA) on the higher river terrace. Evuka Downs. AMG 498373 mE, 7691925 mN.

F Areas of brown soil (RS) with a lag of river gravel set among black soil (BS) which is grassed preferentially. The grey colour (GC) is due to black soil washed from nearby. View from a site southeast of the track intersection on the aerial photograph on Figure 12C. AMG 499750 mE, 7677579 mN.

G Air photograph of patches of black soil (BS) developed from brown soil (RS) on the higher river terrace, southwest of the Landsborough Highway. Note the photo texture of the black soil follows the drainage pattern at DR.

H An extensive, flat and poorly drained black soil plain at Longford, northeast of Eloise. Note the cracking of these smectitic soils. Soil characterisation samples were collected from about 250 mm. AMG 509470 mE, 7692510 mN.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pieces of ferruginised saprock are present within it. The soil is in its initial stages of development as it is a mixture of local rock and quartz fragments and fine soil particles. It is residual and derived from *in situ* weathering of Proterozoic outcrops. Since both the low hills and the terrace are in an erosional regime, weathering products cannot accumulate long enough for a soil profile to develop fully.

5.1.5 Lag of iron-rich rock fragments and brown, lithic soil on saprock

A lag of Fe-rich rock fragments and nodules occur on brown, lithic, sandy soil (Figure 14A). The soil, which formed on saprock over Proterozoic basement rocks, has similar characteristics to the non-ferruginous lithic soil (above) except that it contains some light brown clay. There are dark brown, subrounded to irregular, ferruginous nodules formed from ferruginous, lithic fragments. Their size ranges from a few millimetres to a few tens of millimetres; the large nodules have dark brown cores indurated by hematite and goethite. Quartz grains and lithorelics are common on the surface of the nodules. The saprock, on which the soil with nodules is developed, forms low hills and an erosional terrace.

5.1.6 Thin, orange, stony soil on saprock

Proterozoic rocks, adjacent to the Fullarton River, have been stripped to a flat or undulating erosion plain. Most parts of the erosional plain have a soil of 50-500 mm thick which is carbonate free, hematite rich, developed on saprock over Proterozoic rocks and has formed from products of *in situ* weathering. Typically, it contains dominant (30%) lithorelics and large rock fragments. Where hard, steeply inclined, resistant strata are interlayered with relatively soft rocks, the tops of the resistant strata define a former level of the terrain about 100 to 500 mm above the softer strata.

5.2 COLLUVIUM-ALLUVIUM

5.2.1 Mixture of brown, residual, lithic soil with minor alluvium

Brown soil, with locally derived lithic fragments, mixed with rounded river gravels and minor alluvium, occurs on the higher river terrace where the erosional terrace changes gradually to the higher river terrace (Figure 14B). Here, alluvial sediments appear to have been largely removed by sheet wash but river gravels remain on the Proterozoic basement. A thin layer of brown soil is formed on weathering products of the basement rocks after removal of the river sediments. Here, lithorelics are abundant in the soil and the rock fragments were derived from the nearby saprock.

5.2.2 Lag of Fe-rich nodules and fluvial gravels on brown, sandy soil over alluvium

Tertiary sediments on the higher river terrace are generally very coarse sands with a large quantity of rounded gravels overlain by fine sands and clay. About 1 m of brown to dark brown sandy soil is developed over the fine sands and clays of the upper part of the profile (Figure 14C). Chemical analysis of nine samples of the brown soil indicates it consists of SiO_2 (50-68%), Fe_2O_3 (4.5-9.5%) and CaO (0.4-1.7%) with much zirconium (238-887 ppm) as zircon. It seems that the brown colour is not due to increased Fe, as the amount of Fe_2O_3 is very similar to that of black soil elsewhere in the area.

Under the brown soil, sediments are generally mottled; large gravel fragments are set in a mottled matrix of sand and clay. The mottles are small (a few tens of mm; Figure 14C), dissimilar to those of deeply weathered saprolite elsewhere. The thickness of the mottled horizon is also limited, generally 1.0-1.5 m. It is this mottling, as well as its position higher in the landscape, that suggests that the sediments have undergone a longer period of weathering than the alluvium on the black soil plain.

A lag of quartz fragments, river gravels, and iron nodules are common on the brown soil (Figure 14D). The quartz fragments are angular or sub-angular and derived from vein quartz from the outcropping Proterozoic rocks southwest of Eloise Mine. River gravel and cobble clasts range from 10-100 mm, have a variety of lithologies (shale, amphibolite, arenite, slate, chert and quartzite). Fragments of phyllite, schist and gneiss are common (Figure 14E) in the coarse quartz sands, which enclose the gravels. Iron oxide aggregates and nodules, with or without ring patterns in cross-section, and lithorelics in their cores, occur in the gravels.

5.2.3 Lag of river gravels over brown, sandy soil

A lag of river gravel occurs on brown sandy soil over fluvial ridges and minor rises on the lower river terrace. In the lag, there are no ferruginous nodules and aggregates. After river sands and clay have been washed away, river gravels remain in a matrix of sediments on which soil is developed. This unit occupies a very small portion of the study area, but it is distinctive on satellite images, as very little vegetation grows on the coarse material.

5.2.4 Brown and black soils over alluvium

An alternate distribution of brown and black soils is prominent in the study area. On aerial photographs it resembles a dune field (Figures 12C and 14F). Two sets of the brown to black soils are recognised, based on their appearance and their position in the landscape. The major part of the higher river terrace is covered by brown, sandy soil but, along drainages and at the edges of the terrace, black soil has developed from the brown soil. In this case, the alternation does not give any particular pattern.

The areas of brown to black soils form a honeycomb pattern on aerial photographs. Black soils are developed where there are fine particles in the sediments but brown soil is commonly associated with coarse sands and gravels. Generally, the brown soil is dominant on the higher river terrace. The contact between brown and black soils can be discerned in places (Figure 12D) but, in most places, it is gradational. In a few cases, black soil has developed along local drainage lines, suggesting that, where water is available, brown soil can turn black (Figure 14G). Development of black soil will be further discussed later. Very similar soil distribution patterns were noted at Little Eva by Robertson *et al.*, (1995).

On the lower river terraces, where black soil forms flat plains, brown, sandy soil over fluvial ridges and minor rises has been partly changed to black soil. Here, black soil is developed along drainages so black and brown soils alternate and their transition is gradational. In general, grass grows preferentially on black soil, possibly because the material on the brown soil areas is very coarse and not particularly water retentive. On the other hand, it is probably the humus content that is at least partly responsible for darkening the soil.

5.2.5 Black soil on gravelly alluvium

Swelling black soils are well developed (Figure 14H) on the flat, alluvial plains at a lower level in the landscape. It is suggested that the alluvium on the low-lying plains is Quaternary because of its proximity to modern drainages. The dominant weathering process is development of black soil closely associated with poor drainage and fine materials. Eight samples of the black soil from the area were analysed by XRF, XRD and INAA. The black soil consists of SiO_2 (50-60%), Fe_2O_3 (5-7%), Al_2O_3 (11-17%), MgO (1.0-1.5%) and CaO (1-2%). The black soil (XRD) contains significant smectite (absent in brown soil) which causes the soil expansion and contraction on wetting and drying (churning). The soil is rich in zircon (274-515 ppm Zr) which is consistent with the soil being developed on alluvium containing minerals resistant to weathering derived from Proterozoic rocks southwest of the study area.

The alluvium consists of fine clays and minor, rounded gravel. Clay churning results in upward migration of gravel through the soil profile so that clasts of 20-50 mm are common on the surface

of the black soil. Down a typical profile, small clasts of river gravel (5-20 mm) occur. Compared with brown soil, black soil has a higher content of fine materials (clay and silt) and much less gravel. The large variety of lithologies of these rounded gravel clasts indicates their source area is the Proterozoic to the southwest.

5.2.6 Recent alluvium

Regolith materials stored as channel infillings, sand bars and levees, associated with modern streams, is classed as alluvium. Weathering after deposition is very minor (mechanical break-down or chemical migration). The fluvial processes have collected a variety of material, transported in stream channels and deposited on channel beds and levees. Therefore, the actual components of the alluvium depend largely on the geology and weathering history of individual catchments.

The catchment of Scrubby Creek is limited to the higher river terrace and, as such, the discharge of the creek is much less than that of the Fullarton River. Therefore, Scrubby Creek transports predominantly finer particles compared to the Fullarton River. Surface runoff is responsible for sediment input to the creek so that sands would be washed down the creek in most rain events but coarse gravels would be left on the terrace. Moreover, well-rounded quartz gravel clasts, found in the creek at its headwaters, show that these sediments were originally deposited by a river much larger than the present creek and were transported for some distance. Scrubby Creek is now reworking and removing Tertiary sediments from the higher terrace. Sediments in Gypsum Creek are similar to those in Scrubby Creek, but their grain size is finer, mostly fine sand and silt. The Fullarton River carries a large volume of coarse sediments with gravel (50-150 mm) in its modern channel. On its levees, silt and clay have been deposited on coarse sand and gravel.

6. LANDSCAPE EVOLUTION

As the study area is rather small, discussions on landscape evolution of the area should be placed in context with the regional framework; what has happened in the neighbouring areas can assist understanding changes in landscape at Eloise. Mesozoic sediments provide a time mark in the course of the changes and geomorphic history can be unfolded from there onwards. Much information is available on the Tertiary and Quaternary landscapes from the Eloise area.

6.1 LATE JURASSIC - EARLY CRETACEOUS LANDSCAPE

The history of landscape evolution in the Eloise area can be traced as far back as Late Jurassic when deposition of fluvial and deltaic sediments of the Gilbert River Formation began. These sediments consist of basal, fluvial sandstone and conglomerate which fine upward into marine mudstone. They are preserved as mesas on Proterozoic lithologies at the headwaters of the Cloncurry, Bustard and Fullarton Rivers immediately southwest of the study area (see Figures 3A, B, and C). The composition, distribution and elevations of these preserved sediments, as well as their relation to the Cloncurry fault, provide information on landscape evolution of the region.

Crespin and Dickins (1955) described pelecypod shells from a mesa of coarse-grained siltstone and fine-grained sandstone at Soldiers Cap (14 km west of the Eloise area), suggest that the deposits are Early Cretaceous and are marine or brackish water in origin. They also identified radiolaria (*Cenosphaera* sp.) and foraminifera (cf. *Dentaline*) from siltstone about 30 km to the south of Soldiers Cap which they considered to be Early Cretaceous in age. Well-preserved fossil plants (*Pterophyllum (Nilssonia)* princeps O. and M). from the headwaters of the Cloncurry River are most common in the Lower Jurassic (White, 1957). The elevations of the Cretaceous sediments in which these fossils were found range from 380-400 m above m.s.l.

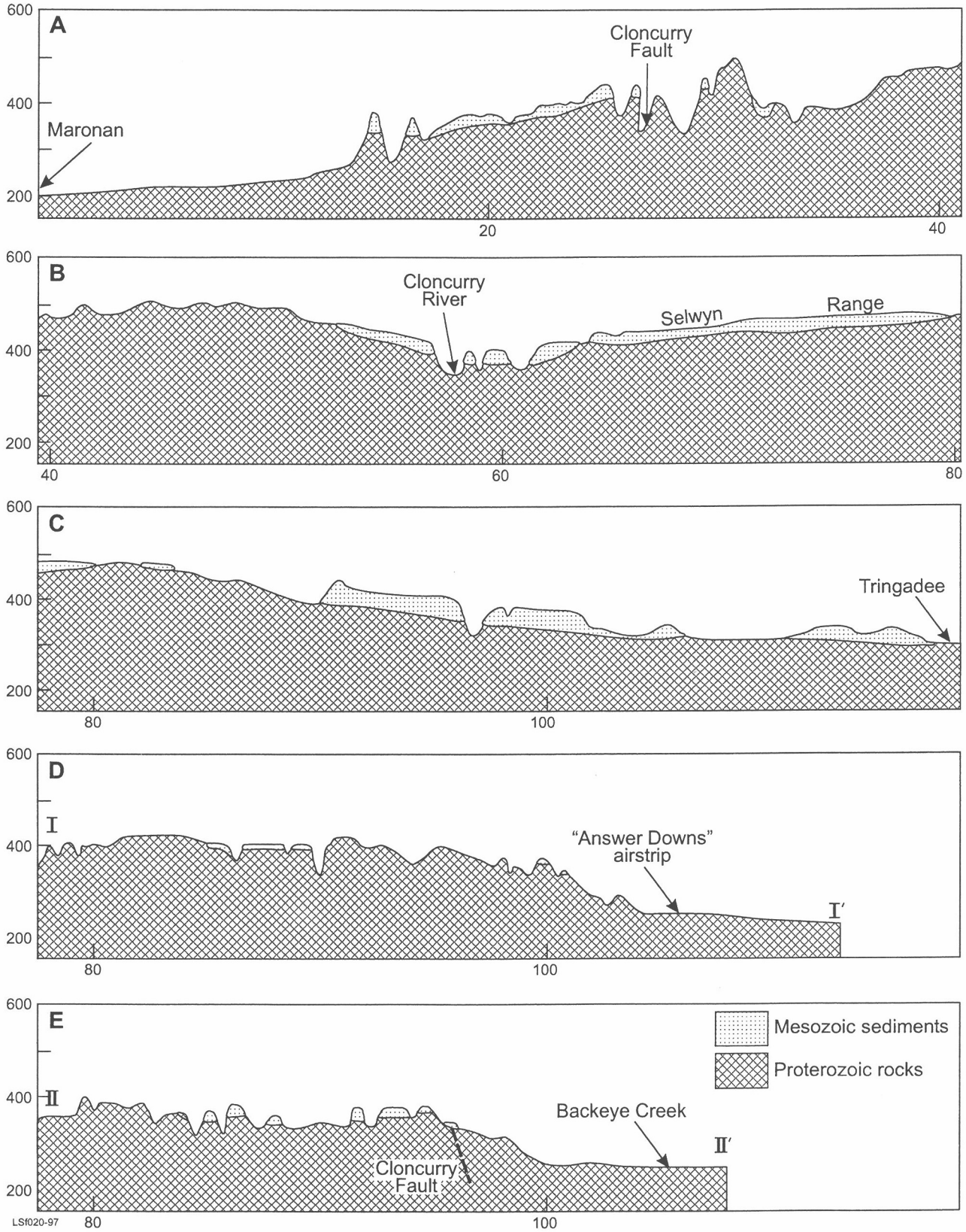


Figure 15. A cross-section from Maronan through the headwaters of the Fullarton and the Cloncurry rivers to Tringadee (A-C) showing interfluve hills above the Gilbert River Formation and a Palaeo river terrace at 460 to 480 m above m.s.l. (location of this traverse on Figures 3A-C). Fossils of salt water fauna of Late Jurassic - Early Cretaceous age are reported from the Mesozoic sediments, now standing as mesas at 400-440 m above m.s.l. Two traverses (D and E) show Mesozoic valley infills (location on Figure 3C).

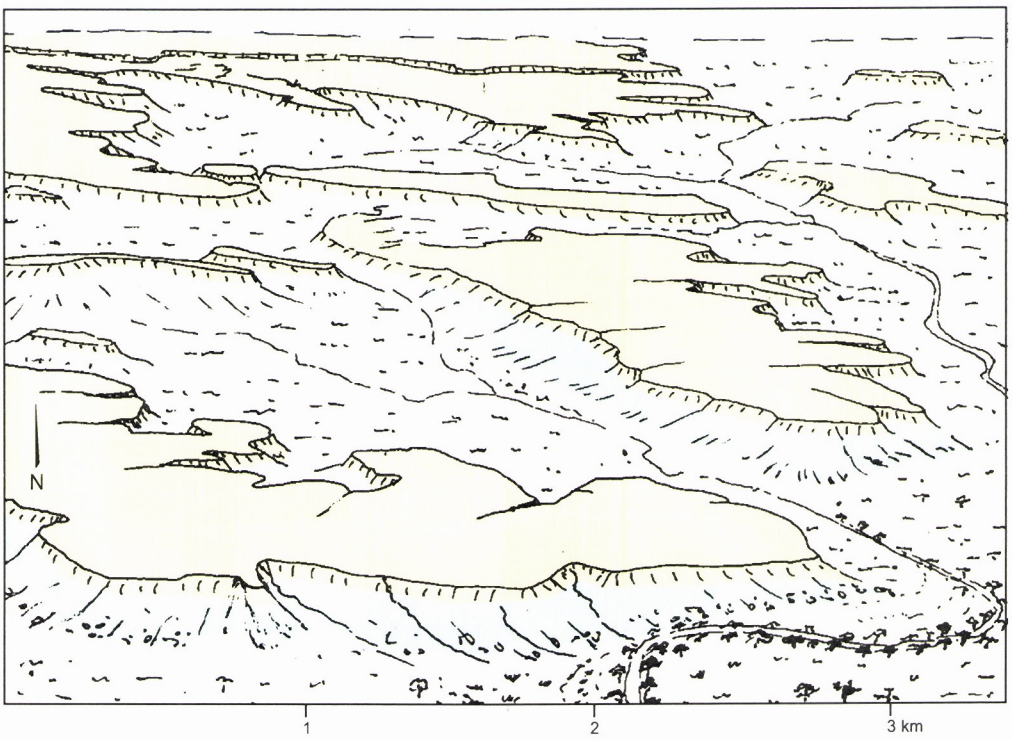


Figure 16. A view of flat-topped mesas (Gilbert River Formation) on Proterozoic basement, east of Selwyn. The mesas consist predominantly of fluvial gravel and sand and once constituted a large, broad valley in Mesozoic times.

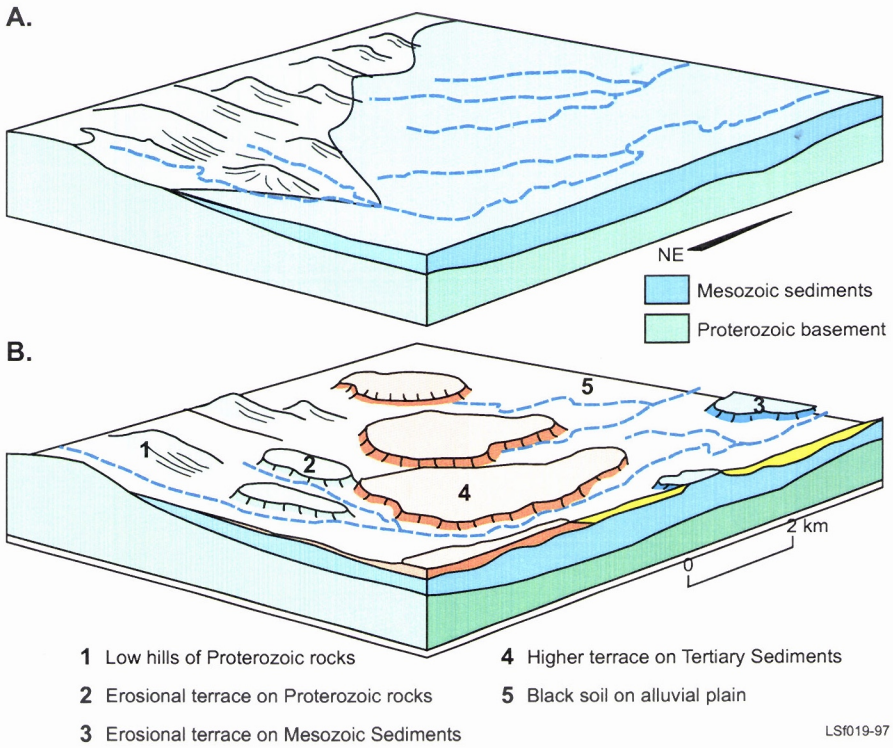


Figure 17. Evolution of the Tertiary landscape in the Eloise area. (A) Following marine regression in the Cretaceous, drainages developed on Mesozoic sediments as a precursor to Tertiary landscape evolution. (B) Partial erosion of the Mesozoic formed low hills (1) and left erosional terraces both on Mesozoic sediments (3) and Proterozoic rocks (2). The ancestral Fullarton River must have passed through the Eloise Mine area, at some stage, depositing fluvial sediments. Later erosion of these sediments left a higher river terrace (4). Reworking of the Tertiary sediments and deposition of post-Tertiary alluvium formed extensive black soil plains (5).

The distribution pattern of the Gilbert River Formation suggests a palaeodrainage from Selwyn to the east and then southeast towards Tringadee. Some tributaries to this main palaeodrainage can be clearly seen (see Figure 3C). The Mesozoic sediments to the east of the Cloncurry fault seem to represent deltaic deposition on the Mesozoic coast. However, there are insufficient data to exclude the possibility that the Mesozoic palaeodrainage from Selwyn ran to the east for some distance and then branched; one distributary turned to the northeast, which formed the Gilbert River Formation at the modern headwaters of the Fullarton River, the other turned southeast towards Tringadee. Because the distribution of the sediments are extensive and because a majority of their occurrences (90%) are at about 380 to 400 m above modern sea level along the Cloncurry Fault, a Mesozoic delta probably existed. This is consistent with large cobbles and gravels in the lower part of the stratigraphy which fine upward where there are fossils of salt water species. As the sediments around Selwyn are at about 380-440 m above m.s.l. the Mesozoic river system was well graded.

Fluvial sediments form flat-topped mesas and occur at two levels, about 380-440 m and 460-480 m above m.s.l. (Figure 15). The marine sediments deposited on fluvial cobbles and gravels are found at 380-440 m above m.s.l., but there is no suggestion of marine sediments at the higher level. From Figure 15, it can be seen that the sediments at the higher level formed a terrace of the broad palaeodrainage. After the river cut through the terrace, it formed another terrace at 380-440 m. The lower terrace was once innundated by salt water and contains Cretaceous fossils (mentioned above). This suggests a pre-existing major river which cut down to accommodate Late Jurassic to Early Cretaceous sediments. If the Gilbert River Formation is Late Jurassic - Early Cretaceous, the sediments on the higher palaeodrainage terrace should be older than the Gilbert River Formation.

The erosion surface concept, used by previous workers in the region, as discussed earlier, is not viable. Firstly, the sediments have their origins as river deposits, as indicated by water rounded cobbles and gravels and, secondly, fluvial sediments deposited at the same time in different river catchments can vary in elevation as do modern sediments in different catchments. On a local scale, flat-topped mesas may look like a surface, as one may see to the east of Selwyn (Figure 16). Viewing in a regional context, however, there is no extensive surface.

Mesozoic sediments never covered the whole region. As shown on Figure 15, hills of Proterozoic rocks stood above broad valleys at that time. At the headwaters of the Fullarton and Cloncurry rivers, Proterozoic rocks are above 500 m above m.s.l., in the modern landscape, which is over 20 m above flat-topped mesas of Mesozoic sediments. Although this height difference is small, it suggests that Mesozoic sediments were valley deposits, since the Proterozoic rocks have experienced prolonged lowering by erosion, whereas formation of duricrust by Fe-induration made the sediments harder to erosion than Proterozoic rocks in the surroundings. Cross-sections also show the fluvial sediments are valley infillings (Figure 15). When the sediments were deposited, the river valleys were broad. There were many hills defining the valley and standing well above the ancient flood plains. This, on the other hand, indicates that the surface concept is untenable.

The hypothesis of upwarping of the Selwyn Range (e.g., Twidale, 1956) is also invalid. The Selwyn Range, which divides the southerly from the northerly flowing rivers, consists of the Mesozoic sediments which formed a higher terrace at the headwaters of the Cloncurry and the Fullarton rivers at about 460-480 m above m.s.l. Where the Mesozoic sediments have been transformed to duricrust and are more resistant to erosion than outcropping Proterozoic rocks, they form a divide consisting of mesas. Prolonged unloading by erosion of the region can result in isostatic rebound but this passive uplift would have occurred in a much broader region than in the area envisaged by Twidale (1956). Therefore, it is not necessary to invoke upwarping to explain the formation of the Selwyn Range. Provided upwarping occurred at the Selwyn Range in post-Mesozoic times, it would be reasonable to expect reactivation of the Cloncurry fault. This is not the case, as Mesozoic sediments cross the fault without displacement.

The fossils found in the Eloise area (see Figures 7B and C) are Early Cretaceous and are similar in age to those of the Gilbert River Formation (Late Jurassic to Early Cretaceous) to the west but about 200 m higher. The calcareous concretions and a thin layer of Cretaceous limestone indicate a shallow water environment. Therefore, there must have been a high and a low stand of sea level, since there is no indication of a post-Cretaceous tectonic displacement at the margin of the Mount Isa Inlier. After the sea level dropped from the higher stand, the Eloise area was exposed to subaerial erosion when the sea reached its low stand. Sedimentation at the low stand of the Cretaceous sea set the stage for landscape evolution at Eloise in post-Cretaceous times. There must have been substantial relief prior to deposition of the marine sediments in this area. It is unlikely that erosion between the two marine transgressions, i.e., the higher and lower stands of sea level, removed up to 180 m of Proterozoic rocks and Mesozoic sediments to accommodate the calcareous concretions and limestone at Eloise.

In summary, the Late Jurassic - Early Cretaceous landscape to the southwest of the study area is of broad river valleys with low hills at interfluves. The Eloise area, at that time, was about 180 m below sea level. Marine conditions entered the ancient river system and penetrated inland for some distance so that marine sediments and fossils were deposited at 380-440 m above m.s.l., around Selwyn. After the sea level declined, the study area was exposed to erosion and rounded gravels were deposited in river channels (conglomerates marking the contact between Proterozoic basement and Cretaceous sediments). With subsidence of the Eromanga Basin in the later part of the Early Cretaceous, marine transgression took place up to the level of the erosional terrace at Eloise.

6.2 TERTIARY LANDSCAPE

Landscape evolution at Eloise in the Tertiary was by (i) erosion and (ii) deposition and erosion (Figure 17). The erosional terrace both on Proterozoic rocks and Mesozoic sediments must have been in an erosional regime since regression of the Early Cretaceous sea. Marine sediments might have covered the Proterozoic rocks which formed the erosional terrace as a later event, but they would have been removed before deposition of the Mesozoic sediments at Eloise. The Cretaceous sea, at its lower stand, would not have reached high enough. Since the erosional terrace is situated on the eastern margin of the Mount Isa Inlier, it has been subjected to intense erosion compared to other parts of the region.

Since the sea retreated in the Early Cretaceous, most parts of the study area were first eroded and then alluvium was deposited on them. This is because the limestone marks the level the Cretaceous sea once reached, while the higher river terrace is at the same level as the limestone and the lower river terrace is below the limestone. Prior to formation of the higher and lower river terraces, the Mesozoic mudstone and limestone must have been partly removed to give space for fluvial sedimentation. Therefore, the area where the higher and lower river terraces stand must have undergone erosion followed by deposition.

The front of a hill belt facilitates fluvial sedimentation because a sudden change in gradient occurs where streams exit the hilly country onto the pediment. The first episode of erosion took place because the rivers downstream of the study area were not graded to the decreased sea level. Once the adjustment was completed, sedimentation could occur in the rivers with abundant supplies of material. From the variety and roundness of gravel on the high river terrace, it seems that the ancient river had a catchment much larger than that of the present Scrubby Creek. This must have been the ancestral Fullarton River.

When the higher river terrace had been constructed, the whole area around Eloise would have been very flat with alluvium built up as a floodplain gently inclined to the northeast. Proterozoic outcrops had been eroded to a surface levelled to this ancient floodplain which, later, became the higher river terrace. As the thin layer of limestone is at a similar level to the ancient floodplain, it

is suggested that the Mesozoic sediments, capped with limestone, might behave as a local base level for river incision in the study area. Tertiary rivers on the ancient floodplain laterally migrated, deposited the sediments seen in the open testing pits at the Eloise Mine.

Weathering on the higher terrace took place soon after the Tertiary floodplain was abandoned. Material in the upper part of the profile of the terrace is generally ferruginous, brown to red with ferruginous pisoliths and a lag of pebbles covers the surface. The lower part generally is slightly mottled. Mesozoic sediments have turned to duricrust, forming flat-topped mesas at the headwaters of the Fullarton River. The degree of weathering is much greater than in Tertiary sediments around Eloise, due to longer exposure.

6.3 QUATERNARY LANDSCAPE

Landscape evolution in the Quaternary consisted of (i) river downcutting and terrace construction, (ii) reworking of Tertiary sediments, and (iii) black soil development. The ancestral Fullarton River resumed its erosional activity after development of extensive plains in the Tertiary, possibly prompted by removal of Mesozoic limestone or by further lowering of sea level. It gradually shifted its course to the east and incised the Mesozoic mudstone, leaving the former floodplain as a river terrace. In this way, the river developed another flood plain about 15 m below the former one, the Tertiary sediments forming either fluvial ridges or high river terraces to give rise to rolling plains.

Once the river cut down to form a new floodplain, erosion of the Tertiary sediments on the higher terrace was initiated. Gullies developed on the terrace which eventually became Scrubby Creek. As there is no duricrust to preserve the sediments on the higher terrace, the terrace was readily dissected. The higher terrace has a very gentle gradient so the newly formed creek on it is braided, with dendritic tributaries. The material eroded from the higher terrace was redistributed to the lower floodplain and, along with sediments brought down by the Fullarton River and Gypsum Creek, built up the lower terrace as the river cut down further.

Alluvium on the lower terrace is thought to be Quaternary on the basis of its low position in the landscape and its proximity to modern drainages. Development of black soil is associated closely with poor drainage and fine materials (Figure 18). Where the alluvium contains much gravel and cobbles, little water is retained and the alluvium remains brown; where the alluvium is fine and water is retained the soil matrix turns black.

Patches of black soil commonly occur adjacent to brown soil. On close examination, the material may show that both are developed over the same unit of the alluvium. After rain, water is retained by the black soil. Availability of water facilitates development of black soil in most cases. Where fine material occurs, due to facies changes or overbank deposition, black soil is formed. As long as water is available, black soil also develops on coarse material such as coarse sands and gravels, which are commonly associated with brown soil.

Black soil and brown soil are found side by side across the same sedimentary structure in a similar morphological setting. XRD results show that, in brown soil, kaolinite is the predominant clay but in black soil, smectite is significant and kaolinite is minor. The formation of black soil from brown soil is essentially a process of partial transformation of kaolinite into smectite.

Grass grows preferentially on black soil rather than brown soil because black soil is finer grained and retains water. Biological activity facilitates weathering and the black colour of the soil is probably related to an increase in biomass and, therefore, carbon content. Black soil swells when wet and cracks on drying, a feature normally associated with smectitic soils, but the brown soil

FIGURE 18

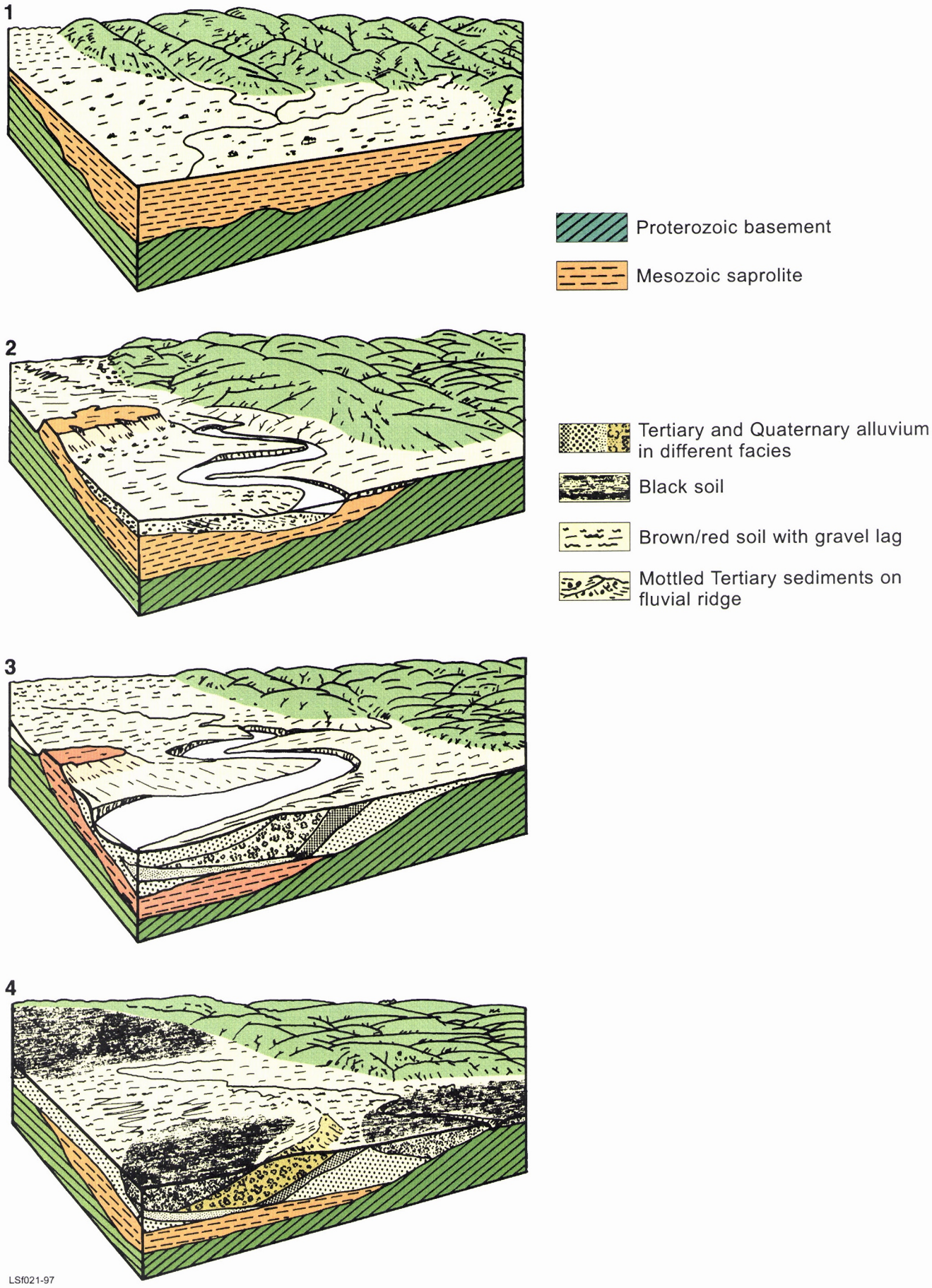
DEPOSITION OF MESOZOIC SEDIMENTS, EROSION OF LANDSCAPE, DEPOSITION OF TERTIARY ALLUVIUM AND DEVELOPMENT OF AREAS OF BLACK SOIL FROM ALLUVIUM

1. In the Mesozoic, marine sediments were deposited on a Proterozoic basement. Sandstone, mudstone and siltstone were formed from material derived from Proterozoic hills to the southwest.

2. After the end of sedimentation and following marine regression and uplift, erosion began. Most of the Mesozoic sediments were removed, leaving remnants as mesas. Although covered with a layer of Tertiary sediments out on the plains, the Mesozoic sediments continued to be eroded as drainages shifted their course.

3. The hill belt retreated with further erosion over a long period and eventually an alluvial plain was formed by channel aggradation and course change, as shown.

4. Black soil was developed in depressions where drainage was poor and the weathering environment of the profile is such that smectite is not weathered to kaolinite. Note Tertiary fluvial ridge in the foreground, and the former hills, to the southwest, have become part of a rolling plain.


1
2
3
4
Proterozoic basement
Mesozoic saprolite
Tertiary and Quaternary alluvium in different facies
Black soil
Brown/red soil with gravel lag
Mottled Tertiary sediments on fluvial ridge
LSf021-97

does not. Therefore, it seems that the weathering of brown soil to black is a process of smectite formation.

7. THE CRETACEOUS UNCONFORMITY ON THE PROTEROZOIC

The thick Cretaceous cover at Eloise appears to present an effective barrier to geochemical exploration and exploration in this environment has been primarily by drilling geophysical targets. Apart from the orebodies themselves, which present quite small targets, the most promising geochemical target at Eloise is the Proterozoic-Cretaceous unconformity. Here, a very thin and probably discontinuous layer of coarse sediments (gravelly sand and conglomerate) are sealed by a thick mass of semi-pelitic to pelitic sediments. The coarse sediments were developed on and, in part, from erosion of the basement and would be expected to retain any mechanical or hydromorphic dispersions from the Eloise deposit. Details of the palaeotopography of this unconformity were obtained from water bores, distant from the mine, and drilling to probe geophysical targets and the mineralisation near the mine (percussion and diamond drilling). Maps were prepared from this on a local (Figure 19A) and on a broader scale (Figure 19B).

7.1 BROAD-SCALE PALAEOTOPOGRAPHY OF THE UNCONFORMITY

The RL data controlling the broad-scale map is sparse at any significant distance from the Mine (>1 km; see control points of Figure 19B). Although this map should be treated with reservation, nevertheless, some useful and general trends emerge.

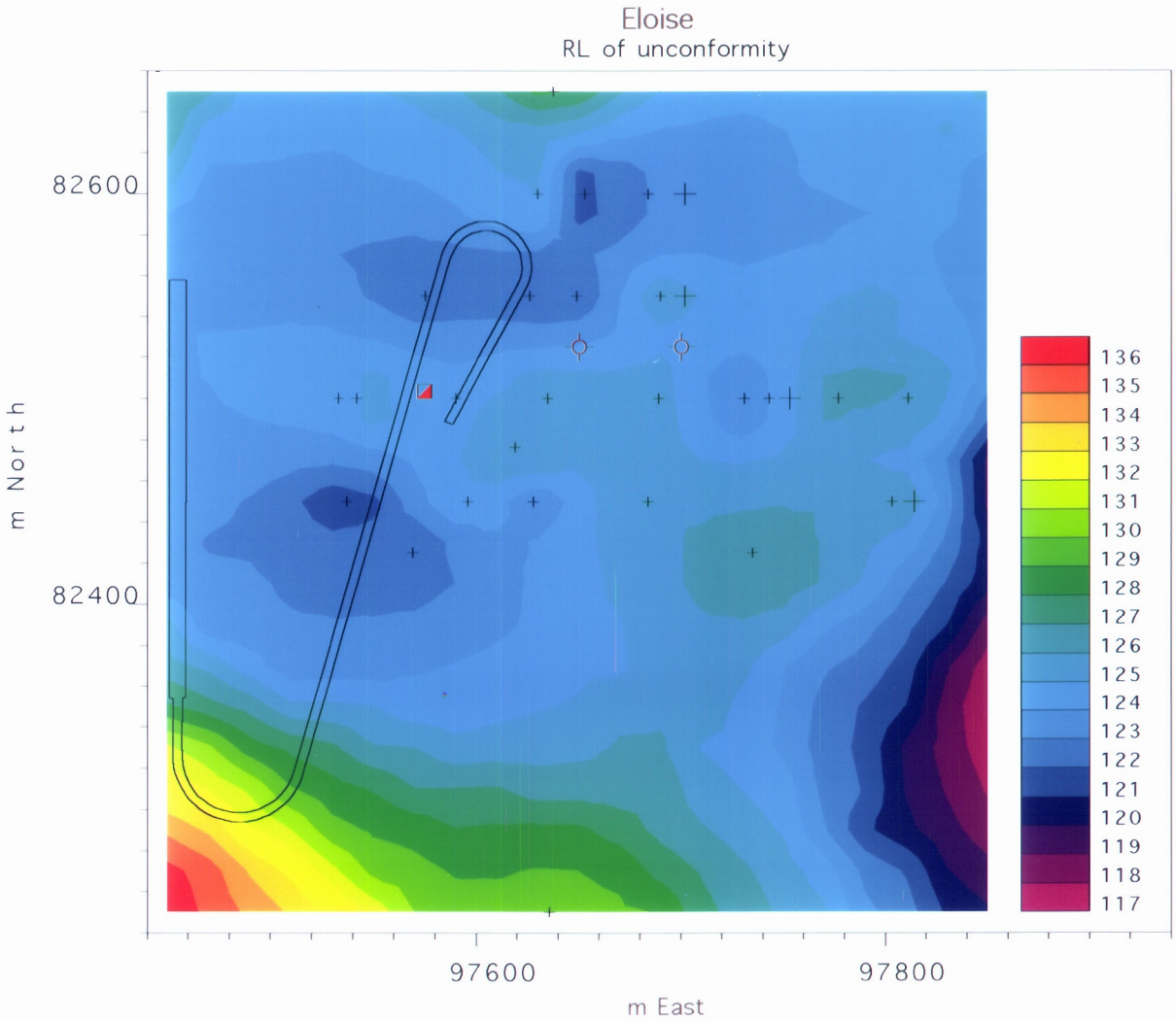
The depth of the Eromanga Basin increases to the north-east. The gradient of the unconformity close to the mine is relatively slight (1:1250). This is also the case for the water bore drillholes at Scrubby Creek (diamond drillholes 1TT, 2TT, 3TT and 4BTT). However, the Scrubby Creek location lies substantially below (>40 m) the mine area, implying a much steeper slope (1:100) between the two than implied by the gradients at the two sites. This suggests some form of scarp. That it is located equidistant between the two sites and has the form shown on the contour map (Figure 19B) is open to question in view of the sparse data but, nevertheless, a scarp at some point and of some form between the two locations seems likely.

7.2 LOCAL MAP AND DISPERSION IMPLICATIONS

In contrast, the local map (Figure 19A) is well controlled by the data points from mine drilling shown on it and also by numerous data points not shown around its periphery (Figure 19B). Together, these imply an arcuate palaeodrainage to the east and northeast towards the upper edge of the scarp. Dispersion from the mineralisation outcropping at the unconformity to the north of the Median Fault would have been largely dispersed to the east, down the scarp. However, some leakage from the Median Fault could have dispersed west to the arcuate palaeodrainage. Geotechnical drillhole ENG2 is the nearest to the fault; drillhole ENG1 being more distant. The point where the decline intersected the unconformity is still more distant and probably up-stream of any point where mechanical dispersion from the subcrops of Eloise mineralisation or from the Median Fault could have entered the palaeodrainage.

7.3 GEOCHEMICAL INVESTIGATION

Those parts of the decline, where bedrock was exposed below the concrete casing, were sampled to the unconformity; the sample density was deliberately increased close to the unconformity. Core from geotechnical diamond drillholes ENG1 and ENG2 were sampled, with particular attention also being paid to coarse sediments close to the unconformity. These sites (decline, diamond drillholes ENG1 and ENG2) comprise a near mineralisation data set. This was compared to a 'background' data set collected from diamond drilling to investigate hydrological aspects of



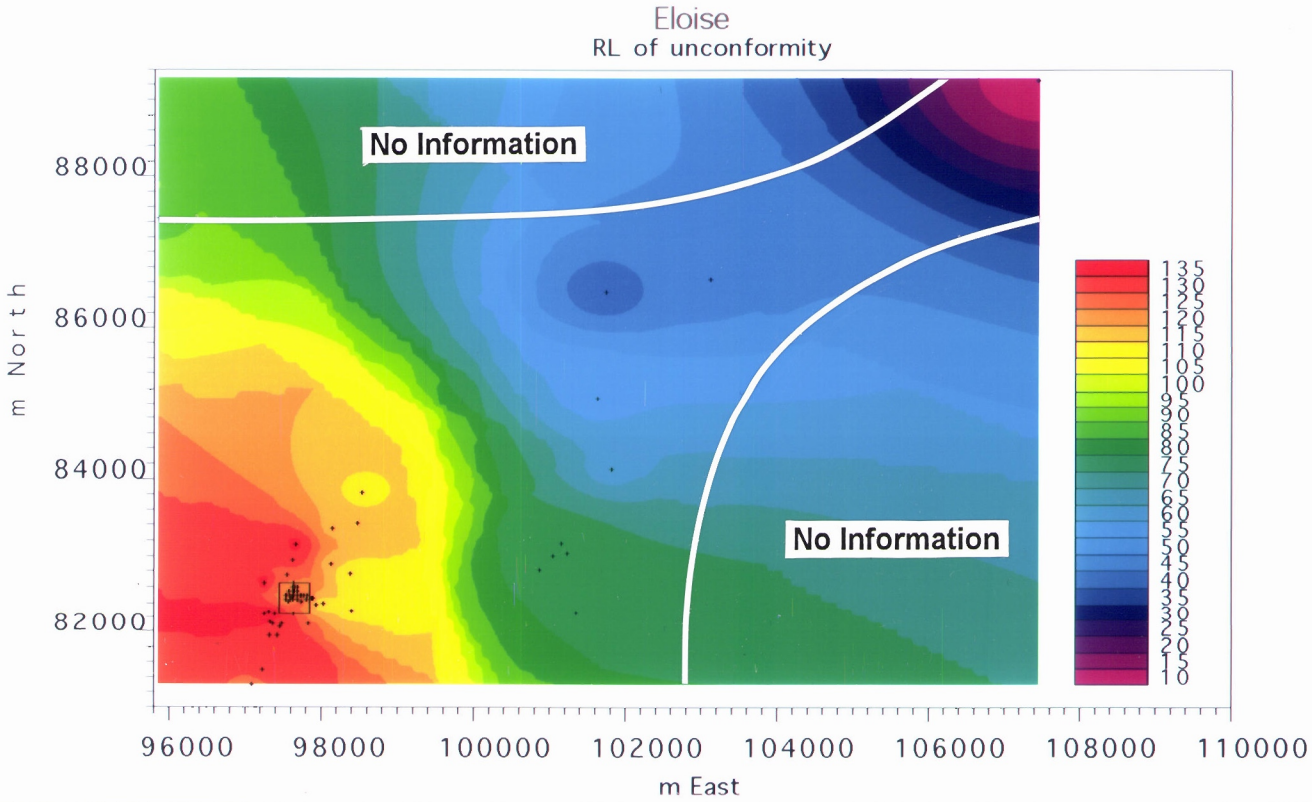


Figure 19. A. Detailed palaeotopography of the Proterozoic-Mesozoic unconformity in the immediate environs of the Eloise Mine. B. Regional palaeotopography of the Proterozoic-Mesozoic unconformity.

the unconformity (diamond drillholes 1TT, 2TT, 3TT and 4BTT) about 3 km distant from the mine (Scrubby Creek drilling). Here sampling also concentrated on coarse sediments close to the unconformity. Sampling techniques are described in Appendix 1 as are methods of sample preparation and analysis. Analytical data are provided in tabular form in Appendix 2 and data from standards in Appendix 3.

7.4 RESULTS FROM NEAR-MINERALISATION DRILLING

The stratigraphy and selected geochemistry from diamond drillholes ENG1, ENG2 and the decline are plotted in Appendix 4. Important elements were found to be Cu, Au As and Sb. Significant anomalies in these elements (Sb is weak) occur within the Cretaceous sediments only at or very close to the unconformity in diamond drillholes ENG1 and ENG2 (Au 90 ppb, Cu 75 ppm, As 125 ppm, Sb 0.7 ppm) and within coarse sediments (gritty mudstone and basal conglomerate). The decline shows no such anomalies.

7.5 RESULTS FROM BACKGROUND DRILLING

Three of the drillholes (2TT, 3TT and 4BTT) contain Cu at background concentrations, there being 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. Gold is at background concentrations (<detection) in diamond drillholes 3TT and 4BTT but shows a significant anomaly (57 ppb) at the base of the sandstone in drillhole 2TT and a weak anomaly (26 ppb) in a thin conglomerate in sandstone 0.3 m above the unconformity. Arsenic and Sb anomalies (102 and 1.5 ppm respectively) occur in drillhole 4BTT in sandstones and conglomerates 1.3 m above the unconformity.

8. CONCLUSIONS AND IMPLICATIONS FOR MINERAL EXPLORATION

8.1 THE PROTEROZOIC-MESOZOIC UNCONFORMITY AT ELOISE

The discovery of Eloise was by geophysical techniques, so most diamond drilling was restricted to the basement and most diamond drilling was precollared. Precollar drillspoil was no longer available. Thus, the availability of materials and the layout of drilling to test this dispersion were not ideal. Despite this, some general conclusions may be reached.

- Where the depth of Mesozoic cover is significant, as for most of the Eromanga Basin, the Proterozoic rocks are relatively fresh (saprock). Thus, the extent of dispersion within the Proterozoic rocks, due to weathering, is likely to be minimal. The only useful dispersions would be mechanical and restricted to the Mesozoic sediments just above the unconformity.
- It seems that the mechanical dispersion halo at the unconformity around Eloise may have extended about 100 m from the mineralisation of from mineralised faults and was strongly influenced by the topography of the unconformity; dispersion appearing to have been by mechanical means (Figure 20B).
- The drilling chosen to give background information at the unconformity, at Scrubby Creek, about 3 km from the mine, contains some anomalies, notably above the unconformity. The broad-scale map of the unconformity suggests that this site may have been located directly down-slope of Eloise and early sediments infilling this area may have been derived from erosion of Eloise and were, therefore, anomalous (Figure 20A).
- Apart from the coarse sediments close to the unconformity, the remainder of the Mesozoic stratigraphy is argillaceous, so any weak geochemical halos are likely to be sealed where the rocks are fresh. However, where the Mesozoic rocks and the Proterozoic basement are

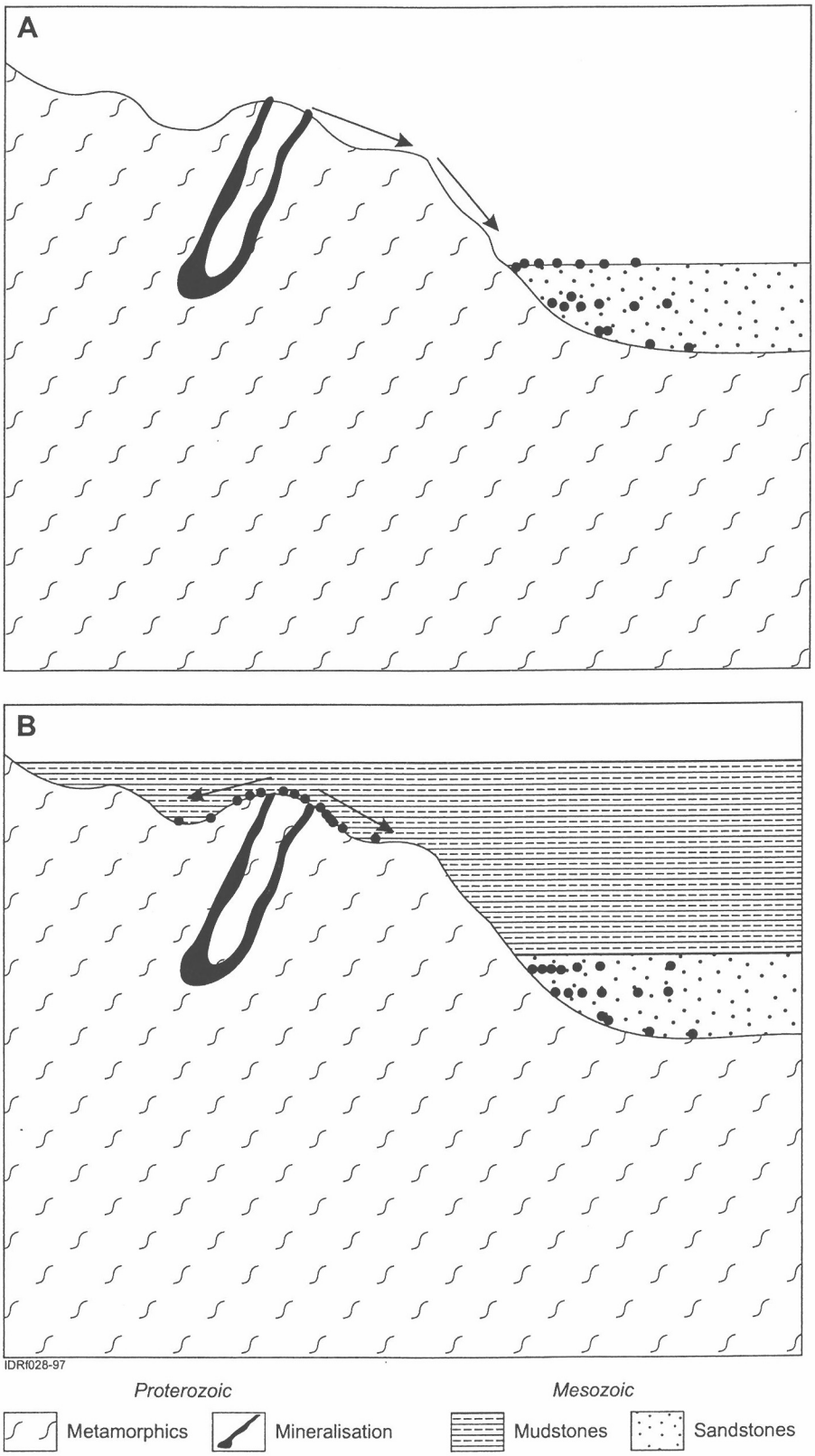


Figure 20. Model of dispersion along the Proterozoic-Mesozoic unconformity at Eloise Mine.

weathered, there are additional opportunities for geochemical dispersion, particularly along ferruginised joints and fractures.

- Investigation of mechanical dispersions of Cu, Au, As and Sb at the Proterozoic-Mesozoic unconformity from the Eloise mineralisation and other, similar, ore deposits, seems to be a valid prospecting method in areas of unweathered or slightly weathered Mesozoic cover. Care should be taken to collect samples from coarse sediments at and just above the unconformity to detect a near-miss when drilling a geophysical target. The configuration of the palaeolandscape is critical to mechanical dispersion directions from mineralisation so this needs to be thoroughly understood. To this end, accurate logging and surveying of all available drillholes are essential steps, perhaps augmented by geophysical methods to determine the palaeotopography of the unconformity.

8.2 OTHER MEDIA

From an exploration point of view, lateral migration of regolith material, history of weathering, and geochemical dispersion are key issues in locating mineralisation in regolith dominated terrain. This study provides some guidelines for further exploration around Eloise. First, ferruginous nodules and soil developed over Proterozoic rocks, both on the erosional terrace and on the erosional plain at a lower level, would be valid sampling media. However, due to the active erosion in the area, any weathered profiles tend to survive for a short time only so extensive dispersion patterns in the regolith should not be expected.

Alluvium, developed on the higher terrace, is generally not suitable for sampling because argillaceous Mesozoic sediments beneath would have prevented any dispersion from the basement. A similar conclusion was reached by Jones (1997). The weathering of this alluvium is slight compared to that of deeply weathered terrains such as the Yilgarn Craton. However, alluvium may carry detrital gold dispersions. Where alluvium has been locally derived from a basement source, systematic sampling may help to locate the source of the detrital gold.

The Mesozoic sediments are not ideal sampling media. Their thickness and compaction form a barrier to mineral dispersion from the basement they cover. However, although some geochemical signatures may be found in samples of high energy sediments collected immediately at or above the Proterozoic-Mesozoic unconformity, surface sampling is not viable.

Alluvium on black soil plains is a mixture of weathering products from Proterozoic outcrops southwest of the study area and Tertiary sediments on the higher river terrace around Eloise. The alluvium is deposited on about 50 to 150 m thick Mesozoic sediments in most cases. Therefore, the alluvium on black soil plains is not recommended for geochemical sampling.

9. ACKNOWLEDGMENTS

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APPENDIX 1

Study methods

APPENDIX 1
STUDY METHODS

1. Geomorphology

Regolith mapping was achieved by remote sensing checked by extensive field traverses. Regolith units were delineated on colour aerial photographs at scales of 1:50 000 and 1:16 000 and on satellite TM at a scale of 1:50 000. Polygons from aerial photographs were transferred to the rectified satellite image, to eliminate photographic distortions. Geomorphic observations were made during field mapping to better understand landscape evolution. All varieties of regolith and landforms in the area and all regolith units in doubt were checked on the ground. The regolith-landform units were scanned and a map was produced using Arc/Info and ArcView.

2. Co-ordinates

AMG Grid co-ordinates were used for the regional regolith study. However, the local mine grid has been used throughout for the detailed study. This grid is only slightly rotated in relation to AMG by 1° 21" 21.65". The relationships are as follows:-

Mine Grid to shortened AMG

AMG Easting = -1886.4102+(Grid East x Cos 1°21'21.65") + (Grid North x Sin 1°21'21.65")
AMG Northing = 2298.7913 + (Grid North x Cos 1°21'21.65") - Grid East x Sin 1°21'21.65")

Shortened AMG to Mine Grid

Mine Easting = 1940.2827 + (AMG East x Cos 1°21'21.65") - (AMG North x Sin 1°21'21.65")
Mine Northing = -2253.5068 + (AMG North x Cos 1°21'21.65") + (AMG East x Sin 1°21'21.65")

3. Unconformity mapping

Relative levels of the unconformity were determined from a number of sources:-

- Vertical drilling near the Deposit which had been logged and sampled as part of this program. Collar coordinates were available.
- Inclined drilling by BHP on sections near the deposit provided by AMALG. The co-ordinates of these reliably determined intersections of the unconformity were measured from the sections.
- Other inclined drilling in the vicinity of the deposit, for which the unconformity intersections were available. Its coordinates were determined from the down-hole log, the collar azimuth and declination. No account was taken of the subsequent course of the drillhole but the depths were not sufficiently great to require this.
- Logs of vertical water bores. The logging was not as accurate as for exploration drilling, largely because of the drilling method. Nevertheless, accurate collar coordinates were available. These gave information distant from the Eloise deposit.

4. Diamond drill core logging

Core logging of the Cretaceous sediments was not detailed. The main focus was on grain size (mudstone, siltstone, sandstone, grit and conglomerate) to determine the energy of sedimentation and, by analogy, the energy of erosion in the source area. The weathered state of the core was also recorded (fresh rock, saprock and saprolite). This was estimated from the coherence of the core. Even small amounts or readily oxidised sulphides in such sediments can lead to very rapid deterioration of drillcore over a few months; these cores were a few years old.

5. Drill core sampling

All drilling had been pre-collared so the Tertiary alluvial deposits were not represented. Spot samples were collected of dominant lithologies at about 5 m intervals. The sampling interval decreased towards the base of the Cretaceous where coarse sediments were encountered which were regarded as the most promising. There was a tendency for the finer sediments to break into

thin, fragile discs which made core cutting impossible without significant core loss and sample bias. Thus, the spot samples consisted of 100-200 mm of whole NQ core and their locations were clearly marked in the core boxes.

6. Pit sampling

The pit wall was first scraped clean (25 mm) to remove a patina of material washed down the face by rain. Channel samples of about 750-1000g were scraped from the pit face and bagged in plastic.

7. Decline sampling

The first 200 m of the decline was encased in concrete, making sampling impossible. Elsewhere, the walls and roof of the decline was sheathed in reinforcing mesh and shockcrete and the floor was of compacted gravel. Apart from near the active face, where excavation was taking place, the only place where wallrocks were accessible was at the base of the shockcrete sheathing at the level of the drain. Spot samples were collected here at about 30 m intervals down the decline. Care was taken to avoid including cement with the sample; two samples had to be cleaned.

8. Splitting and Milling

Each sample for geochemical analysis was split on a PVC riffle. Aliquots of 100 g were pulped to a nominal <75 μm in a case-hardened K1045 steel mill (Robertson *et al.*, 1996) using a double sand clean and ethanol wipe of the mill components between samples.

9. XRD mineralogy

Pulped samples were examined by CuKα radiation, using a Philips PW1050 diffractometer, fitted with a graphite crystal diffracted beam monochromator. Each sample was scanned over a range 3-65° 2θ at a speed of 1° 2θ/min and data were collected at 0.02° 2θ intervals. Charts, plotted at 0.5° 2θ/cm were used for interpretation.

10. Chemical analysis

All samples were analysed by XRF (CSIRO) and by INAA (Becquerel Laboratories), as follows:-

INAA

Aliquots of 10 or 30 g (depending on availability) were encapsulated at CSIRO and sent to Becquerel Laboratories for INAA analysis. Detection limits were as follows (in ppm):- K (2000); Fe (500); Zn, Ba, Na (100); Rb (20); Ag, Se, Cr, Mo (5); W, Ce, Br, U (2); As, Co, Cs, Ta (1); La, Eu, Yb, Hf, Th (0.5); Sb, Sm, Lu (0.2); Sc (0.1); Ir (0.02); Au (0.005).

XRF

X-ray fluorescence analysis was performed at CSIRO on fused discs (0.7 g sample and 6.4 g Li borate) using a Philips PW1480 instrument by the method of Norrish and Hutton (1969). Detection limits were as follows (in ppm):- Si, Al (100); Mg, Na (100); Fe (50); Ti (30); Mn, P (20); Ca, K (10); Ba (30); Ce, Cl (20); Cr, Co, Cu, La, Ni, S (10); Pb, Rb, Sr, V, Y, Zn, Zr (5); Nb (4); Ga (3).

The data are presented in Appendices 2 and 3. A data disc is appended as Appendix 8. In-house standards were entered into the analytical stream at an interval of every 10-15 samples. Results from the standards are presented in Appendix 3. Samples were analysed in random order.

APPENDIX 2

Tabulated analytical data

DECLINE GEOCHEMISTRY

SAMPLE NUMBERS			LOCATIONS			XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	Grav	Grav	INAA	INAA	XRF	INAA	INAA	XRF	INAA	INAA
						SiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOD	LOI	As	Au	Ba	Br	Ce	Cl	Co	Cr
			m	m	m	0.01	0.01	0.01	0.002	0.01	0.00	0.01	0.01	0.00	0.002	-	-	2.00	5	30	2	10.0	20	1.00	5
FieldNo	LabSeqNo	LibNo	east	north	RL	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm
RLO-01	L08-1868	08-1864	97454.91	82345.18	163.40	52.40	12.02	6.95	0.158	2.07	5.24	0.48	1.49	0.56	1.307	4.57	9.81	18.40	<5	204	<2	54.0	220	18.00	49
RLO-02	L08-1875	08-1865	97454.79	82330.75	161.60	61.29	12.94	5.57	0.044	2.28	1.03	0.54	1.60	0.62	0.139	6.41	7.62	5.03	<5	222	<2	42.7	150	13.10	55
RLO-03	L08-1880	08-1866	97459.48	82310.13	159.20	63.37	12.09	5.44	0.037	2.15	0.94	0.50	1.50	0.55	0.127	5.63	7.56	6.25	<5	215	<2	41.9	160	11.80	51
RLO-04	L08-1874	08-1867	97477.22	82297.45	156.90	65.94	11.38	4.50	0.031	2.01	0.84	0.46	1.47	0.53	0.099	5.66	7.15	5.71	<5	218	<2	38.9	190	8.95	55
RLO-05	L08-1877	08-1868	97502.83	82302.33	154.10	63.21	12.91	5.22	0.033	1.94	1.10	0.77	1.75	0.61	0.151	4.91	7.02	5.03	<5	265	<2	49.1	70	7.15	65
RLO-06	L08-1865	08-1869	97514.85	82320.36	151.70	61.96	12.59	5.60	0.033	2.01	1.00	0.71	1.72	0.59	0.139	5.91	7.09	4.14	<5	272	<2	46.7	20	7.50	61
RLO-07	L08-1871	08-1870	97522.53	82348.98	148.00	61.11	13.42	5.31	0.042	2.27	1.01	0.49	1.74	0.68	0.155	5.76	7.78	12.40	<5	280	<2	51.3	60	14.50	63
RLO-08	L08-1864	08-1871	97529.22	82372.38	144.90	61.34	13.13	5.32	0.036	1.97	1.17	0.83	1.71	0.62	0.172	6.24	7.12	5.62	<5	268	<2	49.7	30	8.39	56
RLO-09	L08-1867	08-1872	97535.79	82395.48	141.90	61.22	13.44	5.00	0.035	2.00	1.18	0.87	1.72	0.65	0.167	6.30	7.43	5.94	<5	298	<2	50.5	0	8.00	60
RLO-10	L08-1881	08-1873	97541.50	82415.50	139.30	61.11	12.20	4.82	0.035	1.88	1.20	0.51	1.71	0.60	0.252	5.46	9.64	7.67	<5	276	<2	55.4	0	8.93	73
RLO-11	L08-1876	08-1874	97546.02	82431.73	137.30	64.50	10.36	4.54	0.029	1.68	0.99	0.46	1.49	0.48	0.175	4.99	9.62	7.53	<5	271	3	43.9	-40	6.27	72
RLO-12	L08-1879	08-1875	97555.06	82463.11	133.20	64.87	11.03	5.04	0.029	1.73	0.96	0.53	1.53	0.50	0.111	5.21	8.28	7.57	<5	266	<2	39.9	-20	6.86	63
RLO-13	L08-1869	08-1876	97558.75	82476.59	131.40	64.89	11.03	5.09	0.028	1.69	0.94	0.55	1.53	0.51	0.111	5.13	8.10	7.88	<5	1741	<2	41.0	-40	7.76	57
RLO-14	L08-1873	08-1877	97562.73	82490.14	129.70	68.16	9.87	4.75	0.027	1.48	0.86	0.54	1.41	0.46	0.110	4.44	7.88	8.62	<5	337	<2	36.1	-30	6.52	59
RLO-15	L08-1872	08-1878	97564.50	82496.00	129.00	69.55	9.43	4.65	0.025	1.43	0.84	0.50	1.35	0.44	0.116	4.07	7.23	13.60	<5	271	<2	37.4	-30	6.46	55
RLO-16	L08-1878	08-1879	97566.50	82504.00	128.00	69.54	8.73	4.73	0.024	1.33	0.84	0.44	1.29	0.42	0.134	3.88	8.27	11.10	<5	295	2	38.2	-50	6.32	65
RLO-17	L08-1882	08-1880	97568.50	82512.00	127.00	70.61	8.52	4.47	0.026	1.32	0.79	0.44	1.23	0.39	0.125	3.58	8.35	13.50	<5	282	2	34.2	-20	5.15	60
RLO-18	L08-1870	08-1881	97571.00	82520.00	126.00	69.62	10.15	4.80	0.025	1.47	0.82	0.47	1.52	0.47	0.104	4.14	6.51	27.20	<5	273	<2	41.8	-40	7.24	54

DECLINE GEOCHEMISTRY

LibNo	INAA Cs 1.00 ppm	XRF(p) Cu 10 ppm	INAA Eu 1.00 ppm	XRF Ga 3 ppm	INAA Hf 1.00 ppm	INAA La 0.5 ppm	INAA Lu 0.20 ppm	INAA Mo 5 ppm	XRF Nb 4 ppm	XRF Ni 10 ppm	XRF Pb 5 ppm	XRF Rb 5 ppm	XRF S 10 ppm	INAA Sb 0.50 ppm	INAA Sc 0.1 ppm	INAA Se 10 ppm	INAA Sm 0.20 ppm	XRF Sr 5 ppm	INAA Ta 1.0 ppm	INAA Th 0.50 ppm	INAA U 2 ppm	XRF V 5 ppm	INAA W 2 ppm	XRF Y 5 ppm	INAA Yb 0.50 ppm	XRF Zn 5 ppm	XRF Zr 5 ppm
08-1864	4.72	21	1.20	14	3.04	24.1	0.31	<5	4	106	16	64	17930	0.33	12.1	<5	5.36	206	<1	7.25	<2	138	<2	22	2.19	118	107
08-1865	5.43	24	1.08	17	2.82	19.4	0.27	<5	6	25	20	74	6840	0.28	13.3	<5	4.40	158	<1	6.92	<2	150	<2	17	1.95	129	105
08-1866	4.78	19	0.83	14	2.92	19.1	0.27	<5	6	15	14	68	7380	0.33	12.6	<5	4.37	151	1.2	7.04	<2	136	<2	17	1.90	109	101
08-1867	4.94	22	0.83	15	2.60	17.9	0.24	<5	4	20	11	69	5250	<0.20	11.8	<5	3.96	143	<1	6.77	<2	117	<2	15	1.63	103	117
08-1868	5.18	14	1.07	17	3.87	21.7	0.30	<5	6	13	21	76	6400	<0.20	12.5	<5	5.12	167	1.3	7.41	<2	97	<2	22	2.11	87	141
08-1869	4.49	14	1.04	15	3.87	21.0	0.31	<5	6	16	18	76	5920	<0.20	11.9	<5	4.95	172	<1	6.88	<2	105	<2	19	1.95	90	138
08-1870	5.53	21	1.12	18	3.76	22.7	0.35	<5	6	22	19	78	6470	<0.20	14.0	<5	5.39	180	1.6	8.00	<2	138	<2	20	2.37	135	123
08-1871	4.77	30	1.05	15	3.87	21.0	0.34	<5	7	13	17	72	6490	0.22	12.0	<5	5.19	197	<1	6.23	<2	108	<2	22	2.14	83	141
08-1872	4.67	14	1.26	15	4.14	22.4	0.33	<5	6	14	15	75	5890	<0.20	12.6	<5	5.41	210	1.0	6.97	<2	113	<2	22	2.06	89	147
08-1873	4.91	19	1.18	17	3.92	25.4	0.36	<5	7	21	15	77	8290	<0.20	12.0	<5	5.87	190	<1	7.90	<2	93	<2	26	2.47	74	131
08-1874	5.46	34	0.98	15	2.70	21.0	0.30	<5	7	24	16	74	7600	0.25	11.2	<5	4.61	172	<1	7.52	<2	90	<2	21	2.08	97	91
08-1875	5.77	27	0.98	15	2.86	19.3	0.27	<5	5	17	13	76	7730	0.37	11.6	<5	4.33	186	<1	7.47	<2	97	<2	19	2.00	89	95
08-1876	5.07	25	0.76	13	2.91	18.8	0.28	<5	5	15	15	73	8140	0.23	11.1	<5	4.29	194	<1	6.68	<2	108	<2	17	1.89	103	103
08-1877	5.34	21	0.81	13	2.93	17.5	0.27	<5	5	17	14	69	8330	<0.20	10.5	<5	3.93	164	<1	6.37	<2	82	<2	16	1.79	81	94
08-1878	4.45	20	0.89	11	2.59	17.0	0.25	<5	6	17	13	65	7480	0.22	9.7	<5	3.79	156	1.8	6.53	<2	79	<2	14	1.64	79	89
08-1879	4.58	23	0.86	14	2.48	18.1	0.27	<5	5	19	13	62	9810	0.27	9.4	<5	4.04	151	1.0	6.32	<2	84	<2	18	1.85	79	88
08-1880	4.65	25	0.87	13	2.30	16.7	0.26	<5	6	20	15	59	8160	0.24	9.2	<5	3.75	149	<1	5.99	<2	78	<2	17	1.80	69	77
08-1881	5.11	24	0.83	11	2.69	19.1	0.29	<5	4	109	17	73	5480	<0.20	10.6	<5	4.12	160	1.1	7.44	<2	90	<2	17	1.96	79	100

DRILLHOLES ENG 1 and ENG2

FieldNo	LabSeqNo	LibNo	Drillhole	East	North	Depth	XRF SiO2 0.01 %	XRF Al2O3 0.01 %	XRF Fe2O3 0.01 %	XRF MnO 0.002 %	XRF MgO 0.01 %	XRF CaO 0.001 %	XRF Na2O 0.01 %	XRF K2O 0.005 %	XRF TiO2 0.003 %	XRF P2O5 0.002 %	Grav LOD - 105	Grav LOI - 1050	INAA As 2 ppm	INAA Au 5 ppb	XRF Ba 30 ppm	INAA Br 2 ppm	INAA Ce 10 ppm
RLO-2001	L08-1941	'08-1911	ENG2	97700	82525	30.95	61.62	13.94	5.59	0.031	2.22	0.92	0.69	1.88	0.64	0.127	5.37	7.49	3.5	<5	268	<2	52.6
RLO-2002	L08-1934	'08-1912	ENG2	97700	82525	33.75	62.16	13.84	5.32	0.031	2.17	0.9	0.77	1.87	0.65	0.129	5.08	7.06	3.03	<5	270	<2	53
RLO-2003	L08-1939	'08-1913	ENG2	97700	82525	37	60.43	13.45	5.28	0.04	2.15	1.08	0.7	1.66	0.67	0.151	5.41	8.57	12.7	<5	278	<2	52.1
RLO-2004	L08-1921	'08-1914	ENG2	97700	82525	41.4	61.31	13.13	5.4	0.034	2	1.17	0.82	1.66	0.62	0.162	5.6	7.82	5.15	<5	252	2.02	49.9
RLO-2005	L08-1954	'08-1915	ENG2	97700	82525	46.7	65.02	11.01	4.73	0.03	1.69	1.12	0.62	1.5	0.52	0.231	4.75	8.32	7.54	<5	252	<2	48
RLO-2006	L08-1960	'08-1916	ENG2	97700	82525	50.15	63.94	11.39	4.91	0.031	1.77	1.02	0.63	1.5	0.54	0.168	4.56	8.97	9.45	<5	259	<2	46.5
RLO-2007	L08-1920	'08-1917	ENG2	97700	82525	53.94	66	10.43	4.69	0.026	1.65	0.9	0.47	1.4	0.47	0.118	4.22	9.22	9.2	<5	232	2.51	36.7
RLO-2008	L08-1955	'08-1918	ENG2	97700	82525	37.7	67.19	10.03	4.9	0.026	1.57	0.86	0.52	1.48	0.47	0.123	4.12	8.04	25	<5	278	2.23	40
RLO-2009	L08-1943	'08-1919	ENG2	97700	82525	59.85	72.97	8.35	4.35	0.02	1.3	0.69	0.38	1.3	0.39	0.09	3.03	6.88	26	<5	260	<2	35
RLO-2010	L08-1919	'08-1920	ENG2	97700	82525	60.25	68.95	10.18	4.98	0.024	1.47	0.79	0.45	1.6	0.48	0.102	3.53	7.17	40.6	<5	246	2.29	43.2
RLO-2011	L08-1912	'08-1921	ENG2	97700	82525	60.88	69.29	9.91	5.1	0.026	1.45	0.82	0.44	1.45	0.48	0.125	3.36	7.25	64	<5	260	<2	37.6
RLO-2012	L08-1953	'08-1922	ENG2	97700	82525	61.35	79.59	6.28	3.62	0.023	0.73	0.56	0.4	1.1	0.33	0.153	1.53	5.42	123	90.8	229	<2	32.5
RLO-2013	L08-1918	'08-1923	ENG2	97700	82525	61.58	59.17	14.7	6.49	0.14	1.17	4.69	5.52	0.99	1	0.097	0.79	4.69	10.1	<5	120	<2	58.3
RLO-2014	L08-1947	'08-1924	ENG2	97700	82525	62.3	56.36	14.81	4.87	0.186	0.87	7.46	6.54	1.01	0.94	0.126	0.3	5.76	8.29	<5	85	<2	45.4
RLO-2015	L08-1946	'08-1925	ENG1	97650	82525	32.75	63.98	12.05	5.39	0.038	2.13	0.93	0.52	1.5	0.56	0.121	5	7.9	7.36	<5	223	<2	42.4
RLO-2016	L08-1935	'08-1926	ENG1	97650	82525	44.35	62.68	11.98	5.12	0.035	1.95	1.04	0.68	1.51	0.57	0.134	4.75	9.56	7.3	<5	255	<2	41.2
RLO-2017	L08-1940	'08-1927	ENG1	97650	82525	49.88	62.52	12.12	4.73	0.031	1.97	1.1	0.64	1.51	0.57	0.163	4.86	9.43	6.23	<5	273	<2	43.9
RLO-2018	L08-1922	'08-1928	ENG1	97650	82525	54.14	64.99	11.09	4.77	0.028	1.84	0.94	0.55	1.52	0.52	0.112	4.56	8.8	7.6	<5	263	<2	41.3
RLO-2019	L08-1927	'08-1929	ENG1	97650	82525	58.13	71.31	8.88	4.27	0.021	1.52	0.73	0.4	1.38	0.41	0.091	3.27	7.57	5.77	<5	249	2.78	37.2
RLO-2020	L08-1916	'08-1930	ENG1	97650	82525	59.9	69.88	9.4	4.57	0.026	1.59	0.84	0.48	1.33	0.44	0.126	3.87	7.2	7.63	<5	260	<2	34.7
RLO-2021	L08-1931	'08-1931	ENG1	97650	82525	60.25	83.45	5.27	3.02	0.02	0.74	0.51	0.38	0.99	0.23	0.105	1.37	3.83	5.25	5.9	237	<2	27.2
RLO-2022	L08-1915	'08-1932	ENG1	97650	82525	60.44	46.92	16.28	7.67	0.244	1.85	9.09	3.26	1.95	1.3	0.286	1.48	8.46	15.6	73.5	323	<2	29.6
RLO-2023	L08-1957	'08-1933	ENG1	97650	82525	60.61	38.57	14.42	7.09	0.36	2.68	15.33	1.67	2.3	0.67	0.114	1.89	14.31	7.64	35.3	590	<2	14.3
RLO-2024	L08-1926	'08-1934	ENG1	97650	82525	61.15	54.64	16.15	11.07	0.205	3.34	5.09	4.9	1.45	1.08	0.112	0.22	1.76	15.1	<5	377	<2	17.8

DRILLHOLES ENG 1 and ENG2

FieldNo	XRF Cl 20 ppm	INAA Co 1 ppm	INAA Cr 5 ppm	INAA Cs 1 ppm	XRF Cu 10 ppm	INAA Eu 1 ppm	XRF Ga 3 ppm	INAA Hf 1 ppm	INAA La 0.5 ppm	INAA Lu 0.2 ppm	INAA Mo 5 ppm	XRF Nb 4 ppm	XRF Ni 10 ppm	XRF Pb 5 ppm	XRF Rb 5 ppm	XRF S 10 ppm	INAA Sb 0.5 ppm	INAA Sc 0.1 ppm	INAA Se 10 ppm	INAA Sm 0.2 ppm	XRF Sr 5 ppm	INAA Ta 1 ppm	INAA Th 0.5 ppm	INAA U 2 ppm	XRF V 5 ppm	INAA W 2 ppm	XRF Y 5 ppm	INAA Yb 0.5 ppm	XRF Zn 5 ppm	XRF Zr 5 ppm
RLO-2001	180	12.5	43.1	6.05	14	1	18	3.59	22	0.31	<5	9	41	19	86	2140	0.32	14	<5	4.98	177	<1	7.96	<2	150	<2	19	2.19	107	118
RLO-2002	80	11.5	46.9	6.86	14	1.12	17	3.54	23.3	0.31	<5	6	36	16	83	2820	0.21	14.1	<5	5.15	179	<1	8.04	<2	138	<2	19	2.21	102	120
RLO-2003	80	13.9	62.4	5.65	11	1.41	15	3.61	22.5	0.34	<5	8	21	13	72	7450	0.25	13.9	<5	5.4	195	<1	7.77	<2	132	<2	23	2.32	126	120
RLO-2004	190	9.8	60.3	5.33	19	1.22	15	4.23	22.1	0.29	<5	4	39	14	73	6570	0.2	13	<5	5.32	213	1.12	7.13	<2	103	<2	18	2.1	92	144
RLO-2005	20	5.82	65.3	5.16	11	1.3	13	3.45	22.4	0.32	<5	7	17	10	66	8020	0.22	10.7	<5	5	187	<1	6.66	<2	88	<2	23	2.18	76	112
RLO-2006	60	9.46	62	4.74	8	1.09	13	3.14	20.7	0.32	<5	6	17	15	68	8710	0.29	11.7	<5	4.65	186	<1	6.9	<2	106	<2	21	2.03	101	105
RLO-2007	20	8.46	55.6	5.51	10	0.83	13	2.53	17.8	0.27	<5	3	15	18	67	8480	0.3	11.4	<5	3.96	172	1.12	6.7	<2	102	<2	16	1.9	91	85
RLO-2008	110	6.4	57.2	5.31	24	0.95	13	2.82	18.5	0.25	<5	6	37	16	72	7570	<0.2	10.3	<5	4.14	163	<1	6.79	<2	94	<2	16	1.79	83	100
RLO-2009	30	4.77	56.2	4.79	11	0.7	10	2.25	16.1	0.23	<5	5	17	10	60	5650	<0.2	8.7	<5	3.49	137	<1	6.39	<2	77	<2	14	1.54	81	82
RLO-2010	30	7.39	60.7	5.2	14	0.82	13	3.03	20.3	0.29	<5	4	24	14	77	6220	0.43	11	<5	4.38	152	<1	7.88	<2	81	<2	18	1.98	88	96
RLO-2011	0	7.02	53.8	4.73	15	0.91	14	2.7	18.4	0.27	<5	5	17	12	70	6760	0.39	10.9	<5	4.3	157	<1	6.81	<2	91	<2	17	1.95	90	94
RLO-2012	110	9.52	27	3.01	6	0.74	9	2.34	15.7	0.23	<5	2	14	13	48	7990	0.54	9.67	<5	3.19	92	<1	5.62	<2	74	<2	17	1.65	38	77
RLO-2013	720	20.6	27.4	1.4	159	1.02	22	5.4	29	0.5	<5	12	55	5	38	2850	0.47	19.5	<5	5.77	99	2.25	11.9	<2	136	<2	32	3.4	22	185
RLO-2014	580	18.4	23.8	1.76	30	0.97	20	4.9	18.4	0.43	<5	9	25	5	32	2100	<0.2	18.1	<5	4.91	96	3.35	11.2	<2	144	<2	31	2.85	19	170
RLO-2015	170	13.6	51.8	6.57	12	0.96	15	3.04	19.5	0.29	<5	4	22	18	71	7760	<0.2	12.9	<5	4.37	169	<1	6.75	<2	135	3.19	15	1.86	125	98
RLO-2016	30	9.59	56.1	4.97	15	1.18	15	3.16	19.8	0.25	<5	5	16	14	69	8870	<0.2	12	<5	4.46	197	<1	6.71	<2	115	<2	16	1.89	93	108
RLO-2017	10	8.6	61.1	5.26	9	1.05	16	3.45	20.4	0.29	<5	7	17	16	67	7760	0.21	12.2	<5	4.65	204	<1	7.17	<2	111	<2	19	1.98	101	105
RLO-2018	20	8.14	63	5.86	10	1.16	13	2.8	19.3	0.26	<5	6	17	13	76	7420	0.34	12	<5	4.44	183	<1	7.17	<2	109	<2	15	2.01	91	97
RLO-2019	20	5.67	65.1	5.76	15	0.77	13	2.59	18	0.26	<5	5	21	14	67	5450	0.33	10.2	<5	3.88	152	<1	7.08	<2	81	<2	16	1.83	81	81
RLO-2020	80	7.63	49.8	5.07	9	0.97	13	2.77	16.7	0.25	<5	6	19	14	64	6690	0.29	10.1	<5	3.89	160	1.22	6.3	<2	91	<2	17	1.68	79	90
RLO-2021	140	12.1	26.4	2.77	3	0.65	7	1.87	13.2	<0.2	<5	1	11	10	41	4720	0.49	5.37	<5	2.71	85	<1	4.56	<2	43	<2	12	1.21	35	67
RLO-2022	260	30.1	172	2.59	79	1.37	14	3.38	11.9	0.34	<5	3	56	9	125	4400	0.67	30.3	<5	4.6	208	<1	5.48	<2	270	<2	21	2.32	80	118
RLO-2023	290	20.5	130	2.62	61	0.59	15	2.51	7.13	0.2	<5	7	52	<4	136	2850	0.8	31.3	<5	1.9	245	<1	4.4	<2	217	<2	13	1.56	63	96
RLO-2024	1770	44.2	47.3	1.24	48	1.02	23	3.28	8.1	0.36	<5	7	75	10	63	1350	0.59	28.8	<5	3.81	146	2.32	6.77	<2	239	<2	24	2.71	70	122

BACKGROUND DRILLING

FieldNo	LabSeqNo	LibNo	Drillhole	East	North	Depth	Rock Type	Ident	XRF SiO2 0.01 %	XRF Al2O3 0.01 %	XRF Fe2O3 0.01 %	XRF MnO 0.002 %	XRF MgO 0.01 %	XRF CaO 0.00 %	XRF Na2O 0.01 %	XRF K2O 0.01 %	XRF TiO2 0.00 %	XRF P2O5 0.002 %	Grav LOD < %	Grav LOI < %	INAA As 2.0 ppm	INAA Au 5 ppb	XRF Ba 30 ppm	INAA Br 2 ppm	INAA Ce 10.0 ppm
RLO-2025	L08-1945	08-1935	UScrub1TT	101042.2	83006.6	90.3		L08-1945	70.12	9.59	4.48	0.027	1.25	0.86	0.75	1.40	0.45	0.116	3.44	6.84	8.2	<5	225	<2	38.5
RLO-2026	L08-1962	08-1936	UScrub1TT	101042.2	83006.6	95.7		L08-1962	64.60	11.76	5.00	0.034	1.45	1.06	0.84	1.70	0.55	0.172	4.37	7.73	10.5	<5	235	<2	47.5
RLO-2027	L08-1913	08-1937	UScrub1TT	101042.2	83006.6	100.0		L08-1913	95.43	1.98	1.18	0.012	0.13	0.08	0.14	0.78	0.09	0.006	0.10	0.47	1.4	<5	137	<2	11.6
RLO-2028	L08-1944	08-1938	UScrub1TT	101042.2	83006.6	106.0		L08-1944	58.89	15.18	6.83	0.039	1.27	0.70	0.50	2.28	0.77	0.057	3.60	8.86	12.6	<5	231	<2	74.9
RLO-2029	L08-1917	08-1939	UScrub1TT	101042.2	83006.6	109.5		L08-1917	68.77	12.93	4.62	0.052	0.68	0.82	0.32	2.44	0.76	0.050	0.89	7.10	11.5	<5	357	<2	87.7
RLO-2030	L08-1961	08-1940	UScrub1TT	101042.2	83006.6	110.7		L08-1961	76.07	10.97	3.58	0.039	0.53	0.21	0.33	1.87	0.88	0.071	0.57	4.83	8.6	<5	278	<2	111.0
RLO-2031	L08-1930	08-1941	UScrub1TT	101042.2	83006.6	111.4		L08-1930	78.16	9.47	2.71	0.031	0.58	0.16	0.64	2.43	0.68	0.024	0.30	4.66	5.7	<5	542	<2	124.0
RLO-2032	L08-1942	08-1942	UScrub1TT	101042.2	83006.6	111.7		L08-1942	81.63	4.20	1.67	0.221	0.16	4.98	0.27	1.09	0.82	0.018	0.10	4.95	5.6	27	267	<2	140.0
RLO-2033	L08-1923	08-1943	UScrub4BTT	101151.8	83170.6	103.0		L08-1923	56.81	15.22	7.31	0.054	1.73	1.03	0.48	2.25	0.69	0.100	4.96	8.21	10.7	<5	210	<2	80.0
RLO-2034	L08-1958	08-1944	UScrub4BTT	101151.8	83170.6	105.9		L08-1958	58.24	16.46	5.83	0.041	1.27	0.71	0.48	2.42	0.82	0.051	3.58	9.36	9.4	<5	245	2	53.5
RLO-2035	L08-1952	08-1945	UScrub4BTT	101151.8	83170.6	108.9		L08-1952	61.56	17.21	4.84	0.029	0.87	0.49	0.40	2.49	0.90	0.126	1.79	8.42	14.5	<5	292	<2	100.0
RLO-2036	L08-1959	08-1946	UScrub4BTT	101151.8	83170.6	110.2		L08-1959	74.58	8.68	6.50	0.033	0.39	0.15	0.25	1.29	0.71	0.031	0.53	5.46	102.0	<5	158	<2	79.5
RLO-2037	L08-1933	08-1947	UScrub4BTT	101151.8	83170.6	111.3		L08-1933	89.80	4.74	2.23	0.013	0.13	0.06	0.38	1.84	0.15	0.010	0.06	0.76	9.4	<5	312	<2	19.2
RLO-2038	L08-1949	08-1948	UScrub4BTT	101151.8	83170.6	111.5		L08-1949	85.48	5.80	3.83	0.041	0.17	0.08	0.41	2.02	0.20	0.018	0.11	1.66	10.5	<5	308	<2	30.6
RLO-2039	L08-1925	08-1949	UScrub2TT	100859.9	82820.2	102.8		L08-1925	57.02	15.23	7.82	0.056	1.79	0.95	0.56	2.42	0.69	0.096	4.51	8.23	10.5	<5	223	3	76.6
RLO-2040	L08-1951	08-1950	UScrub2TT	100859.9	82820.2	106.2		L08-1951	56.03	17.91	6.20	0.039	1.41	0.81	0.56	2.70	0.89	0.105	3.99	9.35	9.7	<5	290	<2	80.8
RLO-2041	L08-1928	08-1951	UScrub2TT	100859.9	82820.2	108.8		L08-1928	74.18	10.63	4.45	0.032	0.65	0.18	0.30	2.39	0.75	0.040	0.68	5.31	10.7	<5	309	<2	91.9
RLO-2042	L08-1956	08-1952	UScrub2TT	100859.9	82820.2	109.8		L08-1956	73.07	10.52	6.57	0.036	0.95	0.28	1.11	2.43	0.59	0.096	0.40	4.07	7.9	<5	489	<2	130.0
RLO-2043	L08-1914	08-1953	UScrub2TT	100859.9	82820.2	110.5		L08-1914	81.73	8.19	2.14	0.029	0.37	0.13	0.86	2.71	0.68	0.022	0.29	2.98	3.1	6	680	<2	124.0
RLO-2044	L08-1936	08-1954	UScrub2TT	100859.9	82820.2	111.8		L08-1936	87.76	5.19	1.73	0.032	0.19	0.07	0.22	1.10	0.63	0.030	0.23	2.90	5.7	57	263	<2	147.0
RLO-2045	L08-1932	08-1955	UScrub3TT	101228.6	83035.7	106.0		L08-1932	54.29	17.50	7.19	0.046	1.42	0.78	0.53	2.44	0.83	0.072	3.92	10.22	17.0	<5	230	<2	78.3
RLO-2046	L08-1948	08-1956	UScrub3TT	101228.6	83035.7	109.3		L08-1948	73.03	11.22	4.28	0.040	0.62	0.26	0.30	2.34	0.77	0.040	0.66	5.75	19.9	<5	313	<2	90.5
RLO-2047	L08-1929	08-1957	UScrub3TT	101228.6	83035.7	109.8		L08-1929	73.12	11.25	5.77	0.035	0.69	0.17	0.38	1.69	0.70	0.040	0.57	5.22	19.9	<5	226	<2	74.3
RLO-2048	L08-1938	08-1958	UScrub3TT	101228.6	83035.7	111.8		L08-1938	74.99	11.64	3.40	0.026	0.73	0.15	0.92	2.55	0.71	0.026	0.36	5.07	9.0	<5	558	<2	150.0

BACKGROUND DRILLING

FieldNo	XRF Cl 20 ppm	INAA Co 1 ppm	INAA Cr 5 ppm	INAA Cs 1.00 ppm	XRF Cu 10 ppm	INAA Eu 1.00 ppm	XRF Ga 3 ppm	INAA Hf 1.0 ppm	INAA La 0.5 ppm	INAA Lu 0.20 ppm	INAA Mo 5 ppm	XRF Nb 4 ppm	XRF Ni 10 ppm	XRF Pb 5 ppm	XRF Rb 5 ppm	XRF S 10 ppm	INAA Sb 0.50 ppm	INAA Sc 0.1 ppm	INAA Se 10 ppm	INAA Sm 0.20 ppm	XRF Sr 5 ppm	INAA Ta 1.0 ppm	INAA Th 0.50 ppm	INAA U 2.0 ppm	XRF V 5 ppm	INAA W 2.0 ppm	XRF Y 5 ppm	INAA Yb 0.50 ppm	XRF Zn 5 ppm	XRF Zr 5 ppm
RLO-2025	10	7	53	6.32	10	1.10	12	2.6	17.8	0.25	<5	6	18	13	74	7990	<0.2	9.8	<5	3.89	206	<1	6.14	<2	82	<2	17	1.71	113	101
RLO-2026	80	10	52	7.32	11	1.04	14	3.1	20.5	0.33	<5	6	33	20	81	9560	0.21	12.0	<5	4.68	240	<1	7.22	<2	100	<2	18	2.17	213	111
RLO-2027	60	2	8	<1	<2	<0.5	2	1.4	6.0	<0.2	<5	2	<3	10	27	1110	0.21	1.4	<5	0.89	27	<1	1.63	<2	17	<2	6	<0.5	83	42
RLO-2028	30	18	43	9.01	14	1.42	17	6.0	33.9	0.43	<5	9	19	25	105	14100	0.25	15.6	<5	7.11	205	<1	11.80	2.2	117	4.0	25	3.23	125	207
RLO-2029	90	17	40	5.22	80	1.55	17	13.0	40.2	0.53	<5	15	62	20	91	11060	0.45	13.7	<5	7.69	82	1.3	14.20	<2	79	3.7	30	3.52	119	433
RLO-2030	90	19	37	4.40	12	1.68	14	10.3	49.4	0.60	<5	12	23	13	77	5000	<0.2	13.4	<5	10.00	65	1.8	16.80	4.3	87	<2	37	4.23	75	358
RLO-2031	420	16	40	3.08	31	0.71	12	5.4	69.8	0.31	<5	11	35	23	98	2200	0.24	9.3	<5	7.78	40	1.0	10.40	<2	63	5.2	18	2.17	35	170
RLO-2032	300	11	16	<1	5	<0.5	6	2.6	72.9	0.28	<5	9	8	21	33	870	0.27	3.6	<5	7.43	40	1.0	7.93	2.7	33	7.8	20	1.89	25	85
RLO-2033	<20	19	70	14.40	6	1.60	21	4.8	37.8	0.48	<5	7	21	21	132	9400	0.38	17.6	<5	8.39	269	<1	12.30	<2	148	<2	29	3.50	135	168
RLO-2034	0	17	53	10.60	18	0.90	21	5.2	26.6	0.37	<5	14	22	27	119	12490	0.40	16.6	<5	4.72	196	1.1	13.00	3.0	113	<2	17	2.67	122	176
RLO-2035	20	16	46	8.34	22	2.05	20	7.8	42.3	0.61	<5	13	25	18	100	7440	0.38	18.0	<5	9.38	127	2.2	13.70	4.8	119	4.3	39	4.10	83	266
RLO-2036	50	14	28	3.68	22	1.08	11	7.4	37.2	0.39	<5	9	27	14	51	17920	1.43	10.3	<5	6.82	49	<1	12.70	<2	70	4.6	25	2.77	43	246
RLO-2037	110	16	13	1.07	3	<0.5	7	1.6	10.7	<0.2	<5	4	35	11	59	460	0.21	3.9	<5	1.50	29	<1	2.71	<2	30	3.2	4	0.72	14	48
RLO-2038	83	22	17	1.43	2	<0.5	7	1.7	17.2	<0.2	<5	5	16	14	68	965	0.29	5.6	<5	2.01	30	<1	3.68	<2	35	3.1	11	1.15	24	57
RLO-2039	<40	19	67	12.60	19	1.60	19	4.8	36.9	0.46	<5	8	60	25	136	9550	<0.2	17.5	<5	7.94	275	1.4	12.30	<2	140	<2	29	3.18	118	160
RLO-2040	20	17	52	10.80	20	1.70	23	5.6	37.2	0.62	<5	11	20	26	115	6530	0.28	20.0	<5	8.44	237	1.0	13.80	2.6	124	<2	33	4.21	109	195
RLO-2041	110	14	40	4.61	19	1.37	14	13.5	43.7	0.50	<5	10	16	20	80	7870	0.30	11.2	<5	7.90	67	1.0	15.40	3.4	67	3.8	30	3.41	55	455
RLO-2042	420	20	34	3.61	26	1.06	19	5.1	76.7	0.33	<5	10	30	11	109	1730	<0.2	10.9	<5	8.51	49	<1	10.10	<2	81	<2	24	2.30	38	182
RLO-2043	220	8	29	1.24	34	0.68	11	5.0	72.1	0.27	<5	10	21	17	89	1050	<0.2	6.3	<5	7.60	41	<1	9.62	<2	48	6.3	17	1.90	23	166
RLO-2044	280	9	23	1.18	21	<0.5	6	2.8	89.2	0.20	<5	7	15	25	42	840	<0.2	4.2	<5	8.04	38	1.2	7.79	<2	43	3.2	14	1.53	24	81
RLO-2045	40	22	54	11.20	23	1.55	22	5.1	37.1	0.51	<5	11	20	23	108	12370	0.29	19.4	<5	7.98	235	1.9	14.00	<2	124	<2	31	3.66	110	174
RLO-2046	70	14	43	4.57	14	1.22	16	13.1	42.0	0.50	<5	11	11	18	84	7600	0.27	11.3	<5	7.42	62	1.6	15.10	3.4	76	<2	30	3.33	55	464
RLO-2047	40	20	37	4.92	25	1.37	15	7.1	34.8	0.47	<5	10	15	17	65	5900	0.31	13.8	<5	6.88	57	1.3	12.30	<2	112	<2	24	3.05	61	248
RLO-2048	570	18	46	3.56	39	0.85	18	6.0	84.1	0.38	<5	12	43	15	112	1160	<0.2	10.4	<5	8.89	44	1.4	12.50	<2	72	6.0	22	2.38	28	211

PROFILE SAMPLING OF PITS AT ELOISE

FieldNo	LabSeqNo	LibNo	Pit	From	To	east	north	XRF SiO2 0.01 %	XRF Al2O3 0.01 %	XRF Fe2O3 0.01 %	XRF MnO 0 %	XRF MgO 0.01 %	XRF CaO 0 %	XRF Na2O 0.01 %	XRF K2O 0.01 %	XRF TiO2 0 %	XRF P2O5 0 %	Grav LOD - %	Grav LOI - %	INAA As 2 ppm	INAA Au 5 ppb	XRF Ba 30 ppm	INAA Br 2 ppm	INAA Ce 10 ppm	XRF Cl 20 ppm	INAA Co 1 ppm	INAA Cr 5 ppm	INAA Cs 1 ppm
RLO 1001	L08-1900	08-1884	1	0	700	497344	7682950	42.3	7.37	3.28	0.03	1.01	21.5	0.19	0.68	0.38	0.03	3	21	5.06	<5	226	21.1	61.6	10	9.81	33.1	2.33
RLO 1002	L08-1888	08-1885	1	700	1450	497344	7682950	28.2	6.25	2.54	0.03	1.26	30.4	0.14	0.49	0.23	0.02	3.04	27.8	2.14	<5	181	9.25	50.7	10	9.43	27.3	1.79
RLO 1003	L08-1899	08-1886	1	1450	2300	497344	7682950	59	8.35	3.6	0.05	1.18	10.4	0.36	0.8	0.61	0.03	3.75	12.6	3.86	<5	306	11.8	65.8	40	11.9	38.3	2.56
RLO 1004	L08-1892	08-1887	2	0	500	497311	7683125	70.2	10.65	5.65	0.05	0.69	1.88	0.53	1.23	0.75	0.04	2.26	5.84	5.4	<5	325	7.31	87.5	100	11.8	46	1.95
RLO 1005	L08-1891	08-1888	2	500	2000	497311	7683125	57.8	15.51	6.64	0.07	1.74	2.12	1.01	1.44	0.94	0.05	9.58	2.68	4.48	<5	907	3.75	153	550	20.8	53.6	3.27
RLO 1006	L08-1893	08-1889	3	0	400	497297	7683321	69.3	9	6.74	0.06	0.7	3.39	0.46	1.01	0.71	0.05	2.39	6.66	10	<5	302	11.2	73.1	90	10.4	48.9	1.85
RLO 1007	L08-1902	08-1890	3	400	1100	497297	7683321	63.2	7.97	5.92	0.05	0.83	7.97	0.46	0.9	0.65	0.04	2.18	9.87	9.46	<5	279	5.95	70.2	70	9.9	42.4	2.33
RLO 1008	L08-1901	08-1891	3	1100	1400	497297	7683321	57.5	7.89	5.02	0.06	1.28	11.2	0.61	0.85	0.63	0.04	2.54	12.5	7.36	<5	986	7.72	66.4	320	10.5	41.4	1.65
RLO 1009	L08-1903	08-1892	3	1400	2000	497297	7683321	49.2	8.68	4.43	0.08	1.92	12.5	0.74	0.83	0.64	0.04	4.4	13.9	4.68	<5	897	5.05	78.2	700	12.2	41.3	3.52
RLO 1010	L08-1889	08-1893	3	2000	2700	497297	7683321	43.8	9.17	4.11	0.11	2.16	16.6	0.66	0.84	0.45	0.03	4.72	18.2	4.82	<5	433	<2	62.1	80	12.7	37.7	3.06
RLO 1011	L08-1890	08-1894	4	0	400	497479	7683473	68.2	8.28	6.44	0.06	0.69	4.69	0.51	1.09	0.73	0.05	2.31	7.39	8.8	<5	328	18	73.6	130	9.82	47.8	1.6
RLO 1012	L08-1898	08-1895	4	400	1200	497479	7683473	59.5	7.81	4.83	0.05	0.91	10.9	0.6	0.89	0.61	0.03	2.42	11.8	6.47	<5	217	7.09	60	120	9.36	39.9	1.52
RLO 1013	L08-1906	08-1896	4	1200	1900	497479	7683473	36.6	6.6	3.43	0.04	1.31	25.1	0.42	0.59	0.28	0.02	2.93	23.2	4.62	<5	359	6.2	45.4	350	9.59	31.8	1.2
RLO 1014	L08-1910	08-1897	4	1900	3200	497479	7683473	51.7	9.31	28.23	0.6	0.56	0.52	0.72	0.89	0.49	0.28	1.29	5.9	61.5	<5	1406	3.48	38.2	650	35.8	109	1.8
RLO 1015	L08-1908	08-1898	5	0	1620	497577	7683428	69.1	8.2	4.8	0.09	0.87	4.51	0.41	0.94	0.57	0.03	3.13	7.69	5.4	<5	324	14.3	60	90	12.3	38.8	1.68
RLO 1016	L08-1894	08-1899	5	1620	2020	497577	7683428	58	9.76	5.71	0.07	1.18	8.96	0.85	0.97	0.73	0.04	3.33	10.8	7.48	<5	541	5.28	83.4	1190	14.9	48.6	3.16
RLO 1017	L08-1895	08-1900	5	2020	2460	497577	7683428	77.5	7.21	7.41	0.09	0.56	0.75	1.07	0.95	0.61	0.07	1.26	2.59	12.3	<5	338	<2	61.1	590	11.3	40.1	<1
RLO 1018	L08-1886	08-1901	6	0	700	497724	7683449	71.2	11.1	7.08	0.07	0.44	0.48	0.21	0.89	0.74	0.05	2.88	5.21	9.17	<5	255	20.9	76.8	30	12.4	55.7	2.06
RLO 1019	L08-1907	08-1902	6	700	1680	497724	7683449	65	6.74	8.4	0.06	0.45	7.55	0.51	0.76	0.4	0.07	1.17	8.87	13.7	<5	282	2.33	48.3	110	10.6	41.6	1.63
RLO 1020	L08-1896	08-1903	6	1680	2650	497724	7683449	65.5	8.44	11.5	0.12	0.57	3.75	0.9	1.08	0.43	0.08	1.79	6.25	30.2	<5	733	<2	45.9	220	11	53.2	1.44
RLO 1021	L08-1904	08-1904	7	0	1070	497855	7683439	75.8	8.04	7.21	0.05	0.46	0.65	0.29	0.96	0.63	0.04	2.14	4.06	10.5	<5	223	9.07	54.8	60	10	48.3	2.06
RLO 1022	L08-1887	08-1905	7	1070	1300	497855	7683439	39.9	5.8	3.72	0.03	0.82	24.5	0.27	0.64	0.3	0.03	2	22.2	5.32	<5	142	12	43.2	40	7.49	27.2	1.31
RLO 1023	L08-1884	08-1906	7	1300	2570	497855	7683439	29.4	5.56	2.69	0.03	1.59	30.3	0.29	0.5	0.19	0.02	3.47	27.3	1.77	<5	204	3.01	34.3	0	9.82	21.9	2.31
RLO 1024	L08-1905	08-1907	7	2570	3340	497855	7683439	66.5	8.66	4.85	0.04	2.22	3.56	0.82	1.04	0.53	0.06	4.22	7.36	5.92	<5	206	<2	53.3	10	12	34.1	3.4
RLO 0101	L08-2027	08-2025	8	0	100	497564	7683063	66	9.59	5.29	0.07	1.1	3.89	0.38	0.87	0.74	0.04	4.12	8.04	5.82	<5	300	12	74.5	50	11.8	46.7	1.91
RLO 0102	L08-2028	08-2026	8	100	450	497564	7683063	65.7	9.56	5.48	0.07	1.1	4.28	0.47	0.86	0.73	0.03	3.99	8.22	6.57	<5	322	11.6	76.8	70	11.5	46.5	2.8
RLO 0103	L08-2025	08-2027	8	450	1200	497564	7683063	63.7	10.67	5.63	0.06	1.24	3.98	0.6	0.97	0.77	0.04	4.5	8.39	5.85	<5	368	14	77.5	300	12	48.5	2.54
RLO 0104	L08-2026	08-2028	8	1200	2400	497564	7683063	69.7	9.21	12.07	0.05	0.51	0.73	1.39	1.85	0.37	0.07	1.38	3.38	17.6	<5	886	5.21	48.3	1410	13.4	60.3	1.19
RLO 0105	L08-2030	08-2029	8	2400	3350	497564	7683063	74.3	9.18	7.28	0.03	0.63	0.35	1.53	2.02	0.3	0.05	1.56	2.92	10.4	<5	553	6.53	44.3	1890	7.31	39.9	<1
RLO 0106	L08-2029	08-2030	8	3350	4400	497564	7683063	44.4	7.71	3.69	0.06	2.36	17.5	0.74	0.99	0.3	0.07	4.37	18.2	5.3	<5	1179	7.11	44.7	1180	9.49	31.2	2.39

PROFILE SAMPLING OF PITS AT ELOISE

LibNo	Pit	From	To	XRF Cu 10 ppm	INAA Eu 1 ppm	XRF Ga 3 ppm	INAA Hf 1 ppm	INAA La 0.5 ppm	INAA Lu 0.2 ppm	INAA Mo 5 ppm	XRF Nb 4 ppm	XRF Ni 10 ppm	XRF Pb 5 ppm	XRF Rb 5 ppm	XRF S 10 ppm	INAA Sb 0.5 ppm	INAA Sc 0.1 ppm	INAA Se 10 ppm	INAA Sm 0.2 ppm	XRF Sr 5 ppm	INAA Ta 1 ppm	INAA Th 0.5 ppm	INAA U 2 ppm	XRF V 5 ppm	INAA W 2 ppm	XRF Y 5 ppm	INAA Yb 0.5 ppm	XRF Zn 5 ppm	XRF Zr 5 ppm
08-1884	1	0	700	25	1.03	10	7.33	29.4	0.37	<5	9	40	3	36	80	0.41	8.05	<5	5.39	141	<1	10.6	<2	105	<2	23	2.6	24	262
08-1885	1	700	1450	21	0.85	8	4.07	25.7	0.28	<5	5	12	3	27	60	<0.2	6.87	<5	4.65	168	<1	8.11	<2	80	<2	21	2.11	25	148
08-1886	1	1450	2300	22	1.24	10	8.54	32	0.42	<5	10	37	6	40	80	0.34	9.01	<5	5.85	119	<1	13	<2	84	<2	24	2.86	28	297
08-1887	2	0	500	26	1.2	14	10.5	46.1	0.53	<5	11	13	15	58	60	0.28	10.5	<5	7.22	80	2.15	17.7	<2	111	<2	33	3.5	26	373
08-1888	2	500	2000	50	1.62	21	9.2	68	0.68	<5	17	23	15	86	300	<0.2	16.9	<5	11.2	158	2.11	23.7	3.4	126	<2	39	4.47	44	317
08-1889	3	0	400	26	1.11	12	10.2	34.3	0.47	<5	7	67	17	46	100	0.48	9.42	<5	5.95	98	1.66	15.4	2.64	173	<2	24	3.05	32	388
08-1890	3	400	1100	23	1.04	10	10.4	32.7	0.45	<5	10	44	15	40	120	0.8	8.92	<5	5.78	121	1.48	16.1	<2	148	<2	24	3.03	32	372
08-1891	3	1100	1400	21	1.07	10	10.3	32.8	0.44	<5	10	13	12	41	330	0.38	8.72	<5	5.84	202	1.58	14.7	<2	117	<2	26	3.17	32	360
08-1892	3	1400	2000	27	1.31	11	10	38.9	0.49	<10	9	19	14	41	7020	0.55	10.2	<5	7.21	872	1.01	14.3	5.09	114	<2	27	3.25	45	358
08-1893	3	2000	2700	31	0.99	14	6.02	27.3	0.38	<10	9	41	4	46	230	0.46	10	<5	5.24	327	<1	10.1	5.08	127	<2	23	2.5	51	232
08-1894	4	0	400	23	0.89	10	11.6	34.8	0.49	<5	9	18	17	42	90	0.54	8.47	<5	5.9	98	2.32	15.6	<2	162	<2	23	3.08	30	436
08-1895	4	400	1200	20	0.94	8	8.73	29.6	0.39	<5	6	70	14	37	80	0.33	8	<5	5.19	137	1.25	13.8	2.2	117	<2	23	2.61	30	325
08-1896	4	1200	1900	19	0.89	6	5.01	23.4	0.31	<5	9	19	7	30	210	0.43	7.17	<5	4.5	176	<1	8.38	<2	92	<2	21	2.01	34	186
08-1897	4	1900	3200	55	1.32	19	3.6	22.1	0.47	10.7	7	46	37	31	330	2.22	15.7	<5	5.26	147	<1	12.9	3.03	755	<2	29	3.36	120	128
08-1898	5	0	1620	22	1.19	11	7.87	30.2	0.41	<5	9	16	14	45	60	0.55	8.65	<5	5.64	83	<1	12.5	2.29	115	<2	21	2.8	32	259
08-1899	5	1620	2020	31	1.17	12	9.29	41	0.51	<5	14	62	16	53	180	0.57	11.3	<5	7.55	132	1.05	15.8	3.67	126	<2	31	3.35	56	331
08-1900	5	2020	2460	23	1.17	10	7.1	28.8	0.44	<5	4	39	18	37	100	0.63	8.56	<5	5.16	73	1.3	12.7	2.42	169	<2	23	2.84	44	249
08-1901	6	0	700	29	1.05	16	9.22	34.4	0.48	<5	9	17	18	48	80	0.44	11.6	<5	6.32	53	<1	15.4	<2	164	<2	26	3.32	31	329
08-1902	6	700	1680	24	1.13	11	4.1	24.5	0.26	<5	8	13	16	31	140	0.41	7.61	<5	4.62	81	<1	8.57	<2	205	<2	17	1.78	33	146
08-1903	6	1680	2650	25	1.15	11	4.23	22.6	0.26	<5	3	15	19	39	160	1.31	8.78	<5	4.8	107	<1	9.06	<2	327	<2	16	2.09	48	147
08-1904	7	0	1070	19	0.79	13	9.81	26.8	0.41	<5	8	38	16	46	80	1.38	8.77	<5	4.89	55	1.39	13.5	<2	163	<2	20	2.69	32	325
08-1905	7	1070	1300	18	0.75	5	6.08	20.8	0.28	<5	9	<4	1	30	110	0.31	6.12	<5	3.77	157	1.49	9.21	<2	101	<2	17	1.89	24	238
08-1906	7	1300	2570	15	0.64	6	2.85	15.9	0.22	<5	4	<3	3	28	160	<0.2	6.06	<5	3.2	224	1.08	5.06	<2	79	<2	14	1.4	31	102
08-1907	7	2570	3340	21	1.01	12	5.14	22.3	0.3	<5	7	22	19	44	50	0.38	9.25	<5	4.55	115	<1	9.56	3.4	103	<2	17	2.06	58	189
08-2025	8	0	100	25	1.32	11	9.56	36.5	0.49	<5	13	56	18	51	90	0.38	10	<5	6.58	95	1.29	15.5	<2	115	<2	27	3.26	33	341
08-2026	8	100	450	21	1.49	13	9.47	36.4	0.46	<5	8	24	20	52	130	0.41	10.2	<5	6.38	102	<1	14	2.6	130	<2	29	3.27	30	347
08-2027	8	450	1200	28	1.24	13	9.8	36	0.5	<5	13	16	17	57	170	0.27	10.9	<5	6.45	124	1.04	14.5	<2	122	<2	25	3.24	35	351
08-2028	8	1200	2400	28	1.02	13	3.71	25.3	0.34	<5	7	35	19	65	220	0.53	8.09	<5	4.47	99	<1	11.7	<2	289	<2	20	2.34	50	137
08-2029	8	2400	3350	23	0.78	14	3.07	23.8	0.3	<5	6	12	12	69	120	0.45	6.72	<5	3.91	100	1.35	10.9	<2	162	<2	18	1.95	33	95
08-2030	8	3350	4400	24	1.09	9	2.98	23	0.29	<5	6	0	5	46	350	0.4	8.06	<5	4.71	209	<1	6.51	2.09	109	<2	20	1.92	49	104

GEOCHEMISTRY OF BLACK AND BROWN SOILS

Sample No	Field No	Easting	Northing	Colour	Location	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	MnO	P2O5	LOI	As	Au	Ba	Br	Ce	Cl	Co	Cr	Cs	Cu	Eu
					Unit	%	%	%	%	%	%	%	%	%	%	%	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
					Detn Limit	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.002	0.002		1	5	30	2.0	2.0	20	1.0	5	1.0	10	0.50
					Method	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	Grav	INAA	INAA	XRF	INAA	INAA	XRF	INAA	INAA	INAA	XRF	INAA
11<0718	shu01	496897	7694302	black	Arrolla	61.80	15.80	6.06	1.23	1.39	0.65	1.91	0.89	0.047	0.077	8.19	8	<5	317	7.0	65.5	<20	12.3	60	6.2	12	1.31
11<0720F	shu03	499390	7693350	black	Levuka	64.58	12.92	5.24	1.07	1.56	0.43	0.73	0.96	0.074	0.039	8.01	10	<5	312	5.4	74.7	<20	16.4	68	4.3	22	1.86
11<0722F	shu11	496184	7688180	black		56.73	16.44	6.87	1.25	1.23	0.49	0.95	1.09	0.047	0.039	9.29	7	<5	567	16.2	97.4	<20	14.6	70	3.5	16	1.35
11<0723F	shu12	493151	7694616	black	Arrolla	65.65	11.57	5.70	1.16	1.24	0.38	0.63	1.00	0.118	0.033	7.50	8	<5	367	4.1	78.5	<20	17.9	62	2.7	12	1.38
11<0726F	shu15	499750	7677579	black	Eloise	65.91	12.05	4.74	1.23	1.04	0.58	0.83	0.93	0.099	0.028	7.30	4	<5	419	2.9	92.3	<20	17.4	57	2.4	<10	1.42
11<0728F	shu17	498631	7680703	black	Oorindi Rd	55.14	17.15	7.19	1.09	1.25	0.45	1.06	1.03	0.088	0.046	10.39	6	<5	405	21.8	110.0	<20	19.0	70	3.9	20	1.77
11<0735F	shu31	500140	7684620	black		53.25	16.92	6.92	1.56	1.83	0.39	1.02	1.02	0.052	0.054	10.67	6	<5	309	23.3	110.0	20	16.2	70	3.8	17	1.59
11<0744F	shu40	509470	7692510	black	Longford	64.69	12.42	4.95	1.03	1.47	0.34	0.69	0.96	0.116	0.025	7.14	6	<5	316	4.5	81.5	<20	18.9	64	3.2	14	1.44
11<0719F	shu02	498158	7692660	d.brown	Levuka	62.91	13.57	5.59	1.19	1.59	0.40	0.91	0.86	0.088	0.060	8.24	21	<5	357	6.1	65.9	<20	19.6	83	6.0	61	1.63
11<0736F	shu32	501918	7691095	d.brown		52.48	12.28	5.50	1.24	7.75	0.33	0.69	0.69	0.118	0.159	12.72	32	9	329	9.2	61.4	<20	29.2	84	4.4	83	2.56
11<0724F	shu13	493933	7690692	d.brown		66.87	11.95	4.91	1.12	0.95	0.92	0.86	0.90	0.092	0.035	6.84	6	<5	224	9.1	68.5	440	15.5	54	3.4	<10	1.27
11<0727F	shu16	499750	7677579	brown	in B/B	68.19	10.58	4.51	1.16	1.22	0.63	0.62	1.18	0.077	0.034	6.85	4	<5	291	8.0	88.6	<20	13.6	62	3.0	<10	1.45
11<0725F	shu14	498445	7678019	brown	Eloise	52.02	22.72	8.79	0.65	0.46	0.25	1.22	1.07	0.051	0.059	9.91	9	<5	176	2.9	101.0	10	18.7	76	6.0	54	1.63
11<0729F	shu18	498631	7680703	brown	Oorindi Rd	52.22	21.01	8.55	0.70	0.44	0.19	1.09	1.12	0.039	0.053	10.40	8	<5	218	9.9	95.2	<20	17.4	74	4.5	21	1.59
11<0731F	shu20	499562	7681195	brown	Elrose	56.34	19.99	8.32	0.46	0.29	0.21	1.24	1.26	0.085	0.082	9.56	9	<5	234	6.7	116.0	20	21.8	81	4.5	24	2.00
11<0732F	shu22A	491850	7691600	brown	Levuka	64.05	15.83	7.07	0.41	0.22	0.63	1.44	1.36	0.089	0.076	6.86	6	8	322	3.8	158.0	<20	21.3	68	2.8	19	1.99
11<0741F	shu37	488392	7671650	brown	Maronan	45.23	26.81	7.87	0.95	0.41	0.30	3.00	0.94	0.031	0.061	10.31	7	47	697	9.6	113.0	<20	16.4	96	5.4	30	1.71
11<0742F	shu38	488392	7671650	brown	Maronan	54.65	19.16	7.30	1.42	0.74	0.56	1.63	1.11	0.092	0.056	8.88	10	161	504	10.7	124.0	30	22.9	77	4.2	30	1.65
11<0730F	shu19	498631	7680703	g.brown	Oor. Rd	55.20	17.97	7.21	1.37	0.55	0.48	1.02	0.96	0.023	0.037	9.53	6	10	262	<2	75.6	<20	7.3	64	3.2	16	0.82
11<0739F	shu35	488392	7671650	grey	Maronan	48.06	21.92	5.02	2.27	1.78	0.25	2.28	1.16	0.048	0.067	11.16	9	182	735	5.7	189.0	<20	19.7	98	4.2	16	1.21
08-1884	RLO 1001	497344	7682950	brown	Eloise	42.27	7.37	3.28	1.01	21.48	0.19	0.68	0.38	0.033	0.030	20.98	5	<5	226	21.1	61.6	10	9.8	33	2.3	25	1.03
08-1887	RLO 1004	497311	7683125	brown	Eloise	70.19	10.65	5.65	0.69	1.88	0.53	1.23	0.75	0.054	0.035	5.84	5	<5	325	7.3	87.5	100	11.8	46	2.0	26	1.20
08-1889	RLO 1006	497297	7683321	brown	Eloise	69.26	9.00	6.74	0.70	3.39	0.46	1.01	0.71	0.058	0.046	6.66	10	<5	302	11.2	73.1	90	10.4	49	1.9	26	1.11
08-1890	RLO 1007	497297	7683321	brown	Eloise	63.16	7.97	5.92	0.83	7.97	0.46	0.90	0.65	0.053	0.043	9.87	9	<5	279	6.0	70.2	70	9.9	42	2.3	23	1.04
08-1894	RLO 1011	497479	7683473	brown	Eloise	68.17	8.28	6.44	0.69	4.69	0.51	1.09	0.73	0.060	0.046	7.39	9	<5	328	18.0	73.6	130	9.8	48	1.6	23	0.89
08-1895	RLO 1012	497479	7683473	brown	Eloise	59.52	7.81	4.83	0.91	10.90	0.60	0.89	0.61	0.051	0.031	11.83	6	<5	217	7.1	60.0	120	9.4	40	1.5	20	0.94
08-1898	RLO 1015	497577	7683428	black	Eloise	69.12	8.20	4.80	0.87	4.51	0.41	0.94	0.57	0.085	0.029	7.69	5	<5	324	14.3	60.0	90	12.3	39	1.7	22	1.19
08-1901	RLO 1018	497724	7683449	red	Eloise	71.24	11.10	7.08	0.44	0.48	0.21	0.89	0.74	0.066	0.047	5.21	9	<5	255	20.9	76.8	30	12.4	56	2.1	29	1.05
08-1904	RLO 1021	497855	7683439	r.brown	Eloise	75.78	8.04	7.21	0.46	0.65	0.29	0.96	0.63	0.047	0.042	4.06	11	<5	223	9.1	54.8	60	10.0	48	2.1	19	0.79
08-2025	RLO 0101	497564	7683063	black	Eloise	65.99	9.59	5.29	1.10	3.89	0.38	0.87	0.74	0.065	0.037	8.04	6	<5	300	12.0	74.5	50	11.8	47	1.9	25	1.32
08-2026	RLO 0102	497564	7683063	black	Eloise	65.66	9.56	5.48	1.10	4.28	0.47	0.86	0.73	0.066	0.033	8.22	7	<5	322	11.6	76.8	70	11.5	47	2.8	21	1.49
08-2027	RLO 0103	497564	7683063	brown	Eloise	63.70	10.67	5.63	1.24	3.98	0.60	0.97	0.77	0.058	0.037	8.39	6	<5	368	14.0	77.5	300	12.0	49	2.5	28	1.24

GEOCHEMISTRY OF BLACK AND BROWN SOILS

Sample No	Colour	Ga	Hf	La	Lu	Mo	Nb	Ni	Pb	Rb	S	Sb	Sc	Se	Sm	Sr	Ta	Th	U	V	W	Y	Yb	Zn	Zr
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
		3	0.50	0.50	0.20	5	4	10	5	5	10	0.20	0.10	5	0.20	5	1.0	0.5	2.0	5	2.0	5	0.50	5	5
		XRF	INAA	INAA	INAA	INAA	XRF	XRF	XRF	XRF	XRF	INAA	INAA	INAA	INAA	XRF	INAA	INAA	INAA	XRF	INAA	XRF	INAA	XRF	XRF
11<0718	black	21	7.26	30.30	0.43	<5	14	23	24	97	360	0.45	15.70	<5	6.36	154	1.7	11.8	<2	169	<2	25	3.13	114	274
11<0720F	black	16	12.10	33.40	0.61	6	8	38	14	56	520	1.63	13.10	<5	7.79	152	<1	12.9	3.1	221	<2	38	4.33	107	467
11<0722F	black	20	13.90	39.20	0.59	<5	11	23	19	68	80	0.40	15.40	<5	6.66	107	1.7	22.0	2.1	140	<2	31	4.26	37	515
11<0723F	black	15	13.10	33.70	0.51	<5	10	16	19	52	90	0.64	12.00	<5	6.56	119	2.0	13.2	<2	130	<2	30	3.72	47	497
11<0726F	black	16	12.00	40.80	0.54	<5	9	16	17	59	60	0.47	11.70	<5	7.42	120	1.7	16.5	<2	85	<2	31	3.98	32	421
11<0728F	black	23	10.90	48.50	0.57	<5	14	24	18	78	100	0.40	16.80	<5	8.59	108	1.3	19.9	<2	135	<2	35	4.33	38	410
11<0735F	black	24	10.70	46.70	0.56	<5	17	22	23	75	110	0.34	16.70	<5	8.11	131	1.7	20.1	2.8	131	<2	34	4.18	43	383
11<0744F	black	15	11.50	34.70	0.53	<5	11	23	17	57	90	0.87	12.50	<5	6.91	130	1.5	12.8	<2	140	<2	30	3.74	55	423
11<0719F	d.brown	17	9.04	32.50	0.57	38	5	80	19	72	220	4.07	14.10	<5	7.15	160	1.1	11.7	6.9	496	<2	34	4.10	245	328
11<0736F	d.brown	17	6.42	30.10	0.77	97	6	173	17	50	510	8.21	13.60	<5	9.03	224	1.2	9.1	11.4	880	<2	53	5.68	485	252
11<0724F	d.brown	14	9.60	30.50	0.46	<5	8	19	20	58	120	0.31	11.90	<5	6.28	155	1.3	11.8	<2	113	<2	28	3.20	55	374
11<0727F	brown	15	23.50	43.20	0.68	<5	14	16	18	44	90	0.22	10.90	<5	7.57	120	1.8	19.9	4.0	105	<2	35	4.72	34	887
11<0725F	brown	27	11.40	44.80	0.58	<5	13	191	20	95	60	0.40	19.50	<5	7.29	100	2.4	18.0	2.4	159	<2	31	4.09	38	428
11<0729F	brown	26	12.30	49.80	0.58	<5	14	33	18	100	120	0.41	18.30	<5	8.20	83	<1	20.2	2.9	158	<2	36	4.07	44	470
11<0731F	brown	27	13.80	54.90	0.67	<5	18	28	21	88	110	0.38	19.20	<5	9.53	76	1.9	21.0	3.0	153	<2	38	4.74	39	511
11<0732F	brown	21	21.40	73.10	0.86	<5	17	19	21	79	80	0.43	16.00	<5	12.10	73	1.3	33.1	3.1	131	<2	50	6.36	32	804
11<0741F	brown	32	7.46	61.30	0.60	<5	18	33	23	130	90	0.31	21.30	<5	8.31	79	2.4	29.6	3.1	152	3.0	38	4.36	35	238
11<0742F	brown	25	11.40	62.60	0.61	<5	14	39	50	94	170	0.65	18.80	<5	9.47	91	2.1	21.6	3.6	157	<2	40	4.63	45	430
11<0730F	g.brown	23	11.20	46.00	0.44	<5	11	20	13	68	80	0.40	16.80	<5	5.83	100	2.5	22.2	3.0	125	<2	23	3.16	36	423
11<0739F	grey	27	7.61	78.70	0.44	<5	15	46	201	108	1020	0.93	23.50	<5	6.90	128	1.6	17.8	3.6	152	4.3	24	3.25	45	255
08-1884	brown	10	7.33	29.40	0.37	<5	9	40	3	36	80	0.41	8.05	<5	5.39	141	<1	10.6	<2	105	<2	23	2.60	24	262
08-1887	brown	14	10.50	46.10	0.53	<5	11	13	15	58	60	0.28	10.50	<5	7.22	80	2.2	17.7	<2	111	<2	33	3.50	26	373
08-1889	brown	12	10.20	34.30	0.47	<5	7	67	17	46	100	0.48	9.42	<5	5.95	98	1.7	15.4	2.6	173	<2	24	3.05	32	388
08-1890	brown	10	10.40	32.70	0.45	<5	10	44	15	40	120	0.80	8.92	<5	5.78	121	1.5	16.1	<2	148	<2	24	3.03	32	372
08-1894	brown	10	11.60	34.80	0.49	<5	9	18	17	42	90	0.54	8.47	<5	5.90	98	2.3	15.6	<2	162	<2	23	3.08	30	436
08-1895	brown	8	8.73	29.60	0.39	<5	6	70	14	37	80	0.33	8.00	<5	5.19	137	1.3	13.8	2.2	117	<2	23	2.61	30	325
08-1898	black	11	7.87	30.20	0.41	<5	9	16	14	45	60	0.55	8.65	<5	5.64	83	<1	12.5	2.3	115	<2	21	2.80	32	259
08-1901	red	16	9.22	34.40	0.48	<5	9	17	18	48	80	0.44	11.60	<5	6.32	53	<1	15.4	<2	164	<2	26	3.32	31	329
08-1904	r.brown	13	9.81	26.80	0.41	<5	8	38	16	46	80	1.38	8.77	<5	4.89	55	1.4	13.5	<2	163	<2	20	2.69	32	325
08-2025	black	11	9.56	36.50	0.49	<5	13	56	18	51	90	0.38	10.00	<5	6.58	95	1.3	15.5	<2	115	<2	27	3.26	33	341
08-2026	black	13	9.47	36.40	0.46	<5	8	24	20	52	130	0.41	10.20	<5	6.38	102	<1	14.0	2.6	130	<2	29	3.27	30	347
08-2027	brown	13	9.80	36.00	0.50	<5	13	16	17	57	170	0.27	10.90	<5	6.45	124	1.0	14.5	<2	122	<2	25	3.24	35	351

APPENDIX 3

Analytical standards

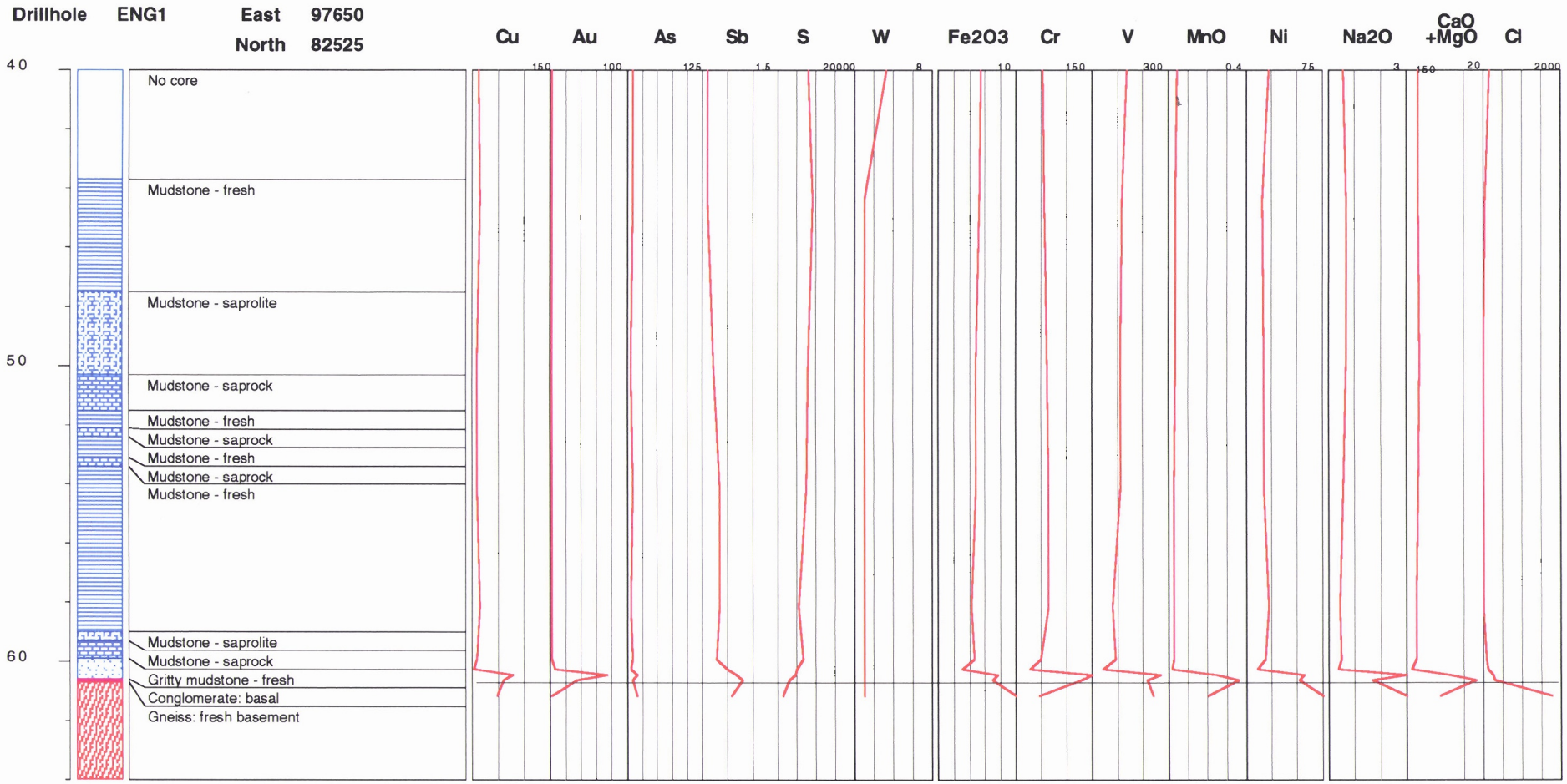
STANDARDS - ELOISE

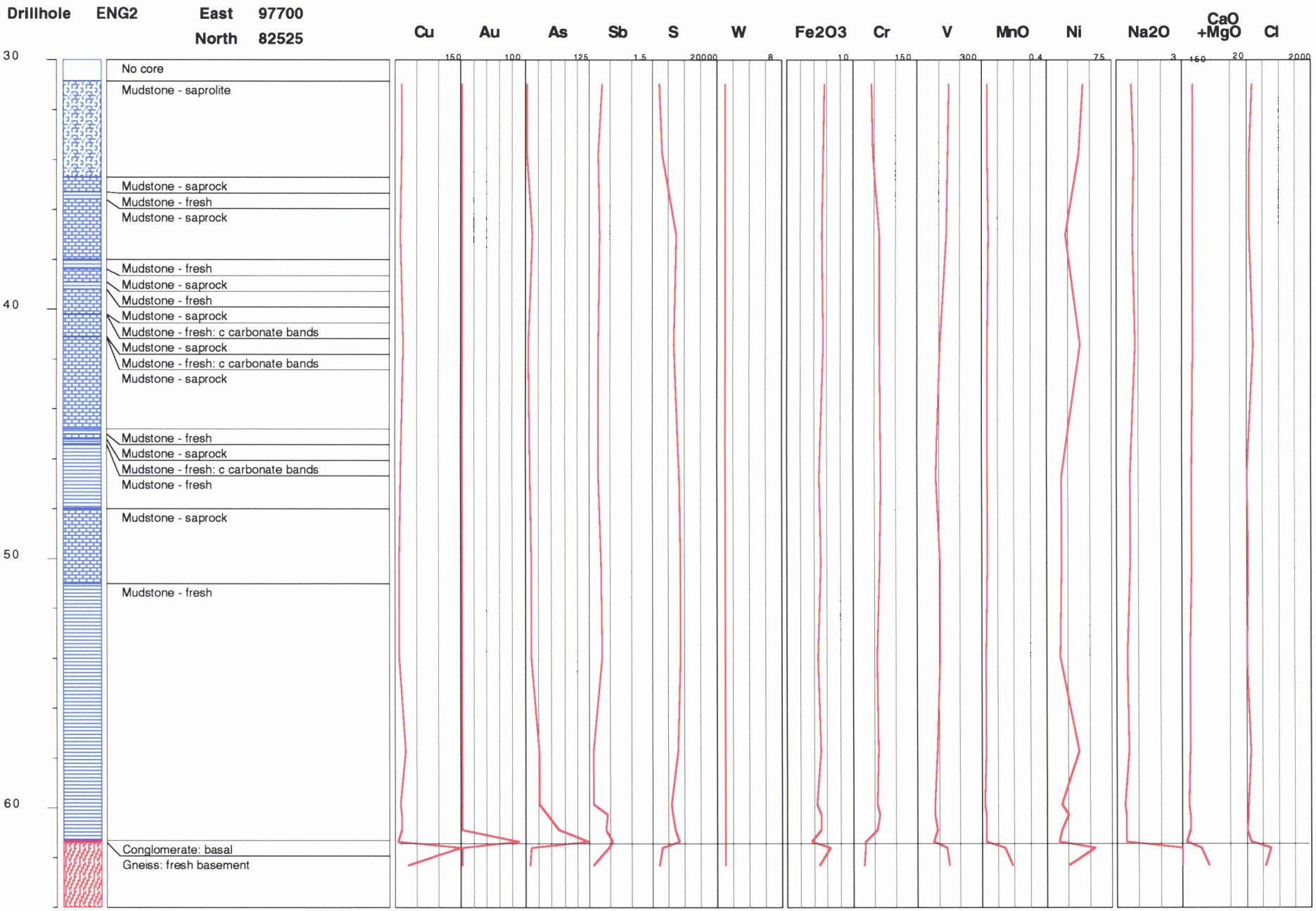
FieldNo	LabSeqNo	LibNo	SiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOD	LOI	As	Au	Ba	Br	Ce	Cl	Co	Cr
			0.01	0.01	0.01	0.002	0.01	0.00	0.01	0.01	0.00	0.002	-	-	2.00	5.0	30	2.00	10.0	20	1	5
			%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm
STD 006	L08-1866	08-01882	71.88	18.15	0.39	0.003	0.30	0.02	0.39	3.64	0.41	0.006	0.19	3.73	1.72	84.0	289	4.19	36.6	2310	<1	120
STD 006	L08-1883	08-01883	72.75	18.43	0.39	0.003	0.31	0.02	0.39	3.69	0.41	0.006	0.12	3.80	2.31	108.0	291	4.67	39.5	2400	<1	123
STD 006	L08-1885	08-01908	72.72	18.26	0.39	0.004	0.30	0.02	0.38	3.68	0.42	0.005	0.27	3.64	1.55	91.5	307	4.81	39.0	2370	<1	122
STD 006	L08-1897	08-01909	72.49	18.26	0.39	0.003	0.30	0.02	0.38	3.66	0.41	0.003	0.22	3.70	2.06	85.8	301	4.05	39.3	2430	<1	124
STD 006	L08-1909	08-01910	72.60	18.31	0.39	0.003	0.29	0.02	0.39	3.67	0.41	0.009	0.22	3.72	1.34	81.9	268	4.56	37.8	2500	<1	123
STD 006	L08-1911	08-01959	72.56	18.22	0.39	0.004	0.31	0.02	0.39	3.64	0.41	0.002	0.16	3.77	2.22	85.2	273	4.57	39.2	2260	<1	125
STD 006	L08-1924	08-01960	72.38	18.28	0.38	0.004	0.30	0.02	0.37	3.66	0.41	0.007	0.23	3.75	1.73	88.6	308	4.52	40.1	2430	<1	127
STD 006	L08-1937	08-01961	72.43	18.33	0.40	0.003	0.29	0.02	0.36	3.66	0.41	0.006	0.19	3.80	2.06	100.0	291	4.92	38.3	2220	<1	123
STD 006	L08-1950	08-01962	72.69	18.26	0.39	0.004	0.30	0.02	0.40	3.66	0.40	0.005	0.19	3.81	2.24	82.1	305	4.86	39.0	2220	<1	125
STD 006	L08-1963	08-01963	72.13	18.20	0.39	0.003	0.30	0.02	0.38	3.65	0.41	0.006	0.17	3.80	1.23	83.9	279	4.52	39.1	2240	<1	124
		Mean	72.46	18.27	0.39	0.003	0.30	0.02	0.38	3.66	0.41	0.006	0.20	3.75	1.85	89.1	291	4.57	38.8	2338	-	124
		Acc.Val	72.21	18.23	0.42	0.001	0.34	0.03	0.40	3.54	0.37	0.030	0.28	4.06	2.00	86.0	330	5.00	31.0	-	0.7	120

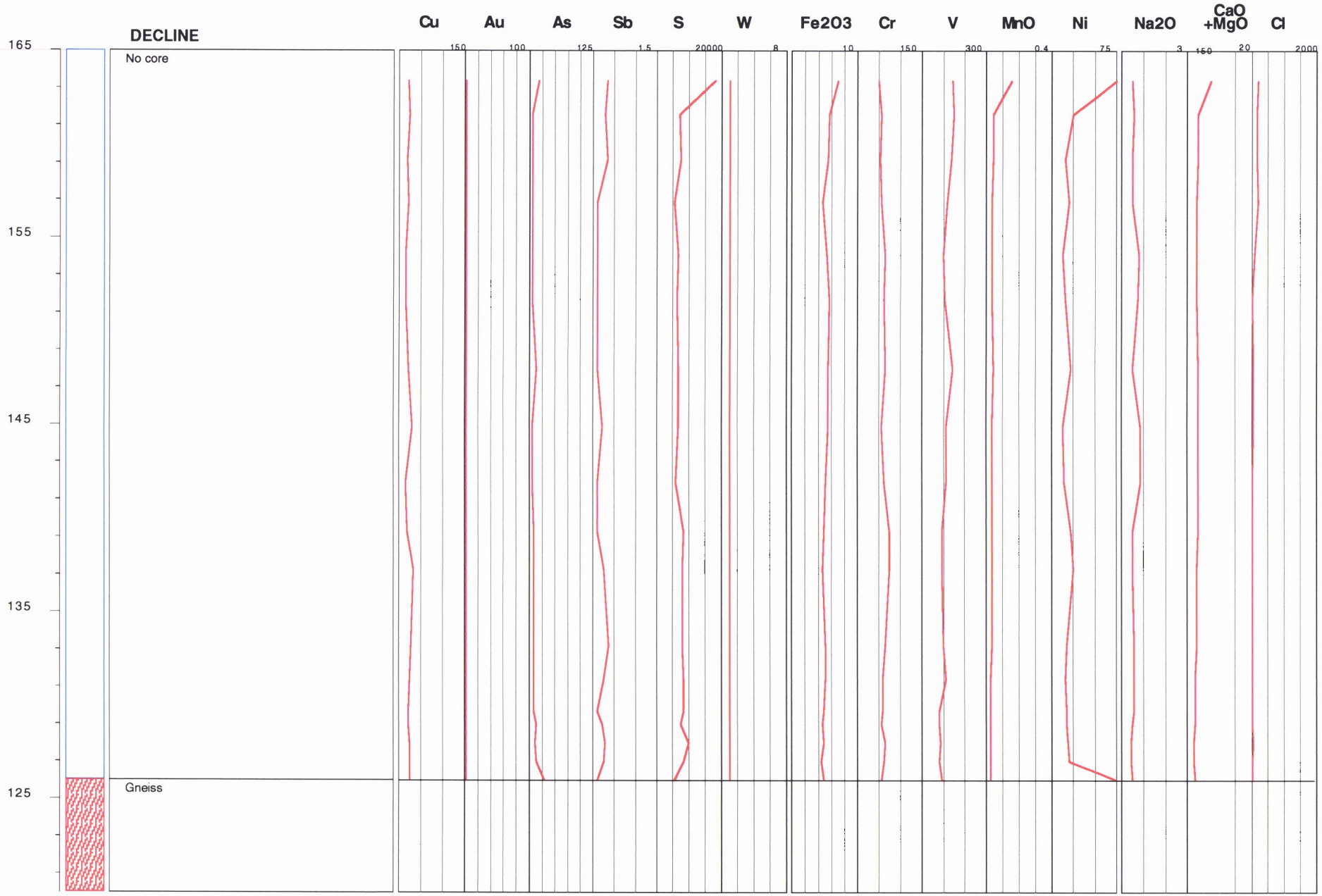
LibNo	Cs	Cu	Eu	Ga	Hf	La	Lu	Mo	Nb	Ni	Pb	Rb	S	Sb	Sc	Se	Sm	Sr	Ta	Th	U	V	W	Y	Yb	Zn	Zr
	1	10	1	3	1.00	0.5	0.2	5	4	10	5	5	10	0.5	0.1	10	0.20	5	1	0.50	2	5	2	5	0.50	5	5
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
08-01882	6.84	4	0.65	23	2.75	19.3	<0.2	<5	2	1	13	100	110	12.3	13.1	<5	2.16	56	<1	4.77	<2	80	5.95	9	0.98	5	94
08-01883	7.11	3	<0.5	26	2.81	19.7	<0.2	<5	1	23	13	102	100	12.5	13.4	<5	2.23	58	<1	4.90	<2	81	5.84	9	0.90	6	92
08-01908	7.77	5	<0.5	24	2.84	19.7	<0.2	<5	3	5	12	100	110	12.5	13.6	<5	2.24	60	<1	4.98	<2	80	5.87	9	0.89	5	94
08-01909	7.29	3	0.56	24	2.81	20.0	<0.2	<5	1	5	15	101	100	13.0	13.9	<5	2.36	58	<1	4.82	<2	86	4.65	8	0.99	5	94
08-01910	7.85	5	<0.5	23	2.84	19.3	<0.2	<5	3	4	8	98	100	12.8	13.9	<5	2.27	59	1.07	4.87	<2	78	5.72	8	0.96	3	91
08-01959	8.23	5	0.56	23	3.04	20.3	<0.2	<5	2	37	16	99	110	13.0	14.1	<5	2.36	61	<1	4.86	<2	80	6.06	9	0.93	4	93
08-01960	7.87	5	<0.5	24	2.80	20.9	<0.2	<5	3	20	20	100	110	13.3	14.2	<5	2.40	56	<1	4.82	<2	78	5.43	6	0.95	5	91
08-01961	7.81	4	<0.5	23	2.76	20.1	<0.2	<5	2	59	11	102	100	12.8	13.7	<5	2.30	60	<1	5.03	<2	75	5.36	9	0.96	7	91
08-01962	7.53	3	<0.5	22	2.83	19.8	<0.2	<5	4	27	10	101	110	12.5	13.5	<5	2.27	56	<1	4.68	<2	85	6.37	9	0.90	4	93
08-01963	7.36	5	0.51	23	2.66	19.9	<0.2	<5	1	3	15	99	100	12.5	13.5	<5	2.27	59	<1	4.61	<2	79	5.82	7	0.89	4	94
Mean	7.57	4.2	-	24	2.81	19.9	-	-	2	18	13	100	105	12.7	13.7	-	2.29	58	-	4.83	-	80	5.71	8	0.94	5	93
Acc.Val	7.6	6	0.5	23	2.70	21.6	0.1	3	4	9	10	109	160	12.8	13.8	2	2.30	68	0.4	4.50	1	102	6	7	0.80	5	120

APPENDIX 4

Near mine drillcore and decline geochemistry
Data plots


Drillhole ENG1
East 97650
North 82525
Cu
Au
As
Sb
S
W
Fe2O3
Cr
V
MnO
Ni
Na2O
CaO +MgO
Cl
40
50
60
No core
Mudstone - fresh
Mudstone - saprolite
Mudstone - saprock
Mudstone - fresh
Mudstone - saprock
Mudstone - fresh
Mudstone - saprock
Mudstone - fresh
Mudstone - saprolite
Mudstone - saprock
Gritty mudstone - fresh
Conglomerate: basal
Gneiss: fresh basement


Drillhole ENG2
East 97700
North 82525
Cu
Au
As
Sb
S
W
Fe2O3
Cr
V
MnO
Ni
Na2O
CaO +MgO
Cl
30
40
50
60
No core
Mudstone - saprolite
Mudstone - saprock
Mudstone - fresh
Mudstone - saprock
Mudstone - fresh
Mudstone - saprock
Mudstone - fresh
Mudstone - saprock
Mudstone - fresh: c carbonate bands
Mudstone - saprock
Mudstone - fresh: c carbonate bands
Mudstone - saprock
Mudstone - fresh
Mudstone - saprock
Mudstone - fresh: c carbonate bands
Mudstone - fresh
Mudstone - saprock
Mudstone - fresh
Conglomerate: basal
Gneiss: fresh basement

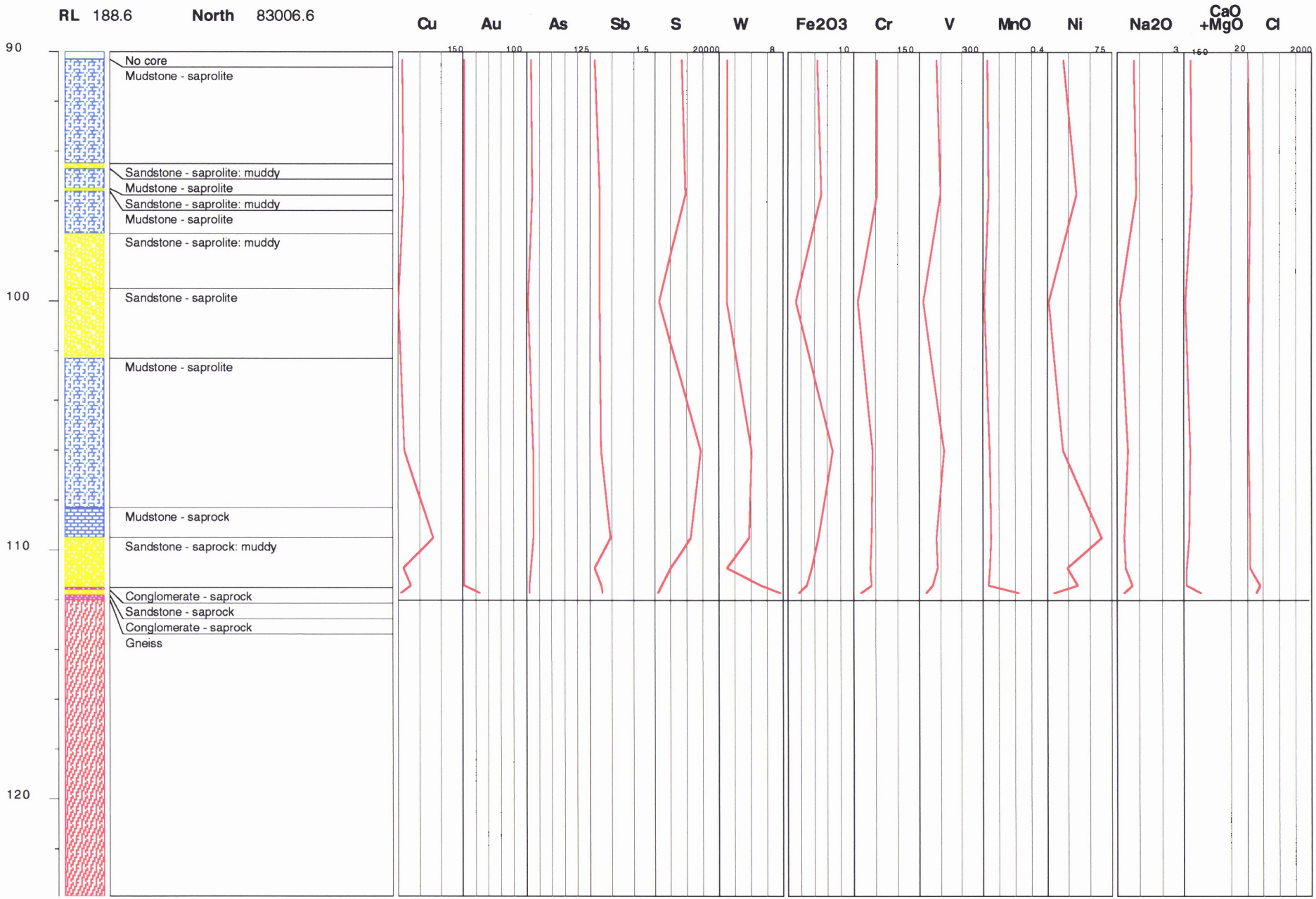

DECLINE
No core
Gneiss
165
155
145
135
125
Cu
150
Au
100
As
125
Sb
1.5
S
20000
W
8
Fe2O3
10
Cr
150
V
300
MnO
0.4
Ni
75
Na2O
3
CaO +MgO
150
20
Cl
2000

APPENDIX 5

Scrubby Creek drillcore geochemistry
Plots

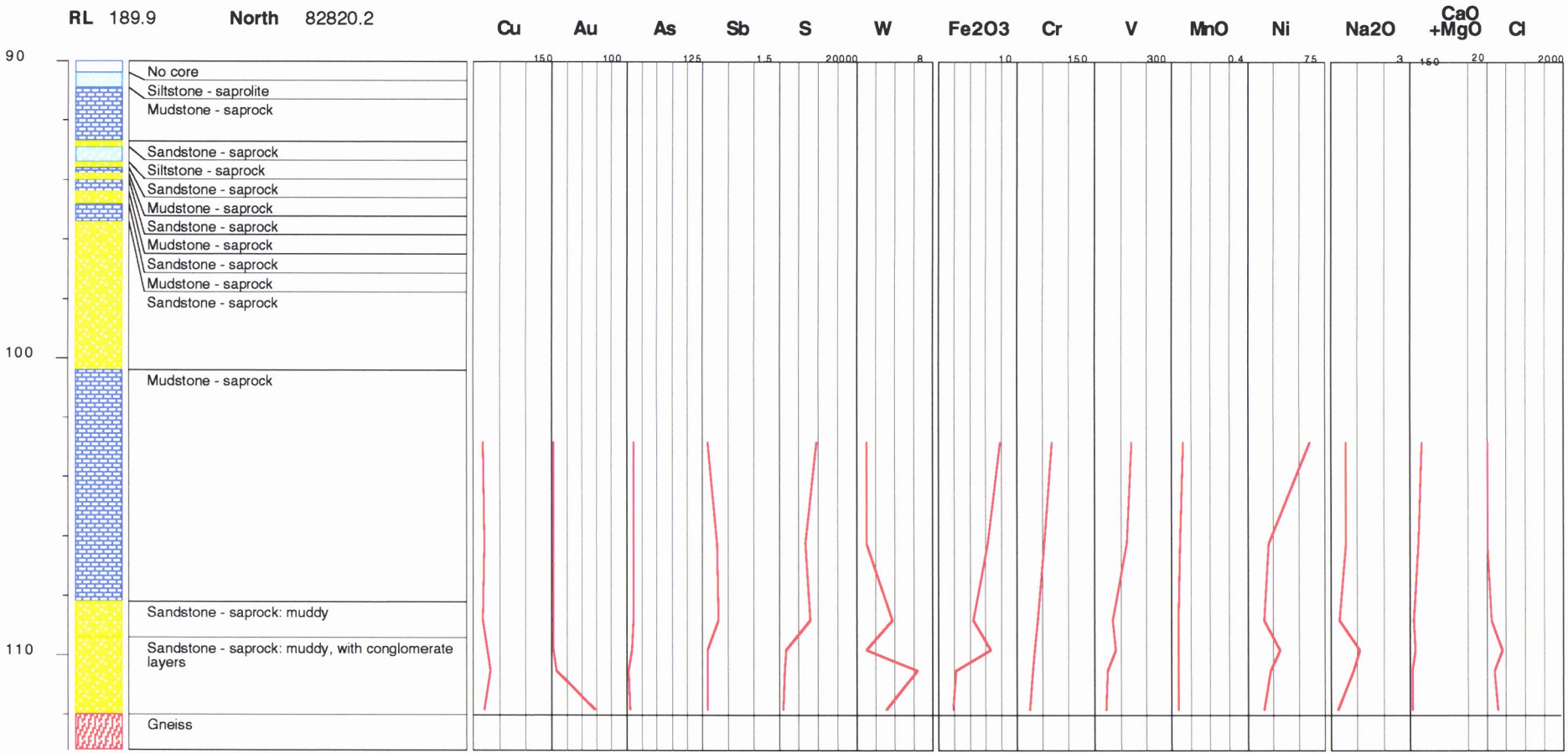
Drillhole 1TT **East** 101042.2

RL 188.6 **North** 83006.6



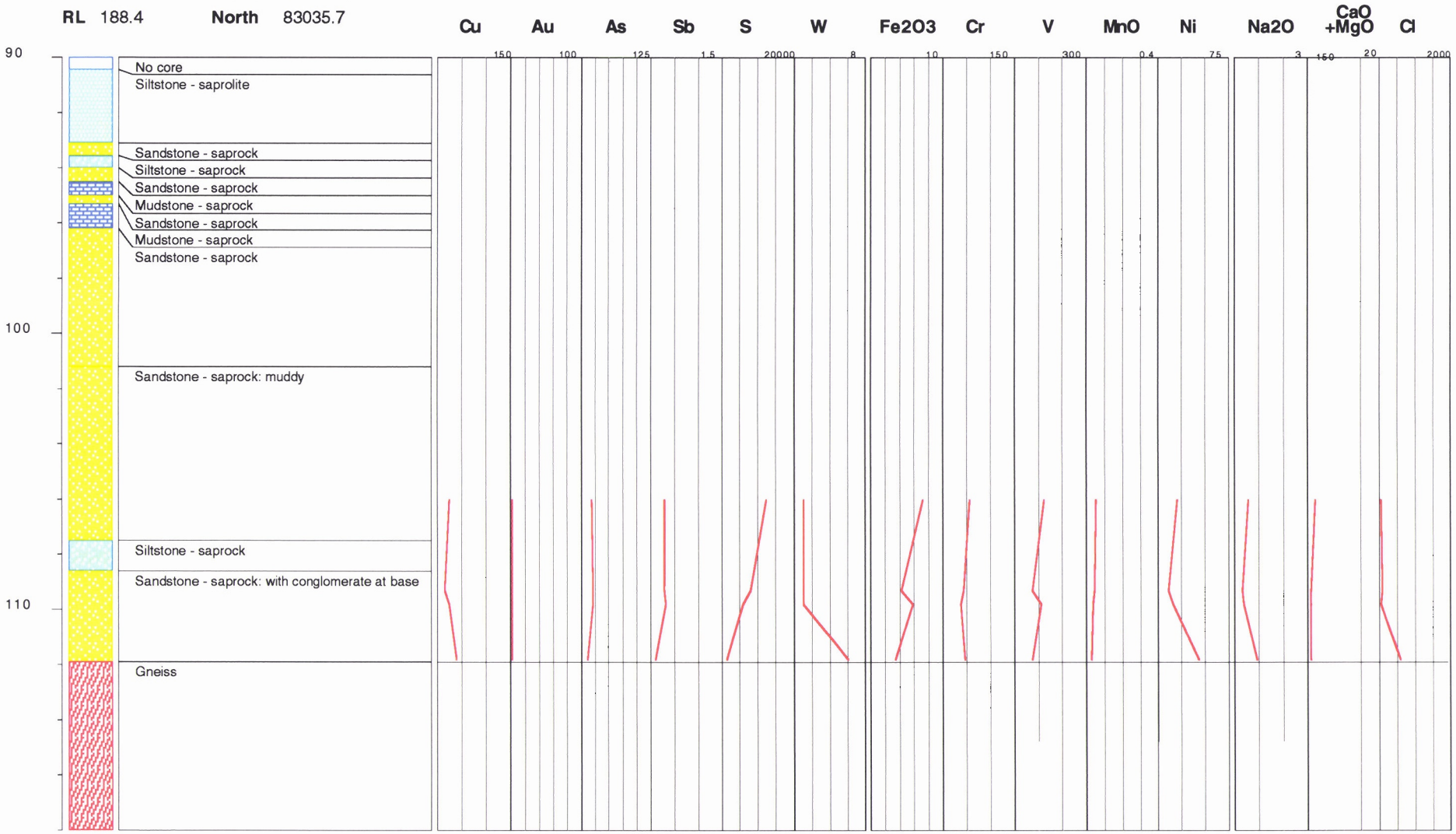
Drillhole 2TT **East** 100859.9

RL 189.9 **North** 82820.2



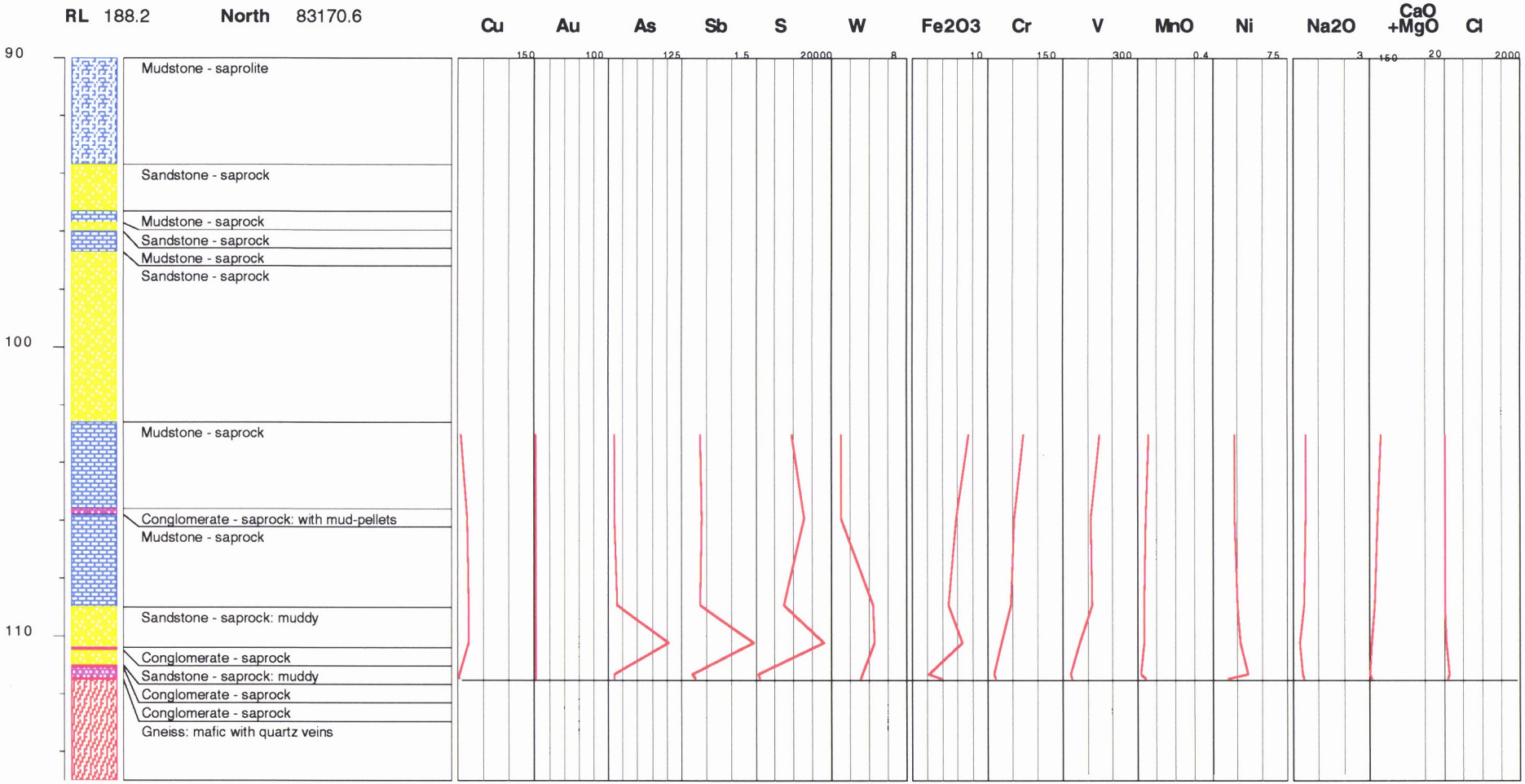
Drillhole 3TT **East** 101228.6

RL 188.4 **North** 83035.7



Drillhole **4BTT** **East** 101151.8

RL 188.2 **North** 83170.6

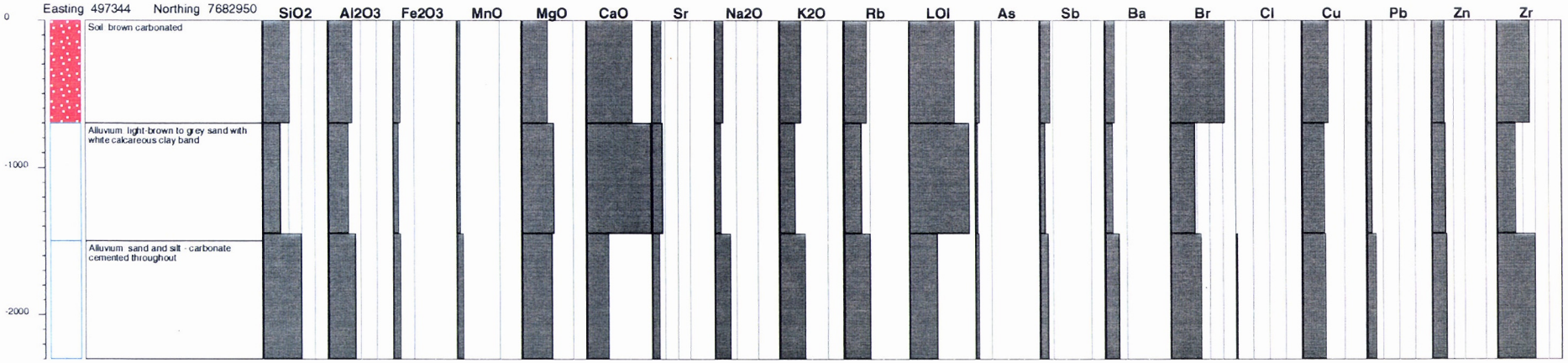


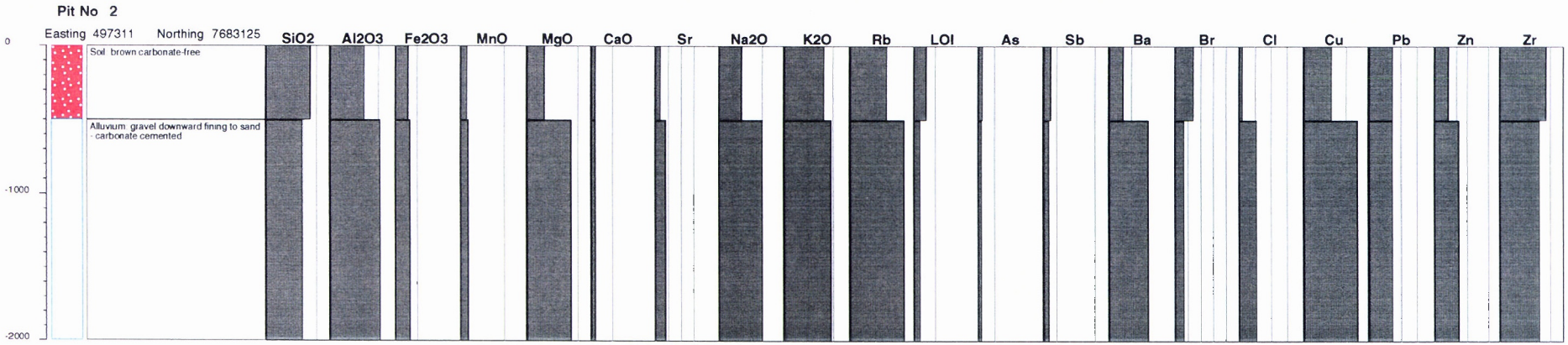
APPENDIX 6

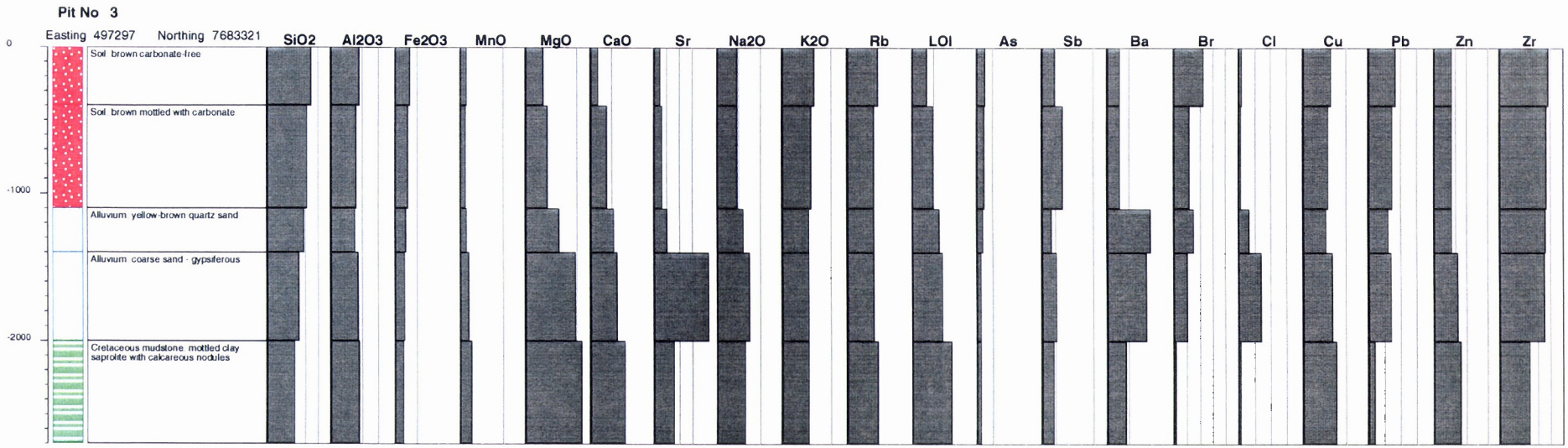
Pit sampling - near Eloise
Plots

Pit No 1

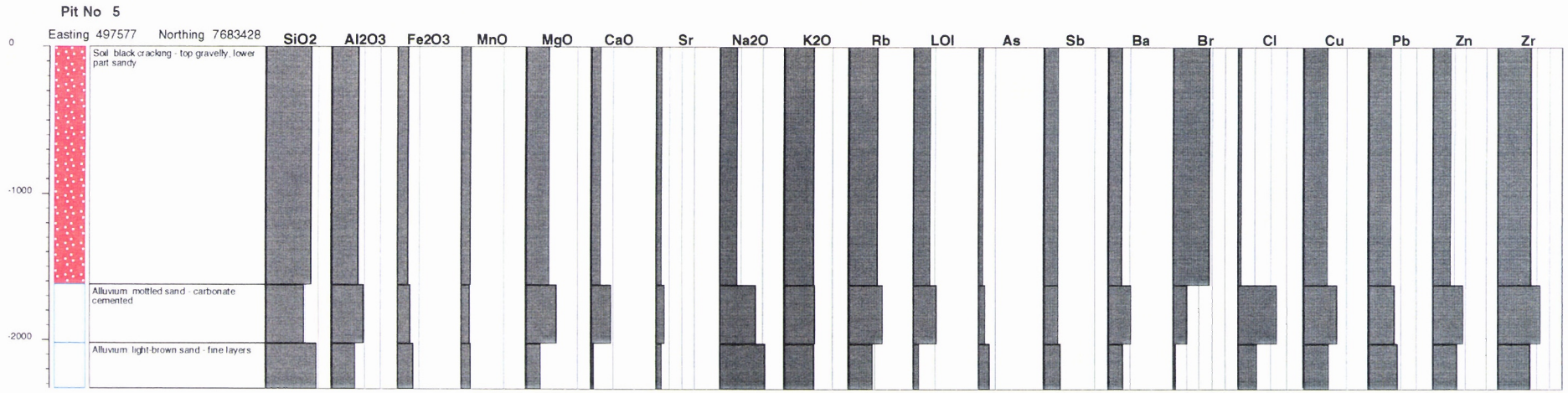
Easting 497344 Northing 7682950

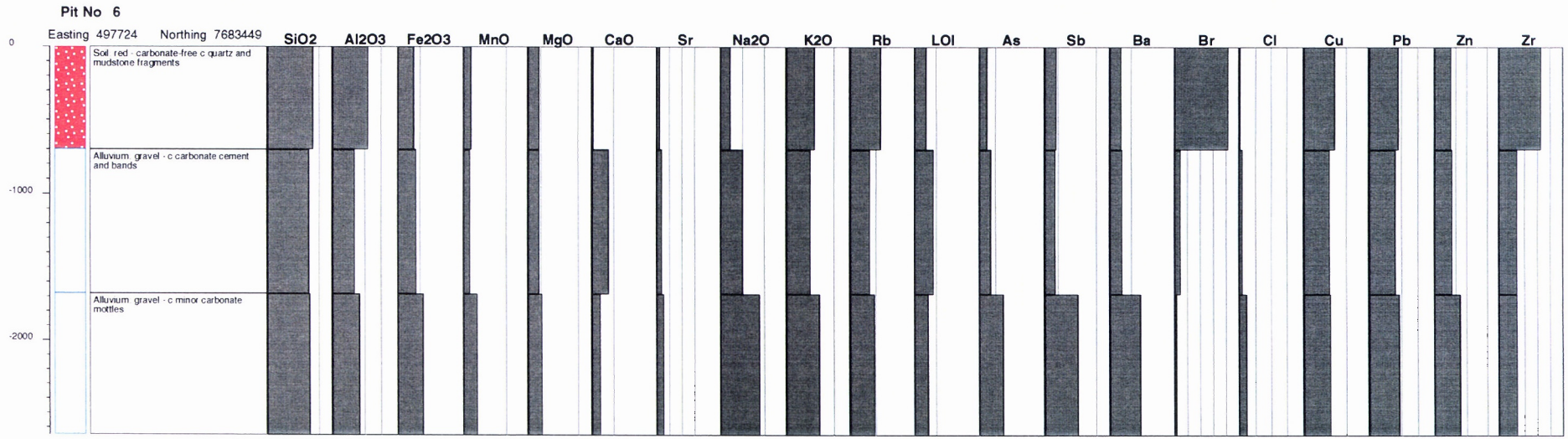



Pit No 2
Easting 497311 Northing 7683125
0
-1000
-2000
Soil brown carbonate-free
Alluvium gravel downward fining to sand
- carbonate cemented
SiO2
Al2O3
Fe2O3
MnO
MgO
CaO
Sr
Na2O
K2O
Rb
LOI
As
Sb
Ba
Br
Cl
Cu
Pb
Zn
Zr


Pit No 3
Easting 497297 Northing 7683321
SiO2
Al2O3
Fe2O3
MnO
MgO
CaO
Sr
Na2O
K2O
Rb
LOI
As
Sb
Ba
Br
Cl
Cu
Pb
Zn
Zr
0
-1000
-2000
Soil brown carbonate-free
Soil brown mottled with carbonate
Alluvium yellow-brown quartz sand
Alluvium coarse sand - gypsiferous
Cretaceous mudstone mottled clay saprolite with calcareous nodules

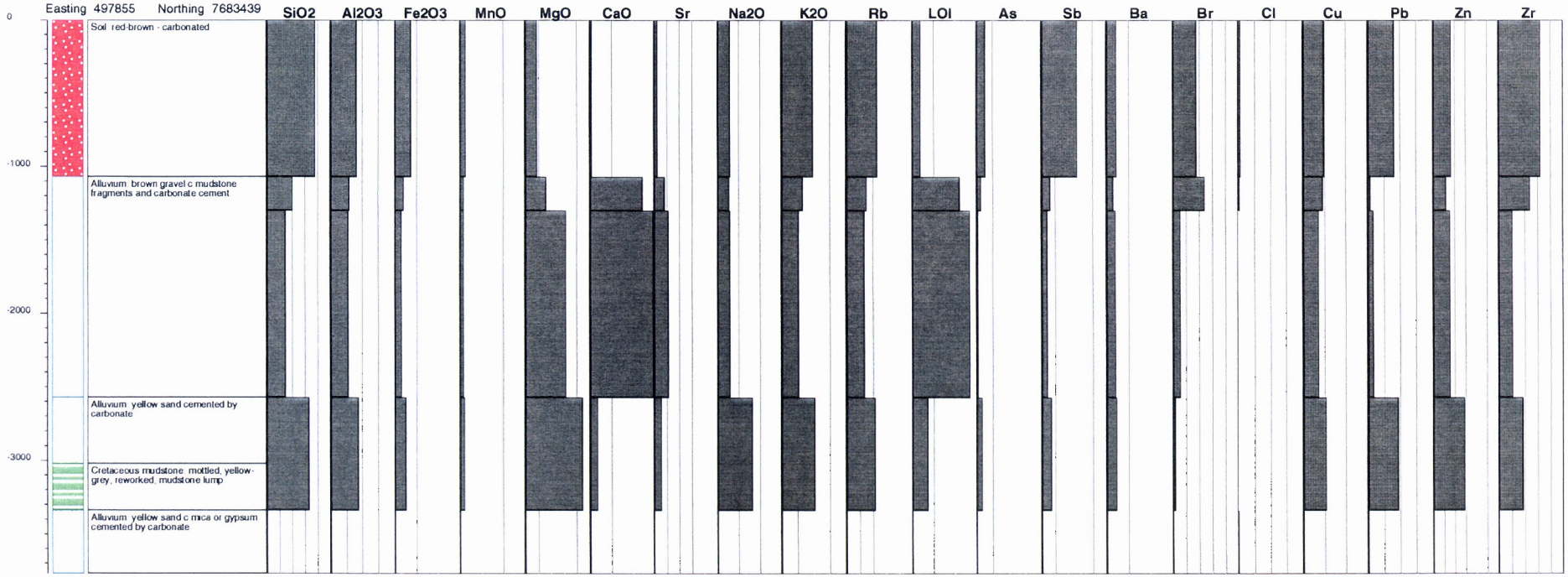

Pit No 4
Easting 497479 Northing 7683473
SiO2
Al2O3
Fe2O3
MnO
MgO
CaO
Sr
Na2O
K2O
Rb
LOI
As
Sb
Ba
Br
Cl
Cu
Pb
Zn
Zr
0
-1000
-2000
-3000
Soil brown carbonated with quartz and mudstone fragments
Soil brown mottled with carbonate
Alluvium sand and pebble beds - calcified and mottled
Alluvium brown coarse sand - crossbedded and uncemented
Alluvium pebble beds in grey sand with red bands
Cretaceous mudstone clay saprolite with gypsum and carbonate cement


Pit No 5
Easting 497577 Northing 7683428
0
-1000
-2000
Soil black cracking - top gravelly, lower part sandy
Alluvium mottled sand - carbonate cemented
Alluvium light-brown sand - fine layers
SiO2
Al2O3
Fe2O3
MnO
MgO
CaO
Sr
Na2O
K2O
Rb
LOI
As
Sb
Ba
Br
Cl
Cu
Pb
Zn
Zr


Pit No 6
Easting 497724 Northing 7683449
0
-1000
-2000
Soil red - carbonate-free c quartz and mudstone fragments
Alluvium gravel - c carbonate cement and bands
Alluvium gravel - c minor carbonate mottles
SiO2
Al2O3
Fe2O3
MnO
MgO
CaO
Sr
Na2O
K2O
Rb
LOI
As
Sb
Ba
Br
Cl
Cu
Pb
Zn
Zr

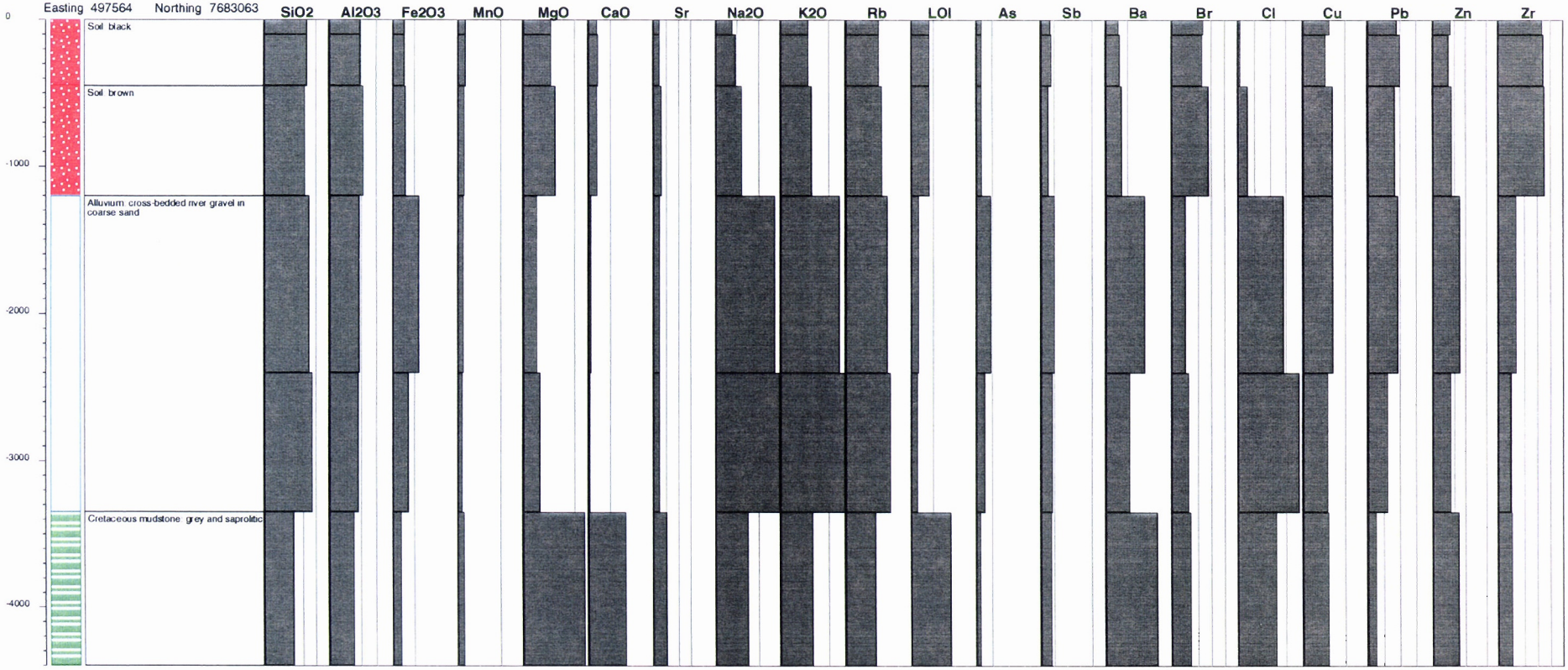
Pit No 7

Easting 497855 Northing 7683439



Pit No 8

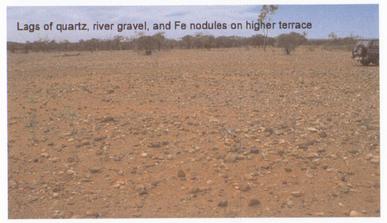
Easting 497564 Northing 7683063

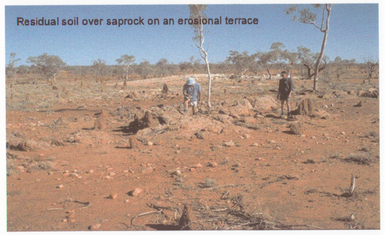


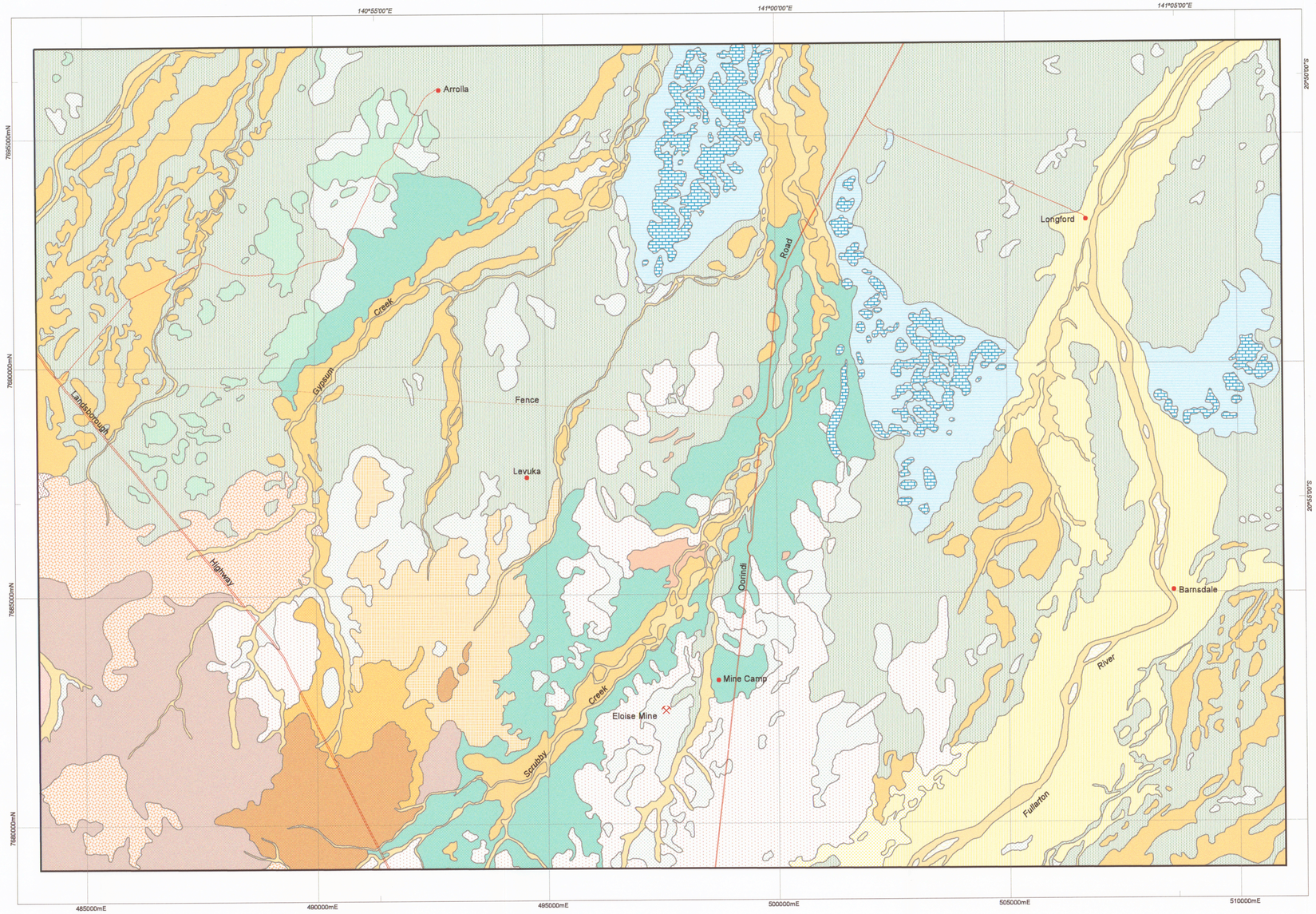
APPENDIX 7

Regolith Map

REGOLITH - LANDFORM MAP OF ELOISE, NORTHWEST QUEENSLAND







N

1 : 50 000

0 1 2 3 4 5 KM

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SAPROLITE

PROTEROZOIC

- Mixture of brown, residual, lithic soil over saprock with minor alluvium; higher terrace
- Non-ferruginous, residual, lithic soil; erosional terrace
- Thin, residual, stony soil over saprock; low hill
- Lag of Fe-rich nodules, brown, sandy, lithic soil over saprock; low hill
- Residual, stony soil with Fe-rich nodules over saprock; erosional terrace
- Thin, residual, stony soil over saprock; undulating erosional plain
- Bedrock hill

POST PROTEROZOIC

- saprock on Cretaceous limestone; Erosional terrace

ALLUVIUM

- Alluvium in modern channel
- Sand bar inside river channel
- Recent alluvium; levee
- Gravelly alluvium, fluvial ridge and lower river terrace
- Brown, sandy soil over alluvium with minor black soil; higher terrace
- Lag of Fe-rich nodules, fluvial gravel and brown, sandy soil over mottled Tertiary sediments; higher terrace
- Brown, sandy soil over alluvium; minor rise on alluvial plain
- Brown, gravelly soil with patches of black soil over alluvium; lower terrace
- Patches of brown and black soil; plain and river terrace
- Calcareous soil over Cretaceous mudstone; plain
- Black soil over sandy alluvium; plain and gilgai

Compiled by Li Shu (CRC LEME / CSIRO), 1997

It is recommended that the map be referred to as:
Li Shu 1997 – Regolith-landform map of Eloise, Northwest Queensland (1:50,000 map scale). Cooperative Research Centre for Landscape Evolution and Mineral Exploration (CRC LEME), Perth.

This map is based on aerial photograph interpretation and field observations.

Inquiries should be directed to:
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CRC LEME
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Wembley, WA 6014
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Published by CRC LEME, Perth, Australia

CRC LEME is an unincorporated joint venture between the Australian National University, University of Canberra, Australian Geological Survey Organisation and CSIRO Exploration and Mining, established and supported under the Australian Government's Cooperative Research Centre's Programme.

Appendix 7 - Li Shu and I.D.M. Robertson 1997: Surficial geology around the Eloise Cu-Au mine and dispersion into Mesozoic cover from the Eloise Mineralisation, NE Queensland - CRC LEME Restricted Report 56R

WARNING: Inks will fade with prolonged exposure to light.

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APPENDIX 8

Data Disc
Type README.DOC for contents and format