

**EXPLANATORY
NOTES**



GEOCHEMICAL MAPPING OF THE ROBINSON RANGE 1:250 000 SHEET

by **J. J. BRADLEY, J. A. FAULKNER
and A. J. SANDERS**



**GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
DEPARTMENT OF MINERALS AND ENERGY**



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Perth 1997

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19. Cu
20. F
21. Ga
22. La
23. Li
24. Mo

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Digital dataset (in pocket)



ROBINSON RANGE regional-geochemistry data (ROBCHEM.CSV)

Geochemical mapping of the Robinson Range 1:250 000 sheet

by

J. J. Bradley, J. A. Faulkner and A. J. Sanders

Abstract

Regolith on the ROBINSON RANGE 1:250 000 map sheet area has been mapped and sampled at a nominal density of 1 sample per 16 square kilometres. A total of 1019 samples were collected, comprising stream sediments, sheetwash and soil. Each sample has been analysed for 47 elements, pH and total dissolved solids.

The major results of this project are a regolith-materials map and element-concentration maps for 43 elements. These are supported by maps showing areas of previous mineral-exploration projects, on which surface geochemistry is included as an exploration activity, and appendices tabulating known mineralization for ROBINSON RANGE.

Regolith materials have been divided into 28 regolith units, including 4 within a relict regime, 9 within an erosional regime, and 15 within a depositional regime. ROBINSON RANGE contains the northern boundary of the Yilgarn Craton, the southern boundary of the Bangemall Basin and the western boundary of the Glengarry Basin (which includes the Bryah, Padbury and Yerrida Basins). Regolith chemistry can be used to separate the various bedrock units in areas of poor exposure, especially the Proterozoic units of the Glengarry Basin.

Statistical analysis of regolith chemical data, involving principal-component-analysis and several element ratios ($\text{CaO}/\text{Na}_2\text{O}$, $\text{Na}_2\text{O}/\text{K}_2\text{O}$, K/Rb , Rb/Ba and Th/U) have been used to delineate several granitoid bodies on ROBINSON RANGE. Chemically distinct granitoid bodies include the Archaean granite and granitic gneiss near Talbot Divide, Wilthorpe Granite, Proterozoic granite (at Mount Marquis), and a possible pegmatitic granite in the west of the map sheet.

An additive index of chalcophile elements (As, Bi, Mo, Sb, Se, Sn, and W), based on the CHI*6 chalcophile index of Smith et al. (1989), is used to highlight areas of potential gold and base-metal mineralization on ROBINSON RANGE. Higher chalcophile-index values occur in the east of ROBINSON RANGE, within the Bangemall, Bryah, and Padbury Basins, coincident with most major gold and manganese deposits. There are several other areas within these Proterozoic basins with potential for base-metal mineralization.

KEYWORDS: Robinson Range, regional surveys, geochemistry, regolith, multi-element analysis, Bangemall Basin, Bryah Basin, Padbury Basin, Capricorn Orogen, gold, manganese, base metals.

Introduction

In 1994, the Geological Survey of Western Australia (GSWA) initiated a program of regional regolith and geochemical mapping as an aid to mineral exploration, and to assist monitoring of the environment. ROBINSON RANGE* is the sixth in this regolith and geochemical mapping series, following MENZIES (Kojan and Faulkner, 1994), LEONORA (Bradley et al., 1995), PEAK HILL (Subramanya et al., 1995), GLENGARRY (Crawford et al., 1996), and SIR SAMUEL (Kojan et al., 1996). Geological mapping of the Glengarry Basin is currently being undertaken by GSWA (Adamides, in prep.; Pirajno and Occhipinti, in prep.;

Occhipinti et al., in prep; Swager and Myers, in prep.), and published regolith and geochemical series maps for PEAK HILL (Subramanya et al., 1995) and GLENGARRY (Crawford et al., 1996) provide complementary information over the Glengarry Basin and adjacent geological provinces.

The broad aims of the GSWA regolith and geochemical mapping program are to:

- provide regional-scale geochemical data to assist in mineral exploration;
- identify metallogenic provinces and potential areas of mineralization;
- assist in identification of rock types present, and complement published geological maps; and

* Capitalized names refer to standard map sheets.

- provide information to the agricultural industry, and to aid environmental monitoring and regulation.

Regional geochemical mapping involves determining the distribution of surficial material (regolith), and sampling and analysis of such material. Regolith is formed by weathering and erosion of bedrock, and deposition by sedimentary or chemical processes, and is used here as a general term for the entire cover, whether consolidated or unconsolidated, that overlies and may conceal bedrock. Regolith includes both residual weathered rock and transported material (Anand et al., 1993). Although regolith may obscure the geology of an area, including possible mineral deposits, it carries an expression of the underlying rocks or deposits in the form of large, though often weak, geochemical dispersion patterns. An understanding of these patterns when exploring for concealed mineral deposits requires an understanding of regolith formation and its relationship to landforms and underlying geology.

Regional geochemical mapping programs have been carried out at various scales, in a number of countries (including the UK, Greenland, the former East Germany, Hungary, Finland, Canada and China), as summarized by Darnley (1990) and Davenport (1993). There is little published work on the subject of regional geochemical mapping in Australia, with the exception of a stream-sediment survey of EBAGOOLA (1:250 000) in Queensland (Cruikshank, 1994), and the current GSWA program.

Regolith sampling and mapping of the ROBINSON RANGE map sheet commenced in May 1995, with assistance from sampling teams from Geochemex Australia. Chemical analyses of regolith samples were carried out by Genalysis Laboratory Services (WA) and Amdel Laboratories (WA).

Setting

ROBINSON RANGE (SG/50-7) is bounded by latitudes 25°00'S and 26°00'S and longitudes 117°00'E and 118°30'E. The map sheet straddles the Peak Hill, Murchison and Gascoyne Goldfields. There are no towns situated on ROBINSON RANGE; the closest town is Meekatharra, which is approximately 80 km south-southeast of the southern boundary of the map sheet. The small population on ROBINSON RANGE is either involved in the pastoral or mining industries. Pastoral stations wholly or part on ROBINSON RANGE include Berringarra, Errabiddy, Landor, Milgun, Milly Milly, Moorarie, Mount Clere, Mount Gould, Mount Padbury, Mulgul, and Yarlaweelor (Fig. 1). The Fortnum gold project (Perilya Mines NL) is currently (1997) the only active major mine, and the Mount Seabrook talc mine (Sons of Gwalia) is intermittently active.

Access

There are no sealed roads on ROBINSON RANGE, but major graded roads link homesteads and minesites with Meekatharra (Fig. 1). The crossings of the Murchison and

Gascoyne Rivers are usually sealed or built up, and access is only a problem after heavy rain. The numerous station tracks in the area are in varying states of repair, and access away from these tracks ranges from relatively good on extensive sheetwash plains, to difficult in the rocky terrain of Talbot Divide (Fig. 1). Dense vegetation on large floodplains of the major river systems also hinders access.

Climate and vegetation

ROBINSON RANGE has an arid climate, with mean annual rainfall between 190 and 240 mm. An average annual rainfall of 200 mm has been recorded over a seventy five year period at Errabiddy homestead.

Summer days are typically hot and dry, whereas nights are mild to warm. Average maximum temperatures range from 38°C in January to 24°C in April (Curry et al., 1994). Cyclones and thunderstorms between November and April provide the summer rainfall, as either rare widespread major falls or more common localized minor falls. The winter months have mild days and cool to cold nights, with average maximum temperatures ranging from 19°C in June to 29°C in October. Winter rain results from strong cold fronts from the southwest associated with low-pressure cells, or from tropical cloud bands originating from the north-northwest interacting with cold fronts (Curry et al., 1994).

ROBINSON RANGE lies in the Austin Botanical District of the Eremaean Botanical Province of Beard (1981). Low mulga woodland (*Acacia aneura*) occupies the extensive sheetwash areas and floodplains, with some ghost gums and other acacias lining major drainage channels. This low woodland may be continuous or interrupted by bare patches. The general structure consists of an open tree layer over 3 m tall, a sparse low shrub layer of 1–2 m, and a ground layer of ephemeral herbs, which appear only in good seasons (Beard, 1981). There are also sparse perennial and annual grasses. The vegetation on the poor stony soils of the erosional uplands includes wattle, teatree, and mulga scrub.

Physiography

Topography and drainage

Areas of high relief on ROBINSON RANGE correspond to prominent Proterozoic banded iron-formation (BIF) ridges of Robinson Range, found in the eastern part of the area (Fig. 1), including Mount Fraser (which is the highest point on the map sheet, at 799 m) and Mount Padbury. The map sheet is traversed by two of Western Australia's major west-flowing rivers, the Murchison and the Gascoyne. All drainages on ROBINSON RANGE are ephemeral, and the Murchison and Gascoyne Rivers flow intermittently.

Elias and Williams (1980) recognized three main physiographic units on ROBINSON RANGE; the plains around the main drainages, the central drainage divide, and an

area of dissected Proterozoic sedimentary rocks. The Murchison and Gascoyne River systems consist of sandy water courses and braided streams surrounded by broad alluvial flood plains and colluvial plains. Dissected platforms of calcrete are common in parts of the main drainage channels.

The central drainage divide consists of rugged uplands of metamorphic rocks, dissected by dendritic, incised watercourses. This topography results from erosion of a Tertiary land surface, parts of which remain as a lateritized plateau in the central western part of the area (Elias and Williams, 1980). Scree and sheetwash slopes blanket the upland areas, passing down into broad alluvial plains, which contain the major watercourses. Hardpan is commonly exposed in the banks of incised streams.

Proterozoic sedimentary rocks occur to the north and east of ROBINSON RANGE (Fig. 2). In the north, rocks resistant to weathering, such as sandstone and chert, form the tops of prominent strike ridges, whereas shale, siltstone, and to a lesser extent carbonate, underlie valleys and scree slopes (Muhling and Brakel, 1985). To the east lie the prominent BIF ridges of the Robinson Range, flanked by arenite, with basalt and less resistant sedimentary rocks forming low-lying hills.

The Archaean terrain, in the south of ROBINSON RANGE, is characterized by very shallow, broad alluvial valleys. Granite typically forms large monoliths and extensive uplands of flat pavements, whereas basalt typically produces rugged round hills, and felsic volcanic rocks form gently undulating plains.

Landforms and regolith development

Major landforms and associated regolith recognized on ROBINSON RANGE are:

- dissected plateaus with lateritic remnants and abundant ferruginous lag,
- hills and strike ridges of sandstone and banded iron-formation, with a coarse lag of weathered bedrock on slopes,
- rugged hills of dissected granitic gneiss and migmatite (Talbot Divide) with a coarse lag of weathered bedrock,
- low hills and rises of granitoid and greenstone with medium- to fine-grained detritus of weathered rock overlying bedrock,
- upland colluvial plains interrupted by areas of outcrop,
- undulating plains developed over granitoids and sedimentary rocks, with fine debris of weathered rock overlying bedrock,
- major alluvial and sheetwash fans, and
- major drainage floors containing active streams, extensive floodplains and calcrete platforms.

Regolith classification

The classification scheme for the GSWA regional regolith mapping program uses three major regimes to cover all categories of landforms. The regimes are relict, erosional and depositional, which are similar to those of Anand et al. (1993a), except for the usage of the term 'relict' instead of 'residual' to avoid genetic implications. Figure 3 is a simplified regolith map of ROBINSON RANGE, which shows the position of these three regimes.

Relict regime

The development and preservation of well-developed thick relict weathered profiles relies principally on long-term tectonic stability, low relief, a long subaerial history with a general absence of Cainozoic glaciation, and a climatic trend to aridity (Mabbutt, 1980). The old land surface formed in a warm to tropical climate, and consisted of a broad undulating surface formed by lateritization. With the onset of arid conditions in the mid-Miocene, fresh rock was exposed by the downcutting and partial stripping of the old undulating surface. The remains of the old surface were exposed as discrete, resistant, duricrust-capping mesas, or tablelands where most of the duricrust was bounded by breakaways.

The relict regime includes not only ferruginous duricrusts (or ferricretes) but also siliceous duricrusts (silcretes). On ROBINSON RANGE, there has been extensive stripping of the old surface, and relict surfaces are found only in small areas in the west and north of the map sheet.

Erosional regime

Erosional regimes occur in areas where there is continuing downcutting by high energy channels and there is a net removal of material. The erosional regime is characterized by hills, strike ridges and cuestas of more resistant lithologies, dissected plateaus of fresh granitoid, greenstone, and sedimentary rocks, and breakaways exposing the mottled zone or saprolite of the weathering profile. At topographically lower levels, erosional regimes include stony pediments where rock is either exposed or concealed as subcrop beneath shallow skeletal soils, or beneath thin, locally derived sediments.

Depositional regime

Depositional regimes have a net gain of detritus and are characterized by widespread sediments of variable thickness, deposited in lower energy environments. Colluvial pediments with incised drainage lines drain onto broad, flat sheetwash plains with extremely shallow gradients. Sediments are transported in alluvial channels, on slopes by creep under the influence of gravity, and on areas of water-transported sheetwash with poorly defined channels. Thin accumulations of surface sand with an extensive underlying poorly bedded, reddish brown hardpan (Wiluna Hardpan) are common features of these sheetwash plains. Hardpan is developed by the partial consolidation of colluvium and alluvium, with either

an iron- or silica-rich cement. Sheetwash drainage is terminated partly by infiltration and partly by discharge at or near major tributaries and channels of the Murchison and Gascoyne River systems. Calcrete platforms (calcrete and opaline silica deposits) have been formed by the deposition of carbonate in valley-fill deposits by percolating groundwater. The margins of the calcrete interfinger with and are commonly overlain by alluvial sediments. Eolian sediments deposited as sandplains or dunes are also part of the depositional regime.

Soils

Curry et al. (1994) included the southern half of ROBINSON RANGE in their study of the Murchison River catchment. They divided the soils of the region into twelve main groups, eleven of which occur on ROBINSON RANGE. The soils are primarily classified in terms of their profile development and parent material, ranging from poorly sorted river sands to well-structured deep-cracking clays. Soil colour is described using a Munsell colour chart as predominantly red, ranging from dark red (2.5YR 3/6), to yellow (10YR 8/6) to strong brown (7.5YR 4/6). Soil pH ranges from acidic (pH=5) in skeletal soils over granites and metamorphic rocks, to strongly alkaline (pH>9) in clays and calcareous soils (Curry et al., 1994). The three most abundant soil groups present on ROBINSON RANGE are shallow, skeletal soils over bedrock in upland areas, red-brown hardpan soils, and duplex soils in floodplain areas (i.e. sandy soils with a light clay subsoil).

Data acquisition and previous geoscientific investigations

Geological mapping

The earliest geological work on ROBINSON RANGE was by Maitland (1898), who described the geology of the Mount Taylor – Mount Gould area, and the Mount Maitland gold mine. Johnson (1950) described the geology of most of ROBINSON RANGE in a study of the Murchison, Yalgoo, Peak Hill, and Gascoyne Goldfields. The GSWA 1:250 000 geological map and explanatory notes for ROBINSON RANGE (Elias and Williams, 1980) resulted from mapping carried out in 1974–75. The geochronology and evolution of the Gascoyne region, including some or all of ROBINSON RANGE, have been described by Williams et al. (1977), Libby et al., (1986) and Myers (1990). Other workers have mapped parts of ROBINSON RANGE (Lewis, 1970; Barnett, 1975; Muhling, 1988), or studied particular lithological associations (Muhling and Brakel, 1985; Hynes and Gee, 1986; Williams, 1990).

The eastern part of ROBINSON RANGE is currently being remapped at 1:100 000-scale as part of the GSWA regional geological mapping program. This includes MILGUN (Swager and Myers, in prep.) and PADBURY (Occhipinti et al., in prep.).

Previous regolith mapping

Regolith mapping has not been previously carried out on ROBINSON RANGE, but Curry et al. (1994) divided the southern half of the map sheet using a land-systems approach. This involved identification of land types that have similar landforms, soils, vegetation, and pastoral value.

Previous hydrogeological investigations

The first hydrogeological study that included ROBINSON RANGE was carried out by Maitland (1908). More recent overviews have been provided by Elias and Williams (1980), Water Authority of Western Australia (WAWA, 1989), and Laws (1994). The area has a great reliance on groundwater, principally for the pastoral industry, but also for domestic use (stations and the Meekatharra township). The mining industry also uses poorer quality groundwater for exploration drilling programs and the processing of ore and tailings at mine sites.

The largest source of groundwater is the more permeable calcrete and valley-fill alluvium deposits near main drainages, which are utilized for the Meekatharra township (Water Authority of Western Australia, 1989). Water is mainly drawn for stock requirements from similar calcrete and alluvial deposits, and also from shallow colluvial aquifers of poorly sorted silty sand overlying hardpan, which occur in broad valleys on either side of the major drainages. Water quality is fresh to brackish, although salinity increases closer to the Murchison and Gascoyne drainage systems. In areas of greater relief, limited water can be obtained from colluvial hillslope deposits near rock outcrop, from the weathered bedrock profile, and also from fractures and shear zones within fresh bedrock. The quality tends to vary with bedrock, salinities typically being higher in areas of greenstone than in granitoids (Laws, 1994). Surface water is confined to a small number of semi-permanent pools in the Murchison and Gascoyne Rivers.

Mineral resource and occurrence datasets

Data on mineral resources presented in this report (Appendices 1 and 2) are current up to 30 June 1996. Data on historic gold production are derived from a 1954 Department of Mines publication of cancelled gold-mining leases, for mines that have produced gold, and more up-to-date production records kept by the Royalties Section, Policy and Planning Division of the Department of Minerals and Energy (DME).

Records of published in-ground resources were extracted from DME's MINEDEX database. The locations of the major gold producers were obtained from the Bureau of Resource Services MINLOC database.

Geochemical surveys in WAMEX open-file company reports

Mineral-exploration reports are lodged with DME in compliance with the Mining Act (1978). These are indexed in the WAMEX database of the GSWA, as either open-file or confidential reports. Details of open-file company reports that contain surface or near-surface geochemical data are summarized in Appendix 3. For each project, surface geochemical exploration data (including costean and shallow-drilling information) is captured to depths of up to 4 m. Projects with less than 30 samples have been omitted.

Each project has been assigned an identification number (ID No. of Appendix 3), and boundaries of the entire project area, along with the identification number, are shown on Plates 3 and 4, providing an overview of surface-exploration coverage on ROBINSON RANGE. Most projects cover a single area, although some projects comprise two or more separate areas.

The projects in Appendix 3 are tabulated in order of increasing M-number for the period 1968 to 1995. When reports are released to open-file, the M-number is replaced by an item number, with the highest item number denoting the most recent release. Gaps in reporting may result from either the failure of some tenement holders to lodge reports on their tenements or because mineral-claim holders were not obliged to report all of their exploration results prior to 1978.

The 56 projects listed in Appendix 3 represent a total of 32 294 samples, which have been analysed on average for three elements. The projects are classified according to the targeted mineralization as follows:

Gold	77%
Copper-nickel	13%
Copper-lead	5%
Uranium	5%

Topographic and remote-sensing datasets

Topographic information was supplied by the Australian Land Information Group (AUSLIG). Landsat Thematic Mapper (TM) scenes were used to interpret regolith boundaries for Plate 1. The six 1:100 000-scale scenes displaying bands 1, 4 and 7, were obtained from the Department of Land Administration (DOLA).

Other remote-sensing datasets, used in selecting sample sites and interpreting results, included available airborne-survey data for total magnetic intensity and gamma-ray spectrometry. The most recent geophysical data was collected between July and October 1994 by Tesla Airborne Geoscience, but covers only the two eastern 1:100 000 map sheets of MILGUN and PADBURY. World Geoscience Corporation Ltd has recently collected multiclient geophysical data (flown 1995–96) for the remainder of ROBINSON RANGE.

Geology

ROBINSON RANGE covers the northern boundary of the Yilgarn Craton, and the southern margins of the Capricorn Orogen and the Bangemall Basin. The major tectonic units on ROBINSON RANGE are the Murchison and Narryer Terranes of the Yilgarn Craton; the Gascoyne Complex and the Padbury, Bryah and Yerrida Basins, which form part of the Capricorn Orogen; and the Bangemall Basin. A generalized geological map for ROBINSON RANGE (Fig. 2) has been compiled after Elias and Williams (1980), and Myers, Occhipinti, and Swager (1996, pers. comm.). The large area of undivided Archaean granite and granitic gneiss includes the both Narryer and Murchison Terranes of the Yilgarn Craton (Myers, 1993; Swager and Myers, in prep.; Occhipinti et al., in prep.). Within this, Elias and Williams (1980) mapped units of migmatite, quartz–muscovite schist, banded quartz–feldspar rock, Archaean granites, and some Proterozoic granites. The justification for combining them into one unit in this study is that most of these rocks have been derived from homogeneous Archaean granitic rocks and may show broad geochemical similarity (J. S. Myers, 1996, pers. comm.). Regolith chemistry will be used to identify variations in bedrock composition within this unit. The unit may also include intrusions of Proterozoic granitic rocks of the Gascoyne Complex, which outcrop in the northwestern part of ROBINSON RANGE.

In the east, low-grade Proterozoic metasedimentary rocks have been divided into the Padbury, Bryah and Yerrida Groups (after Pirajno et al., 1996). Within these groups only the BIF of the Padbury Group has been delineated on Figure 3, as it is a compositionally distinct unit within the Padbury Group (J. S. Myers, 1996, pers. comm.). In the centre of the map sheet, the layered mafic–ultramafic intrusive rocks and mafic volcanic rocks of the Trillbar Complex may be equivalent to mafic extrusive rocks in the Bryah Group (Occhipinti et al., in prep.). In the north of the map sheet, the Bangemall Group has been divided into the Collier and Edmund Subgroups (after Muhling and Brakel, 1985).

Stratigraphic descriptions of the Glengarry Basin in this study take into account recent mapping by Martin (1994), Pirajno et al. (1995), Swager and Myers (in prep.), and Occhipinti et al. (in prep.).

Tectonic setting

The Capricorn Orogen lies between the Archaean Pilbara and Yilgarn Cratons, and was formed in the Early to Middle Proterozoic (between 2 and 1.6 Ga) as a result of the collision of the two cratons (Muhling, 1988; Myers, 1990; Tyler and Thorne, 1990). According to Pirajno et al. (1995), the Yerrida, Bryah, and Padbury Basins formed along the southwestern margin of the Capricorn Orogen as pull-apart sub-basins, in response to east–west transpressive (oblique-convergent) movements.

On ROBINSON RANGE, the exact position of the northern boundary of the Yilgarn Craton is uncertain, although Elias and Williams (1980) defined 'a structural zone where

the northerly trends of the Yilgarn Craton become disrupted and folded into the generally easterly trends of the Gascoyne Province'. However, Williams (1986) questioned the significance of this boundary, because Archaean gneisses reworked by Proterozoic tectonism during the Capricorn Orogeny pass transitionally southwards into the stable Archaean terranes of the Yilgarn Craton.

The nature of the boundary between Archaean granitic gneiss and essentially undeformed Proterozoic granite in the northwest of the map sheet is unknown due to poor outcrop, and is interpreted to be faulted.

The Capricorn Orogen is overlain to the north by the Bangemall Basin, which is a Middle Proterozoic, intracratonic basin containing gently folded marine and continental sedimentary rocks.

Greenstone belts

There are two elongate greenstone belts within the Archaean granitic gneiss: the Mount Maitland belt in the southeast, and the Mount Taylor belt in the southwest (Fig. 3). The Mount Maitland Belt is approximately 3 km wide and 30 km long, and is exposed as low ridges of metamorphosed ultramafic rocks (serpentine), basalt, mafic intrusive rocks, fine-grained sericitic schist (deformed and metamorphosed felsic volcanic rock), and BIF with minor chert. The metamorphic grade ranges from greenschist to lower amphibolite facies (Elias and Williams, 1980; Occhipinti et al., in prep.).

The Mount Taylor belt contains a sequence of BIF, quartz-magnetite rock, supergene-enriched quartz-hematite rock, and recrystallized chert, along with less well-exposed chlorite schist and minor ultramafic rock interlayered with the BIF and chert (Elias and Williams, 1980). The sequence of chloritic schist and supergene-enriched BIF at Mount Gould is also within the Mount Taylor belt. Chloritic schists are both of sedimentary and igneous origin according to Elias and Williams (1980). The belt extends southwestwards and includes Jack Hills on BELELE.

Granite and granitic gneiss

The Narryer Terrane contains the oldest known material forming part of the Yilgarn Craton (Williams and Myers, 1987; Myers, 1990, 1993). It consists of Meeberrie and Dugel Gneiss, layered basic rocks of the Manfred Complex, and metasedimentary rocks. According to Myers (1993), the oldest rocks are the Meeberrie Gneiss (formed from 3730 Ma tonalite and 3680 to 3600 Ma granite) and the Manfred Complex, which formed from 3730 Ma layered anorthosite, gabbro, and ultramafic rocks. After a period of deformation and metamorphism these rocks were intruded by the 3400 Ma granite-precursor of the Dugel Gneiss and 3300 Ma granite. These intrusions coincided with high-grade metamorphism at 3300 Ma. Deposition of quartzite, pelite, and BIF occurred between 3100 and 2700 Ma. A plutonic episode,

between 2780 and 2630 Ma, involved the widespread emplacement of granite, and intense deformation and high-grade metamorphism. This plutonic episode is related to the collision between the Narryer and Murchison Terranes and subduction of the oceanic crust separating them.

The Wilthorpe Granite of Windh (1992) is a fault-bounded unit between the Narryer Terrane and Proterozoic metasedimentary rocks. It is an elongate body with a faulted eastern contact (Wilthorpe Fault) with the Padbury Group, and its margin to the west is the Billara Fault. A previous interpretation suggested that it is an Early Proterozoic pluton along the Narryer Terrane – Glengarry Basin boundary (Windh, 1992), although Swager and Myers (in prep.) argue that it is Archaean, and is contained within a separate tectonic slice.

Archaean granite-greenstones of the Yilgarn Craton have been metamorphosed to greenschist facies. On ROBINSON RANGE the major rock type is a heterogeneously deformed biotite monzogranite that ranges from largely undeformed granite to gneissic granite (Occhipinti et al., in prep.).

Proterozoic granites

Proterozoic granites within the Narryer Terrane mostly consist of medium- to coarse-grained granite and pegmatite (Elias and Williams, 1980).

Trillbar Complex

Deformed and metamorphosed mafic volcanic rocks, gabbroic rocks and ultramafic rocks in the centre of ROBINSON RANGE form the Trillbar Complex (Myers, 1990). These rocks are interpreted by Myers (1990) to be a Proterozoic thrust sheet that overlies the Archaean Dugel Gneiss of the Narryer Terrane, and was later overridden by a complex thrust sequence of low-grade metasedimentary rocks of the Glengarry Basin. Following recent mapping, an alternative interpretation by Occhipinti et al. (in prep.) suggests a correlation of the Trillbar Complex with mafic volcanic rocks of the Bryah Group.

Glengarry Basin

Low-grade Proterozoic metasedimentary rocks and mafic and ultramafic extrusive rocks in the eastern part of ROBINSON RANGE have been included the Glengarry Group, deposited in the Glengarry Basin (Gee, 1990; Gee and Grey, 1993; Pirajno et al., 1995). The Glengarry Basin of Gee and Grey (1993) also included the Padbury Group. The Glengarry Group has since been further subdivided into the Bryah and Yerrida Groups, which are now considered to have been deposited in separate basins called the Bryah and Yerrida Basins (Pirajno et al., 1996). The Padbury Group was deposited in the Padbury Basin, developed over the Bryah Basin as a peripheral foreland basin (Martin, 1994).

Yerrida Group

The Yerrida Group has been divided into the Windplain and Mooloogool Subgroups, but only the Windplain Subgroup outcrops on ROBINSON RANGE. The Windplain Subgroup represents an initial sag-basin succession, and contains the basal units of the Yerrida Group (Juderina and Johnson Cairn Formations). The unconformable contact with the underlying, foliated granites of the Yilgarn Craton is marked by ridges of basal quartz arenite defined as the Finlayson Member (Occhipinti et al., in prep.). Above the Finlayson Member, the Juderina Formation contains quartz wacke, and several chert, quartz arenite and quartz conglomerate beds, which are conformably overlain by ferruginous shale and siltstone of the Johnson Cairn Formation. The boundary with the overlying Narracoota Formation of the Bryah Group is not exposed but has been interpreted as a fault (Pirajno and Occhipinti, in prep.; Pirajno et al., 1995; Occhipinti et al., in prep.).

Bryah Group

The Bryah Group consists of mafic and ultramafic volcanic rocks of the Narracoota Formation, turbiditic sedimentary rocks of the Ravelstone Formation, and BIF and associated fine-grained clastic rocks of the Horseshoe Formation. This sequence is intensely deformed and metamorphosed to low- to mid-greenschist facies (Pirajno et al., 1995).

The Narracoota Formation contains Fe- and Mg-rich tholeiitic basalt, ultramafic and mafic schist, volcanoclastic and subvolcanic rocks, and lenses of shale and chert (Swager and Myers, in prep.). Hynes and Gee (1986) suggested that the Narracoota Formation was erupted onto or near rapidly subsiding continental crust, associated with continental rifting. The Narracoota Formation interfingers with, and occurs as lenses within, the overlying Ravelstone Formation. The Ravelstone Formation (previously known as the Thaduna Greywacke of Gee, 1979) typically consists of coarse-grained turbidite beds of lithic wacke and interbedded slaty mudstone. The formation is the result of high-energy terrigenous sedimentation from uplifted granite blocks (Pirajno et al., 1995). The contact between the Ravelstone Formation and the overlying Horseshoe Formation is gradational. The Horseshoe Formation consists of ferruginous shale and siltstone with interleaved iron-formation and chert (Swager and Myers, in prep.). The Horseshoe Formation is the remnant of a more continuous cover deposited as basin-fill sediments in a shallow-water environment.

Padbury Group

The Padbury Group consists of a sequence of quartz wacke, conglomerate, shale, BIF and dolomite, that has been strongly deformed and only weakly metamorphosed from low- to mid-greenschist facies. Higher metamorphic grades are reported near the faulted contact zones with Archaean rocks (Elias and Williams, 1980; Gee, 1990). The Padbury Group is thought to have formed in a foreland basin over the deforming Bryah Group (Windh, 1992; Martin, 1994; Occhipinti et al., in prep.). The Padbury Group on ROBINSON RANGE consists of, in ascending order,

the Labouchere, Wilthorpe, Robinson Range, and Millidie Creek Formations.

The boundary between the Labouchere Formation and the underlying Horseshoe Formation of the Bryah Group, has been described as an unconformity (Gee 1987; Windh, 1992; Martin, 1994), which has been reactivated by faulting and shearing (Occhipinti et al., 1996; Pirajno and Occhipinti, in prep.). The Labouchere Formation comprises coarse-grained sericitic quartz wacke, siltstone, shale, and minor conglomerate. Martin (1994) interpreted the Labouchere and Wilthorpe Formations as a coarsening-upwards, deep-water turbidite complex.

The Wilthorpe Formation (Wilthorpe Conglomerate of Elias and Williams, 1980) is a sequence of quartz-pebble conglomerate, wacke and siltstone, and includes two distinct units, the Heines and Beatty Park Members (Occhipinti et al., 1996; Pirajno and Occhipinti, in prep.). The Heines Member is not exposed on ROBINSON RANGE. The Beatty Park Member consists mainly of chlorite-quartz wacke, shale and siltstone, with lenses of conglomerate and layers of finely laminated chert, and has been derived in part from a mafic precursor (Occhipinti et al., 1996). The contact between the Wilthorpe Formation and the overlying Robinson Range Formation is gradational. The Robinson Range Formation is a sequence of hematitic shale and two iron-formations that are overlain by hematite-chlorite siltstone (Gee, 1990; Swager and Myers, in prep.). The conformably overlying Millidie Creek Formation is poorly exposed on ROBINSON RANGE, and includes hematitic shale and siltstone, manganiferous iron-formation, quartz wacke, and dolomitic sandstone, with chloritic siltstone at the top (Occhipinti et al., 1996).

Bangemall Basin

The southern margin of the Bangemall Basin lies in the northern part of the map sheet. ROBINSON RANGE has formations of both the western and eastern successions of the Bangemall Basin, called the Edmund and Collier Subgroups (Muhling and Brakel, 1985). The Edmund (western) Subgroup is the thicker and lithologically more diverse. The main lithological variation from west to east is the lensing out of dolomite, chert and sandstone units, with the persistence of shale and siltstone beds (Muhling and Brakel, 1985). The basin is intruded by dolerite sills and dykes, which are exposed only at a few localities on ROBINSON RANGE, notably at the Sawback Range. Although they are of upper Proterozoic age, the dolerite has been grouped with Archaean volcanic rocks on the simplified geological interpretation map (Fig. 2). A more detailed description of the stratigraphic units is given by Muhling and Brakel (1985).

Edmund Subgroup

The Tringadee Formation is the basal unit of the Edmund Subgroup, unconformably overlying the Labouchere Formation of the Padbury Group. The Tringadee Formation comprises irregular conglomerate grading to quartz sandstone and wacke, which occurs on ROBINSON

RANGE as small outcrops to the north and northeast of Mount Clere (Fig. 1). The Irregularly Formation conformably overlies the Tringadee Formation 9 km northeast of Mount Clere (Elias and Williams, 1980). It consists of layered dolomite with interbedded shale and siltstone, and minor conglomerate, sandstone, and chert. The Irregularly Formation and the Kiangi Creek Formation are lateral facies equivalents, although the Irregularly Formation is older in a vertical profile (Muhling and Brakel, 1985). The Kiangi Creek Formation predominantly consists of well-sorted, medium-grained quartz arenite, with siltstone, shale, minor dolomite and conglomerate. In some areas this formation may be laterally replaced by the Irregularly or Jillawarra Formations due to lensing out of sandstone. The upper boundary with the Jillawarra Formation is a gradational, upward-fining sequence of arenite, siltstone and shale.

The Jillawarra Formation consists of finely bedded siltstone and shale, with less common fine-grained sandstone, dolomite and chert. The Jillawarra Formation has a conformable relationship with the overlying Discovery Chert, which is a highly resistant unit of light- and dark-coloured chert and subordinate interbedded shale. The Discovery Chert is a distinctive unit and is used as a marker horizon in the Bangemall Group. There is a transitional contact with the Discovery Chert and the Devil Creek Formation, which is a sequence of dolomite and silty shale, with minor siltstone, sandstone, breccia, and chert (Muhling and Brakel, 1985). The Nanular Sandstone is the uppermost unit of the Edmund Subgroup that outcrops on ROBINSON RANGE. Swager and Myers (in prep.) report that the lower contact of the Nanular Sandstone is not exposed on MILGUN but there is a presumed conformable relationship. The Nanular Sandstone comprises regularly bedded quartz arenite, poorly sorted feldspar-quartz-wacke, with minor siltstone and shale.

Collier Subgroup

Nearly flat-lying units of the Collier Subgroup outcrop only in the Dunns Range, in the northeastern corner of ROBINSON RANGE. The lowest unit of the Collier Subgroup is a feldspar-quartz sandstone and has been correlated by Swager and Myers (in prep.) with the Wonyulgunna

Sandstone. The contact with the overlying Backdoor Formation is not exposed, although Muhling and Brakel (1985) reported it as an unconformity elsewhere in the Bangemall Basin. The Backdoor Formation consists predominantly of shale, mudstone, siltstone, and minor chert. The unit has a gradational boundary with the Calyie Sandstone, which is a quartz arenite forming the prominent Dunns Range. The Calyie Sandstone also has minor interbedded siltstone and brown shale.

Mineralization

ROBINSON RANGE straddles the boundaries of the Peak Hill, Murchison, and Gascoyne Goldfields. There has been no reported mineral production on ROBINSON RANGE from the Gascoyne Goldfield, and the majority of the area and its historical mineral production falls within the Peak Hill Goldfield. Using the classification scheme for mines and deposits, listed in Table 1, the Peak Hill Goldfield has one major gold mine, one gold mine, two minor gold mines and three gold prospects. This is accompanied by a talc mine and an additional talc deposit, one deposit and two minor deposits of manganese, one major deposit of iron ore, and minor occurrences of variscite and copper (Plate 1). The Murchison Goldfield has three gold prospects and one iron-ore (hematite) deposit. The Fortnum gold mine and Mount Seabrook talc mine are the only active mines on ROBINSON RANGE. Production figures and resources for gold and other commodities, between 1900 and 1995, are listed in Appendices 1 and 2. To simplify background information presented on all figures in this report, only mining localities and the two largest gold deposits (Fortnum and Labouchere) are displayed (rather than individual deposits).

Gold

Gold has been produced at five mining localities (Wilthorpe, Horseshoe, Mount Fraser, Mount Seabrook, and Mount Maitland) on ROBINSON RANGE. Apart from Mount Maitland, mineralization is confined to deformed Proterozoic sedimentary rocks in quartz reefs and veins, and pyritic chert and shale (Elias and Williams,

Table 1. Size classification scheme for mines and prospects on ROBINSON RANGE

	Gold		Manganese		Iron ore		Copper	
	Cutoff (kg Au)	No. of mines or deposits	Cutoff (Kt Mn)	No. of mines or deposits	Cutoff (Kt Fe)	No. of mines or deposits	Cutoff Kt Cu	No. of mines or deposits
Major mine or deposit	>10 000	1	>2 000	—	>200	1	>350	—
Mine or deposit	1 000–10 000	1	25–2 000	1	25–200	1	5–350	—
Minor mine or deposit	30–1 000	2	<25	2	<25	—	<5	1
Prospect	<30	6	—	—	—	—	—	—
Cutoff grade	1 g/t		38% Mn (metal) 50% Mn+Fe		55% Fe		1% Cu	

1980). Mineralization at Mount Maitland is in schistose Archaean felsic volcanic rocks. The majority of gold production has come from the Horseshoe mining centre (12 t), which includes the Labouchere and Fortnum projects. Recent descriptions of the geology at Fortnum and Labouchere have been made by Hill and Cranney (1990) and Meiklejohn (1995), and Hanna and Ivey (1990) respectively.

The Fortnum mining project comprises, to date, seven deposits (listed in Appendix 1). These occur in a folded sequence of Bryah Group sedimentary rocks. Mineralization is hosted by mafic volcanic rocks of the Narracoota Formation, and is controlled by two main structures, the Fortnum Fault and a shear zone. The north-striking shear zone is 100 m wide and hosts most of the economic mineralization (Hill and Cranney, 1990). The Fortnum Fault strikes west-northwest and truncates the Narracoota Volcanic sequence in the north of the project area (Meiklejohn, 1995). Four distinct styles of mineralization are outlined in Hill and Cranney (1990). They report that analysis of 25 selected ore samples yielded high concentrations of Cu (maximum 1130 ppm), Ba (maximum 3960 ppm), Sc (maximum 67 ppm), Y (maximum 27 ppm), La (maximum 100 ppm), and Ce (maximum 640 ppm).

The Labouchere mining project, including the Nathans – Deep South deposit, lies within the Labouchere Formation of the Padbury Group. The Nathans – Deep South deposit is situated approximately 7 km to the south-east of Labouchere. The gold deposits occur on the limbs of an isoclinally folded, south plunging, major synformal structure that is bounded to the west by gneiss (Hanna and Ivey, 1990). There are similar controlling structural features to the Fortnum project, and the Fortnum Fault appears to be a regional control on mineralization. A north-west trending shear zone may control high-grade mineralization at the Labouchere Main Lode deposit (Hanna and Ivey, 1990).

Two stratabound pyritic chert units host the mineralization at Labouchere Main Lode. The units are characteristically massive and blocky and contain abundant coarse, euhedral pyrite. The Nathans – Deep South mineralization is represented at the surface by a poorly outcropping, ferruginous and siliceous shale. The ore-bearing shale is characterized by abundant fine to coarse euhedral pyrite associated with minor quartz in laminae parallel to bedding (Hanna and Ivey, 1990). Anomalous As, Pb and Ba are associated with the Deep South mineralized shale. The Labouchere deposit, however, has no anomalous base-metal values associated with gold mineralization (Hanna and Ivey, 1990).

Talc

The Mount Seabrook and Livingstone talc deposits are situated near the centre of ROBINSON RANGE, the latter 6 km north-northeast of the Mount Seabrook deposit. The geology of the deposits has been described by Lipple (1975, 1990) and Blount (1988). Associated bedrock around Mount Seabrook consists of metasedimentary rocks

with minor gabbro and ultramafic intrusions, most of which have been metamorphosed to greenschist facies, with localized higher grade rocks (Lipple, 1975). The orebody consists of steeply plunging lenses of high-grade, white to grey, and pale green talc, enclosed in a sequence of schists and minor marble. At the Livingstone deposit, 13 lenticular bodies of similar grade talc have been identified.

There are various interpretations as to the origin of the talc. Blount (1988) favoured a hydrothermal origin, whereas Lipple (1975) argued for low-temperature, hydrous metamorphism of sandy dolomite. Alternatively, Lipple (1990) suggested retrograde metamorphism of serpentinite within the Trillbar Complex.

Manganese

Manganese deposits of the Mount Fraser and Mount Padbury mining centres occur as black mesas over sedimentary rocks of the Millidie Creek Formation (Padbury Group) and the Horseshoe Formation (Bryah Group) respectively. Mining occurred at Mount Fraser during 1949–1967 and 1979–1980, and Mount Padbury during 1977–1982 (Appendix 2). The ore was reported to average 47% Mn at Mount Fraser, and 48% Mn at Mount Padbury (Fetherston, 1990). It was initially suggested that the deposits were formed from replacement infillings in old drainage lines (MacLeod, 1970), although more recent reports suggest a supergene origin, relating to underlying manganeseiferous shale units (Pirajno and Occhipinti, in prep.).

Iron ore

Small, scattered, high-grade iron-ore deposits have been reported in the Robinson Range and Millidie Creek Formations of the Padbury Group (Sofoulis, 1970). These deposits consist of hematite and goethite and are associated with BIF. There are also iron-ore resources in Archaean greenstones at Mount Taylor and Mount Gould (Appendix 2), which consist of small lenses of massive hematite and iron-rich hematitic quartz. It has been suggested that iron-ore deposits on ROBINSON RANGE formed by supergene enrichment of BIF (Sofoulis, 1970; Elias and Williams, 1980). There has been no iron-ore production for ROBINSON RANGE.

Variscite

Variscite is a green hydrated aluminium phosphate ($\text{Al PO}_4 \cdot 2\text{H}_2\text{O}$) and is used as a gemstone. There are two occurrences on ROBINSON RANGE, one 1.5 km southwest of Sawback Bore (situated in a brecciated chert near the base of the Jillawarra Formation of the Bangemall Group), and another, 13 km east of Kelly Well that consists of green encrustations on deeply weathered high-magnesium basalt of the Narracoota Formation (Elias and Williams, 1980). The only recorded production of 1.8 t is at the Milgun Station (Sawback Bore) deposit (Appendix 2).

Copper

There are two minor occurrences of copper mineralization on ROBINSON RANGE. Bornite and malachite occur in a quartz vein cutting dolomite of the Labouchere Formation (Bryah Group), 12 km southwest of Milgun Station. Malachite also occurs in quartz reefs at Baxters Find.

Regional regolith and geochemical mapping

The GSWA regional regolith and geochemical mapping program involves the sampling, description and chemical analysis of regolith, and the mapping of regolith units. These data are shown as a series of element-concentration maps (Fig. 4–43) and a regolith-materials map (Plate 1).

Regolith sampling on ROBINSON RANGE was carried out between 31 May and 27 June 1995 by J. J. Bradley (GSWA), and P. Penna, E. Spartali, and G. Tolland (Geochemex Australia).

Sampling density

A nominal sampling density of approximately one sample per 16 square kilometres has been adopted for the GSWA regolith and geochemical mapping program. This sampling rationale has been discussed by Kojan and Faulkner (1994).

Site selection

Active-stream sediment is the preferred sampling medium, in that such material is representative of a catchment area. However, in areas lacking defined stream channels, sheetwash or soil samples were taken.

Sample sites were selected using a transparent overlay with a 4×4 km grid, over 1:100 000-scale Landsat TM images. A site was chosen within each square according to drainage, geology, topography and access. There was a slight bias towards areas of outcrop, and away from the extensive Murchison and Gascoyne drainage systems. Sample locations were digitized, assigned site reference numbers and Australian Map Grid (AMG) coordinates, which were printed onto 1:100 000-scale topographic maps. Field crews located sites using Garmin 75 Global Positioning System (GPS) units set to the AusGeo84 datum, which are accurate to ± 100 m. The geologist was given scope to move proposed sites to more appropriate or accessible locations.

Sample-site form

At each sampling site, a standard form (Appendix 4) was completed to systematically record characteristics of the sample, its position in the landform profile, and the

nature of the surrounding regolith. These data aid the interpretation of geochemistry, assignment of regolith codes to each site, and production of the regolith-materials map (Plate 1).

Sampling

Two samples were collected at each site: one sample for geochemical analysis, and the other as an archive sample. The analytical samples comprised approximately 2 kg of the <2 mm to >0.45 mm fraction. This fraction was chosen to avoid heterogeneity introduced by larger particles, and to minimize dilution by eolian sediment present in the 0.1–0.2 mm fraction (Davy, unpublished data). The archive sample consisted of approximately 4 kg of the <2 mm fraction. An estimate of the under- (<0.45 mm) and oversize (>2 mm) material was recorded on the sample-site form (Appendix 4).

Prior to sampling, wind-blown sand and vegetation debris were removed from the surface. Well-defined streams were sampled from a 10–40 cm-deep trench across the channel, including some material from the banks. Sampling of braided drainages involved compositing material taken from each main channel. Sheetwash and soil samples were collected as a composite from three 10–40 cm-deep pits. For sheetwash samples, the pits were positioned 30–50 m apart in a line perpendicular to the slope direction. For sites with no defined slope, the pits were similarly spaced, although set in a triangle.

Each sampling site and its regolith sample were allocated a GSWA number and the site was marked with a steel stake bearing a numbered aluminium tag.

At every fiftieth site, a second geochemical sample (duplicate sample) was collected for quality control purposes and allocated a separate GSWA number.

A total of 1039 samples were collected on ROBINSON RANGE and submitted for chemical analysis. These comprise 744 stream-sediment samples, 184 sheetwash samples, and 91 soil samples (and 20 duplicate samples).

Regolith-materials mapping

A 1:250 000-scale regolith-materials map for ROBINSON RANGE (Plate 1) has been produced using 1:100 000-scale Landsat TM imagery, 1:50 000-scale aerial photographs, regolith characteristics recorded on sample-site forms, and bedrock geology (Elias and Williams, 1980; Swager and Myers, in prep.; Occhipinti et al., in prep.). The regolith-materials map shows the distribution of regolith and aids in interpretation of geochemical data.

The GSWA regolith-classification scheme is based on the Kalgoorlie–Kurnalpi regolith–landform map of Craig and Anand (1993), which divides landforms and regolith into relict, erosional, and depositional regimes. In the GSWA program, regolith units within these regimes (listed in Table 2) are particular associations of regolith materials in relation to a landform profile.

Relict regime

The relict regime is the uppermost regime in a lateritic weathering profile, and it contains materials that are more resistant to downcutting and erosion. The regime is subdivided into four mappable units numbered R1–R4 (Table 2). R1 consists of a lag of lateritic pisolites and nodules, and has only been identified in a small area in the southwest of ROBINSON RANGE (Plate 1). R2 and R3 occur as isolated mesas or upland plateaus above breakaways, which are capped by either a ferruginous or silica-rich duricrust respectively. The R2 (iron-rich duricrust) unit is typically formed over greenstone belts or iron-rich sedimentary rocks, such as the BIF of the Robinson Range. As discussed above, duricrust over BIF may also be enriched in manganese. The R3 (silcrete) unit, which caps granite, granitic gneiss and sedimentary rocks, is often too small to portray at 1:250 000 scale. The R4 (quartz-rich sand) unit includes upland sandplains, which presumably cover other relict units.

Erosional regime

The erosional regime is defined as the regime that represents a net removal of material downslope. It is developed in upland areas and stony plains, where bedrock is covered only by a thin veneer of weathered material. The regime is divided into three units: E1, E2, and E4 (Table 2). The E2 and E4 units are further subdivided by a suffix denoting source rock as follows:

- ‘m’ represents metamorphic rocks (predominantly granitic gneiss),
- ‘v’ represents greenstones and mafic igneous rocks,
- ‘a’ represents amphibolite, and
- ‘s’ represents sedimentary rocks.

The E1 unit is not subdivided by parent material: it corresponds to outcropping saprolite or mottled zone, commonly occurring below breakaways in granitic and granitic gneiss terrane. Outcrops of E1 are typically too small to map at 1:250 000 scale, although there is a highly weathered area of granitic gneiss corresponding to this unit delineated in the north of ROBINSON RANGE.

The E2 unit comprises areas of prominent outcrop or extensive subcrop, commonly with an overlying coarse (boulder to cobble) lag of partly weathered bedrock. It develops in areas of high relief, such as the strike ridges of BIF in the Robinson Range (E2s). There are only small areas of E2m defined on Plate 1, and no samples have been collected from this unit.

The E4 unit corresponds to areas of moderate to low relief, downslope from E2, where finer grained lag of locally derived weathered material overlies bedrock. This lag may be locally ferruginized. The E4m and E4s units also include some areas of low relief where a thin regolith cover overlies bedrock. E4s typically does not extend far from E2s, because the sedimentary rocks are rapidly broken down.

Depositional regime

The depositional regime (DC1, DC2, DC3, DA4, DA5, DA7, DA8, D9) is characterized by a net gain of material (Table 2). DC1, DC2, and DC3 represent dominantly colluvial units; DA4 and DA5 are dominantly alluvial units; DA7 and DA8 are chemically precipitated deposits; and D9 is mainly of eolian origin. Where possible, one-letter suffixes denote source rocks (see **Erosional regime**).

DC1 represents coarse colluvial material, deposited downslope from E4. The transition from erosional to depositional is often accompanied by a marked decrease in slope. As it is still possible in most cases to identify the parent material, the DC1 unit can be subdivided on the basis of source rocks into greenstone (v), amphibolite (a), sedimentary (s) or metamorphic (m). No suffix is used when there is more than one major source type for the unit.

Farther downslope from either DC1 or E4, DC2 represents fine- to medium-grained colluvium. This unit has less of an association with defined alluvial channels than the DC1 or E4 units. As the slope angle decreases further, sediment transport is commonly by sheetwash as many drainage channels become less defined. Because the parent material is less obvious, DC2 can seldom be subdivided according to parent rock (v, s, and m). Areas of DC2 with a mixed source were not assigned a suffix.

DC3 represents low-angle, laterally extensive sheetwash fans that grade into alluvial plains (DA5). There are few well-defined drainage channels, and sediment transport is dominated by sheetwash. Most regolith is sand- and clay-sized material, with the majority of feldspar and other rock-forming minerals having been broken down. DC3h represents mappable areas of exposed hardpan, which may not always occur in an equivalent landform position to the DC3 unit. Although the hardpan may be undergoing active erosion, it is assigned the status of a depositional unit because it represents the reworking of consolidated colluvium.

DA4 represents well-defined, active alluvial channels, and comprises gravelly sands and clays. Overbank material, deposited on either side of these channels in flood conditions, are also included within this unit.

DA5 (alluvial plain) includes the extensive Murchison and the Gascoyne River systems on ROBINSON RANGE. These river systems contain many active channels, which have been included in DA5 and are not highlighted as DA4. DA5 consists of sand- or clay-rich alluvium and colluvium occurring on broad drainage floors, and it also includes overbank deposits.

DA7 includes salt-lake deposits, most of which consist of saline clays and silt, covered with a white salt or gypsiferous crust when dry. On ROBINSON RANGE there is only one small lake or claypan mapped as DA7, situated approximately 7 km west of Mount Arapiles (Plate 1).

DA8 is spatially associated with DA5 (alluvial plain). It comprises calcrete platforms, commonly overlain by a thin layer of alluvial and eolian sediment. Areas of DA8 (Plate 1) generally correspond to calcrete (Czk) of Elias

Table 2. Regolith unit codes and description

Regolith code	Description
RELICT REGIME	
R1	Ferruginous pisolites and nodules
R2	Iron-rich duricrust forming remnant land surfaces
R3	Silcrete (commonly weakly ferruginized) and silicified rock
R4	Quartz-rich sand overlying presumed or known R1–R3 material
EROSIONAL REGIME	
E1	Mottled zone and saprolite
E2	Outcrop of saprock and bedrock, and areas of subcrop with locally derived sands and sandy clays. Coarse (boulder to cobble) lag may occur adjacent to prominent ranges
E2v	E2 derived from greenstones and other mafic rocks
E2s	E2 derived from sedimentary rocks
E2m	E2 derived from metamorphic rocks, predominantly granitic gneiss
E2a	E2 derived from amphibolite
E4	Lag of locally derived ferruginous and/or lithic fragments, and/or feldspar in a matrix grading from sandy clay to sand, associated with actively eroding outcrop/subcrop
E4v	E4 derived from greenstones and other mafic rocks
E4s	E4 derived from sedimentary rocks
E4m	E4 derived from metamorphic rocks, predominantly granitic gneiss
E4a	E4 derived from amphibolite
DEPOSITIONAL REGIME	
	Dominantly colluvial
DC1	Medium- to coarse-grained detritus, mainly of lithic or ferruginized lithic clasts (most >25 mm), in colluvium with a sand or sandy clay matrix
DC1v	DC1 derived from greenstones
DC1s	DC1 derived from sedimentary rocks
DC1m	DC1 derived from metamorphic rocks, predominantly granitic gneiss
DC1a	DC1 derived from amphibolite
DC2	Fine- to medium-grained detritus (clasts 4–25 mm) mainly of lithic or ferruginized lithic origin, in a red sandy clay colluvial matrix, or quartz in a sandy clay matrix
DC2s	DC2 derived from sedimentary rocks
DC2m	DC2 derived from metamorphic rocks, predominantly granitic gneiss
DC3	Sand- and clay-dominated colluvium or sheetwash (\pm feldspar); merges into alluvial plains (DA5)
DC3h	Consolidated colluvium (hardpan) with a ferruginous or silica-rich cement; reddish brown and poorly bedded
	Dominantly alluvial
DA4	Gravelly sands and sandy clays of active alluvial channels with mixtures of lateritic, non-lateritic, and variably altered lithic clasts
DA5	Sand- or clay-rich alluvium and colluvium on broad drainage floors, including overbank alluvial deposits and terraces; includes non-saline claypans; calcrete fragments
DA7	Saline clays and sandy clays of playa lakes; commonly lacking vegetation
DA8	Extensive and continuous calcrete outcrop in broad drainage floors (valley calcrete)
D9	Sandplain, eolian in origin. May form dunes and thin sheets

and Williams (1980), although areas assigned to DA8 are less extensive.

Areas of eolian sediments are grouped as D9, which consists of both dunes and thin sheets of eolian sand. The unit is not extensive on ROBINSON RANGE, and the mapped areas correspond to sand in sheets (*Qs*) of Elias and Williams (1980).

Chemical analysis

All regolith samples were analyzed by Genalysis Laboratory Services, Maddington, Perth. Samples were submitted in five separate batches, each containing approximately 200 samples. Results of these analyses are

included on a disk (datafile ROBCHEM.CSV) in the back pocket of these Explanatory Notes.

Each regolith sample was dried at 105°C, and a 150 g split was pulverized in a zirconia ring mill so that at least 90% of the sample was less than 75 μ m. Samples were then analyzed for SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, K₂O and Cr. The remainder of the sample was pulverized in a chrome steel jumbo ring mill to at least 90% less than 75 μ m, and then analyzed for the following 39 oxides and elements: CaO, Na₂O, P₂O₅, Ag, As, Au, Ba, Be, Bi, Ce, Co, Cu, F, Ga, In, La, Li, Mo, Nb, Ni, Pb, Pd, Pt, Rb, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, U, V, W, Y, Zn and Zr. Loss on ignition was determined for 10% of the samples.

Check analyses of 30 samples were carried out by Amdel Laboratories, Wangara, Perth.

Analytical methods

Seven different analytical methods were used:

- *Inductively coupled plasma mass spectrometry (ICP-MS) using a combined hydrofluoric/multi-acid digestion (Genalysis code A/MS):* The pulverized sample was digested in a hydrofluoric/perchloric/nitric acid mixture for at least 24 hours, evaporated to fume dryness and leached in a dilute hydrochloric/nitric acid mixture. The following element concentrations were then obtained using ICP-MS: Ag, As, Ba, Be, Bi, Ce, Co, Ga, In, La, Li, Mo, Nb, Pb, Rb, Sb, Sn, Sr, Ta, Te, Th, U, W, Y and Zr.
- *Inductively coupled plasma optical emission spectroscopy (ICP-OES) using a combined hydrofluoric/multi-acid digestion (Genalysis code A/OES):* The pulverized sample was digested in a hydrofluoric/perchloric/nitric acid mixture for at least 24 hours, evaporated to fume dryness and leached in a dilute hydrochloric/nitric acid mixture. The following oxide and element concentrations were then obtained using ICP-OES: CaO, Na₂O, P₂O₅, Cu, Ni, S, Sc, V and Zn.
- *Inductively coupled plasma optical emission spectroscopy (ICP-OES) using an alkaline oxidative fusion with sodium peroxide in a zirconium crucible followed by leaching with dilute acid (Genalysis code D/OES):* Oxides and elements analyzed by this method were SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, K₂O and Cr.
- *Fire assay lead collection and ICP-MS analysis (Genalysis code FA*MS):* Elements analysed by this method were Au, Pd and Pt.
- *Low-level fluorine determinations involving fusion of the sample with a mixture of sodium carbonate, potassium carbonate and zinc oxide, dissolution in water and reading with a specific-ion electrode (Genalysis code DH/SIE).*
- *Precipitation of selenium metal followed by aqua regia digestion and ICP-MS analysis (Genalysis code AP/MS).*
- *Loss on ignition by gravimetric determination (Genalysis code GRAV).*

Detection limits and the number of samples with values below the limit of detection are shown in Table 3.

Table 3. Detection limits and the number of samples below detection

Element	Detection limit	Number of samples below detection limit (Total number of samples = 1019)
Percent		
SiO ₂	0.01	—
TiO ₂	0.01	—
Al ₂ O ₃	0.01	—
Fe ₂ O ₃	0.01	—
MnO	0.01	50
MgO	0.01	—
CaO	0.01	—
Na ₂ O	0.01	7
K ₂ O	0.01	—
P ₂ O ₅	0.01	1
Parts per million		
Ag	0.5	988
As	2	302
Au	0.001	647
Ba	1	—
Be	0.1	1
Bi	0.5	872
Ce	0.1	—
Co	1	6
Cr	20	24
Cu	1	—
F	50	115
Ga	1	—
In	0.1	721
La	0.1	—
Li	0.5	—
Mo	0.5	—
Nb	0.5	—
Ni	1	—
Pb	2	—
Pd	0.001	287
Pt	0.001	404
Rb	0.2	—
S	10	84
Sb	0.2	157
Sc	2	129
Se	0.2	301
Sn	1	335
Sr	0.1	—
Ta	0.2	26
Te	0.5	899
Th	0.1	—
U	0.1	—
V	2	—
W	1	790
Y	0.1	—
Zn	1	2
Zr	1	—
mS/m		
Soil conductivity	10	992

Quality control

Quality control has been used to monitor variability in geochemical analyses, and to ensure that results reflect genuine geochemical variations. Reproducible results should normally be obtainable from the same sample site and from repeat analyses of each sample, provided that the element occurs at a concentration that is sufficiently above detection limit and that the sample is sufficiently homogeneous. Four main quality-control procedures were used in the regional regolith and geochemical mapping program:

- analysis of GSWA geochemical standards;
- analysis of GSWA duplicate samples from the same sampling site;
- analysis of Genalysis reference samples (including in-house and international standards) and duplicates on a regular basis;
- check analyses of selected samples by Amdel Laboratory.

Analysis of GSWA geochemical standards

In order to monitor analytical precision and accuracy, a number of GSWA reference standards have been analyzed along with regolith samples collected during the regional regolith and geochemical mapping program. The six standards used in this project were GRA-1 (granite), GRA-2 (granite), IQC-41 (vein quartz), IQC-45 (gossan), IQC-47 (laterite), and UM-1 (ultramafic). The results of the analysis of these standards are presented in Appendix 5.

The mean and percent relative standard deviation (RSD%) were used to assess precision. Precision is considered acceptable by Darnley et al. (1995) if, for elemental concentrations over ten times the detection limit, the RSD% is less than three for a major element/oxide, less than ten for trace elements, and less than 30 for selected trace and ultra-trace elements. Analyses of the same standards by Genalysis submitted in different batches show good agreement. For elements well above detection limit, RSD% is typically less than ten (Appendix 5).

Accuracy was assessed by comparing ROBINSON RANGE mean values with analyses previously carried out (for other GSWA regolith and geochemical mapping projects) by Amdel and Genalysis Laboratories (Appendix 5). The relative standard deviation values for these populations are also presented. Comparable data for GRA-1 and UM-1 are unavailable, and these standards could not be used in this comparison. ROBINSON RANGE mean values compare well with previous analyses performed by Genalysis Laboratories. Only K_2O , Cr (IQC-47), and Zr (GRA-2) have >20% difference at 10 times the detection limit. Comparison between ROBINSON RANGE mean values and analysis by Amdel Laboratories showed acceptable agreement, although there is more than a 20% variation for Ga, Th, Y, Zn in GRA-2; Ba, Cr in IQC-41; Ce, La, S in IQC-45; MgO , Ga; and S in IQC-47.

Analysis of GSWA duplicate samples

A total of 20 samples were analyzed in duplicate. In order to check variability within and between batches, GSWA duplicate samples were included either within the same batch as the original sample or in different batches. The variation between the analyses of the original samples and their duplicates was compared, and differences greater than 20% were highlighted, except when concentrations approached detection level. The analyses by Genalysis showed good agreement between GSWA duplicates, except for Fe_2O_3 (>20% in three samples), Cu (two samples), Pb (three samples), Zn (four samples), and Zr (two samples).

Analysis of Genalysis reference samples and duplicates

Genalysis reported analytical data for a control blank (beginning of the analytical run), several analyses of the

same reference standards, blanks (throughout the analytical run), and duplicates, for each of the five batches of samples submitted. On average, a batch of 200 samples contained, at regular intervals, approximately 45 standard samples, 11 blank samples, and nine duplicate samples. Repeat analyses were carried out on samples with elevated Au, Pd, and Pt.

The reference standards analyzed by Genalysis, included in-house standards BCS348 (check for LOI), ETA04 (Au, Pt, and Pd), FA5 (Au), PC03 (multi-element), PL-4 (multi-element), and international standards MRG-1 (gabbro), SARM 7.2 (pyroxenite), SO-2 (podsol soil) and SY-3 (syenite). The results of these standards were compared to their consensus values supplied by Genalysis and Potts et al. (1992), and the percent relative standard deviation of the population was calculated. Most RSD% values were less than ten. In some cases high RSD% values related to one slightly high or low analysis (for Ag, Cu, Ni, Se, Sn, Ta and Zr), but in most cases high RSD% values occurred when element concentrations approached the detection level (for Ag, As, Be, In, Se, Sb and Te). There was very good agreement with consensus values (Genalysis, and Potts et al., 1992).

The same approach of highlighting a greater than 20% variation was used for the Genalysis duplicate samples. Of the 46 duplicates analyzed, there was good agreement between duplicate pairs, apart from some variability in Cu (>20% in two samples), Nb (two samples), Zn (three samples), and Zr (two samples).

Check analyses

A total of 30 samples were submitted to Amdel Laboratories for analysis of the same components (apart from Te). The precision of the Amdel and Genalysis data were then compared using a paired t-test (Koch and Link, 1970), which compares the means of two measured groups based on the Student's t distribution. Critical values for the 5% and 10% confidence levels, with 29 degrees of freedom, were compared with the t-statistic generated using Microsoft EXCEL for each of the replicate pairs. Owing to the high number of values close to detection limit, results are not meaningful for Na_2O , Bi, In and W. The Amdel data were marginally higher than Genalysis for Be, Ga, Se, Zr, and lower for As, Ba, Pb, Pt, Rb, S, and U. There was poor agreement for Ce, Co, Cr, and for some Ta values. Although there are small differences between the two laboratories, the precision of each laboratory is considered acceptable.

Analysis of other components

All regolith samples were tested for soil pH and conductivity (expressed as total dissolved solids (TDS)). Fifteen selected samples were submitted for mineralogical (X-Ray Diffraction) analysis at CSIRO.

Acidity-alkalinity (soil pH) and electrical conductivity

A solution for the determination of soil pH and electrical conductivity was made by thoroughly shaking a 1:5

mixture of archive sample (<2 mm fraction) and de-ionized water, and allowing it to stand for approximately 12 hours. The pH of about 600 samples was measured using a hand-held Eutech Cybernetics pHScan 2 meter. Due to equipment failure, the remaining 400 samples were analyzed by a 3050 Portable Jenway pH meter. Both meters were calibrated before measurements were taken, using three buffer solutions with pH values of 4, 7 and 10. The electrode was rinsed with de-ionized water between measurements of each sample.

All electrical conductivity measurements were made using a hand-held TDScan4 conductivity meter. The meter was calibrated against a buffer solution with a conductivity value of 12.9 millisiemens/cm (mS/cm). The electrodes were rinsed with de-ionized water between each measurement. Both the electrical conductivity (in mS/cm) and temperature of the solution were recorded for each sample. The values presented in the datafile (ROBCHEM.CSV) have been adjusted to equivalent readings at 20°C, and converted to millisiemens/m.

Repeat tests of approximately 400 samples were carried out for both pH and electrical conductivity. Originally, soil/water mixtures were left for one hour before testing, but repeat tests highlighted an unacceptable variability in pH measurements. However, this variation decreased to acceptable levels when the mixture was allowed to stand for 12 hours. The repeat tests for electrical conductivity showed very good agreement.

Mineralogical determinations (XRD)

The mineralogy of 15 selected samples, representing different regolith and geological units, was determined by powder X-ray diffraction analysis at CSIRO, Floreat Park, Western Australia, following the method described by Hart and Nickel (1996). Minerals were detected by identification of characteristic X-ray diffraction patterns, and their relative abundances were derived in conjunction with the chemical data (Table 4). The chemical formulae of identified minerals and the peak height of their characteristic diffraction patterns were then used to allocate the elemental abundances from the analytical data.

Data presentation

The major products from the regional regolith geochemical mapping program on ROBINSON RANGE include a regolith-materials map (Plate 1), a sample-site location map (Plate 2), plans and tables detailing mineral-exploration company geochemical surveys (Plates 3 and 4, Appendix 3), element-concentration maps (Figs 4–43), a map of contoured gold values and gold deposits (Fig. 46), a map of contoured regolith pH values and TDS values (Fig. 48) and the digital datafile (ROBCHEM.CSV). All recent and current GSWA geology, regolith, and geochemistry map products are produced from digital data, which can be purchased from DME.

Element-concentration maps

The concentrations of 43 oxides or elements for the 1019 samples on ROBINSON RANGE are shown in Figures 4–43 (TiO₂, Fe₂O₃, MnO, MgO, CaO, Na₂O, K₂O, P₂O₅, Ag, As, Au, Ba, Be, Ce, Co, Cr, Cu, F, Ga, La, Li, Mo, Nb, Ni, Pb, Pd, Pt, Rb, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, U, V, W, Y, Zn, Zr). In Figure 43 only the higher values of Ag, Sb, Ta, and W are shown, because concentrations of these elements in most samples are close to or less than detection level.

On Figures 4–43, the element concentration is shown as a filled orange circle whose diameter is proportional to the concentration. Where element distributions have a strong positive skew, the highest values are presented as green stars, allowing comparison with lower element concentrations. Those samples with values below detection level are presented as small red dots. Exact values for elements at particular locations can be obtained by identifying the GSWA number from the sample-site location plan (Plate 2), and then referring to the digital datafile (ROBCHEM.CSV).

Mineral-prospectivity maps

Figures 46 and 47 show results of the geochemical data that have been used to highlight prospective areas for gold and base-metal mineralization on ROBINSON RANGE. Figure 46 compares contoured gold geochemistry from regolith data (ROBCHEM.CSV) and areas of known gold mineralization (Appendix 1). Figure 47 is a map of chalcophile-index values, where the chalcophile index is an additive index of standard scores for the chalcophile elements As, Bi, Mo, Sb, Se, Sn, and W. The approach is similar to that of the CHI*6 chalcophile index (Smith et al., 1989), except that Ag has been omitted because most samples have Ag concentrations close to or less than detection level. Element data was initially log transformed and standardized using the Microsoft EXCEL statistical function, to derive standard values that could be directly comparable. This procedure is discussed in detail by Kojan et al. (1996).

Acidity–alkalinity and electrical-conductivity maps

A map of regolith acidity–alkalinity and electrical conductivity (Fig. 48) on ROBINSON RANGE is shown as a contoured plot of pH with TDS values, which were obtained during the regolith sampling program. Figure 49 is a contoured plot of TDS in groundwater, using waterbore data supplied by the Water and Rivers Commission.

Regolith TDS measurements shown on Figure 48 were calculated from conductivity values listed in the digital datafile ROBCHEM.CSV. The initial conductivity values in mS/cm have been corrected to a standard unit (mS/m) and temperature (20°C), using the formula:

$$k_{20} = k \times 100 / (1 + 0.022(T - 20))$$

Table 4. XRD mineralogical analysis of selected samples

GSWA	Regolith unit	Geology	Type	Quartz	Goethite	Hematite	Kaolinite	K-feldspar	Plagioclase	Muscovite	Chlorite	Amphibole	Anatase	Pyro-lusite	Magne-site	Magne-tite	Ilmenite	Talc	Total (%)
133738	DC1	PA	stream	28	27	25	17	2	–	–	–	–	1	–	–	–	–	–	100
133763	E4v	PT	stream	41	12	–	–	–	11	7	8	7	1	–	–	–	–	11	98
133928	E4s	PP	stream	24	32	10	15	–	1	10	1	–	1	8	–	–	–	–	102
133945	E4v	PP	stream	19	11	–	11	–	5	–	19	38	–	–	–	–	–	–	103
133994	DC1s	PMe	stream	54	18	–	12	–	–	15	–	–	1	1	1	–	–	–	102
134003	E4v	Ab	stream	39	10	–	16	5	6	–	4	25	1	–	–	–	–	–	106
134103	DC1s	PMb	stream	68	5	5	11	–	–	16	–	–	1	–	1	–	–	–	107
134194	DC1s	PMe	stream	68	5	–	–	–	1	26	–	–	–	–	2	–	–	–	102
134240	E4s	PMe	stream	62	4	5	13	–	1	8	–	–	–	–	–	–	–	–	93
134339	DC1s	Ab	stream	30	–	7	14	–	6	14	–	15	–	–	–	8	6	–	100
134341	DC1s	PMe	stream	51	5	10	12	–	–	15	–	–	–	1	1	–	–	–	95
134425	DC2s	PMe	stream	21	15	20	23	–	1	3	–	1	2	–	–	15	–	–	101
134608	DC1	Agn	stream	53	–	29	11	10	2	–	–	–	1	–	–	–	–	–	106
134610	DC2	Agn	stream	54	–	19	12	10	3	–	–	–	3	–	–	–	–	–	101
134703	E4m	Agn	stream	52	–	7	7	21	10	–	–	–	1	–	–	–	–	–	98

PA Bryah Group
 PP Padbury Group
 PT Trillbar Complex
 PMe Edmund Subgroup
 PMb Backdoor Formation
 Ab Greenstone
 Agn Archaean granite and granitic gneiss

where k is the measured conductivity in mS/cm recorded at temperature $T^{\circ}\text{C}$. The TDS values (mg/L) are calculated from the formula:

$$\text{TDS} = 4.437 \times (k_{20})^{1.066}$$

Both formulas are similar to those of Kevi (1988) used for calculation of TDS values from resistivity measurements.

Company geochemistry surveys — maps and table

Information from open-file company surface-geochemistry surveys that have been carried out on ROBINSON RANGE are presented as two 1:250 000-scale maps (Plates 3 and 4), with individual exploration project details listed in Appendix 3.

Results and discussion

Three sample types (stream, soil and sheetwash) were collected on ROBINSON RANGE. Stream sediments are the most common and most of these were obtained from erosional units (E1, E2 and E4) and upland colluvial units (DC1). Most sheetwash and soil samples were collected from lower landform positions (DC3), also including colluvial slopes (DC1, DC2) and alluvial plains (DA5, DA8). Only small variations were revealed by a comparison of element geometric mean values between all stream samples and grouped soil and sheetwash samples, and this possibly reflects the different landform positions of the samples. Stream samples show slightly higher values for Ba and Sr, whereas soil/sheetwash samples show slightly higher SiO_2 , Al_2O_3 , Cr, F, Rb, V and Zr. Soil and sheetwash samples have been grouped together because field observations have shown that there are few recognizable differences between them. Soils on ROBINSON RANGE tend to be skeletal, with no well-defined humic or other layers, which is similar to areas of deposition by sheetwash.

The samples collected from extensive areas of active alluvial channels (DA4 on Plate 1) are not represented as DA4 in the datafile (ROBCHEM.CSV). Instead, stream sediments collected in active alluvial channels have been assigned the regolith code of the surrounding area, which may provide more information on landform position and source materials, and hence allow comparison with other regolith samples.

Mineralogy of regolith samples (XRD) — erosion vs weathering

X-ray diffraction results for 15 regolith samples are listed in Table 4. Most samples represent regolith relatively close to source rocks (E4 and DC1). Samples were chosen to represent the majority of geological units on ROBINSON RANGE. The main minerals identified were quartz, kaolinite, iron oxide (as both hematite and goethite), muscovite, and

amphibole. Two of the Archaean granite and granitic gneiss samples situated in the west of ROBINSON RANGE have unusually elevated hematite levels, which may be a result of downslope accumulation from Fe-rich duricrust. However, as expected, K-feldspar and plagioclase almost exclusively occur in the granitic gneiss samples. Amphibole and chlorite are mostly in the three E4v regolith samples from the Trillbar Complex, Padbury Group, and Mount Maitland greenstone belt. Only the Trillbar Complex sample contains talc, which may result from hydrothermal alteration or from shearing of high-magnesium, basic volcanic rocks.

Magnetite and ilmenite are also present in some samples. Anatase, pyrolusite, and magnesite have also been identified, although more from the results of the chemical analysis than by identification of a characteristic diffraction pattern.

The high proportion of primary minerals within these regolith samples (e.g. K-feldspar, plagioclase and muscovite) that persist to downslope positions (such as DC2) may indicate that mechanical erosion is a more dominant process than chemical weathering, particularly within areas of extensive granitic gneiss.

Comparison of regolith units

In order to make meaningful comparisons of results between regolith units, samples have been assigned to a number of separate groups based on regolith type and source rocks. For each of these groups descriptive statistics were performed, including derivation of geometric mean (geomean) values for each element, because geomeans reduce the effect of extreme values within groups. However, geomean values cannot be calculated when concentrations are below detection. Therefore, for these calculations any element concentrations below detection level have been assigned a value half the detection level. In the following discussion, significant variation in results includes only those geomean values which are ten times above the detection level. Geomean values are presented below for regolith units that are sourced by Archaean granite and granitic gneiss, Proterozoic granite, the Padbury Group, Bryah Group, and the Edmund Subgroup of the Bangemall Basin. Other geological units (Trillbar Complex, Yerrida Group, Collier Subgroup, amphibolite, and greenstones) are not tabulated because of the very small population numbers involved. Values for 72 DA5 (broad drainage floors), nine DA8 (calcrete platforms), and two D9 (eolian sand) samples are not discussed because it is not possible to assign source materials to these units.

Regolith units derived from Archaean granite and granitic gneiss

Archaean granite and granitic gneiss represents the most extensive unit on ROBINSON RANGE and this is reflected by a correspondingly high number of regolith samples (460). Table 5 lists the geomean values for the regolith units E1, E4m, DC1m, DC2m and DC3. A number of downslope trends in regolith composition are apparent.

Table 5. Element geometric mean values for regolith units derived from Archaean granite and granitic gneiss

Regolith unit No. of samples	E1 n=5	E4m n=254	DC1m n=80	DC2m n=39	DC3 n=82
Percent					
SiO ₂	88.52	82.75	82.72	82.49	82.84
TiO ₂	0.16	0.22	0.27	0.37	0.39
Al ₂ O ₃	5.82	8.82	8.34	8.80	8.07
Fe ₂ O ₃	2.03	2.34	3.01	3.30	4.08
MnO	0.01	0.02	0.03	0.03	0.05
MgO	0.14	0.20	0.12	0.13	0.13
CaO	0.28	0.44	0.18	0.13	0.08
Na ₂ O	0.95	1.21	0.65	0.45	0.21
K ₂ O	0.89	2.01	2.15	2.45	1.66
P ₂ O ₅	0.01	0.02	0.03	0.03	0.04
Parts per million (a)					
Ag	—	—	—	—	—
As	—	—	2.4	2.5	3.3
Au (ppb)	—	—	—	—	—
Ba	606	778	740	855	604
Be	0.6	0.8	0.7	0.8	0.8
Bi	—	—	—	—	—
Ce	38	46	44	47	41
Co	3.8	4.1	4.0	5.1	6.7
Cr	32	52	86	88	122
Cu	11.1	10.3	11.1	12.1	17.0
F	54	69	58	67	78
Ga	7.1	9.0	9.3	10.7	10.9
La	21	24	23	25	21
Li	3.1	3.6	4.1	5.0	5.9
Mo	3.2	2.5	2.5	2.5	2.8
Nb	2.2	3.7	4.4	5.1	5.5
Ni	10.4	13.5	14.4	15.2	18.6
Pb	13.4	17.9	18.2	20.8	19.1
Pd (ppb)	—	—	—	—	—
Pt (ppb)	—	—	—	—	—
Rb	21	51	57	69	57
S	36	15	24	30	38
Sb	0.2	0.2	0.2	0.3	0.3
Sc	3.0	2.6	2.8	3.4	5.2
Se	—	—	0.2	—	0.2
Sn	—	—	—	1.0	1.1
Sr	49	86	53	51	40
Ta	—	0.6	0.6	0.6	0.5
Te	—	—	—	—	—
Th	10.6	11.3	13.2	13.8	12.1
U	0.4	0.9	1.1	1.3	1.5
V	35	31	41	42	57
W	—	—	—	—	—
Y	3.5	6.1	6.4	7.3	8.3
Zn	4.3	16.2	18.4	21.0	27.4
Zr	34.0	54.3	63.5	69.9	69.1

— indicates too many samples below detection to calculate geomean
(a) except where noted otherwise

Erosional regime

There are no E2m (bedrock) samples of Archaean gneiss, and E4m is the closest sample type to the parent rock. For the erosional units on Archaean granite and granitic gneiss on ROBINSON RANGE, comparisons between E1 and E4m should be treated with caution, as there are only five E1 samples compared to 254 E4m samples. However, E1 results display some evidence that K₂O, Ba, Rb, Sr and Y have been leached, principally from K-feldspar,

plagioclase and micas, and E1 has correspondingly higher SiO₂ than E4m. The E1 unit also has lower Cr, Zn and Zr than E4m, which are held in relatively resistate phases and may be relatively concentrated in E4.

Depositional colluvial regime

The depositional colluvial regime from DC1 to DC3 in Archaean granite and granitic gneiss, represents an increasing distance from source rocks, a decreasing hillslope angle and an increased breakdown of clasts. Results show increases in TiO₂, Fe₂O₃, Co, Cr, Cu, Ni, S, Sc, V, Y and Zn, but decreases in CaO, Na₂O and Sr. This is consistent with the breakdown of minerals such as feldspars, the concentration of more resistate phases (e.g. opaque phases such as chromite) and an increase in the fine fraction of soils, including clays. However, there is no increase in SiO₂ as might be expected from this concentration effect and an input of eolian sand. An interesting feature is the relatively high geomean values of K₂O, Ba, Ce and Rb in DC2m. This may be related to the fact that most DC2m samples occur downslope from flat-lying granitoid outcrop (Plate 1).

Regolith units derived from Proterozoic granite

Geomeans for E4m, DC1m, DC2m, and DC3 derived from largely undeformed Proterozoic granite are listed in Table 6. The majority of the samples are from the DC3 regolith unit (n = 36). The downslope changes are similar to those for Archaean granite and granitic gneiss, with general increases in TiO₂, Fe₂O₃, Co, Cr, Cu, Ni, S, V and Zn, and decreases in CaO, Na₂O, K₂O, Ba, Rb and Sr. As with Archaean granite and granitic gneiss, these changes are consistent with the breakdown of feldspars and mica, and a concentration of the more resistate minerals (often in the fine fraction) and increasing clay content.

The geomean values for E4m sourced from Proterozoic granite are similar to those derived from Archaean granite and granitic gneiss (Table 5), although the populations analysed are vastly different (10 vs 254 samples). The main difference is that Proterozoic granite has higher Na₂O, K₂O, and Rb, with lower CaO, Fe₂O₃, Ba, Ce, Cr, Ni and V.

Regolith units derived from the Padbury Group

The element geomean values for the four regolith units (E4s, DC1s, DC2s, DC3) of the Padbury Group are listed in Table 7. Most regolith samples are from areas relatively close to source rocks (E4s and DC1s units), with only three samples collected in both DC2s and DC3. Some general downslope trends are apparent, with increasing SiO₂, K₂O, Ba, Cu, Rb and Sr, as more resistant quartz is concentrated, and kaolinite and the fine fraction increases. The geomean values of some components increase from E4s to DC1s, then decrease to DC3 (Fe₂O₃, As, Cr, F and V), and this may represent a lag of more resistant, heavier Fe materials

Table 6. Element geometric mean values for regolith units derived from Proterozoic granite

Component No. of samples	E4m n=10	DC1m n=3	DC2m n=10	DC3 n=36
Percent				
SiO ₂	82.02	87.61	85.54	84.99
TiO ₂	0.15	0.16	0.42	0.41
Al ₂ O ₃	8.93	7.24	7.73	6.73
Fe ₂ O ₃	1.50	1.88	3.69	3.74
MnO	0.01	0.02	0.06	0.05
MgO	0.12	0.08	0.16	0.12
CaO	0.28	0.27	0.11	0.06
Na ₂ O	1.58	0.70	0.29	0.13
K ₂ O	2.65	2.03	1.74	1.13
P ₂ O ₅	0.02	0.02	0.04	0.04
Parts per million (a)				
Ag	—	—	—	—
As	2.1	—	3.0	3.7
Au (ppb)	—	—	—	—
Ba	720	680	459	377
Be	1.1	0.8	0.8	0.7
Bi	—	—	—	—
Ce	34	41	61	44
Co	2.5	3.3	6.9	6.8
Cr	26	—	86	106
Cu	8.5	9.0	15.5	17.1
F	109	151	102	97
Ga	10.9	9.2	10.2	9.8
La	20	20	30	22
Li	4.0	4.0	6.8	6.4
Mo	3.5	3.6	2.5	3.2
Nb	3.8	3.9	6.0	5.4
Ni	8.2	7.0	14.6	17.4
Pb	18.6	17.1	19.9	14.8
Pd (ppb)	—	—	—	—
Pt (ppb)	—	—	—	—
Rb	85	69	61	46
S	19	18	32	43
Sb	0.2	0.2	0.4	0.4
Sc	—	—	4.8	5.4
Se	—	—	0.2	0.2
Sn	—	—	1.3	1.3
Sr	82	61	32	24
Ta	0.4	0.4	0.6	0.6
Te	—	—	—	—
Th	9.9	10.6	18.6	12.6
U	1.3	1.1	1.7	1.5
V	20	27	54	61
W	—	—	—	—
Y	6.0	5.2	8.8	8.4
Zn	13.7	10.1	26.2	32.4
Zr	62.7	53.0	66.5	62.1

— indicates too many samples below detection to calculate geomean
(a) except where noted otherwise

Table 7. Element geometric mean values for regolith units derived from the Padbury Group

Regolith unit No. of samples	E4s n=24	DC1s n=27	DC2s n=3	DC3 n=3
Percent				
SiO ₂	66.41	64.46	71.64	81.64
TiO ₂	0.41	0.44	0.52	0.43
Al ₂ O ₃	7.34	8.15	9.30	7.70
Fe ₂ O ₃	11.24	14.66	8.89	5.39
MnO	0.10	0.08	0.08	0.04
MgO	0.14	0.15	0.23	0.18
CaO	0.04	0.04	0.05	0.07
Na ₂ O	0.04	0.05	0.07	0.19
K ₂ O	0.71	0.82	1.12	1.55
P ₂ O ₅	0.07	0.08	0.06	0.05
Parts per million (a)				
Ag	—	—	—	—
As	13.7	20.4	8.8	6.3
Au (ppb)	—	—	1.71	—
Ba	282	274	388	427
Be	1.0	1.3	1.2	0.9
Bi	—	0.5	0.6	—
Ce	33	42	45	36
Co	7.7	8.2	8.7	7.7
Cr	198	241	215	136
Cu	21.9	22.9	24.0	25.3
F	146	197	172	132
Ga	12.0	14.3	14.6	9.5
La	14	18	21	18
Li	5.4	5.2	8.4	6.7
Mo	3.0	2.9	3.2	5.0
Nb	4.8	5.1	6.1	6.4
Ni	24.9	28.3	28.2	25.1
Pb	29.0	29.3	28.1	27.3
Pd (ppb)	1	2	1	1
Pt (ppb)	1	2	1	—
Rb	38	46	67	67
S	77	80	44	52
Sb	1.0	1.7	1.0	0.8
Sc	6.9	8.2	9.0	6.5
Se	1.1	1.3	0.7	0.4
Sn	1.6	1.9	2.4	1.7
Sr	16	16	20	31
Ta	0.7	0.8	1.1	1.0
Te	—	—	—	—
Th	14.2	17.4	19.6	10.4
U	1.8	2.1	2.2	1.6
V	104	129	111	75
W	1.1	1.2	1.3	0.8
Y	5.7	7.6	8.8	8.9
Zn	35.0	40.1	46.6	36.9
Zr	86.4	98.5	104.0	73.7

— indicates too many samples below detection to calculate geomean
(a) except where noted otherwise

upslope (in DC1s), and finer material being moved further downslope. The concentration of F is expected to decrease rapidly under weathering conditions, but may remain in micas or, in acidic conditions, adsorbed onto clays (Wedepohl, 1978a).

Samples of BIF have been treated separately. Only two samples have been sourced from this unit (Table 8). Although they have similar low SiO₂ and high Fe₂O₃, their

diversity in terms of other components prohibits making any generalizations.

Regolith units derived from the Bryah Group

The regolith units of the Bryah Group and their geomean values are listed in Table 9. There has been no attempt to

Table 8. Analytical results for samples of regolith units derived from banded iron-formation

<i>GSWA number</i>	<i>133923</i>	<i>133929</i>
<i>Sample type</i>	<i>stream</i>	<i>stream</i>
<i>Regolith unit</i>	<i>E4s</i>	<i>E4s</i>
	Percent	
SiO ₂	38.60	41.46
TiO ₂	0.72	0.68
Al ₂ O ₃	9.73	11.52
Fe ₂ O ₃	50.37	43.25
MnO	0.15	1.60
MgO	0.14	0.27
CaO	0.03	0.03
Na ₂ O	0.01	0.02
K ₂ O	0.36	0.67
P ₂ O ₅	0.18	0.26
	Parts per million (a)	
Ag	<0.5	<0.5
As	50.0	60.0
Au (ppb)	<1	1
Ba	218	1056
Be	1.4	1.9
Bi	0.7	0.5
Ce	34	70
Co	9.6	33
Cr	703	610
Cu	21.0	45.0
F	220	220
Ga	25.0	29.0
La	13	21
Li	6.2	11.0
Mo	2.9	3.4
Nb	11.0	11.0
Ni	39.0	61.0
Pb	45.0	77.0
Pd (ppb)	2	2
Pt (ppb)	3	4
Rb	32	46
S	240	270
Sb	2.9	2.0
Sc	11.0	14.0
Se	5.3	3.6
Sn	2.9	2.5
Sr	11	25
Ta	1.5	2.0
Te	1.0	1.0
Th	27.0	22.0
U	3.1	3.4
V	230	206
W	2.6	3.0
Y	7.6	8.4
Zn	52.0	82.0
Zr	138.0	132.0

(a) except where noted otherwise

Table 9. Element geometric mean values for regolith units derived from the Bryah Group

<i>Regolith unit</i>	<i>E4s</i>	<i>DC1s</i>	<i>DC2s</i>	<i>DC3</i>
<i>No. of samples</i>	<i>n=11</i>	<i>n=26</i>	<i>n=4</i>	<i>n=5</i>
	Percent			
SiO ₂	53.67	54.97	76.44	68.21
TiO ₂	0.48	0.53	0.52	0.40
Al ₂ O ₃	9.31	8.52	8.90	8.57
Fe ₂ O ₃	24.57	21.28	8.94	8.97
MnO	0.39	0.15	0.05	0.06
MgO	0.22	0.15	0.12	0.21
CaO	0.05	0.03	0.03	0.11
Na ₂ O	0.04	0.02	0.05	0.17
K ₂ O	0.74	0.52	0.65	0.93
P ₂ O ₅	0.17	0.12	0.07	0.07
	Parts per million (a)			
Ag	—	—	—	—
As	34.0	26.1	10.8	13.5
Au (ppb)	—	1	—	—
Ba	503	284	180	358
Be	1.7	1.2	0.8	1.0
Bi	0.5	—	—	—
Ce	53	41	35	34
Co	17.8	11.9	6.9	10.5
Cr	413	396	280	269
Cu	48.2	29.1	24.8	27.3
F	168	162	167	99
Ga	16.9	15.4	13.6	13.3
La	20	17	17	16
Li	6.9	6.4	6.8	7.1
Mo	2.8	3.1	3.3	3.7
Nb	6.6	6.3	6.6	6.4
Ni	56.3	38.8	22.6	49.0
Pb	46.6	32.6	17.5	22.8
Pd (ppb)	2	2	2	2
Pt (ppb)	3	2	1	1
Rb	47	36	45	48
S	128	120	81	104
Sb	1.5	1.5	0.9	1.0
Sc	11.6	9.8	9.6	7.8
Se	1.6	1.7	1.3	0.9
Sn	1.8	1.8	1.8	1.6
Sr	22	18	20	37
Ta	0.8	0.8	1.0	0.8
Te	0.6	—	—	—
Th	15.4	15.2	13.0	12.7
U	2.6	2.2	2.0	2.0
V	141	149	116	113
W	1.6	1.4	—	1.1
Y	9.0	8.1	8.8	8.8
Zn	67.3	48.9	36.6	42.2
Zr	85.6	92.0	86.1	87.8

— indicates too many samples below detection to calculate geometric mean
 (a) except where noted otherwise

highlight the Narracoota Formation (as was done for the adjoining PEAK HILL map sheet: Subramanya et al., 1995), due to the small number of regolith samples overlying this unit on ROBINSON RANGE.

As there are only two samples of E2s from the Bryah Group, they have been grouped with nine samples from E4s. The composition of these 11 samples is highly variable, reflecting the wide range of rocks present (from

feldspathic wacke to ultramafic rocks). As a result of this and the low number of samples collected, downslope trends are not well defined, especially between DC2 and DC3. Components that show a broad decrease in concentration with distance from source include Fe₂O₃, MnO, Ce, Cr and V, whereas SiO₂ increases with distance from source. However, there is also a decrease in As, Ba, Cu, Ni, Pb, S and Zn from E4s to DC2s, but with a slight increase for DC3. From E4 to DC1s

components held in resistate phases, such as Fe_2O_3 , As, and Cr, show only slight decreases, whereas V increases slightly. Other components are more easily leached (Ce, Cu, Ni and S) or broken down (e.g. Ba and Zn) and this may account for their decrease in concentration downslope. The components that have geomeans that increase from DC2 to DC3 may reflect an increase in the fine fraction and clays (e.g. As, Ba and Zn), but may also relate to the formation of complexes in more alkaline environments. For example, Ni may be co-precipitated with Fe and Mn oxides, carbonates and sulfides (Wedepohl, 1978b).

Regolith over the Padbury and Bryah Groups

Overall, the Padbury and Bryah Groups appear to have distinct chemical characteristics. Geomean values appear to reflect the more mafic nature of the Bryah Group compared to the Padbury Group, in terms of higher Fe_2O_3 , MnO, As, Ba, Ce, Co, Cr, Cu, Ni, Pb, S, V and Zn.

Regolith units derived from the Edmund Subgroup of the Bangemall Group

Geomeans for four regolith units derived from the Edmund Subgroup of the Bangemall Basin are presented in Table 10. As discussed previously, there are insufficient samples from the Collier Subgroup of the Bangemall Basin for statistical description of regolith.

The average compositions of E4s and DC1s units are similar, but DC2s has some compositional differences that may show some influence from different source materials. Results from DC2s indicate a higher mafic component than either E4s or DC1s, which is shown by lower SiO_2 and higher Fe_2O_3 , Cr, Sc, Th, V and Zr. The DC3 unit, however, may reflect an increase in kaolinite clay and smaller particles, with its relatively high K_2O , Ba, Rb and Sr. The only downslope trends apparent are increasing SiO_2 (except DC2s), and decreasing F, S, and Zn. The decrease in S may be from leaching or breakdown of sulfides (such as pyrite: FeS_2) which in turn increases the mobility of Zn (as ZnSO_4).

Regional considerations

Archaean granite and granitic gneiss and the Bryah Group are the only two geological units that were adequately sampled to allow regional comparison with results from previous GSWA regolith geochemical mapping projects.

A comparison of geomeans for E4 units (Table 11) from Archaean granitoid on PEAK HILL (Subramanya et al., 1995), Archaean granitic gneiss on SIR SAMUEL (Kojan et al., 1996), and Archaean granitoid from GLENGARRY (Crawford et al., 1996), shows that Archaean granite and granitic gneiss on ROBINSON RANGE has higher Na_2O , K_2O , Ba, Ce, La, Rb, Pb and Sr (except for Rb and Pb on

Table 10. Element geometric mean values for regolith units derived from the Edmund Subgroup of the Bangemall Group

Regolith unit No. of samples	E4s n=10	DC1s n=45	DC2s n=6	DC3 n=19
Percent				
SiO_2	72.17	74.11	67.63	79.07
TiO_2	0.63	0.63	0.84	0.54
Al_2O_3	8.19	8.28	8.24	8.32
Fe_2O_3	9.64	9.33	10.42	5.95
MnO	0.10	0.12	0.09	0.07
MgO	0.27	0.21	0.16	0.17
CaO	0.11	0.07	0.05	0.08
Na_2O	0.08	0.06	0.05	0.12
K_2O	1.07	0.98	0.69	1.37
P_2O_5	0.10	0.09	0.08	0.06
Parts per million (a)				
Ag	—	—	—	—
As	14.8	11.2	10.6	5.4
Au (ppb)	—	—	—	—
Ba	351	303	225	519
Be	1.4	1.3	1.2	1.0
Bi	—	—	—	—
Ce	53	52	52	49
Co	10.2	9.4	9.7	9.5
Cr	159	161	169	120
Cu	32.6	27.1	29.2	20.6
F	251	247	186	154
Ga	14.4	13.7	16.0	13.5
La	25	25	26	24
Li	7.8	7.5	7.5	7.8
Mo	3.9	3.2	2.7	2.8
Nb	7.7	6.6	8.3	6.8
Ni	27.2	21.4	20.8	17.8
Pb	29.4	24.6	20.9	23.9
Pd (ppb)	—	—	—	—
Pt (ppb)	1	—	—	—
Rb	63	59	46	61
S	146	100	75	68
Sb	1.6	1.2	1.1	0.6
Sc	8.5	8.4	9.8	7.4
Se	1.0	0.8	0.7	0.4
Sn	1.7	1.7	2.0	1.5
Sr	34	27	21	38
Ta	0.9	0.7	0.8	0.7
Te	—	—	—	—
Th	11.7	12.9	15.4	13.2
U	2.2	1.8	2.0	1.7
V	165	134	171	92
W	—	—	—	—
Y	12.5	11.0	11.8	10.3
Zn	61.5	52.4	50.8	33.4
Zr	95.4	90.3	106.2	75.5

— indicates too many samples below detection to calculate geomean
(a) except where noted otherwise

GLENGARRY). Both ROBINSON RANGE and GLENGARRY show similarly lower As, Fe_2O_3 , Cr and V than SIR SAMUEL and PEAK HILL. Although comparisons are made between possibly heterogeneous datasets, these concentration differences could indicate regional-scale variations in granitoid chemistry.

For the Bryah Group, geomean values of the 11 grouped E2s and E4s samples from ROBINSON RANGE

Table 11. Comparison of element geometric mean values on different map sheets for E4 regolith units sourced by granitoids

1:250 000 map sheet	SIR SAMUEL	PEAK HILL	GLEN- GARRY	ROBINSON RANGE
Regolith unit	E4m	E4	E4g	E4m
No. of samples	n=7	n=41	n=55	n=254
Percent				
SiO ₂	80.1	77.5	85	82.75
TiO ₂	0.32	0.19	0.20	0.22
Al ₂ O ₃	9.1	8.85	6.70	8.82
Fe ₂ O ₃	3.53	3.57	1.70	2.34
MnO	0.03	—	—	0.02
MgO	0.1	0.2	0.15	0.20
CaO	0.18	0.19	0.04	0.44
Na ₂ O	0.45	0.98	0.39	1.21
K ₂ O	1.12	1.36	1.5	2.01
P ₂ O ₅	0.03	—	—	0.02
Parts per million (a)				
As	3.7	3.7	2.0	1.4
Au (ppb)	—	—	—	—
Ba	316	457	302	778
Be	0.70	0.88	0.70	0.84
Bi	—	—	—	—
Ce	23	19	14	46
Co	5	6	4	4
Cr	132	80	47	52
Cu	15	13	7	10
F	54	69	56	69
Ga	12	13	10	9
La	13	12	8	24
Li	7	4	5	4
Mo	3.0	1.1	1.4	2.5
Nb	4	3.8	7	3.7
Ni	24	13	5	14
Pb	14	15	21	18
Pd (ppb)	—	—	—	—
Pt (ppb)	—	—	—	—
Rb	45	36	68	51
S	52	nd	nd	15
Sb	0.2	0.3	—	0.2
Sc	4.0	3.8	2.0	2.6
Se	0.4	0.8	0.6	—
Sn	—	—	1.1	—
Sr	51	60	23	86
Ta	0.4	nd	nd	0.6
Te	—	nd	nd	—
Th	7	6	7	11
U	1.5	1.1	1.3	0.9
V	58	62	30	31
W	0.6	2.3	1.1	0.5
Y	7.0	4.6	3.0	6.1
Zn	29	17	12	16
Zr	56	55	88	54

nd no data available

— indicates too many samples below detection to calculate geometric mean

(a) except where noted otherwise

are only slightly similar compared to the average composition of 37 E2s and E4s samples on PEAK HILL (Subramanya et al., 1995). ROBINSON RANGE has higher MnO (0.39 vs 0.11%), As (34 vs 19 ppm), Ba (503 vs 172 ppm), Ce (53 vs 11 ppm), La (20 vs 4 ppm), Ni (56 vs 40 ppm), Pb (47 vs 21 ppm), Rb (47 vs 15 ppm), Zn (67 vs 42 ppm), and Zr (86 vs 70 ppm), but lower V (141 vs 310 ppm).

Identification of specific granitoid bodies

Archaean granite and granitic gneiss shown on Figure 2 has previously been mapped as migmatite, quartz-muscovite schist, banded quartz-feldspar rock, and Archaean and Proterozoic granites (Elias and Williams, 1980). Principal-component analysis (Rock, 1988) of regolith has been used to identify geochemically distinct groups of samples and to establish which elements are the principal contributors to each group. In addition, several ratios of CaO/Na₂O, Na₂O/K₂O, K/Rb, Rb/Ba and Th/U have been examined. Only data from E1 and E4m regolith units have been used (n = 269), as they are closest to source materials.

Figures 44 and 45 show maps of principal-component scores for the two main element groups identified by principal component analysis. Positive scores are represented by blue circles and negative scores by red circles. For each element, log-normalized standard scores have been multiplied by a factor weighting, derived from principal component analysis, and these modified scores are then added and termed principal-component scores. The method of deriving log-normalized standard scores has been briefly discussed with regard to chalcophile-index values.

Most of the oxides and elements that contribute to high positive scores in principal component 1 (Fig. 44) are normally associated with more mafic lithologies (TiO₂, Fe₂O₃, MnO, P₂O₅, As, Co, Cr, Cu, Li, Nb, Ni, S, Sb, Sc, Sn, Th, V, Y, Zn and Zr). Their distribution suggests input of mafic material from the Mount Maitland greenstone belt, numerous small outcrops of dolerite and amphibolite, and R4 regolith situated southeast of Mount Marquis and west of Errabiddy homestead. In comparison, negative scores (red circles) indicate felsic input (Ba, K₂O, Na₂O, SiO₂ and Sr). Large negative scores are recorded for samples sourced by areas mapped as Proterozoic granite (Mount Marquis, north of Trillbar homestead, west of Mount Marquis and northwest of Bullaroo Hill) by Elias and Williams (1980), and a large area mapped as Archaean biotite adamellite, granite and granitic gneiss in the southeast of ROBINSON RANGE (Elias and Williams, 1980).

The major oxides and elements associated with principal component 2 (Fig. 45) are Al₂O₃, K₂O, Na₂O, Ba, Be, Ga, Rb and Sr. Positive principal-component scores (blue circles) identify several groups. Higher positive scores are recorded in Proterozoic granite (Mount Marquis), an area to the east mapped as Wilthorpe Granite by Windh (1992), an area mapped as Archaean migmatite and biotite adamellite by Elias and Williams (1980) in the southwest, and an area of Archaean biotite adamellite – quartz monzonite – leucogranite in the southeast part of the map sheet. The major contributing oxides and elements for the negative scores of principal component 2 are SiO₂, Cr, Cu, V, S, Fe₂O₃ and Ni. Larger negative scores are recorded in samples close to BIF (east of Red Peak), R1 and amphibolite (west of Mount Marquis, northeast of Yarlalweelor homestead and in the west of the map sheet), and small dolerite sills (east of old Trillbar outcrop).

The positive scores of principal component 2 should be similar to the negative scores of principal component 1, because they have similar suites of major contributing oxides and elements. However, this is not the case for areas west of Mount Marquis, areas in the southwest and southeast of the map sheet, and the Wilthorpe Granite. Ratios of specific granitic elements are used in an attempt to identify whether these variations in granitic response (between positive PC2 and negative PC1) could be explained by any specific lithological or geochemical variation.

The area west of Mount Marquis has only large negative scores for principal component 1 (Fig. 44). It is an area mapped as a deeply weathered granite, which is supported by the analytical results. Compared to surrounding granite samples, the area has lower K_2O , CaO , Na_2O , Rb and Sr with some elevated Th/U values.

The southwest corner of ROBINSON RANGE has high positive principal component 2 scores (Fig. 45) but only low negative values for principal component 1 (Fig. 44). The area has low values for all ratios used, but has elevated K_2O , Pb , Rb and low Sr compared to other granites on ROBINSON RANGE.

The southeast corner of ROBINSON RANGE has a group of negative values for principal component 2 (Fig. 45) where they are expected to be positive. These samples have an elevated K/Rb ratio and lower Na_2O and Ga compared to the surrounding granite. The area is mapped as colluvium by Elias and Williams (1980), and the regolith in the area is a lag of granite and quartz fragments, overlying granite and granitic saprock outcropping or occurring just below the surface. This may indicate increased weathering of granite, rather than original compositional variations.

Granitic gneiss near Talbot Divide also has generally high values for K/Rb but with high Sr concentrations, relatively high Na_2O/K_2O , and relatively low Th/U and Rb/Ba . Granitoid around Hendersons may be compositionally similar because it has high Sr and low Rb/Ba and Th/U , but with low Na_2O/K_2O . An elevated Th/U ratio to the west of Hendersons may reflect input from numerous small dolerite sills.

The Wilthorpe Granite has elevated Rb/Ba and relatively low K/Rb , with low Na_2O , CaO and Sr compared with other granites on ROBINSON RANGE. The only other area of elevated Rb/Ba values corresponds to an area of presumed Proterozoic muscovite granite and Archaean migmatite that extends west and north from Bullaroo Hill.

A geochemically distinct area within the Archaean granite and granitic gneiss is situated south of Errabiddy homestead. The area has been mapped as migmatite and granitic gneiss with extensive relict cover and numerous small outcrops of quartz magnetite rock, amphibolite and ultramafic rocks. Several samples from this area show elevated TiO_2 , Ce , La , Nb , Sn , Te , U , Y and Zr . Whereas elevated concentrations of TiO_2 , Th , U and Zr may be the result of derivation from quartz-magnetite rock, ultramafic rock, amphibolite and lateritic pisolites,

elevated Ce , La , Nb , Sn , Te and Y may suggest a pegmatitic source.

Economic geology

Gold

Figure 46 shows known Au mineralization and contoured regolith Au concentration. Details of individual deposits are presented in Appendix 1.

Most known gold mineralization and past production on ROBINSON RANGE are from the Labouchere and Fortnum deposits (Fig. 46). Samples from these two areas show the highest regolith gold values (554 and 47 ppb). Although most gold deposits are highlighted by areas of elevated regolith gold concentrations, there are exceptions, such as the minor workings at Wilthorpe and Duffer, although the precise location of Duffer is uncertain.

There are several other areas where regolith gold concentrations are greater than or equal to 2 ppb. In the east of ROBINSON RANGE, several higher values correspond to areas of Narracoota Formation (about 12 km northwest of Mount Padbury, approximately 8 km east of Trillbar homestead, and about 10 km south-southeast of Mount Fraser mining centre) and hematitic shale of the Bryah Group, and quartzofeldspathic wacke of the Padbury Group. Several of these elevated gold values within the Bryah and Padbury Groups are accompanied by relatively elevated Pt and Pd concentrations. Elevated gold values also feature in some samples sourced by granites, including the possible area of pegmatite in the west of the map sheet, and a granite located approximately 15 km northwest of the Livingstones Find deposit. Elevated values within the area mapped as Proterozoic granite in the northwest of ROBINSON RANGE correspond to samples sourced by a quartz vein (about 7 km south of Mount Clere), or with possible influence from a dolerite sill (approximately 18 km west-northwest of Mount Clere). The Bangemall Basin has a single elevated value sourced by arenite (about 8 km west of the Mount Clere homestead), and another possibly associated with a dolerite sill (Sawback Range).

Other mineralization

As discussed previously, there are known deposits of copper, iron ore, manganese, talc and variscite on ROBINSON RANGE. This section examines whether the geochemistry of regolith samples has highlighted known deposits or other potential mineralization.

Copper, lead, and zinc

There are elevated Cu , Pb and Zn values to the east of ROBINSON RANGE, within the Bangemall, Bryah and Padbury Groups. However, samples taken in the vicinity of the Cu deposit 12 km southwest of Milgun homestead show only very slightly elevated Cu concentrations.

The highest Cu value (196 ppm) on ROBINSON RANGE is sourced by the Narracoota Formation of the Bryah Basin in the southeast corner of the map sheet. This sample site

also shows the highest Co (96 ppm), and elevated Pt (10 ppb), Sc (42 ppm), V (617 ppm), Y (28 ppm) and Zn (187 ppm) but low Pb. In comparison, the maximum Cu value for the adjoining PEAK HILL map sheet is 220 ppm. Another elevated value on ROBINSON RANGE, sourced by the Narracoota Formation, is located approximately 16 km southeast of Mount Fraser. Also within the Bryah Basin, elevated values situated north and east of Fortnum gold mine are sourced by the Narracoota Formation and shale, and the Horseshoe Formation respectively. The Padbury Basin shows few elevated values of Cu associated with BIF. Within the Bangemall Basin, relatively high values are sourced from Sawback Range (possibly influenced by a dolerite sill or the Discovery Chert), the Backdoor Formation of Dunns Range, and an area including and extending north of Mount Arapiles (sourced by the Discovery Chert, Jillawarra Formation, and small dolerite sills). There are also slightly elevated values associated with the ultramafic rocks of the Trillbar Complex (west of Trillbar homestead) and the Mount Maitland greenstone belt.

Elevated Pb values (maximum 94 ppm) on ROBINSON RANGE are predominantly associated with BIF and hematitic shale of the Padbury Basin and the Horseshoe Formation (southeast of Fortnum gold mine) and hematitic shale (near the Mount Padbury Mn deposit) of the Bryah Basin. Granite and granitic gneiss have relatively low lead concentrations, with the exception of one value of 63 ppm in the southwest corner of ROBINSON RANGE. There is one value of 88 ppm within mapped Proterozoic granite to the northwest; however, this sample is downslope from Mount Clere (orthoquartzite and muscovite-quartz schist).

The higher Zn values occur in the Bangemall Basin, and the maximum (255 ppm) is of a similar magnitude to that on PEAK HILL (283 ppm). Elevated values are situated south and north-northwest of Mount Arapiles, and at Sawback Range, which have regolith derived from the Jillawarra Formation (siltstone, shale and chert), Discovery Chert and dolerite sills. There are less elevated Zn values in the Bryah and Padbury Groups associated with the Horseshoe and Narracoota Formations, hematitic shale and BIF.

Iron ore

The Archaean banded-iron deposits at Mount Taylor and Mount Gould are not highlighted by elevated Fe_2O_3 in regolith samples. Elevated Fe_2O_3 concentrations are largely confined to the Bryah and Padbury Basins. The highest values are located in the Horseshoe Formation (southeast of Fortnum gold mine), and the BIF and hematitic shale near Mount Padbury and the Millidie manganese deposit.

Manganese

There are few elevated Mn concentrations other than those corresponding to the known Mn deposits of Millidie, Mount Fraser and Mount Padbury. The Horseshoe Formation east and southeast of Fortnum gold mine, and Mount Arapiles (west of Milgun homestead) have only slightly elevated concentrations, ranging from 0.7 to 1.4%.

Chalcophile-index values

Chalcophile elements are used as indicators to show potential for both gold and base-metal mineralization (Kojan et al., 1996). Figure 47 is a plot of log normalized chalcophile-index values (CIVs). The elements As, Bi, Mo, Sb, Se, Sn and W were log-normalized and combined to derive the CIVs, which range between 0 and 19. The highest values are calculated for regolith samples from the Bryah, Padbury and Bangemall Basins, with very low values for Archaean granite and granitic gneiss, Proterozoic granite, the Trillbar Complex, and the Mount Maitland greenstone belt. Regolith over the proposed pegmatitic granite in the west of ROBINSON RANGE has only small CIVs. Elevated values correspond to some areas of known mineralization, but values are low for the Mount Maitland, Wilthorpe and Mount Seabrook gold deposits.

Elevated CIVs within the Bangemall Basin occur within the Edmund Subgroup at and extending north from Mount Arapiles, and correspond to several regolith samples with relatively elevated TiO_2 , MgO, CaO, Be, Cu, F, Nb, Rb, S, Y, Zn and Zr. Samples from Sawback Range also have elevated CIVs, especially one sample that shows the highest Ag (3.9 ppm), Mo (32 ppm), and S (5420 ppm), together with relatively high TiO_2 , MgO, Pb and U. Other regolith samples from Sawback Range also have relatively high TiO_2 , MgO, CaO, F, S, Sc, V and Zn. As mentioned previously, these elevated concentrations at Sawback Range may be associated with a dolerite sill, although it is not possible to discount the input from the Discovery Chert, and the Jillawarra and Backdoor Formations.

Areas within the Bryah Group highlighted by elevated CIVs are similar to areas which show an elevated gold and base-metal response. Elevated CIVs are reported for regolith samples around the Fortnum gold mine (corresponding to Narracoota Formation) and areas to the north (shale) and southeast (Horseshoe Formation). Regolith sourced by the following have elevated CIVs: the Narracoota Formation northwest of Mount Padbury; hematitic shale and BIF hosting the Mount Padbury Mn deposit; and shale south of the Millidie Mn deposit.

The Padbury Group shows elevated CIVs over the BIF of Robinson Range, including Mount Padbury and Mount Fraser (including the Mount Fraser Mn deposits), and BIF west and southwest of Fortnum. North of Sawback Range the small area of Padbury Group comprising shale and orthoquartzite also shows lower, though still elevated CIVs.

Regolith acidity-alkalinity and TDS

Results of the regolith pH values are presented as contoured values in Figure 48. There were only 27 TDS values above detection limit, and these are plotted as circles overlying the contoured pH values.

The pH values for ROBINSON RANGE lie between 4.6 and 9.4, with the majority being acidic to slightly acidic

(between 5.5 and 6.5). In general, the more alkaline samples were collected in the Gascoyne and Murchison River systems, commonly associated with calcrete platforms (DA8). However, a value of 8 near Red Peak is from DC1 in Archaean granitic gneiss. There are also high values west and north of Mount Arapiles, in the northeast of the map sheet. The lowest pH value (4.6) occurs downstream of the Mount Maitland gold mine. Low pH values are commonly measured in DC3 sheetwash environments although others are from upland samples (E4 and DC1) in Archaean granite and granitic gneiss, and in the Edmund Subgroup.

TDS values above detection level for ROBINSON RANGE lie between 52 and 3342 mg/L. The highest values occur in the Murchison and Gascoyne River systems, with most being near calcrete platforms. There are some lower values in DC2s and DC3 regolith units, which occur close to the major drainage floors.

Groundwater TDS

A contoured plot of groundwater TDS (from data supplied by the Water and Rivers Commission) is shown in Figure 49. Values range between 170 to 8900 mg/L. Groundwater TDS cannot be directly compared with regolith TDS, because measurements are performed using different techniques, on different media.

High groundwater TDS occur in the north and south of ROBINSON RANGE, mainly near the major drainage floors (predominantly DC3/DA5 regolith units). However, one of the highest values, in the southeast of ROBINSON RANGE, occurs over flat-lying granite (E4m).

Summary and conclusions

As part of the GSWA regional regolith and geochemical mapping program, regolith on ROBINSON RANGE has been mapped and sampled at a density of 1 sample per 16 square kilometres. A total of 1019 regolith samples have been collected, comprising 744 stream samples, 184 sheetwash samples, and 91 soil samples. Analyses of 47 elements have been carried out, and the results of 43 of these are sufficiently above detection level to warrant their presentation. The results for all analyses, including pH and TDS, are included as an attached digital datafile (ROBCHEM.CSV).

The major products of this study are a regolith-materials map (Plate 1), maps of WAMEX open-file company surface geochemical surveys (Plates 3 and 4), and element-concentration maps (Figs 4–43).

ROBINSON RANGE includes the southern boundary of the Bangemall Group and the western boundaries of the Padbury, Bryah and Yerrida Groups, as shown on a simplified geology map (Fig. 2). This map groups several granitoid units of Elias and Williams (1980) into a large unit of Archaean granite and granitic gneiss. The justification for this is that because the granites were derived from Archaean granitic rocks, they are assumed

to have broad geochemical similarities. Principal component analysis, and using regolith geochemistry and ratios of $\text{CaO}/\text{Na}_2\text{O}$, $\text{Na}_2\text{O}/\text{K}_2\text{O}$, K/Rb , Rb/Ba and Th/U , have identified distinct areas within the area of granite and granitic gneiss. This includes distinguishing the previously mapped Proterozoic granite of Mount Marquis (Elias and Williams, 1980) and the Wilthorpe Granite (Windh, 1992) as distinct from other granite and granitic gneiss. Archaean granite and granitic gneiss areas situated near Talbot Divide and Hendersons have been identified as geochemically similar. However, an area of granite and granitic gneiss in the west of ROBINSON RANGE with elevated TiO_2 , Ce, La, Nb, Sn, Te, Th, U, Y and Zr may be pegmatitic.

The regolith-materials map of ROBINSON RANGE (Plate 1) delineates 28 units. Four of these correspond to a relict regime, nine to an erosional regime and 15 to a depositional regime. Most regolith has been divided in terms of source materials as far downslope as a DC2 landform position. The results of XRD analysis of 15 samples and the downslope chemical variation in regolith suggest that a high proportion of primary minerals, such as feldspar, micas and amphibole, persist to a DC2 slope position.

There are minor geochemical differences between stream and soil/sheetwash samples, which are the result of most stream samples being collected in erosional (E2 and E4) or upper slope colluvial (DC1) regimes, whereas soil/sheetwash samples were mostly collected downslope, in DC3 (sheetwash plain) regolith. In comparison with stream samples, soil and sheetwash samples are grouped together because they show similar field characteristics.

Descriptive statistics have been performed on regolith samples grouped in terms of regolith unit and source rocks. Only those geological units with significantly large sample populations have been described, and these include Archaean granite and granitic gneiss, Proterozoic granite, the Bryah Group, Padbury Group, and the Edmund Subgroup. Geometric mean values are used to compare geological units and to identify any downslope compositional trends.

Table 12 presents the average chemistry of E4 regolith samples for geological units on ROBINSON RANGE. E4 samples are shown because they represent the materials sampled closest to source rocks. Although geological units such as the Bryah Group represent a wide range of rocks, the geomean values highlight them as distinctive units. Granitic units (Archaean granite and granitic gneiss and Proterozoic granite) can generally be distinguished because they show the highest SiO_2 , CaO, Na_2O , K_2O , Ba and Sr, (with the lowest Fe_2O_3 , As, Co, Cr, Cu, F, Ni, Pb, S, Sc, V, Zn and Zr). The Bryah Group shows a high mafic component, which is reflected by the highest Fe_2O_3 , As, Co, Cr, Cu, Ga, Ni, Pb, Sc and Zn, with relatively high V and Zr (and with low SiO_2 , CaO, Na_2O and K_2O). The Padbury Group also shows relatively high Fe_2O_3 , Cr, V, and Zr, but the lowest Ba, La, Rb and Sr. The Edmund Subgroup of the Bangemall Basin is characterized by the highest average TiO_2 , F, S, V, Y and Zr, together with relatively high Co, Cu, Rb and Zn.

Table 12. Comparison of element geometric mean values for regolith on the major geological units on ROBINSON RANGE

Regolith unit No. of samples	E4m n=254	E4m n=10	E4s n=24	E4s n=11	E4s n=10
Geological unit (a)	Agn	Eg	Ep	EA	Eme
Percent					
SiO ₂	82.75	82.02	66.41	53.67	72.17
TiO ₂	0.22	0.15	0.41	0.48	0.63
Al ₂ O ₃	8.82	8.93	7.34	9.31	8.19
Fe ₂ O ₃	2.34	1.50	11.24	24.57	9.64
MnO	0.02	0.01	0.10	0.39	0.10
MgO	0.20	0.12	0.14	0.22	0.27
CaO	0.44	0.28	0.04	0.05	0.11
Na ₂ O	1.21	1.58	0.04	0.04	0.08
K ₂ O	2.01	2.65	0.71	0.74	1.07
P ₂ O ₅	0.02	0.02	0.07	0.17	0.10
Parts per million (b)					
Ag	—	—	—	—	—
As	—	2.1	13.7	34.0	14.8
Au (ppb)	—	—	—	—	—
Ba	778	720	282	503	351
Be	0.8	1.1	1.0	1.7	1.4
Bi	—	—	—	0.5	—
Ce	46	34	33	53	53
Co	4.1	2.5	7.7	17.8	10.2
Cr	52	26	198	413	159
Cu	10.3	8.5	21.9	48.2	32.6
F	69	109	146	168	251
Ga	9	11	12	17	14
La	24	20	14	20	25
Li	3.6	4.0	5.4	6.9	7.8
Mo	2.5	3.5	3.0	2.8	3.9
Nb	3.7	3.8	4.8	6.6	7.7
Ni	13.5	8.2	24.9	56.3	27.2
Pb	17.9	18.6	29.0	46.6	29.4
Pd (ppb)	—	—	1	2	—
Pt (ppb)	—	—	1	3	1
Rb	51	85	38	47	63
S	15	19	77	128	146
Sb	0.2	0.2	1.0	1.5	1.6
Sc	2.6	—	6.9	11.6	8.5
Se	—	—	1.1	1.6	1.0
Sn	—	—	1.6	1.8	1.7
Sr	86	82	16	22	34
Ta	0.6	0.4	0.7	0.8	0.9
Te	—	—	—	0.6	—
Th	11.3	9.9	14.2	15.4	11.7
U	0.9	1.3	1.8	2.6	2.2
V	31	20	104	141	165
W	—	—	1.1	1.6	—
Y	6.1	6.0	5.7	9.0	12.5
Zn	16.2	13.7	35.0	67.3	61.5
Zr	54.3	62.7	86.4	85.6	95.4

— indicates too many samples below detection to calculate geometric mean
 (a) Agn — Archaean granite and granitic gneiss; Eg — Proterozoic granite; Ep — Padbury Group; EA — Bryah Group; and Eme — Bangemall Group (Edmund Subgroup)
 (b) except where noted otherwise

Certain chemical trends are apparent in samples collected at increasing distances from source materials. For E4m to DC3 over Archaean granite and granitic gneiss and Proterozoic granite, there is a loss of CaO, Na₂O, K₂O, Ba, Rb and Sr reflecting the breakdown of feldspar and micas. This is accompanied by increasing TiO₂, Fe₂O₃, Co, Cr, Cu, Ni, S, V and Zn, reflecting the concentration of

resistate minerals (often in the fine fraction) and the increase of the clay component. However, unlike previous geochemical mapping studies for SIR SAMUEL (Kojan et al., 1996), LEONORA (Bradley et al., 1995) and MENZIES (Kojan and Faulkner, 1994) there is no significant increase in quartz with increasing distance from source.

The Padbury Group has element trends with increasing distance from source that may be due to increasing quartz, clay and fine-fraction components (e.g. for Ba). Ferric oxide, As, Cr, F and V increase from E4 to DC1, then decrease to DC3, which may be the result of the concentration of more resistant materials and the fines moving further downslope.

Regolith units derived from the Bryah Group also contain increasing quartz downslope. E4s to DC1s units show little difference in components held in resistant (Fe) minerals, whereas other element concentrations decrease (Ba, Ce, Cu, Ni, Pb, S and Zn). Elements that decrease in concentration from E4 to DC2 and slightly increase at DC3 may relate to an increase in clays and the fine fraction (As and Ba), or possibly to the formation of insoluble complexes and redeposition (Ni, S and Zn).

The only apparent downslope trends for the Edmund Subgroup are increasing quartz, and removal of F, S and Zn with the breakdown of sulfides, such as pyrite.

Gold geochemistry results show expression of the major gold mines and deposits on ROBINSON RANGE, with the exception of the minor Wilthorpe and Duffer deposits. Regolith over the Bryah and Padbury Groups has several other elevated gold concentrations, accompanied by relatively elevated Pd and Pt concentrations. These are hosted by regolith derived from the Narracoota Formation and hematitic shale of the Bryah Group, and quartzofeldspathic wacke of the Padbury Group. There are two main elevated gold concentrations from the Bangemall Basin, one sourced by arenite, whereas the other may represent influence from a dolerite sill (in the northwest of ROBINSON RANGE). Regolith over granite and granitic gneiss includes a few elevated gold values associated with the proposed pegmatitic granite in the west of ROBINSON RANGE, and others that represent influence from a dolerite sill and a quartz vein.

Known base-metals and other mineralization on ROBINSON RANGE include deposits of Mn, Cu, iron ore, talc, and variscite. The highest base-metal concentrations occur in the east of ROBINSON RANGE, in regolith over the Padbury and Bryah Groups and Edmund Subgroup. In the Padbury and Bryah Groups, elevated Mn concentrations in the regolith are located proximal to known Mn deposits. However, known deposits of Cu and Fe on ROBINSON RANGE are not identified by elevated regolith concentrations. Maximum regolith concentrations of Fe₂O₃, Cu, Mn, Pb and Zn are similar to those on the adjoining PEAK HILL (Subramanya et al., 1995).

Although maximum Cu, Pb and Zn concentrations in the regolith on ROBINSON RANGE are not extremely high, they are comparable with regolith samples near known deposits from previous geochemical mapping studies on MENZIES (Kojan and Faulkner, 1994), LEONORA (Bradley

et al., 1995), GLENGARRY (Crawford et al., 1996) and PEAK HILL (Subramanya et al., 1995).

A plot of CIVs reinforces the higher relative prospectivity for gold and base-metal deposits within the Bangemall, Bryah and Padbury Groups compared to the granite and granitic gneiss terrain. Areas within the Bryah Group (Narracoota Formation, Horseshoe Formation and hematitic shale) and Padbury Group (BIF and hematitic shale) with high CIVs and base-metal concentrations are associated with elevated Fe concentrations. Prospective areas indicated within the Bangemall Group include Sawback Range, Mount Arapiles northwards, and Dunns Range, which have elevated regolith base-metal and CIV responses, accompanied by elevated sulfur concentrations.

Regolith on ROBINSON RANGE is mostly acidic to slightly acidic (pH 5.5–6.5). The lowest pH is downstream from Mount Maitland gold mine. The more alkaline samples are from within the Murchison and Gascoyne drainage systems, commonly associated with calcrete platforms. Regolith TDS values above detection are also mostly within these major drainage systems.

Higher groundwater TDS values similarly occur near the main drainage floors (in DC3/DA5 slope position) situated in the north and south of ROBINSON RANGE. However, one of the highest values occurs in E4 regolith over granite.

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Appendix 1

Historical gold-production record for ROBINSON RANGE (as of 30 June 1996)

Bradley et al.

Goldfield	Mining centre	Lease number	Name	— Location (AMG) —		Alluvial	Dollied	Ore treated (t)	Gold produced (g)	Inground resources (t)	Total gold (kg)	Year	
				Easting	Northing								
						(g)	(g)						
PEAK HILL	Wilthorpe	300P	Wilthorpe sundry claims	630636	7177192			47.8 90.4	651.0 799.7		0.7 0.8	1904	
	Total					0.0	0.0	138.2	1 450.7		1.5		
	Horseshoe	561P	Nathan Bitter	631200	7199850			194.1	2 884.2		2.9	1943] same ground
		565P	Nathan Bitter	631200	7199850			582.2	5 328.9		5.3	1945–50	
			Subtotal					776.3	8 213.1		8.2		
		560P	Labouchere Range (a)	627800	7204850			1 145.5	5 169.6		5.2	1940–41	
		558P	Mount Labouchere (a)	627800	7204850	484.3		0.0	0.0		0.5	1939	
		564P	Labouchere Main Lode	627800	7204850		395.3	1 774.4	8 486.5		8.9	1945–47] same ground
		575P	Labouchere Main Lode	627800	7204850			1 038.4	3 206.1		3.2	1948–58	
			Subtotal			484.3	395.3	3 958.3	16 862.2		17.8		
		?	Labouchere–Nathans	631696	7199889			2 886 025.0	6 936 064.0		6 936.1	1989–1994	
			Labouchere–U/G	627745	7204881					0.5	470.0		
	Labouchere–Wilthorpe		630588	7177994					0.0	29.0			
		Subtotal					2 886 025.0	6 936 064.0	0.5	7 435.1			
	Fortnum			636372	7197627			1 758 224.0	5 114 965.0		5 115.0	1990–1995	
				636372	7197627			840 000.0	2 115 000.0		2 115.0	1995–1996	
			Fortnum Group	636372	7197627					0.2	155.0		
			Alton	636372	7197627					0.0	24.0		
			Callies	636193	7196552					1.0	1014.0		
			Eldorado	636730	7197285					0.1	127.0		
			Ricks	636266	7198306					0.2	206.0		
			Toms Hill	637162	7198358					0.7	726.0		
			Trev's Group	636413	7198888					3.8	3 789.0		
			Yarlarweelor	636723	7196423					7.4	7 417.0		
			Subtotal					2 598 224.0	7 229 965.0	13.4	20 688.0		
	Total						484.3	395.3	5 488 983.6	14 191 104.3	13.9	28 149.1	
	Mount Fraser	34P	Mount Fraser	645298	7164733			118.9	3 515.9		3.5	1900–02] same ground
		317P	Mount Fraser	645298	7164733			144.8	4 624.7		4.6	1907–08	
		279P	Starlight	645298	7164733			132.1	1 842.2		1.8	1904	
	Mount Padbury	602P	Duffer (b)	616931	7148952			9.7	476.5		0.5	1960	
			sundry claims			2 745.8	1263.1	488.4	14 311.1		18.3		
	Total						2 745.8	1263.1	893.9	24 770.4	0.0	28.7	
	Mount Seabrook	541P	Mount Seabrook No. 1	567270	7170670		157.1	240.3	7 819.9		8.0	1935–36] same ground
		'541P, 542P'	Mount Seabrook GM Ltd	567270	7170670			332.5	4 593.0		4.6	1937–39	
		542P	Mount Seabrook No. 2	567270	7170670			57.4	907.3		0.9	1936	
		sundry claims			563.0		1 113.8	25 083.4		25.6			
Total						563.0	157.1	1 744.0	38 403.6		39.1		

Appendix 1 (continued)

Goldfield	Mining centre	Lease number	Name	Location (AMG)		Alluvial (g)	Dollied (g)	Ore treated (t)	Gold produced (g)	Inground resources (t)	Total gold (kg)	Year
				Easting	Northing							
MURCHISON	Mount Maitland	1563N	Maitland North	602650	7150600			89.4	2 491.7		2.5	1933
		2561	Maitland North	602650	7150600			245.0	1 186.0		1.2	1981–82
		2759	Maitland	601400	7148350			60.0	47.0		0.0	1983
			sundry claims					487.5	7 537.5		7.5	
		Total				0.0	0.0	881.9	11 262.2	0.0	11.2	

(a) Uncertain position, most likely correlating with Labouchere Main Lode

(b) Uncertain position, but probably corresponds to Mount Padbury – Deep Well mineralization

Appendix 2

Production figures and resources for minerals other than gold (as of 30 June 1996)

<i>Holder</i>	<i>Centre/location project</i>	<i>Mineral field</i>	<i>Ore processed (t)</i>	<i>Mineral/metal produced (t)</i>	<i>Year</i>
MANGANESE					
Broken Hill Pty Ltd	Mount Fraser	PEAK HILL	5 074	2 730	1949
Leases include:			5 132	2 510	1950
'Mount Padbury — MC 30P, 31P'			2 201	1 139	1951
'Mount Fraser — ML 105, 64, 65'			918	445	1952
'Horseshoe — MC 28P, 29P'			29 989	14 403	1965
			21 562	10 027	1966
			8 964	4 124	1967
		Total	73 840	35 378	
Dampier Mining Co Pty Ltd (lease ML 52/65)	Mount Fraser	PEAK HILL	16	8	1979
			212	100	1980
		Total	228	108	
Universal Milling Co Pty Ltd	Mount Padbury	PEAK HILL	2 267	1 099	1977
			922	438	1978
			1 379	654	1979
			1 481	704	1980
			1 196	568	1981
			74	35	1982
		Total	7 319	3 498	
VARISCITE					
Bennett JSC	Milgun station	PEAK HILL		1.143	1992
				0.720	1993
		Total		1.863	
TALC					
Sons of Gwalia	Mount Seabrook	Peak Hill		441 326	1974–1995
				4 500	1995–1996
		Total		445 826	

INGROUND RESOURCES

<i>Mineral/ore</i>	<i>Project/site</i>	<i>Tonnage (Mt)</i>	<i>Contained metal/mineral (Mt)</i>
Iron ore	Mount Taylor	1.46	0.88
Manganese ore	Millidie	0.20	0.10
Pigments (hematite)	Mount Gould	0.09	0.09
Talc	Mount Seabrook		
	Livingstone	0.19	0.19
	Mount Seabrook	1.55	1.55
	Total	1.74	1.74

Appendix 3

WAMEX open-file geochemical surveys

KEY	
ID No.	Project reference number — allocated for these notes.
Map sheet	1:100 000 sheet number(s) to aid in project location (Plates 3 and 4).
Area (sq km)	Project area. When the project extends outside ROBINSON RANGE the area is not stated.
Company	The company that carried out the geochemical exploration. Expl: Exploration
M No.	GSWA project reference number.
Item No.	DME library reference number for a group of related open-file reports on microfiche; the Item number replaces the M number for project identification.
A No.	GSWA reference number for individual exploration reports.
Yr	The year that the report was written.
Medium	How the sample was obtained RAB: Rotary air blast drilling RC: Reverse circulation drilling
No/Ag to Zn	The number of samples from the medium indicated, and each element determined marked 'X' or 'x'. The 'x' means that this element was not determined for the entire number of samples listed. If more than one analytical method is used for a group of samples from a particular medium, a new line is taken to identify the elements relevant to each method.
Method/Analyst	Blanks occur in these columns if the information is not given in the company report. AAS: Atomic absorption spectroscopy AR: Aqua regia BLEG: Bulk leach extractable gold DIBK: Di-isobutyl ketone ETA: Electrothermal absorption FA: Fire assay Hydride: Hydride generation ICP: Inductively coupled plasma MS: Mass spectroscopy OES: Optical emission spectroscopy XRF: X-ray fluorescence AAL: Australian Assay Labs ALS: Australian Laboratory Services PML: Perth Metallurgical Labs RDG: Resources Development RW: Rapley Wilkinson TEL: Trace Element Labs
DD	'Y' marked in this column indicates deep drilling activity.
Comments	Further sample details with regards to collection and analysis. D: Depth DL: Detection limit — only correlates to gold analyses sub: subsamples

NOTES: For public use, all open-file company reports indexed in WAMEX are provided on microfiche in the Department of Minerals and Energy (DME) library at Mineral House. To locate a particular report on microfiche, the relevant Item number and A number are required.

Appendix 3

Open-file surface

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu
1A	2346 2446	50	Conwest Aust	221	1758	1667	1968	RAB	10		x		x		X
1B	2346 2446	12	Conwest Aust	221	1758	2207	1971	RAB Soil	18 2 875						X X
2	2446	7	International Nickel Aust	712	1780	2204	1971	RAB Rock Soil	21 38 2 292						X X X
3	2346		Day Dawn Minerals	717	1782	2211	1971	Rock Soil	7 27				X X	x X	X X
4	2546	7	Falconbridge Aust	736	1787	2281	1972	Rock	39				X	X	X
5	2546	7	Jododex Aust	779	2382	2425	1972	Percussion Rock Soil	10 15 209						X X X
6	2546	13	Australasian Minerals	824	1012	2499	1972	Rock Soil	36 4				X X	x X	X X
7	2546		Le Nickel Aust Exploration	841	2059	2521	1971	Soil	1 550				X		X
8	2546	10	Carpentaria Exploration Co	952	1765	2789	1971	Auger Percussion	300 23					X	X
9	2547	5	Newmont	1705	339	5658	1974	Rock	51			X			
10	2346 2446	60	Western Mining Corp Western Mining Corp	1998/1 1998/1	876 876	7339 8204	1977 1978	Ironstone Ironstone Percussion	419 225 3	X			X	X X	X X
11A	2547	200	CRA Exploration	2064/6	5978	7327	1977	Rock Stream	54 5		X X	X X		X X	X X
11B	2547	200	CRA Exploration	2064/6	5978	7328	1977	Soil Stream	340 6			X X		X X	X X
11C	2547	9	CRA Exploration	2064/6	5978	9070	1980	Percussion	10	X				X	X
11D	2547	65	Forrest Gold Forrest Gold	2064/2 2064/2	7723 7723	21476 25296	1987 1980	RAB RAB Stream	3 93 77			X x X			x

geochemistry survey as at 13 December 1995

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
			X					X			Y	D:0-3m composite
			X					x				D:1.5m
			X					X	Perchloric /AAS		Y	D:0.15m, 30m intervals
			X					x			Y	D:1.5m
			X					X				
			X					X	Perchloric /AAS			D:0.15m, 100x400ft grid
			X					X				Poor location
			X					X				Poor location
			X		X			X				
			X					X	AAS	Sampey		D:0-0.15m
			X					x				Also for some Nb
			X						AAS	TEL		Also for Nb (XRF)
			X	X				X				Poor location
			X	X				X				Poor location
			X					X	AAS	Geomin		D:0.3m, recon & infill, results as contours
			X							TEL	Y	D:average 3m
			X									D:1.5m
									FA	Geomin		Channel
X			X	X				X			Y	Also for Cr2O3, FeO, 50x500m grid
X	X										Y	
X			X									
				X								
X	X		X	X	X		X	X				1 traverse, 2m intervals
												Duplicates, fractional analysis, DL:0.04ppm
				X					AAS			Results as contours
X	X		X	X			X	X				Duplicates, fractional analysis, DL:0.04ppm
				x				x	AAS	Analabs		D:0-2m
											Y	D:0-1m, DL:0.01ppm
				x	x			x	AAS	Genalysis	Y	D:0-4m

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu
11D cont	2547	65	Dominion Mining	2064/2	7723	31593-4	1990	RAB Soil	180 305		x	X		x	x
			Dominion Mining	2064/4	4676	32439	1991	Soil "	34			X			
			Dominion Mining	2064/2	7723	35425	1992	RAB "	150		x	X			x
			Dominion Mining	2064/2	7723	38251	1993	Air Core RAB "	36 9		X	X		X	X
											X				
11E	2547	48	Dominion Mining	2064/3	6878	31733	1990	RAB " Soil " Stream "	8 352 80			X			
											X			X	X
											X				X
			Dominion Mining	2064/3	6878	33972	1991	Lag RAB Rock	6 5 12			X			
			Dominion Mining	2064/3	6878	35211	1992	RAB "	4			X		X	X
											X				
11F	2547	200	Whim Creek Consolidated	2064/9	7277	30991	1990	Soil " Stream Stream "	94 12 218			X			
											X				X
												X			
														X	X
											X				
11G	2547	135	Dominion Mining	2064/8	6879	33978	1991	RAB " Rock " Soil "	39 26 651			X			
											X				
												X			
											X			X	X
			Dominion Mining	2064/8	6879	38081	1993	RAB	44		X	X			
12	2446	16	Uranex	2360	2040	9534-35	1980	Rock	155						
	2546							"		x					x
	2547														
			Uranex	2360	2040	9536	1980	Costean Percussion	85 4						
			Uranex	2360	2040	9578-9	1981	Percussion	6						
13A	2546	162	Agip Aust	2468/2	2037	8878	1980	Rock	26						
	2547		Agip Aust	2468/2	2037	9633	1981	Rock	63		x	x	x		x
13B	2546	2	Agip Aust	2468/2	2037	8916	1980	Rock	3						

(continued)

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
			x	x				x	ETA	Genalysis	Y	D: up to 4m, DL: 10ppb, 1ppb
									ETA	"		Mesh: -2mm, 13 traverses, 25x200m grid, DL: 1ppb
				x					ETA	Genalysis		Mesh: -2mm, 2 traverses, D: 0.15m, DL: 1ppb
				x						"		
									ETA, AAS	Genalysis	Y	Vertical & angled holes, DL: 1ppb, DL: 0.01ppm
			x	x				x	AAS	"		D: 2-3m & 0-2m composite
									AAS	Genalysis	Y	D: 0-2m composite
									ETA	"		D: 0-2m composite, DL: 1ppb
			x	x				x	AAS	"		
									ETA	Genalysis	Y	D: 0-2m composite, DL: 1ppb
			x	x				x	AAS	"		Mesh: -2mm, D: 0.15m, DL: 1ppb
									ETA	"		
			x	x				x	AAS	"		Finesilt trap sites, DL: 1ppb
				x					AAS	"		
									AAS	Genalysis	Y	Mesh: -8+2mm, DL: 0.01ppm
												D: 0-2m composite, DL: 0.01ppm
												DL: 1ppb
									ETA	Genalysis	Y	Vertical, D: 0-1m, DL: 1ppb
			x	x				x	AAS	"		
									ETA	Genalysis		Mesh: -2mm, D: 0.05m, photo-located traverses, DL: 1ppb
				x				x	AAS	"		
									BLEG	"		Orientation, mesh: -2mm, Wt: 10kg, DL: 0.1ppb
									ETA	"		Fine silt trap collection, DL: 1ppb
			x	x				x	AAS	"		
									ETA, AAS	Genalysis	Y	DL: 1ppb, 0.01ppm
									AAS	"		D: up to 4m, vertical & angled holes
									ETA	"		DL: 1ppb
			x	x				x	AAS	"		DL: 1ppb, mesh: -2mm, D: 0.05m, 200x25m grid, Wt: 0.2kg
									ETA	"		
									AAS	Genalysis		D: 0-3m, DL: 0.01ppm
						x	x		XRF	SGS		Grab & channel
									AAS			
								x	XRF	SGS		Shallow trenches
								x	XRF	"		D: 0-1m
								x	XRF	SGS		D: up to 4m
						x	x				Y	
x			x	x		x	x	x			Y	
					x	x						

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu		
13C	2546 2547	18	Agip Aust	2468/2	2037	8918	1980	Rock	88								
			Agip Aust	2468/2	2037	9631	1981	Rock	35		x		x		x		
13D	2546	195	Agip Aust	2468/2	2037	9632	1981	Rock	21		x	x	x		x		
14	2546	150	Amoco Minerals	2558	1248	8676	1979	Rock	106	X	x	x			X		
15	2546	200	Electrolytic Zinc Co	3019	1803	11532	1982	Rock	117	X	X				X		
								Soil	86		X			X	X		
								Stream	189		X				X		
16	2546	145	CRA Exploration	3172	5921	12501	1982	Costean	266			X			X		
								RC	1			X					
								Rock	93	x		x			X		
								Rock	76	X		X			X		
								Soil	203	X	x	X			X		
17	2546		Homestake Aust.	3638/6	5632	29680	1989	Rock	270			X					
								Soil	480			X					
			Homestake Aust.	3638/6	5632	32801	1991	RAB	84			X					
								Soil	700			X					
			Homestake Aust	3638/6	5632	34964	1992	Pisolites	8			X					
								Rock	14			X					
								Soil	50			X					
		18	2547	189	Homestake Aust	3638/7	4479	24434	1988	Rock	215			X			
										"		X	X				
					Homestake Aust	3638/7	4479	26886	1989	Rock	181			X			
"											X					X	
"										X							X
	Homestake Aust			3638/7	4479	29577	1989	Rock	30			X					
								"		X	X					X	
								Soil	283			X					
	Homestake Aust			3638/7	4479	32043	1990	Rock	15			X					
								Soil	510			X					
								Stream	1			X					
19	2546				Homestake Aust	3638/10	4316	21403	1987	Rock	140			X			
										Soil	194			X			
			Homestake Aust	3638/10	4316	27529	1989	Rock	23			X					

(continued)

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
				x	x		X				Y	
	x		x	x		X	X	x			Y	
	x		x	x		X	X	x			Y	
	x	x		X				X	AAS			Also for some Ba
X	X			X				X	Perchloric/AAS	Analabs		
X	X			X				X	Perchloric/AAS	"		5 traverses, poor location
X	X			X				X	Perchloric/AAS	"		Some fractional analysis, some samples outside area
									FA	Classic		DL: 0.05 ppm, 4 trenches, channel rock chip
				X				X				DL: 0.05 ppm, D: 0-1m
				X				X	AAS	Genalysis		DL: 0.01 ppm, outcrop, 5m intervals
				X				x	AAS			DL: 0.01 ppm, grab
												DL: 0.01 ppm, D: 0.15m, 10m intervals, 5 traverses
									BLEG	ALS		DL: 5-10 ppb, 25% photo-located, 75% poor location
									50g FA	ALS	Y	Composite over 200m, D: blw 0.2m, mesh: -1.3mm, grid
									30g AR/ETA	Analabs		DL: 0.01 ppm, D: 0-4m composite, random & 160x40m grid
												DL: 1ppb, 80x40m & 160x40m grids
									50g FA	ALS	Y	DL: 1ppb, mesh: -6+2mm
									50g AR/ETA	"		DL: 0.01 ppm
												DL: 1ppb, 40x40m & 80x40m grids
		X		X	X			X	50g FA/AAS	Anal/Analabs		DL: 0.01 ppm, 5 ppb
									Cyanide leach	Analabs		DL: 0.05 ppb, Wt: 5-10kg, mesh: -2mm
									50g FA/AAS	Analabs	Y	DL: 5ppb
									Hydride	"		
		X		X				X	Perchloric/AAS	"		
												DL: 0.05ppb
									ETA	Analabs		DL: 1ppm, surface lag from 0.3m diameter, Wt: 0.3kg.
									50g FA/AAS	"		DL: 5 ppb
	x		X					X	Perchloric/AAS	"		
									BLEG	ALS		DL: 0.05ppb, Wt: 5kg, grid, composite
									BLEG	"		DL: 0.05pp, Wt: 5kg, photo-located, 10% duplicates
									50g FA			DL: 5ppb, Wt: 3-4kg
									BLEG			
									BLEG	ALS		Wt: 5kg
									FA			DL: 5ppb
									BLEG			DL: 0.05ppb, mesh: -2mm, grid, composite over 200m
												DL: 0.01ppm

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu
19 cont	2546		Homestake Aust	3638/10	4316	29576	1989	Soil	415			X			
			Homestakes Aust	3638/10	4316	30850	1990	Soil	570			X			
20	2446 2546	4	D. A. Foster	3747	3184	15529	1984	Rock	48	X	x	X	x		x
21	2547	84	Hunter Resources	3786/3	3649	16091	1984	Rock	30		X	X	X	X	X
22A	2546	22	Hunter Resources	3866/2	3962	15933	1985	Rock	38		X	X	X	X	X
22B	2446 2546	200	Hunter Resources	3866/2	3962	29319	1989	Costean	150		X	X	X		X
								RAB	9		X	X	X		X
								Rock	11		X	X	X		X
23	2546		CSR	4039	3034	16478	1985	Rock	17			X			
								"			X				
								Stream	13	X		X			X
24	2547	37	King Mining Corp	4062/2	6646	17668	1986	Rock	22			X			
			King Mining Corp	4062/2	6646	22746	1988	Rock	11			X			
								"			X				
								Stream	21			X			
			King Mining Corp	4062/2	6646	26475	1989	Rock	16			X			
								"			X				
25	2546	186	Hunter Resources	4111/3	3911	29129	1989	RAB	6			X			
								Rock	17		X	X	X	X	X
			Horseshoe Gold Mine	4111/8	7754	39418	1993	RAB	102		x	X	x		x
								Rock	14			X			
								Soil	273			X			
								Stream	35			X			
26	2346		Battie Mountain Aust	4699	3269	21145-46	1987	Rock	31	X		X			
								Stream	86			X			
27	2446	176	Pancontinental Mining	4715	4702	21313	1987	RC	4			X			
								Rock	63	x	x	X			x
								Soil	187			X			
								"					x	x	x
								"			x				
								Stream	88		x	X			x
			North Coolgardie Resources	4715	4702	28528	1989	RAB	3			X			
								Stream	8			X			

(continued)

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
									BLEG	ALS	Y	DL:0.05ppb, composite over 200m, mesh:-1.3mm, D:0.2m
									ETA	ALS	Y	DL:1ppb, 160x40m grid
			x	x				x	AAS	Genalysis		Poor location, DL:0.01ppm
	x	x	x	x								Also for Ba
	x	x	x	x								Some costean, also for Ba, Bi
			x	x						Analabs	Y	
			x	x								
			x	x								
x									50g FA	AAL		DL:0.01ppm, composite over 25-100m
									AAS	"		
									AAS	PML		Wt:2-5kg, recon & follow up
									AAS	Corning		
									AR	Analabs		DL:0.012ppm
									Hydride	"		
									BLEG	"		Wt: 5kg
									FA	AAL		DL:0.01ppm
									AR/ETA	Analabs		DL:0.05-1ppb
			x	x	x						Y	20% of total holes Also for Ba, Bi
			x	x								45% of total holes
									BLEG	Classic		DL:0.1ppb, Wt:5kg, mesh:-2mm, D:blw 0.1m
									BLEG	"		DL:0.1ppb, Wt:5kg, mesh:-2mm, multiple pits
									AAS	Minilabs		DL:0.05ppm
									FA, BLEG	"		Also for Pd, Pt
				x					50g AR/AAS	SGS	Y	D:0-1m
									50g AR/AAS	"		DL:1-2ppb, 2 traverses, channel, 5m intervals, some Ti, W
			x						Mixed acid/AAS	"		DL:1-2ppb, traverses, 10-25m intervals
										"		Also for V
				x				x	BLEG, AR/AAS	"		DL:0.05-2ppb
									BLEG		Y	D:up to 4m, DL: 0.01ppm
									BLEG			DL:0.1ppb

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu
27 cont	2446	176	Pancontinental Mining	4715	4702	31345	1990	Rock	12			X			
								Soil	182			X			
								Stream	11			X			
28	2547		Homestake Aust Ltd	4769/3	6806	28287	1989	Rock	103			X			
								"		X	x				X
								Soil	164			X			
								Stream	84			X			
			Homestake Aust Ltd	4769/3	6806	29578	1990	Pisolite	13			X			
								Soil	40			X			
29A	2446	140	Western Mining Corp	5205/1	7273	25746	1988	Soil	6654			X			
			Western Mining Corp	5205/1	7273	29671	1990	Soil	126			X			
29B	2346 2446	210	Western Mining Corp	5205/1	7273	32165-66	1990	Lag	115			X			
								RC	23	x	x	X			x
								Soil	410			X			
			Sons of Gwalia	5205/1	7273	36838	1992	Lag	74			X			
								RAB	97			X			
								Rock	14			X			
								"			X				X
								Auger	535			X			
								"						X	X
			Sons of Gwalia	5205/1	7273	38890	1993	RC	13			X			
30	2547	12	S. W. Wilson	5546	5683	24502	1988	Rock	8			X			
								Soil	4			X			
			Sons of Gwalia	5546	5683	33465	1991	Rock	12			X			
								"							X
								"			X				
								"					X		
								Soil	14			X			
								"							X
								"			X				
								"							
								Stream	2			X			
31	2546 2547	70	Wilthorpe Well Gold Expl	5653	3623	23901	1988	Stream	74			X			
32	2546		King Mining Corp.	6098/11	6154	30324	1990	Lag	421		X	X			X
								Rock	2		X				X
								Soil	58		X	X			X
								Stream	68		X	X			X
			King Mining Corp	6098/11	6154	33258	1991	Rock	4		X	X			X
								Stream	9		X	X			X

(continued)

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
									BLEG	ALS		DL:1ppb DL:1ppb, 50x200m grid DL:1ppb
									50g FA Perchloric/AAS	Analabs "		DL:5ppb
	x			X				X	BLEG	ALS		DL:50ppt, composite over 200m (20m subs) Wt:5kg
									BLEG	AAL		DL:50ppt, Wt: 5kg
									30g AR /ETA BLEG	Analabs "	Y	DL:1ppb DL:50ppt
										WMC	Y	400x100m & 100x40m grids, mesh:-6mm, recon & infill
										WMC	Y	DL:1ppb
										WMC		DL:1ppb, 400x100m grid
			x					x		"	Y	DL:1ppb
										"		DL:1ppb, 400x100m grid, mesh:-6+2mm
									ETA	Genalysis	Y	DL:1ppb, mesh:+2mm
									ETA	"		DL:1ppb, D:up to 4m
									AR /ETA	"		DL:1ppb
					X				AR /AAS	"		DL:1ppb, 25x100m & 25x50m grids, D:1m, composite
									ETA	"		
			X						AAS	"		
									AAS	Genalysis	Y	D:0-1m composite, DL:0.01ppm
												Wt:1.5-2kg
									AR /ETA	Analabs/Genal		DL:1ppb
				X				X	Mixed acid/AAS	"		Also for Ce, La, Nb, Y
					X				ICP-MS	"		Also for P
			X						ICP-OES	"		
									ETA	Genalysis		DL:1ppb, mesh:-2mm, 40m intervals
				X				X	AAS	"		
									ICP-OES	"		
					X				ICP-MS	"		
									BLEG	"		DL:0.1ppb, mesh:-2mm, Wt:1kg
									Cyanide/ICP-MS	Sheen		DL:1ppb, Wt:5kg
	X		X					X		Genalysis		DL:1ppb, recon & infill traverses
	X		X					X		"		DL:1ppb
	X		X					X		"		DL:1ppb
	X		X					X		"		DL:1ppb, mesh:-75um & +212um
	X		X					X		Genalysis		DL:1ppb
	X		X					X		"		DL:1ppb, 200m intervals, mesh:-75 & +212um

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ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu
33A	2546	40	King Mining Corp	6098/14	6529	30322	1990	Lag	181		X	X			X
								Rock	3		X	X			X
								Stream	30		X	X			X
			King Mining Corp	6098/14	6529	33257	1991	Lag	98		X	X			X
								Rock	1		X	X			X
								Stream	28		X	X			X
33B	2546	120	Sabminco NL	6098/14	6529	37031	1992	Stream	76			X			
								Stream	78		X				
								"						X	
33C	2546	80	Sabminco NL	6098/17	7978	43183	1995	Stream	68			X			
34	2546	75	Western Mining Corp	6186	5307	27341	1988	Stream	30			X			
								"			X				
35A	2547	63	Homestake Aust Ltd	6283	6861	28188	1989	Rock	7			X			
								"			X				
								"		X					X
								Soil	480			X			
								Stream	102			X			
			Homestake Aust Ltd	6283	6861	31071-72	1990	Rock	137			X			
								"			x				x
								RAB	26			X			
								Soil	333			X			
								Soil	768			X			
								Stream	26			X			
35B	2547	33	Dominion Mining	6283	6861	34713	1991	RAB	522			X			
								"			X				X
35C	2547	30	Dominion Mining	6283	6861	34730	1991	Lag	263		X	X			
								RAB	168			X			
								"			x				x
			Dominion Mining	6283	6861	38083	1993	RAB	19		X	X			
36A	2547	71	Cyprus Gold Aust Corp	6437	4107	28999	1989	RAB	46			X			
								Soil	12			X			
36B	2547		Cyprus Gold Aust Corp	6437	4107	29000	1989	Soil	159			X			
37	2546		Western Mining Corp	6575	5334	32554	1990	Lag	128			X			
38	2346	200	BHP Minerals	6611	3948	30270	1990	Stream	402	x					X
	2347														
	2447														

(continued)

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
			X	X				X		Genalysis		DL:1ppb, recon traverses, 100m intervals
			X	X				X		"		
			X	X				X		"		DL:1ppb, mesh:-75 & +212um
			X	X				X		Genalysis		5 traverses, 50m intervals
			X	X				X		"		DL:1ppb
			X	X				X		"		Infill at 200m intervals, mesh:-75um & +212um
									BLEG			Wt:2kg, mesh:-1mm, DL:1ppb
									Hydride /AAS	Analabs		Wt:0.5kg, mesh:-4+1mm
X	X								ICP-OES	"		Also for Ba (ICP-OES) Ce, Nb, Nd, Sr (ICP-MS)
									50g FA			D:blw 0.1m, mesh:-1.25mm, GPS photo-located
									AR /ETA	Genalysis		DL:1ppb, mesh:-5mm
									AR /AAS			
									50g FA /AAS	Analabs		DL:5ppb
									Hydride/ AAS	"		
		X		X				X	Perchloric/AAS	"		
									BLEG	ALS		DL:50ppt, composite over 200m, photo located, duplicates
									BLEG	"		10% duplicates, mesh:-10#
									50g FA		Y	Wt:2-3kg, channel & grab
X				X				X	AAS			
									AR /ETA	Analabs		Composite, D:up to 4m, 2 lines
									BLEG	"		Composite over 100-200m, Wt:5kg, mesh:-10#
									AR /ETA	"		Grid, mesh:-20#
									BLEG	ALS		Mesh:-10#, Wt:5kg
									AR /ETA	Genalysis	Y	D:up to 4m
			X	X				X	AR /AAS	"		
										Genalysis		
									AR /ETA	"		DL:1ppb
			X	X				X	AR /AAS	"		
									AR /AAS	Genalysis		DL:0.01ppm, D:0-3m
									AR /AAS	Genalysis	Y	DL:0.01ppm, D:0-4m composite
												DL:0.1ppb
									Cyanide/ICP-MS	Sheen		Recon, Wt:1kg, D:0.2-0.3m, 4 traverses, 100m intervals
										WMC		Mesh:-6+2mm, 100x400m grid, DL:1ppb
			X					X	AAS	RDG/Analabs		Various mesh sizes

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu
39	2547		Dominion Mining	6678/1	6841	30844-45	1990	Soil	228			X			
								"			X				X
								RAB	166			X		X	X
40	2447 2547		Western Mining Corp	6699	5149	31076	1990	Lag	310			X			
								"			X				
								"		X					X
								RC	10			X			
41	2347 2447	200	ACM Gold	6701	4142	31079	1990	Stream	181			X			
											X				X
42	2447 2546		Mt Martin Gold Mines	6703	5150	31121	1990	Rock	123			X			
								Soil	31			X			
								Stream	258			X			
43	2446	180	Homestake Aust Ltd	6756	5840	31550	1990	Rock	126			X			
			Homestake Aust Ltd	6756	5840	34758	1992	Soil	413			X			
								Stream	61			X			
44	2546	67	Grants Patch Mining	6908	6698	32699	1991	Stream	55			X			
			Grants Patch Mining	6908	6698	34984	1992	Soil	115			X			
								Stream	9			X			
45A	2546	40	ACM Gold	6929	6758	33126	1991	Rock	35	X		X			X
								Stream	30	X		X			X
45B	2546	22	ACM Gold	6929	6758	33127-28	1991	Rock	105			X			
								"		X	X				X
								RC	1			X			X
								Soil	614	X		X			
								Soil	614		X				
								"							X
46	2546	34	Homestake Aust Ltd	6938	5658	33082	1991	Rock	2			X			
								RAB	52			X			
								Soil	104			X			
								Soil	258			X			
47	2547	200	Sons of Gwaha	7011	5011	33714	1990	Auger	129			X			
								Rock	13			X			
								"			X				X
								Stream	22			X			

(continued)

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
X			X	X				X	AR /ETA AR /AAS AR /ETA AR /AAS	Genalysis " " "	Y	DL:1ppb, mesh:-2mm, D:0.02-0.1m, 50m intervals DL:1ppb, D:up to 4m
x	x	x	x	X				X	25g AR /AAS Hydride /AAS Multi-acid/AAS 25g AR /AAS	WMC " " "	Y	DL:1ppb, mesh:-6+2mm Also for Bi DL:1ppb, D:0-2m
		x			x			x	BLEG XRF AAS, BLEG Multi-acid/AAS	 SGS " "		Wt:5kg, DL:0.01ppb Also for Sn
									AR /ETA AR /ETA AR /ETA	Genalysis " "		DL:1ppb, channel & grab Composite over 50m (10m subsamples) mesh:-1mm DL:1ppb, Wt:0.4kg, mesh:-80um, overbank
									FA BLEG BLEG	 ALS "		DL:5ppb DL:50ppt, composite over 200m (20m subs) Wt:1kg DL:50ppt, Wt:10kg, mesh:-2mm, non-trap sites
									Cyanide/ETA DIBK BLEG	 Classic "		DL:0.05ppb, Wt:5kg, mesh:-2mm, multiple pits DL:0.05ppb, Wt:5kg, mesh:-2mm, multiple pits DL:0.05ppb
									BLEG 50g FA ICP, AAS	AAL RW AAL/RW "		DL:0.01ppm DL:0.01ppb DL:0.01ppm
				X				X	BLEG Hydride AAS	ACM/RW RW "	Y	DL:0.01ppm DL:0.01ppb, Wt: 2kg, mesh:-30#, grid, composite over 100m Wt:4kg, mesh:-80#, grid, composite over 100m (50m subs)
				X				X				DL:0.01ppm, D:up to 4m DL:50ppt, Wt:6-8kg, mesh:-10#, composite over 200m DL:1ppb, mesh:-20#, 80x40m grid
				X				X	AR /ETA AR /ETA AR /AAS BLEG	Genalysis " " "		DL:1ppb, D:1m, composite over 100m (50m subsamples) DL:1ppb DL:0.1ppb, mesh:-2mm, Wt:2kg

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Year	Medium	No.	Ag	As	Au	Co	Cr	Cu
48	2346		WMC	7138	5916	34566	1991	Stream	34			X			
								"			X				
								"							X
49	2546		Grants Patch Mining	7166/2	6171	34644	1991	Rock	15			X			
	2547							"		X	X				X
								Stream	50			X			
			Grants Patch Mining	7166/2	6171	35799	1992	RAB	2			X			
								Rock	68			X			
								"			X				
								Soil	21			X			
								Stream	23			X			
			Giralia Resources	7166/1	6171	37897	1993	RC	1			X			
								Rock	86	X	X	X			X
								Soil	13			X			
50	2546		Sons of Gwalia	7330/3	7203	39827	1993	Auger	918			X			
								Soil	707			X			
								"		X	X				X
								RAB	9			X			
								Rock	312			X			
51	2546	160	Sovereign Resources Aust	7680	6640	37030	1992	Lag	26			X			
	2547							"			X			X	X
								Rock	5	X	X	X	X	X	X
								Stream	21	X	X	X	X	X	X
52	2546		Geopeko	7767/3	7554	37277	1992	Soil	94			X		X	X
			Geopeko	7767/3	7554	39122	1993	RAB	36			X			X
								"							
			North Mining	7767/3	7554	41151	1994	RAB	18			X			
								"						X	
53A	2546		Geopeko	7767/5	7707	37275	1992	RAB	29			X			
								"							X
								Soil	265			X		X	X
			Geopeko	7767/5	7707	40115	1994	RAB	74			X			
								"							X
			North Mining	7767/5	7707	41152	1994	RAB	23			X			
53B	2546	72	Geopeko	7767/5	7707	37281	1992	RAB	9			X			
								"							X
54	2447	200	RGC Exploration	7779	6563	37435	1993	Rock	37	X	X	X			X

(continued)

Fe	Mn	Mo	Ni	Pb	Sb	Th	U	Zn	Method	Analyst	DD	Comment on Samples
									25g AR /AAS	WMC		DL:1ppb, fractional analysis
									Hydride /AAS	"		DL:5ppm, also for Bi
x	x		x	x	X			X	AAS	"		Also for W
				X				X	AR /ETA	Genalysis	Y	DL:1ppb
									AR /AAS	"		
									BLEG	"		DL:0.1ppb, mesh:-2mm, trap sites
									50g FA		Y	D:0-2m, composite, Wt:2kg
									50g FA /AAS	SGS,ALS,RW		DL:0.01ppm
									XRF	SGS		
									BLEG/ICP-MS	Sheen,RW		DL:0.1ppb, DL:1ppb, mesh:-2mm, Wt:2kg
									BLEG/ICP-MS	RW		DL:0.1ppb, mesh:-2mm, Wt:2kg
				X				X			Y	D:0-4m
									BLEG			DL:0.01ppm
												Recon. 3 traverses, Wt:2kg
									AR /ETA	Genalysis	Y	DL:1ppb, D:0-1m, composite over 100m (50m subs) grid
									AR /ETA	"		Wt:1-2kg, mesh:-2mm, composite over 200-400m
				X	X			X	AR /AAS	"		50-100m subsamples, grid, also for W (colorimetry)
									AR /ETA	"		DL:1ppb, composite, D:0-2m.
									AR /ETA	"		DL:1ppb
X			X	X				X	AR /ETA	Genalysis		DL:1ppb, mesh:-7+2mm
X	X	X	X	X	X			X	AR /AAS	"		DL:2ppb, also for P, V
X	X	X	X	X	X			X		Classic		DL:2ppb, also for P, V
												D:0-15-0.3m, mesh:-4mm
									AR /ETA	Genalysis	Y	DL:1ppb, D:0-4m composite
									AR /AAS	"		
									AR /ETA	Genalysis	Y	DL:1ppb, D:0-4m composite
									AR /AAS	"		
											Y	D:0-4m composite
									AR /ETA	Genalysis	Y	DL:1ppb, D:0-4m composite
									AR /AAS	"		
X	X	X	X					X		Analabs		DL:5ppb, also for Ba, Bi, Sn

Appendix 3

<i>ID No.</i>	<i>Map Sheet</i>	<i>Area sqkm</i>	<i>Company</i>	<i>M No.</i>	<i>Item No.</i>	<i>A No.(s)</i>	<i>Year</i>	<i>Medium</i>	<i>No.</i>	<i>Ag</i>	<i>As</i>	<i>Au</i>	<i>Co</i>	<i>Cr</i>	<i>Cu</i>
55	2546	40	Dominion Mining	8079	7984	38518	1993	RAB	94			X			
								"			X			X	X
56	2346	110	Helix Resources	9396	8100	43829	1995	Soil	11			X			
								"		X			X	X	X
								Stream	28			X			
								"		X			X	X	X

Source: Department of Minerals and Energy, WAMEX database, 13 December 1995

(continued)

<i>Fe</i>	<i>Mn</i>	<i>Mo</i>	<i>Ni</i>	<i>Pb</i>	<i>Sb</i>	<i>Sn</i>	<i>Zn</i>	<i>Method</i>	<i>Analyst</i>	<i>DD</i>	<i>Comment on Samples</i>
			X	X	x		X	AR /ETA	Genalysis	Y	DL:1ppb, D:up to 4m, GPS located grid
								AR /AAS	"		
X			X					FA /ICP-MS	Genalysis		DL:1ppb, mesh:-4mm, 1 traverse, also for Pd, Pt
								AAS	"		100m intervals
X			X					FA /ICP-MS	"		DL:1ppb, mesh:-4mm, also for Pd, Pt
								AAS	"		

Appendix 5

Analysis of GSWA standards by Genalysis Laboratories compared with previous analyses

	Granite 1					Granite 2					Previous analyses (a)	
	Batch 1 134652	Batch 2 134520	Batch 5 134571	Rel Std Dev (%)	Mean	Batch 3 134325	Batch 4 133995	Batch 4 134063	Rel Std Dev (%)	Mean	Mean	Rel Std Dev (%)
Percent												
SiO ₂	78.59	76.83	76.10	1.66	76.47	74.25	75.54	75.77	1.09	75.66	73.05	1.92
TiO ₂	0.20	0.20	0.19	2.94	0.20	0.20	0.20	0.23	8.25	0.22	0.21	3.39
Al ₂ O ₃	14.06	13.14	14.85	6.11	14.00	12.38	12.54	12.28	1.06	12.41	13.04	2.95
Fe ₂ O ₃	1.72	1.59	2.01	12.13	1.80	1.68	1.82	1.84	4.90	1.83	1.72	19.34
MnO	0.03	0.03	0.02	21.65	0.03	0.02	0.02	0.02	0.00	0.02	0.02	29.35
MgO	0.38	0.36	0.38	3.09	0.37	0.44	0.39	0.38	7.97	0.39	0.32	24.83
CaO	1.80	1.79	1.75	1.49	1.77	0.64	0.66	0.69	3.79	0.68	0.72	5.69
Na ₂ O	3.32	3.18	3.23	2.19	3.21	2.78	2.63	2.73	2.81	2.68	2.97	4.34
K ₂ O	3.93	4.05	3.82	2.92	3.94	5.35	5.31	5.55	2.38	5.43	5.49	5.92
P ₂ O ₅	0.05	0.06	0.07	16.67	0.07	0.04	0.05	0.05	12.37	0.05	0.06	30.22
LOI	0.79	0.72	0.66	9.00	0.69	0.82	0.77	0.79	3.17	0.78	0.86	4.88
Parts per million (b)												
Ag	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	57.90
As	1.0	1.0	1.0	0.00	1.0	<2	<2	<2	0.00	<2	<2	122.46
Au (ppb)	1	2	1	43.30	1.5	3	2	2	24.74	2	3	59.06
Ba	1 193	1 248	1 112	5.78	1 180	551	545	548	0.55	547	541	2.83
Be	3.7	3.5	3.6	2.78	3.6	3.0	3.1	3.1	1.88	3.1	2.8	32.45
Bi	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	57.74
Ce	103	90	98	6.82	94	140	150	143	3.56	147	135	43.52
Co	4.0	3.4	3.4	9.62	3.4	31.0	31.0	30.0	1.88	30.5	29.9	6.77
Cr	150	154	140	4.87	147	<20	<20	<20	0.00	<20	<20	96.40
Cu	<1	<1	<1	0.00	<1	<1	1.5	1.1	48.71	1.3	3.2	165.52
F	200	200	190	2.94	195	580	500	500	8.77	500	519	11.70
Ga	24	22	18	14.32	20	19.0	19.0	18.0	3.09	18.5	22.6	26.97
In	<0.1	<0.1	<0.1	0.00	<0.1	<0.1	<0.1	<0.1	0.00	<0.1	<0.1	32.27
La	60	52	53	7.93	53	71	76	73	3.43	75	72	36.69
Li	7.6	7.0	6.5	7.83	6.8	8.2	8.6	9.2	5.81	8.9	9.0	6.79
Mo	0.8	0.7	0.6	14.29	0.7	3.2	2.7	3.2	9.52	3.0	3.5	19.67
Nb	7.6	7.2	7.4	2.70	7.3	16.0	16.0	16.0	0.00	16.0	16.0	22.62
Ni	4.2	4.6	5.5	13.97	5.1	<1	2.5	2.5	62.98	2.5	2.2	86.03
Pb	37.0	37.7	43.0	8.36	40.4	40.0	36.0	34.0	8.33	35.0	33.5	21.07
Pd (ppb)	2	1	1	43.30	1	1	1	1	0.00	1	1	87.08
Pt (ppb)	1	1	<1	34.64	1	<1	<1	<1	0.00	<1	2	91.73
Rb	145	140	131	5.12	136	260	237	236	5.56	237	223	35.03
S	30	20	<10	68.63	10	30	30	20	21.65	25	43	36.47
Sb	0.2	<0.2	<0.2	43.30	<0.2	<0.2	0.20	<0.2	43.30	<0.2	0.3	81.06
Sc	<2	<2	<2	0.00	<2	2.6	2.8	2.8	4.22	2.8	2.2	33.49
Se	<0.2	<0.2	<0.2	0.00	<0.2	<0.2	<0.2	<0.2	0.00	<0.2	0.3	58.88
Sn	1.7	1.7	1.7	0.00	1.7	2.2	2.2	2.3	2.59	2.3	2.1	9.15
Sr	177	178	165	4.14	171	91	92	92	0.63	92	92	4.12
Ta	1.9	1.8	2.1	7.90	2.0	1.6	1.6	1.9	10.19	1.8	1.6	36.90
Te	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	0.00
Th	34.0	38.9	35.0	7.20	37.0	59.0	62.0	63.0	3.39	62.5	50.6	35.62
U	6.2	7.0	6.7	6.09	6.9	9.7	9.9	10.0	1.55	10.0	8.1	38.19
V	14	14	15	4.03	15	8	8	8	2.87	8	9	31.16
W	1.6	1.4	1.4	7.87	1.4	291.0	267.0	273.0	4.51	270.0	294.9	19.05
Y	15.0	15.0	14.0	3.94	14.5	26.0	26.0	26.0	0.00	26.0	20.1	34.26
Zn	43.0	41.2	36.0	9.07	38.6	4.0	17.0	18.0	60.08	17.5	24.7	72.07
Zr	148.0	138.5	157.0	6.26	147.8	169.6	179.0	175.0	2.70	177.0	150.3	17.63

Appendix 5 (continued)

Vein quartz (IQC-41)						Previous analyses (c)		
	Batch 1 134831	Batch 3 134100	Batch 4 133882	Batch 4 133951	Rel Std Dev (%)	Mean	Mean	Rel Std Dev (%)
Percent								
SiO ₂	98.95	95.46	93.82	92.80	2.83	93.31	95.87	0.98
TiO ₂	0.02	0.01	0.01	0.01	40.00	0.01	0.01	0.00
Al ₂ O ₃	0.83	0.66	0.72	0.71	9.81	0.72	0.78	16.46
Fe ₂ O ₃	1.11	0.99	1.04	0.94	7.11	0.99	0.80	70.84
MnO	0.01	0.01	0.02	0.01	40.00	0.02	0.01	0.00
MgO	0.14	0.11	0.13	0.14	10.88	0.14	0.04	65.61
CaO	0.03	0.03	0.03	0.04	15.38	0.04	0.04	161.78
Na ₂ O	0.02	0.01	0.02	0.02	46.15	0.02	0.04	73.39
K ₂ O	0.21	0.21	0.22	0.19	6.06	0.21	0.20	23.97
P ₂ O ₅	0.01	0.01	0.01	0.01	0.00	0.01	0.04	56.33
LOI	0.23	0.30	0.26	0.21	15.66	0.24	0.33	59.46
Parts per million								
Ag	6.7	6.6	6.2	6.8	4.00	6.5	5.8	11.31
As	73.0	74.0	75.0	75.0	1.29	75.0	82.0	19.39
Au (ppb)	458	431	499	500	7.12	500	546	7.06
Ba	25	24	22	23	5.49	23	29	29.76
Be	6.6	4.0	5.1	5.8	20.51	5.5	9.4	9.42
Bi	97.0	90.0	95.0	100.0	4.40	97.5	86.7	17.46
Ce	5	5	5	4	4.51	4	5	50.25
Co	2.8	1.8	1.8	2.1	22.20	2.0	2.2	34.74
Cr	561	336	341	326	29.03	334	478	6.10
Cu	34.0	29.0	32.0	35.0	8.14	33.5	30.5	7.40
F	220	250	250	280	9.80	265	275	54.55
Ga	1.7	0.5	1.5	1.7	42.55	1.6	1.9	11.59
In	<0.1	<0.1	<0.1	0.1	40.00	<0.1	<0.1	0.00
La	3	3	3	3	4.23	3	5	18.37
Li	17.0	17.0	16.0	19.0	7.29	17.5	17.2	6.81
Mo	39.0	38.0	38.0	49.0	13.06	43.5	44.0	11.94
Nb	<0.5	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	0.00
Ni	18.0	13.4	15.0	14.0	13.53	14.5	12.0	7.45
Pb	120.0	120.0	119.0	102.0	7.68	110.5	130.5	3.62
Pd (ppb)	3	4	3	4	16.50	4	2	36.51
Pt (ppb)	3	4	4	4	13.33	4	7	75.86
Rb	31	31	30	32	2.63	31	31	13.04
S	250	250	280	290	7.71	285	233	34.99
Sb	215.0	216.0	216.0	220.0	1.02	218.0	260.2	20.69
Sc	<2	<2	<2	<2	0.00	<2	<2	2.67
Se	<0.2	<0.2	0.2	0.2	38.49	0.2	0.3	0.00
Sn	1.0	1.1	1.0	1.2	8.91	1.1	<1	27.22
Sr	11	11	10	11	4.65	11	15	28.73
Ta	<0.2	<0.2	<0.2	<0.2	0.00	<0.2	2.8	141.91
Te	1.2	1.0	1.1	1.2	8.51	1.2	nd	nd
Th	0.5	0.4	0.2	0.3	36.89	0.3	0.5	47.01
U	0.3	0.3	0.3	0.3	0.00	0.3	0.5	82.25
V	13	12	12	13	4.62	13	14	6.39
W	62.0	64.0	63.0	67.0	3.38	65.0	55.5	14.13
Y	0.8	0.8	0.8	0.9	6.06	0.9	1.3	38.73
Zn	15.0	3.0	16.0	14.0	50.46	15.0	19.3	22.35
Zr	3.3	1.0	4.4	8.3	71.74	6.4	2.5	0.00

Appendix 5 (continued)

	Gossan (TQC-45)					Previous analyses (d)		
	Batch 3 134185	Batch 4 133781	Batch 4 134122	Batch 5 133720	Rel Std Dev (%)	Mean	Mean	Rel Std Dev (%)
Percent								
SiO ₂	37.20	42.56	44.89	43.75	8.08	43.73	43.27	2.58
TiO ₂	0.14	0.13	0.17	0.14	11.95	0.15	0.13	8.53
Al ₂ O ₃	2.53	2.43	2.38	2.46	2.56	2.42	2.37	5.50
Fe ₂ O ₃	48.68	45.26	46.10	46.52	3.12	45.96	45.46	3.83
MnO	0.08	0.08	0.08	0.07	6.45	0.08	0.07	17.31
MgO	0.19	0.13	0.14	0.15	17.25	0.14	0.11	59.82
CaO	0.14	0.12	0.12	0.11	10.27	0.12	0.10	28.38
Na ₂ O	0.01	0.01	0.02	0.01	70.71	0.01	0.03	124.17
K ₂ O	0.36	0.34	0.41	0.37	7.96	0.37	0.37	22.75
P ₂ O ₅	0.59	0.59	0.62	0.59	2.51	0.60	0.66	6.55
LOI	6.63	6.60	6.65	6.56	0.59	6.60	6.78	1.75
Parts per million								
Ag	0.5	<0.5	0.5	<0.5	38.49	<0.5	<0.5	44.95
As	446.0	451.0	450.0	445.0	0.66	448.7	448.0	4.77
Au (ppb)	36	36	30	36	8.70	34	37	20.65
Ba	187	191	213	180	7.39	195	185	7.30
Be	5.2	5.2	5.1	4.3	8.81	4.9	4.8	11.20
Bi	189.0	186.0	182.0	177.0	2.83	181.7	184.8	9.40
Ce	68	73	64	62	7.28	66	77	34.65
Co	18.0	17.0	18.0	18.0	2.82	17.7	14.8	31.18
Cr	115	118	121	148	12.11	129	145	21.15
Cu	1 566	1 555	1 525	1 561	1.19	1 547	1 541	5.04
F	70	70	50	60	15.32	60	68	37.67
Ga	4.1	5.0	5.3	3.8	15.70	4.7	8.1	57.06
In	0.9	0.8	0.8	0.9	6.79	0.8	0.9	9.36
La	27	35	24	22	21.17	27	29	27.59
Li	2.2	2.1	2.3	2.3	4.30	2.2	2.1	22.22
Mo	35.0	32.0	33.0	33.0	3.78	32.7	34.3	13.82
Nb	1.9	2.2	2.4	2.4	10.62	2.3	2.1	64.49
Ni	65.4	70.0	67.0	75.0	6.09	70.7	74.7	8.86
Pb	454.0	449.0	421.0	427.0	3.70	432.3	463.8	15.70
Pd (ppb)	4	4	4	4	0.00	4	4	28.75
Pt (ppb)	11	7	8	9	19.52	8	12	36.57
Rb	14	14	14	14	0.00	14	14	13.61
S	160	160	170	170	3.50	167	163	29.92
Sb	1.2	1.6	1.1	1.9	25.50	1.5	1.1	13.73
Sc	45.0	46.0	45.0	43.0	2.81	44.7	47.6	7.81
Se	2.0	2.2	2.2	2.2	4.65	2.2	2.4	34.08
Sn	1.0	1.0	<1	1.0	28.57	<1	<1	32.43
Sr	15	14	15	14	3.98	14	15	10.09
Ta	0.2	0.3	<0.2	0.4	51.64	0.2	0.5	86.92
Te	2.1	1.7	2.1	1.8	10.71	1.9	2.5	28.29
Th	9.9	8.8	9.3	8.3	7.55	8.8	8.9	12.22
U	485.0	454.0	462.0	460.0	2.92	458.7	462.1	7.01
V	113	117	111	123	4.56	117	115	9.67
W	2.2	2.0	1.8	2.4	12.30	2.1	2.5	37.08
Y	124.0	115.0	116.0	119.0	3.41	116.7	109.1	14.73
Zn	200.0	208.0	202.0	203.0	1.67	204.3	201.4	7.97
Zr	19.6	22.0	20.0	25.0	11.40	22.3	23.5	15.57

Appendix 5 (continued)

	Laterite (IQC-47)					Previous analyses (d)		Ultramafic 1				
	Batch 1 134381	Batch 2 134242	Batch 5 133835	Rel Std Dev (%)	Mean	Mean	Rel Std Dev (%)	Batch 2 134286	Batch 2 134488	Batch 3 134453	Rel Std Dev (%)	Mean
Percent												
SiO ₂	85.02	88.41	86.26	1.98	87.34	88.08	2.36	41.22	41.93	38.99	3.77	40.71
TiO ₂	0.02	0.02	0.02	0.00	0.02	0.02	38.62	0.16	0.18	0.17	5.88	0.17
Al ₂ O ₃	0.63	0.67	0.62	4.13	0.65	0.74	6.27	4.59	4.65	4.95	4.08	4.73
Fe ₂ O ₃	8.76	8.36	8.50	2.38	8.43	8.43	3.46	12.52	12.63	12.62	0.48	12.59
MnO	0.07	0.07	0.08	7.87	0.08	0.07	6.98	0.20	0.20	0.21	2.84	0.20
MgO	0.28	0.32	0.35	11.09	0.34	0.27	29.34	29.60	27.66	29.71	3.98	28.99
CaO	0.05	0.05	0.06	10.83	0.06	0.04	28.75	2.87	2.94	2.93	1.30	2.91
Na ₂ O	0.05	0.05	0.04	12.37	0.05	0.06	42.36	0.03	0.03	0.03	0.00	0.03
K ₂ O	0.09	0.01	0.66	139.91	0.34	0.05	54.80	0.01	0.03	0.04	57.28	0.03
P ₂ O ₅	0.01	0.01	0.01	43.30	0.01	0.02	108.87	0.02	0.02	0.02	0.00	0.02
LOI	2.24	2.34	2.86	13.42	2.60	2.35	20.03	9.31	9.58	9.23	1.96	9.37
Parts per million												
Ag	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	56.37	<0.5	<0.5	<0.5	0.00	<0.5
As	7.1	8.6	6.7	13.42	7.7	7.0	38.84	<2	2.3	<2	52.36	<2
Au (ppb)	8	12	15	30.10	14	10	32.38	4	4	3	15.75	4
Ba	159	152	158	2.42	155	164	6.56	17	17	18	3.33	17
Be	0.2	0.1	0.1	43.30	0.1	0.1	37.16	0.1	0.1	0.1	34.64	0.1
Bi	0.7	<0.5	<0.5	64.95	<0.5	<0.5	36.73	<0.5	<0.5	<0.5	0.00	<0.5
Ce	6	6	6	1.75	6	6	40.48	1.8	1.6	1.7	5.88	1.7
Co	183.0	184.0	166.0	5.69	175.0	187.8	11.62	137.0	129.0	139.0	3.92	135.0
Cr	1 373	1 335	1 389	2.03	1 362	1 647	21.49	3 048	3 013	3 075	1.02	3 045
Cu	16.0	17.0	15.0	6.25	16.0	10.6	38.11	13.0	11.0	11.0	9.90	11.7
F	<50	<50	<50	0.00	<50	<50	37.50	<50	<50	<50	0.00	<50
Ga	1.3	1.0	<1	43.30	<1	3.2	85.59	5.4	4.8	5.5	7.23	5.2
In	0.2	<0.1	<0.1	86.60	<0.1	0.1	57.74	<0.1	<0.1	<0.1	0.00	<0.1
La	2	2	2	6.93	2	2	22.88	0.8	0.6	0.7	14.29	0.7
Li	3.5	3.5	4.6	16.42	4.1	3.1	13.76	0.9	0.9	0.8	6.66	0.9
Mo	1.1	1.0	1.0	5.59	1.0	1.2	20.79	<0.5	<0.5	<0.5	0.00	<0.5
Nb	0.7	0.7	<0.5	47.24	<0.5	<0.5	46.12	0.6	0.5	0.6	10.19	0.6
Ni	2 182	2 093	2 224	3.09	2 159	2 280	3.93	870.0	851.0	849.4	1.34	856.8
Pb	9.0	6.7	18.0	53.16	12.4	11.9	23.03	<2	<2	2.1	173.21	<2
Pd (ppb)	8	8	7	7.53	8	7	33.59	6	6	6	0.00	6
Pt (ppb)	6	9	5	31.22	7	7	41.87	6	7	7	8.66	7
Rb	1.5	1.3	0.8	30.05	1.1	1.6	25.47	1.3	1.3	1.4	4.33	1.3
S	100	70	80	18.33	75	75	32.20	50	40	50	12.37	47
Sb	0.5	0.4	1.1	56.79	0.8	0.5	42.71	<0.2	<0.2	<0.2	0.00	<0.2
Sc	5.9	5.4	6.0	5.57	5.7	6.3	9.69	14.0	13.0	14.0	4.22	13.7
Se	0.4	<0.2	0.4	57.74	0.2	0.3	58.06	<0.2	<0.2	<0.2	0.00	<0.2
Sn	1.1	1.1	1.1	0.00	1.1	<1	34.51	<1	<1	<1	0.00	<1
Sr	7	7	7	3.58	7	8	17.18	3	3	3	4.88	3
Ta	<0.2	<0.2	<0.2	0.00	<0.2	0.5	101.03	0.2	<0.2	<0.2	43.30	<0.2
Te	<0.5	<0.5	<0.5	0.00	<0.5	<0.5	0.00	<0.5	<0.5	<0.5	0.00	<0.5
Th	0.7	0.6	0.7	8.66	0.7	0.8	10.88	0.1	<0.1	0.1	86.60	<0.1
U	0.4	0.3	0.3	17.32	0.3	0.5	50.51	<0.1	<0.1	0.1	43.30	<0.1
V	26	23	24	6.28	24	26	4.76	58	57	60	2.62	58
W	<1	1.3	<1	60.25	<1	<1	40.25	<1	<1	<1	0.00	<1
Y	2.6	2.5	2.5	2.28	2.5	2.9	15.84	4.3	4.4	4.5	2.27	4.4
Zn	26.0	32.2	28.0	11.01	30.1	28.5	11.37	77.2	67.2	61.0	11.94	68.5
Zr	7.3	7.0	7.0	2.44	7.0	6.0	32.47	7.5	3.5	6.6	35.77	5.9

Rel Std Dev
nd
(a) Relative standard deviation, which is the (standard deviation / mean) 100
no data
(a) Average of 10 analyses (5 Amdel, 5 Genalysis) 1995-96
(b) Except where noted otherwise
(c) Average of 6 analyses (Amdel) 1996
(d) Average of 10 analyses (6 Genalysis, 4 Amdel) 1995-96

Figures

1. Locality plan
2. Geological interpretation
3. Generalized regolith map
- Element-distribution maps (4–43)**
4. TiO_2
5. Fe_2O_3
6. MnO
7. MgO
8. CaO
9. Na_2O
10. K_2O
11. P_2O_5
12. As
13. Au
14. Ba
15. Be
16. Ce
17. Co
18. Cr
19. Cu
20. F
21. Ga
22. La
23. Li
24. Mo
25. Nb
26. Ni
27. Pb
28. Pd
29. Pt
30. Rb
31. S
32. Sc
33. Se
34. Sn
35. Sr
36. Te
37. Th
38. U
39. V
40. Y
41. Zn
42. Zr
43. Ag, Sb, Ta, and W
44. Principal Component One scores
45. Principal Component Two scores
46. Gold deposits and contoured gold geochemistry
47. Chalcophile index
48. Regolith acidity-alkalinity and TDS
49. Groundwater TDS

Figure 1.

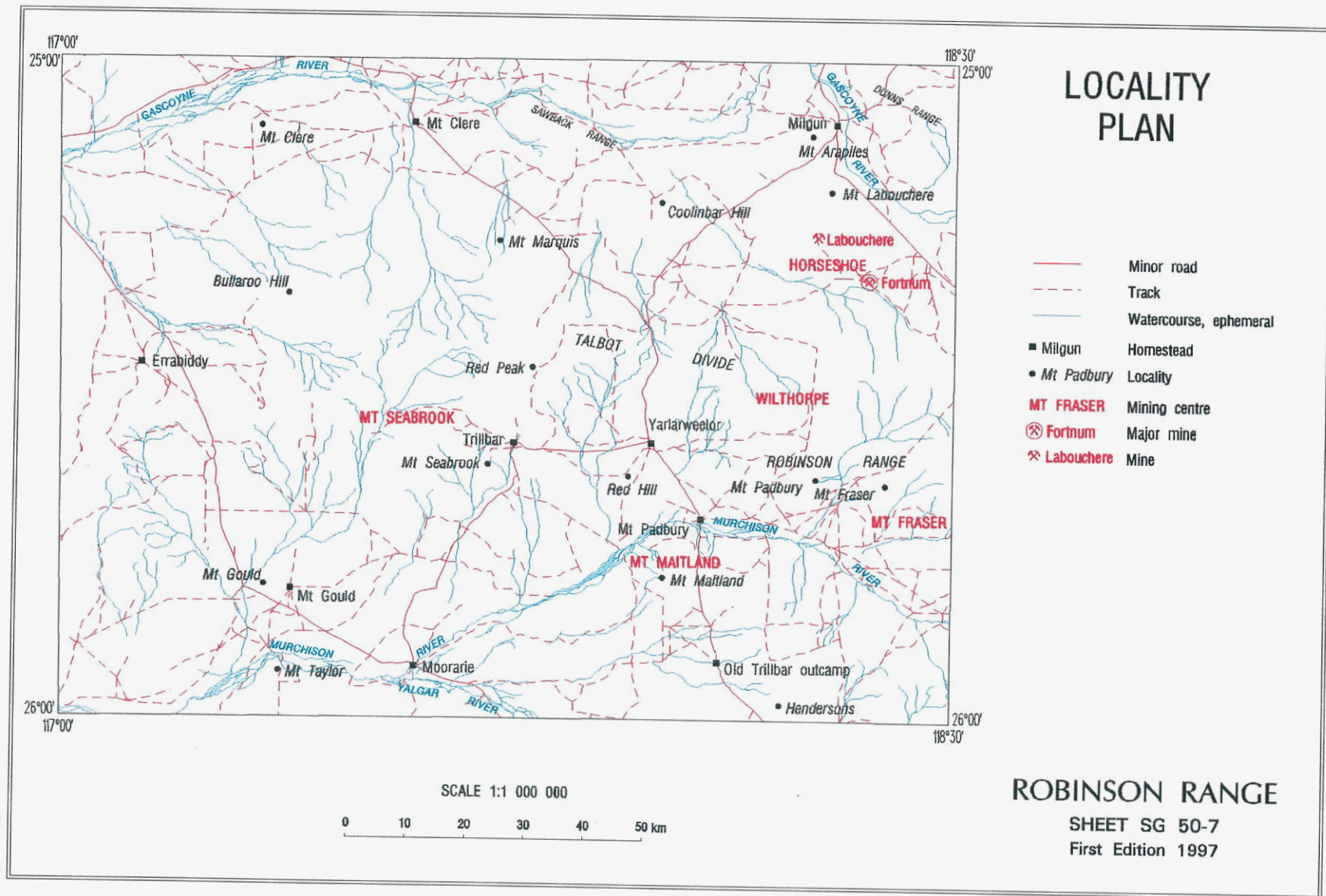
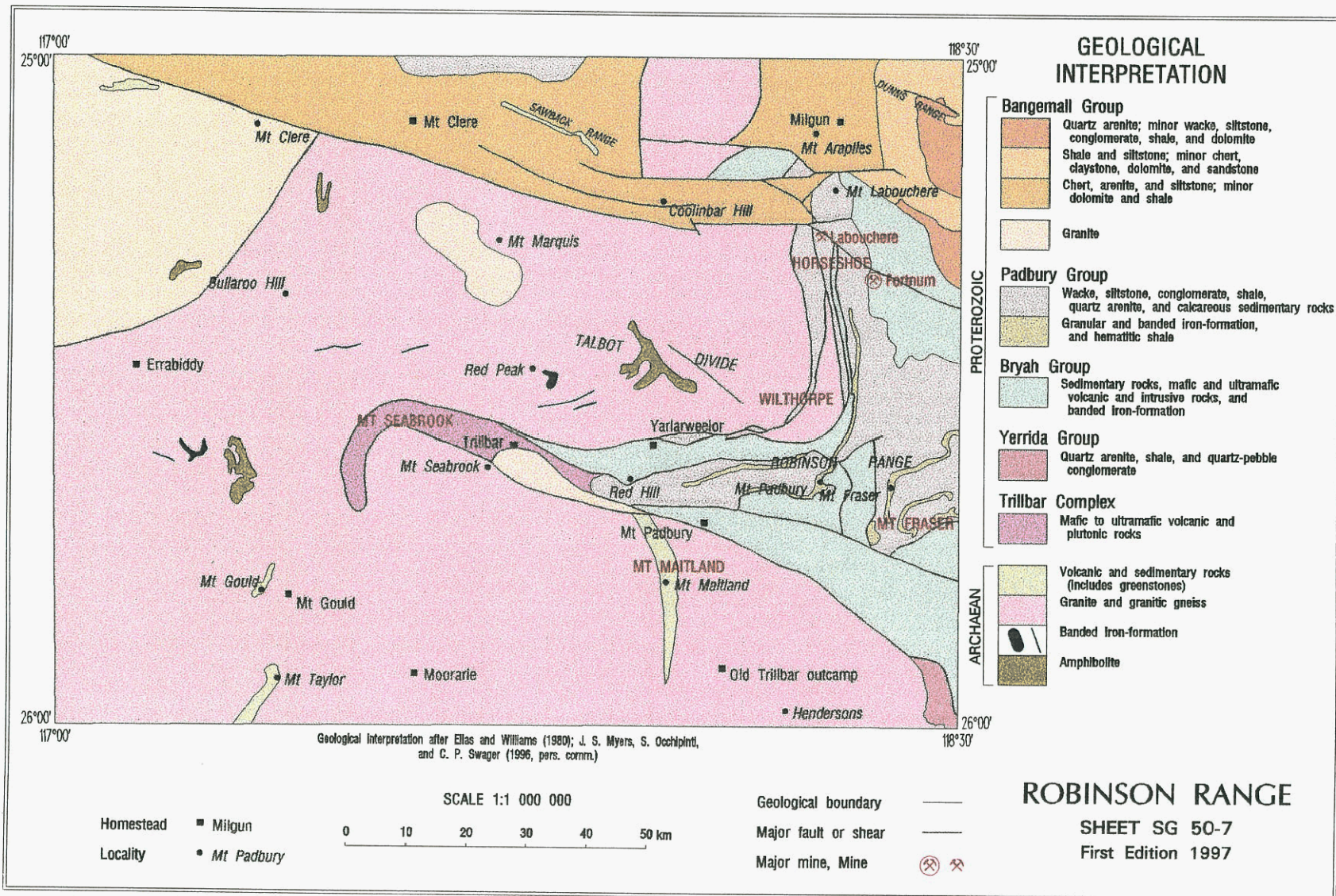


Figure 2.



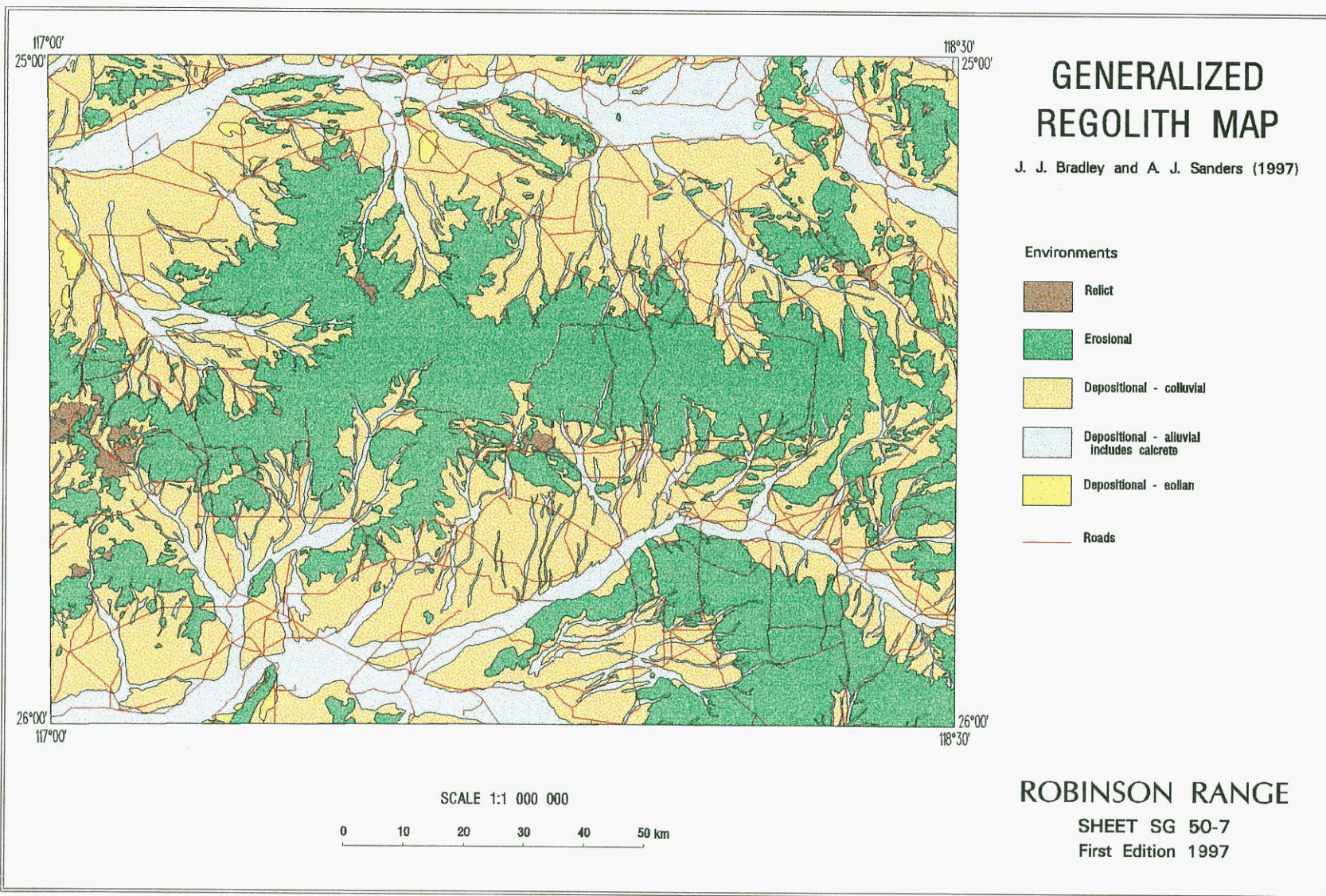
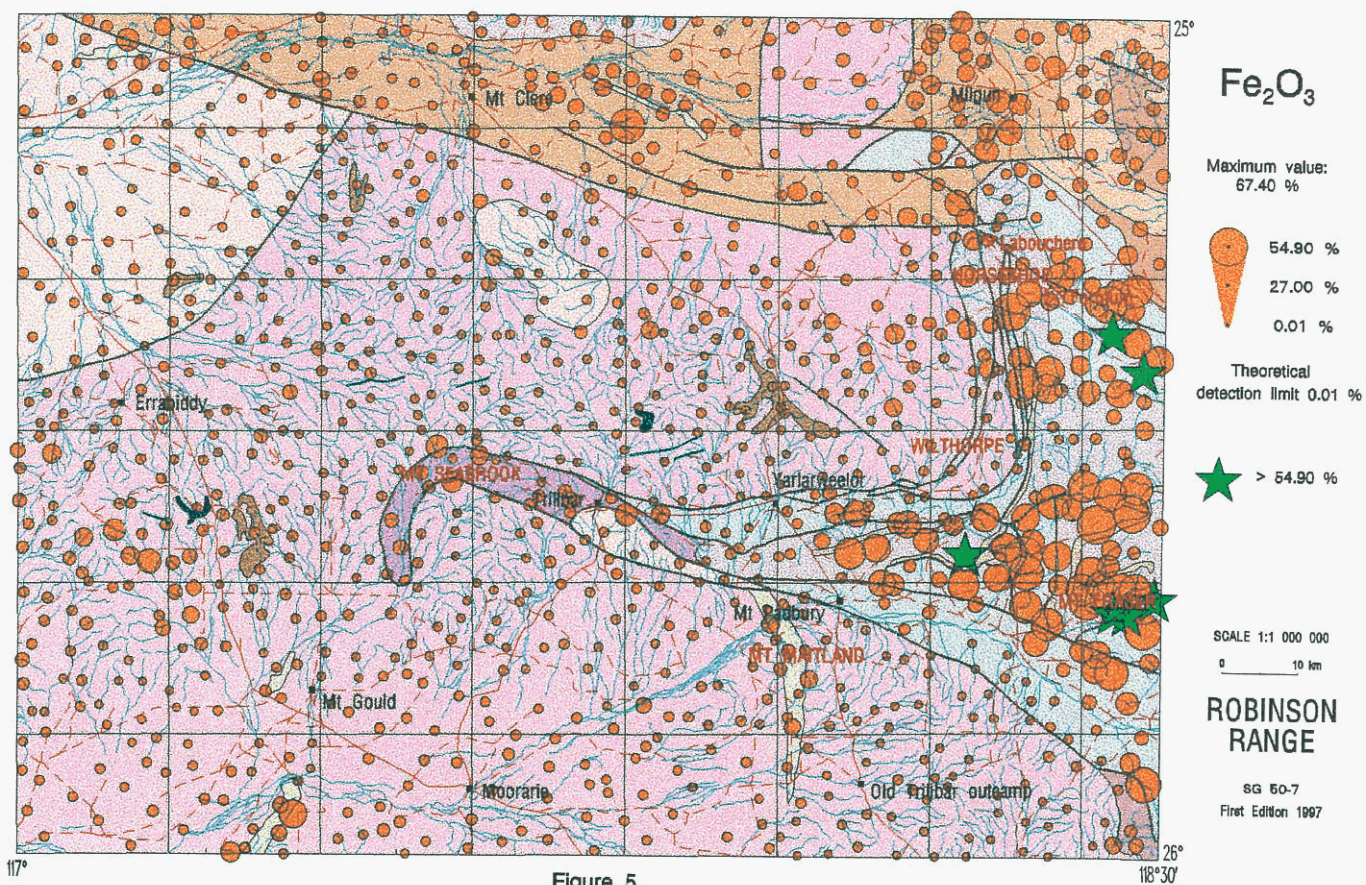
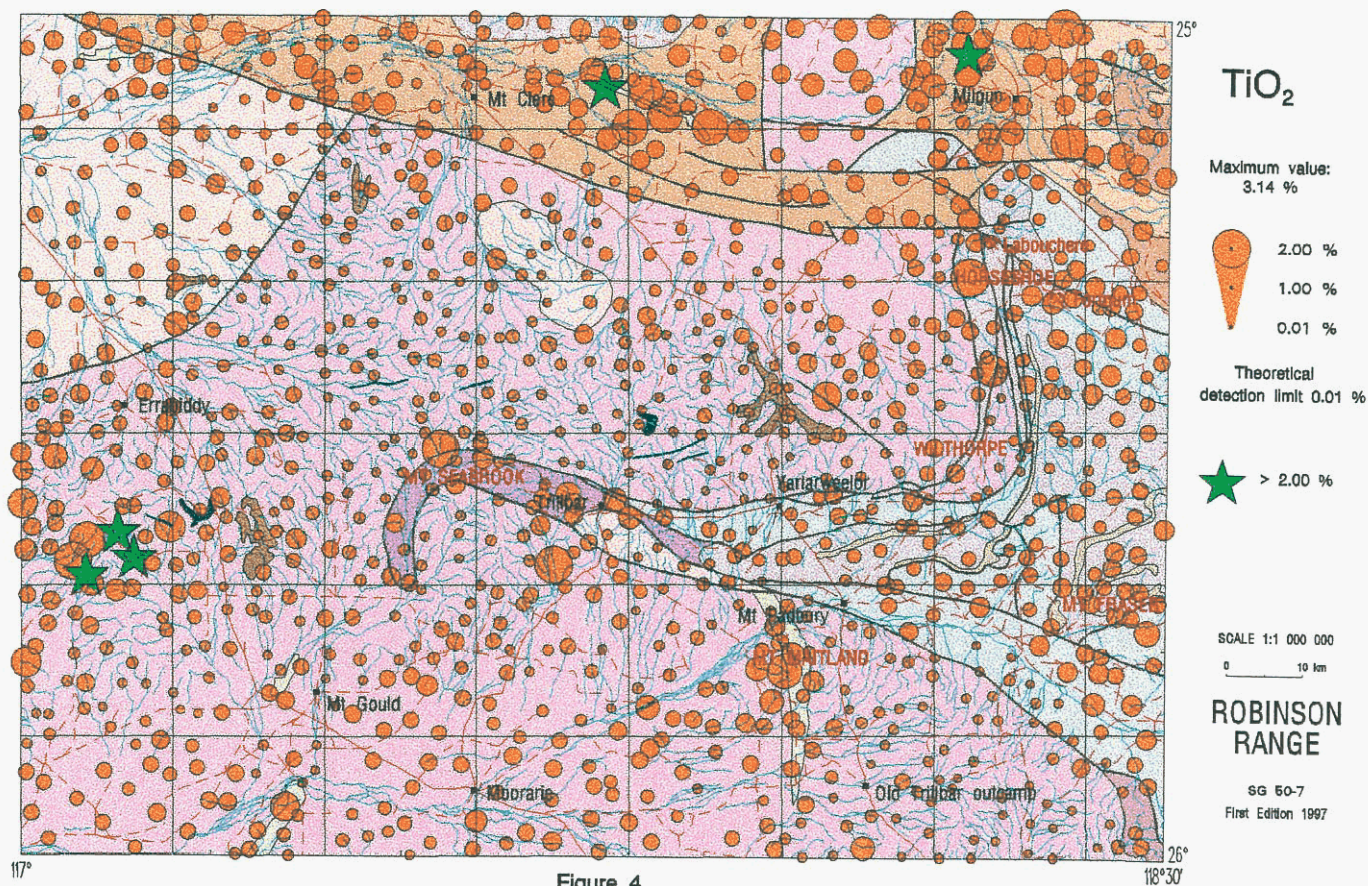


Figure 3.



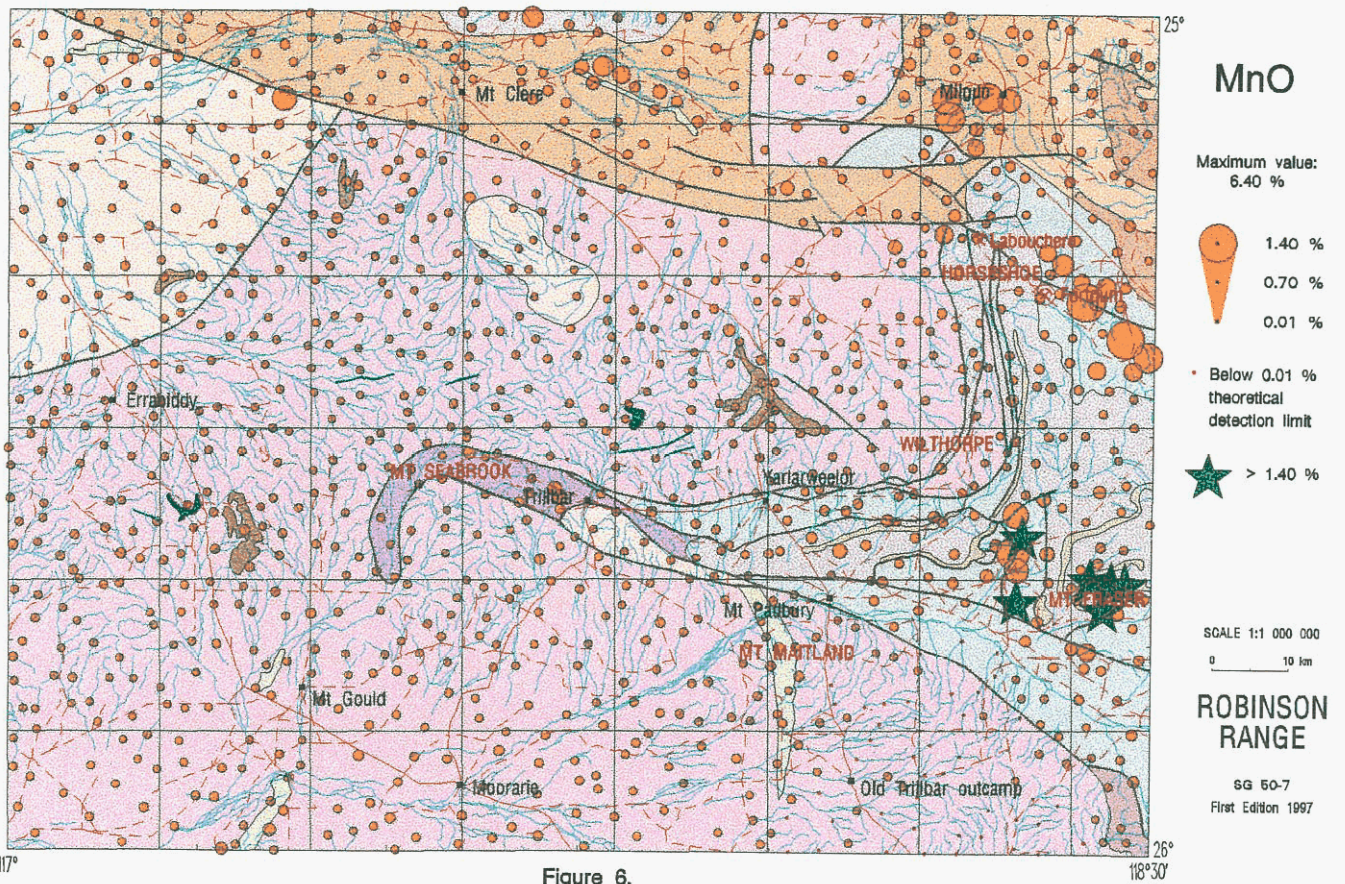


Figure 6.

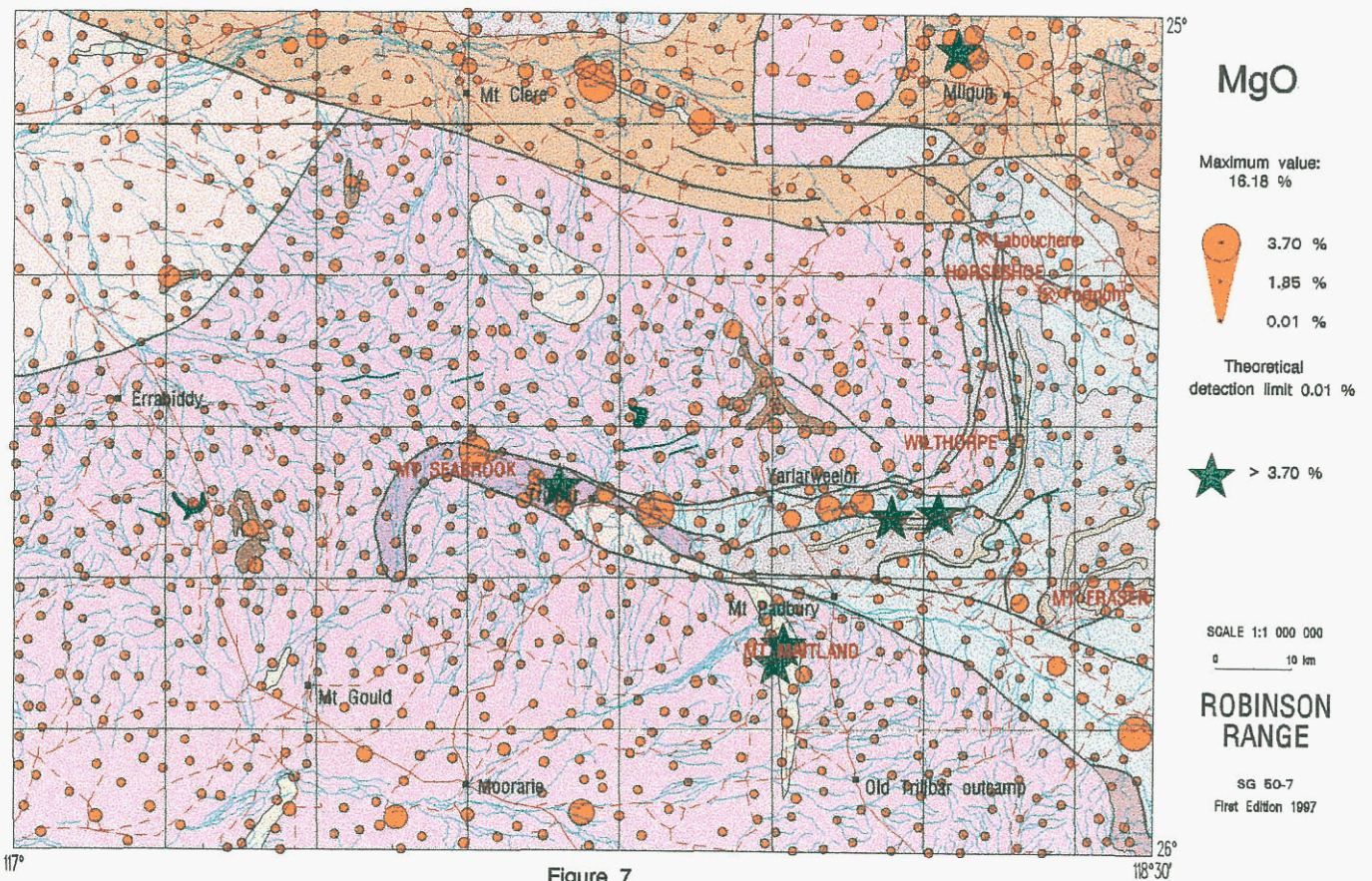


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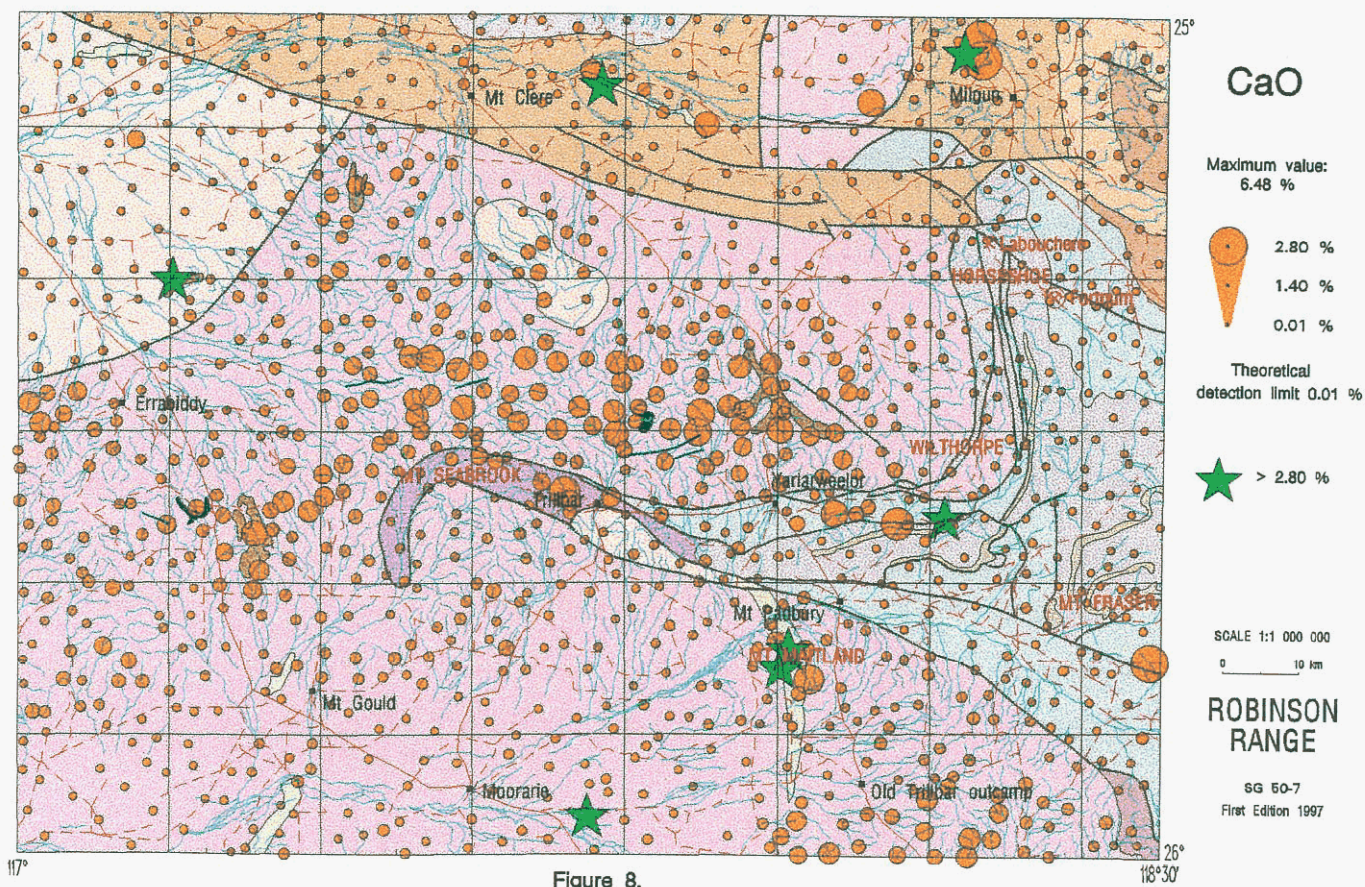


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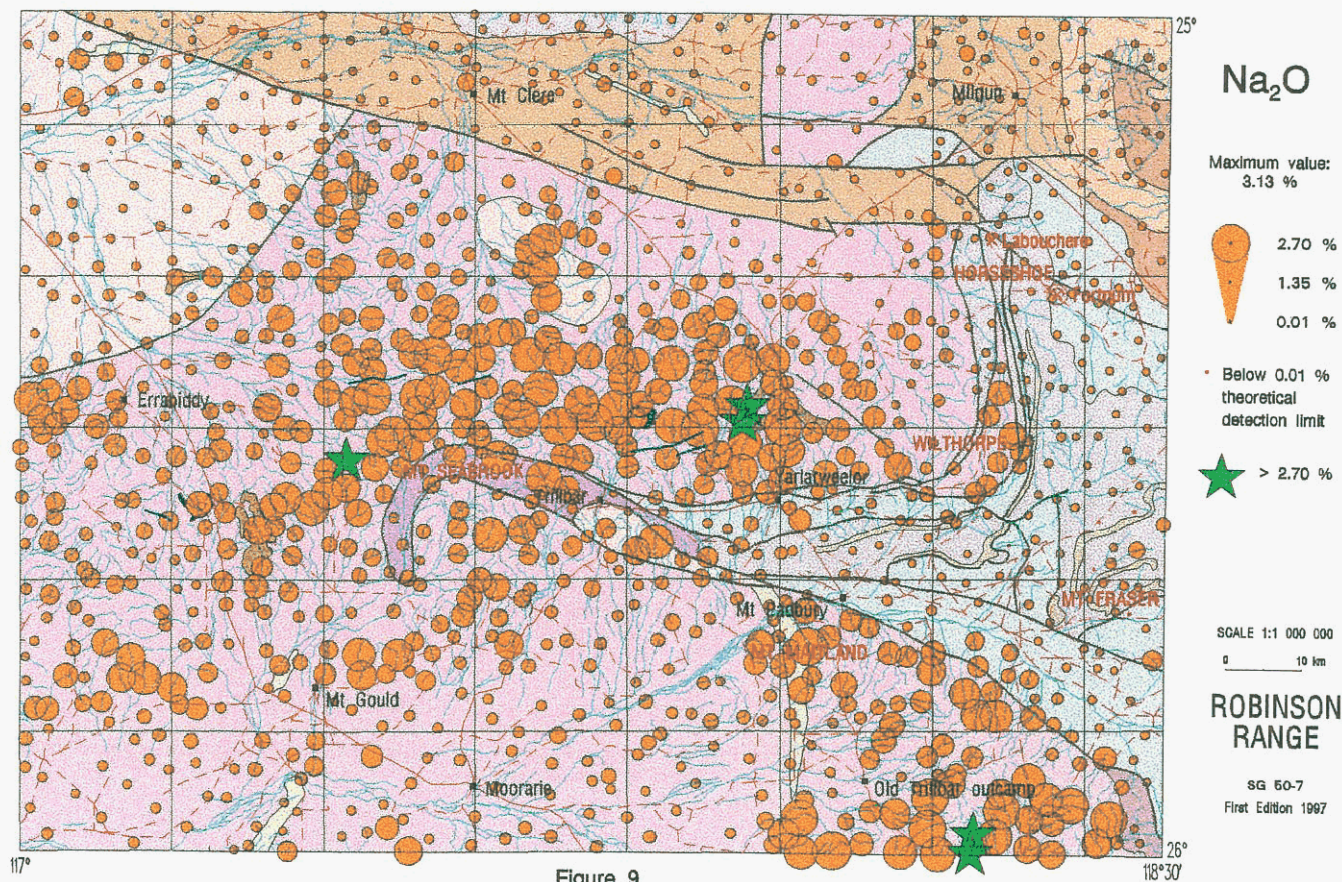


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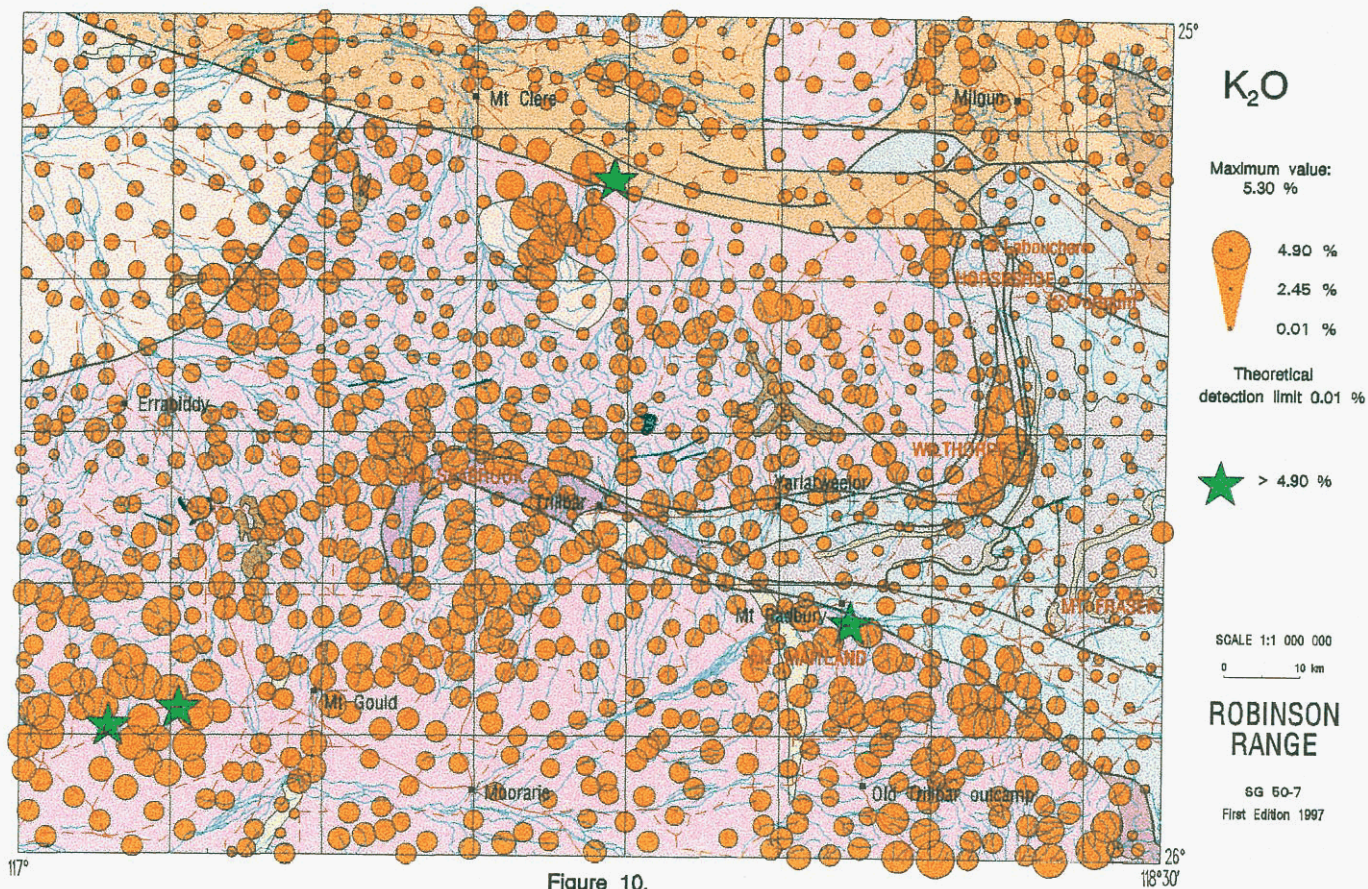


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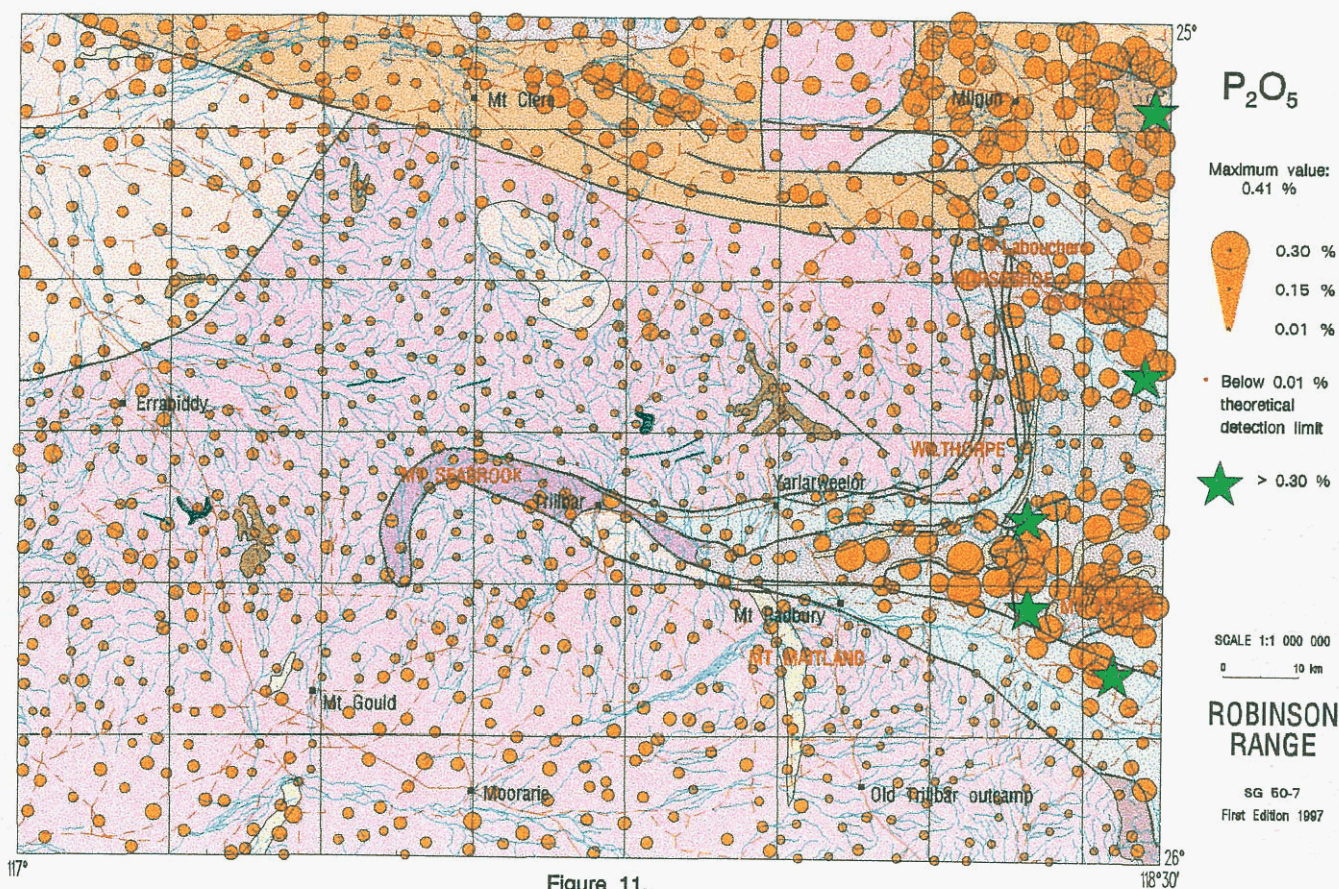


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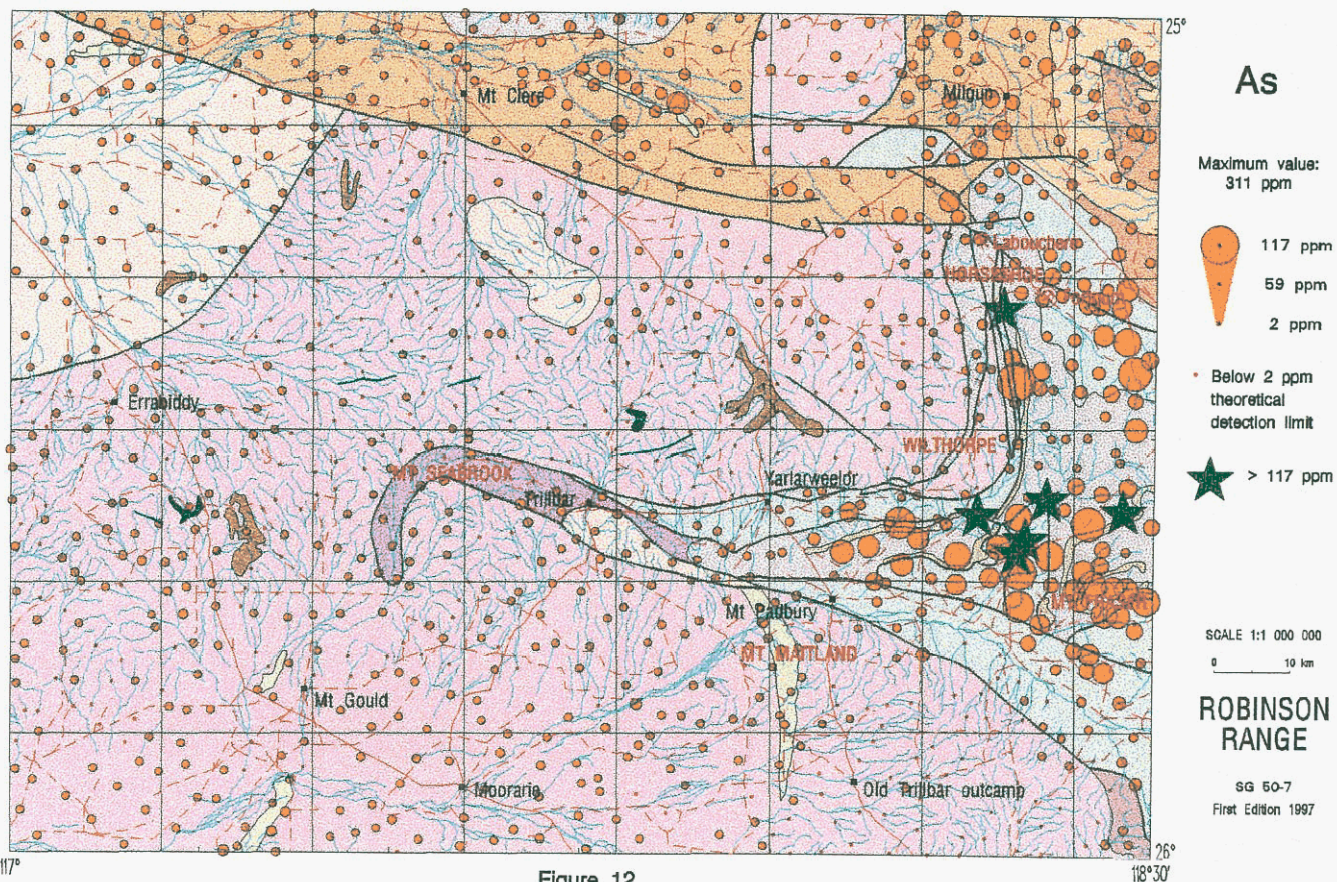


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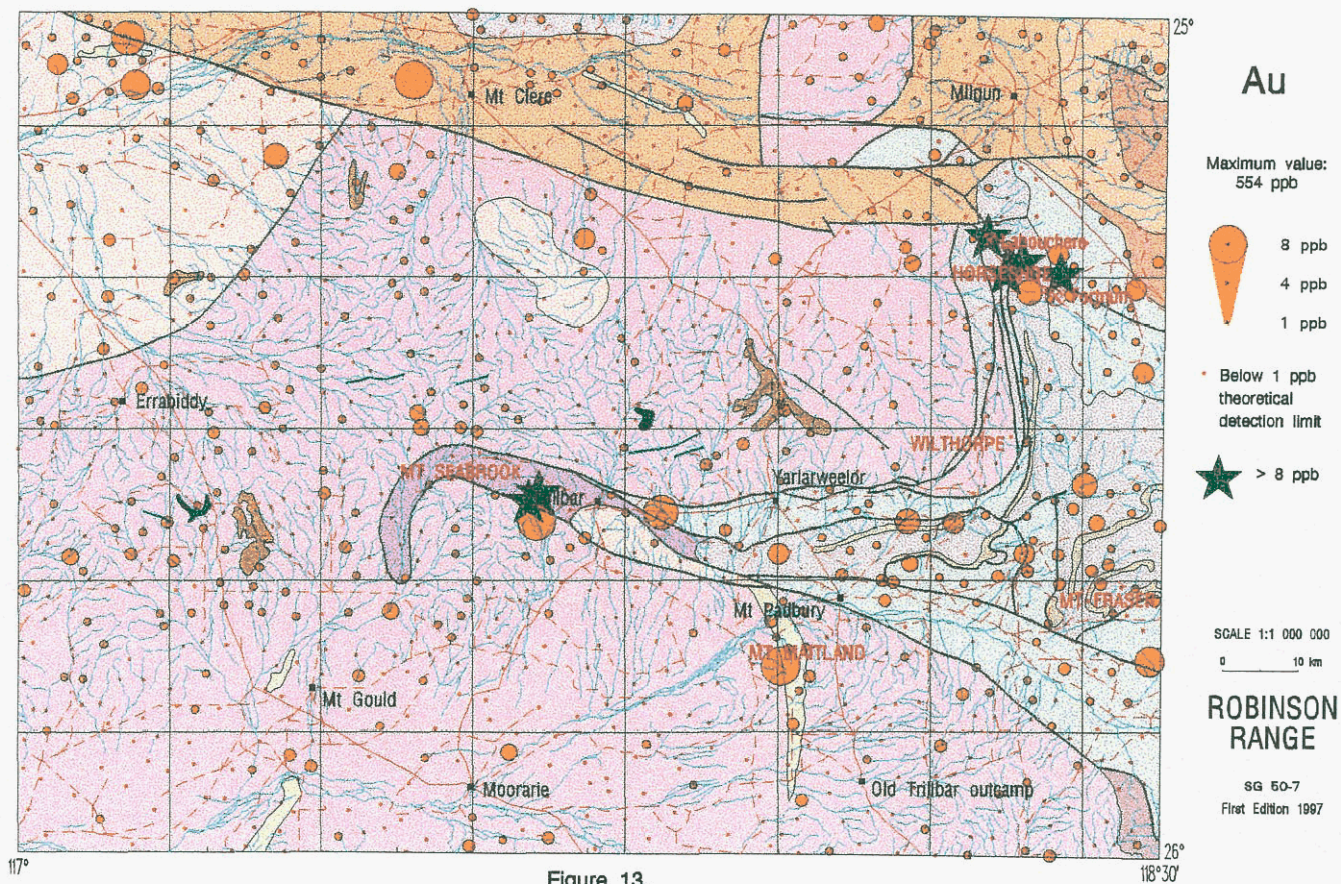


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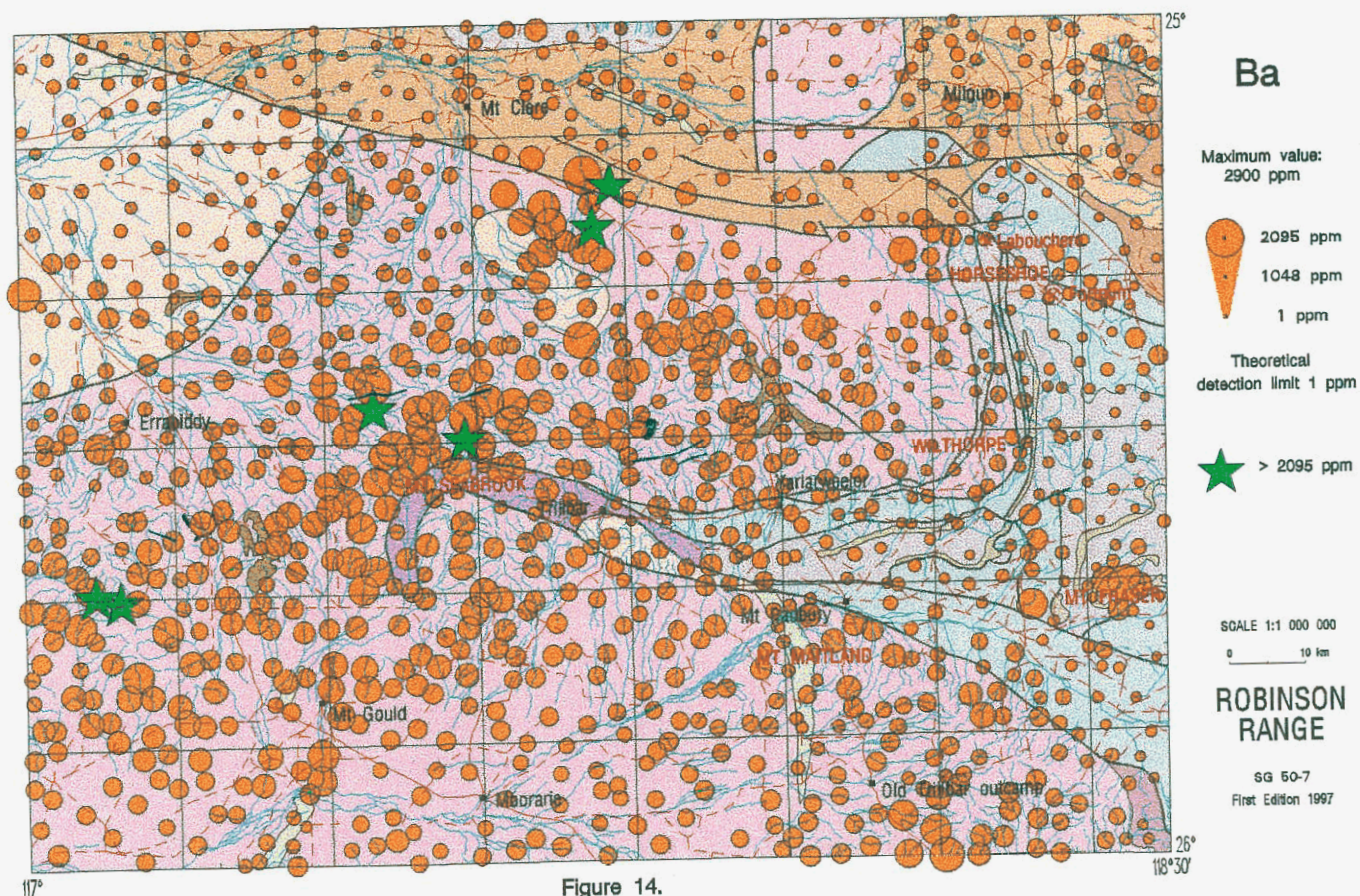


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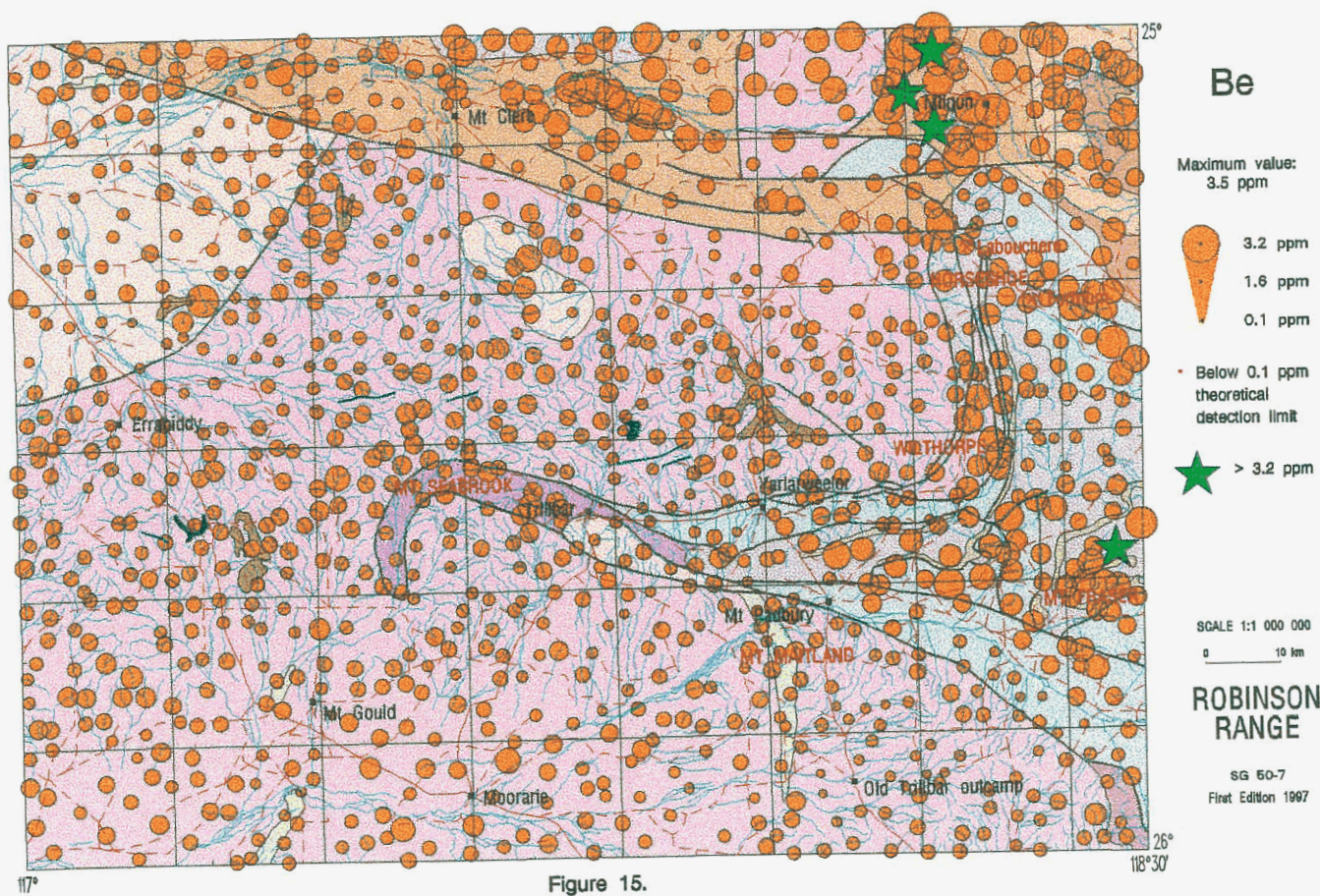


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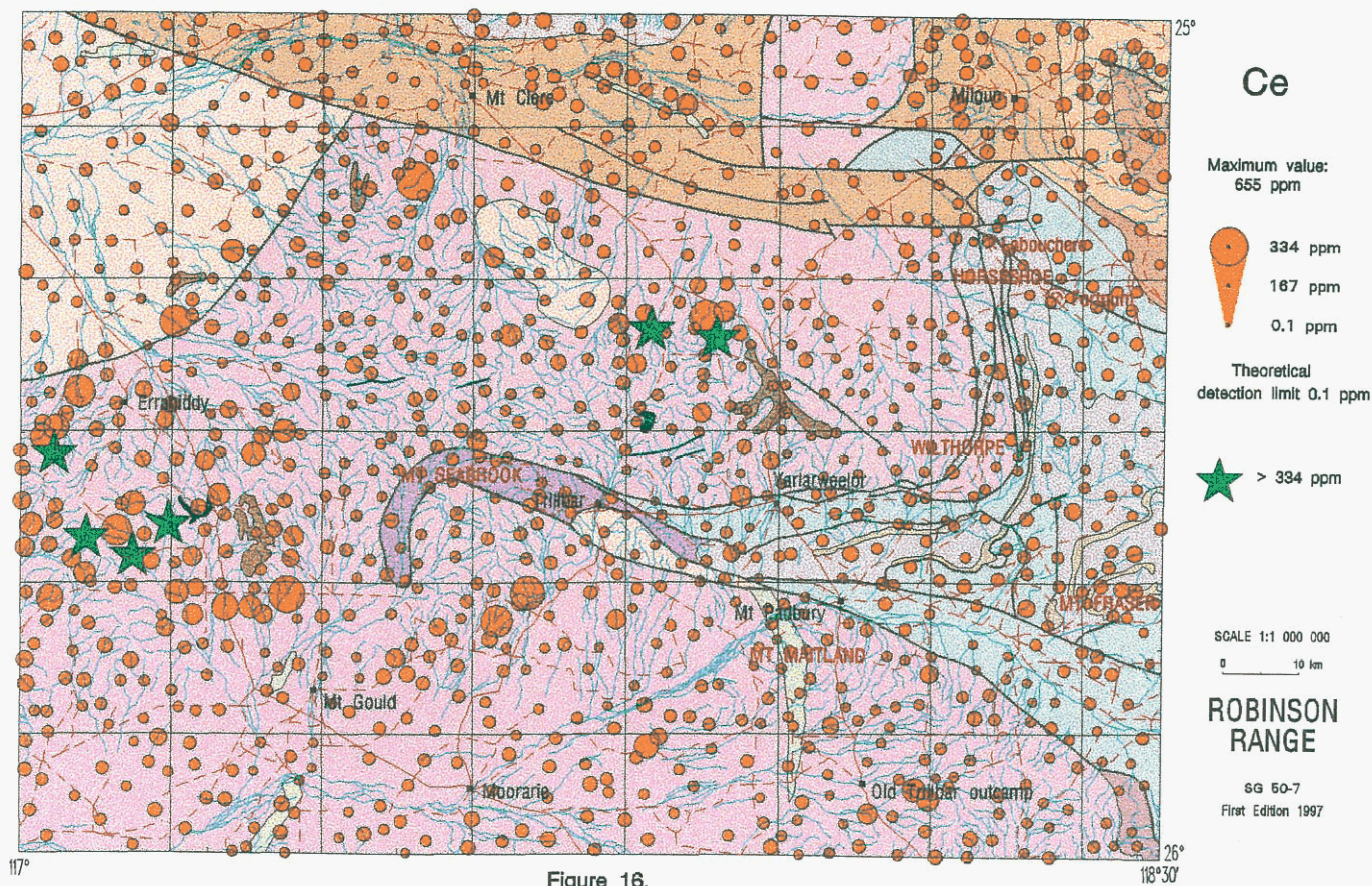


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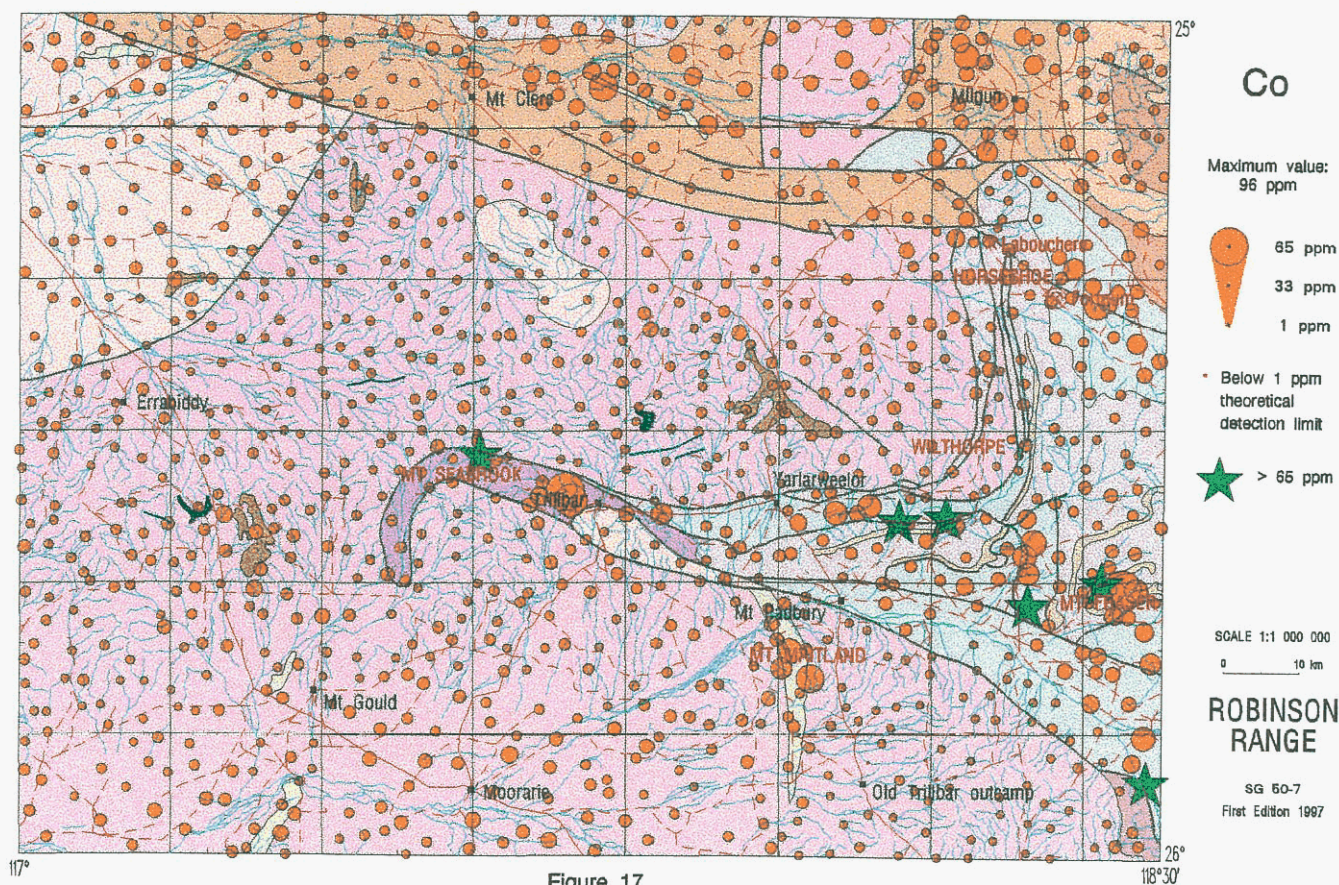


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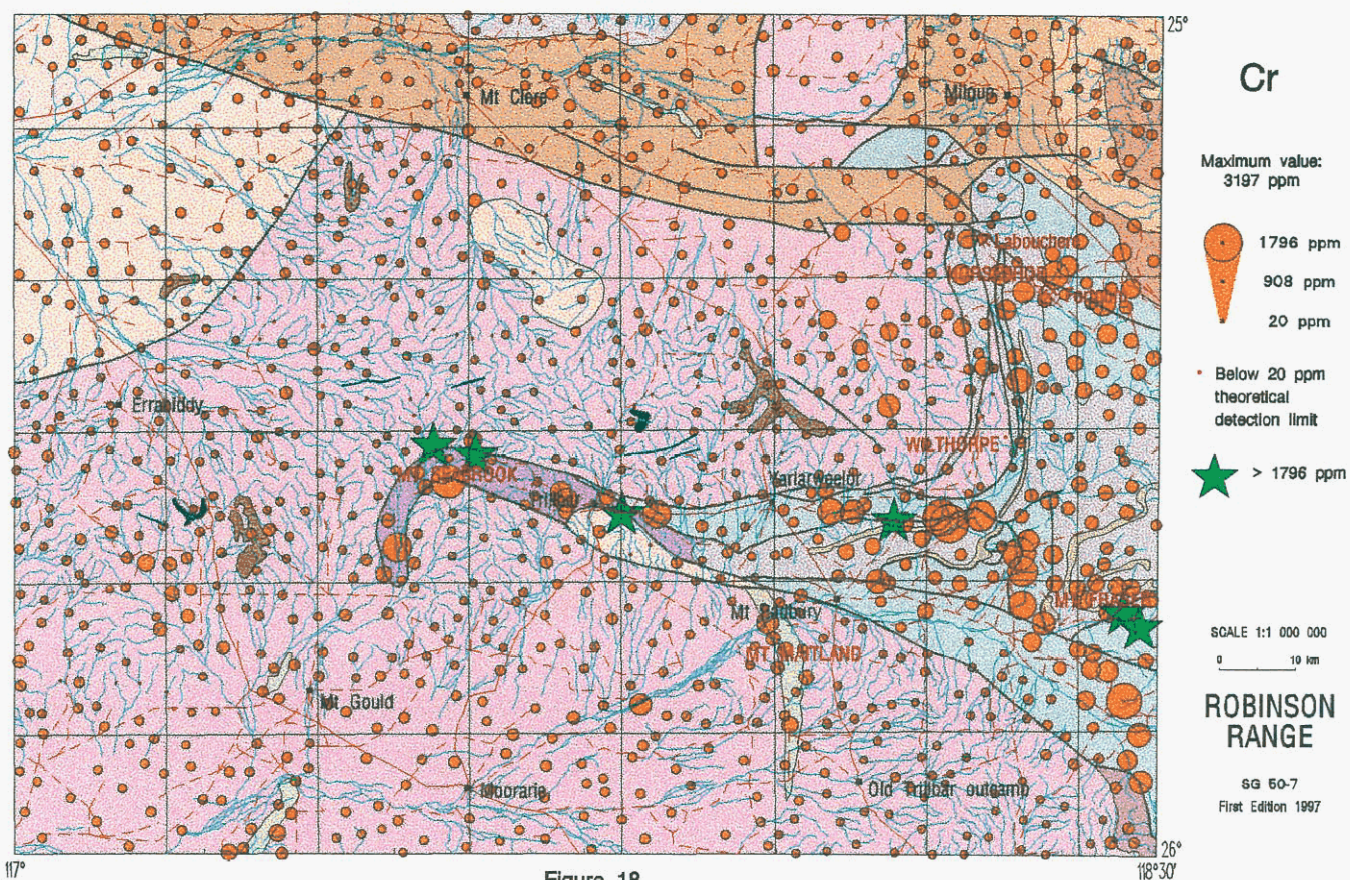


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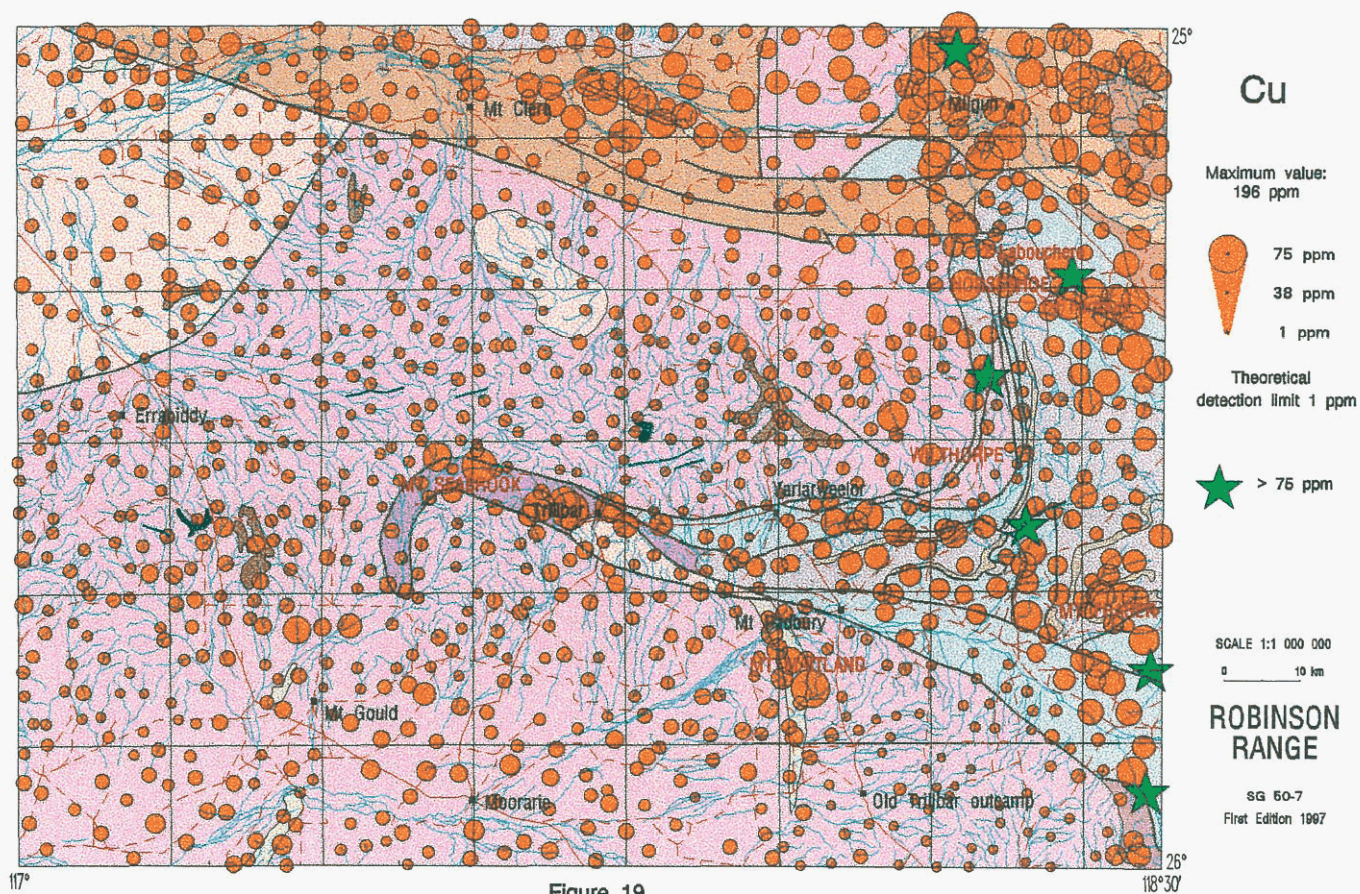


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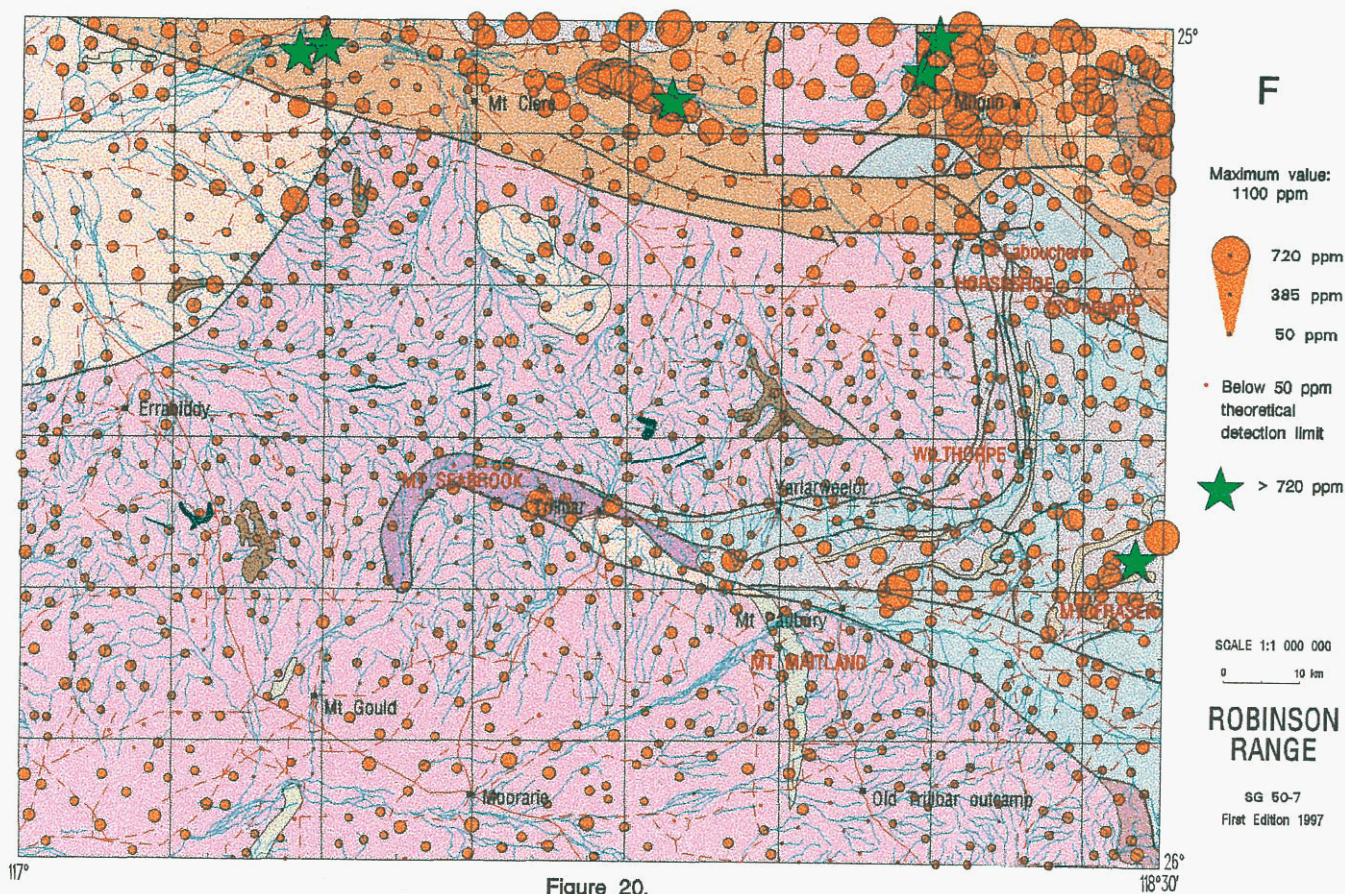


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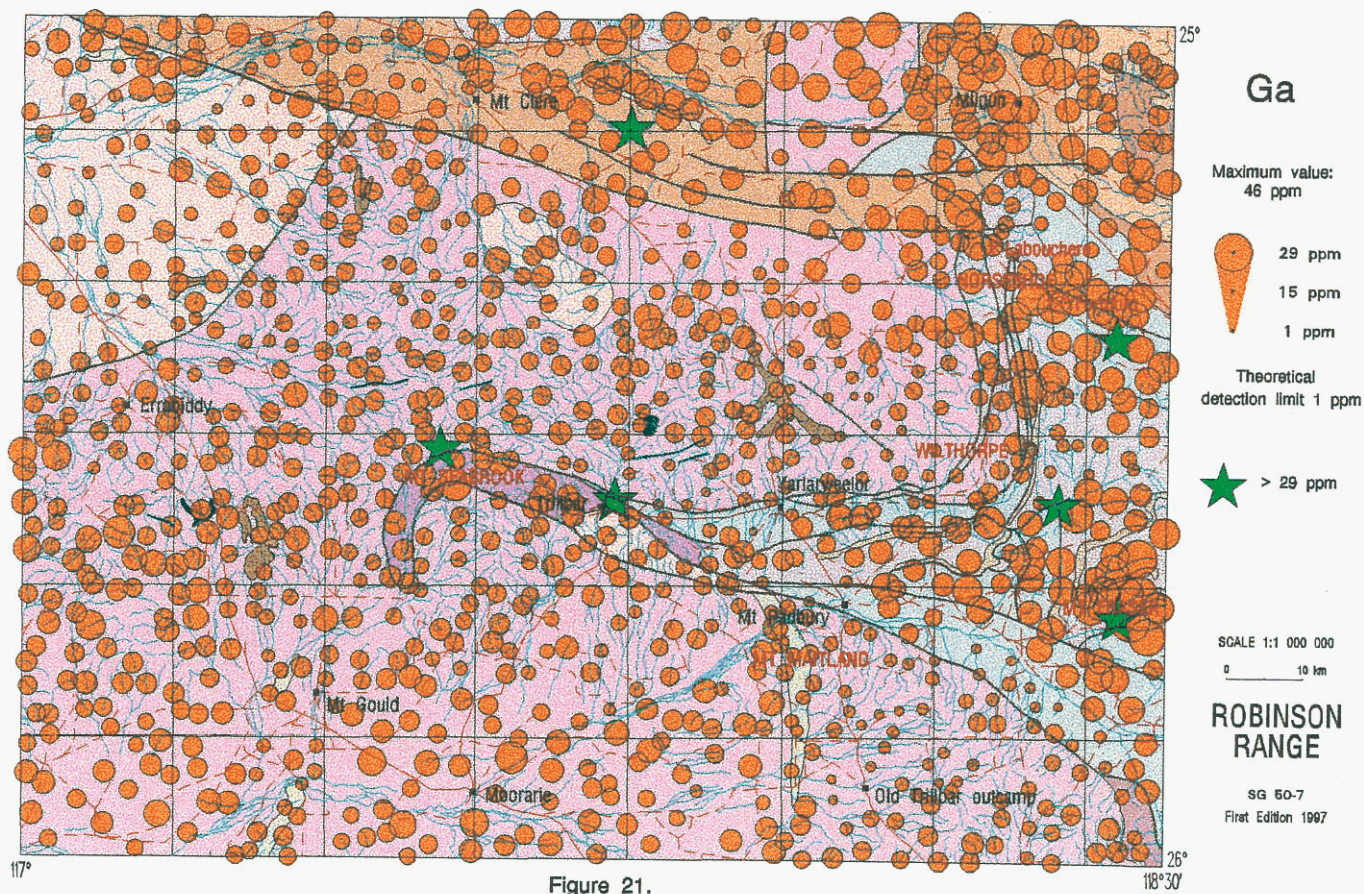


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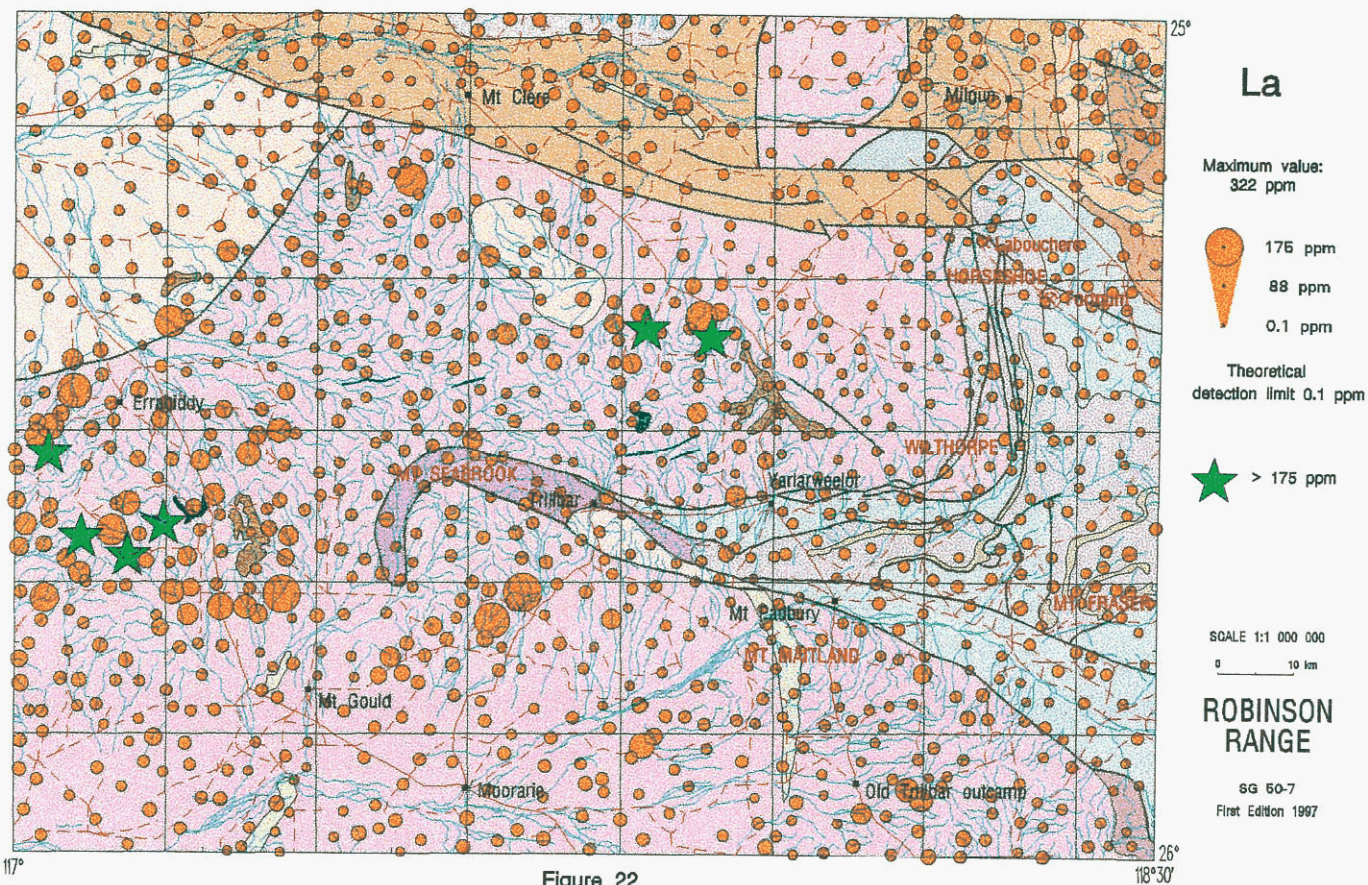


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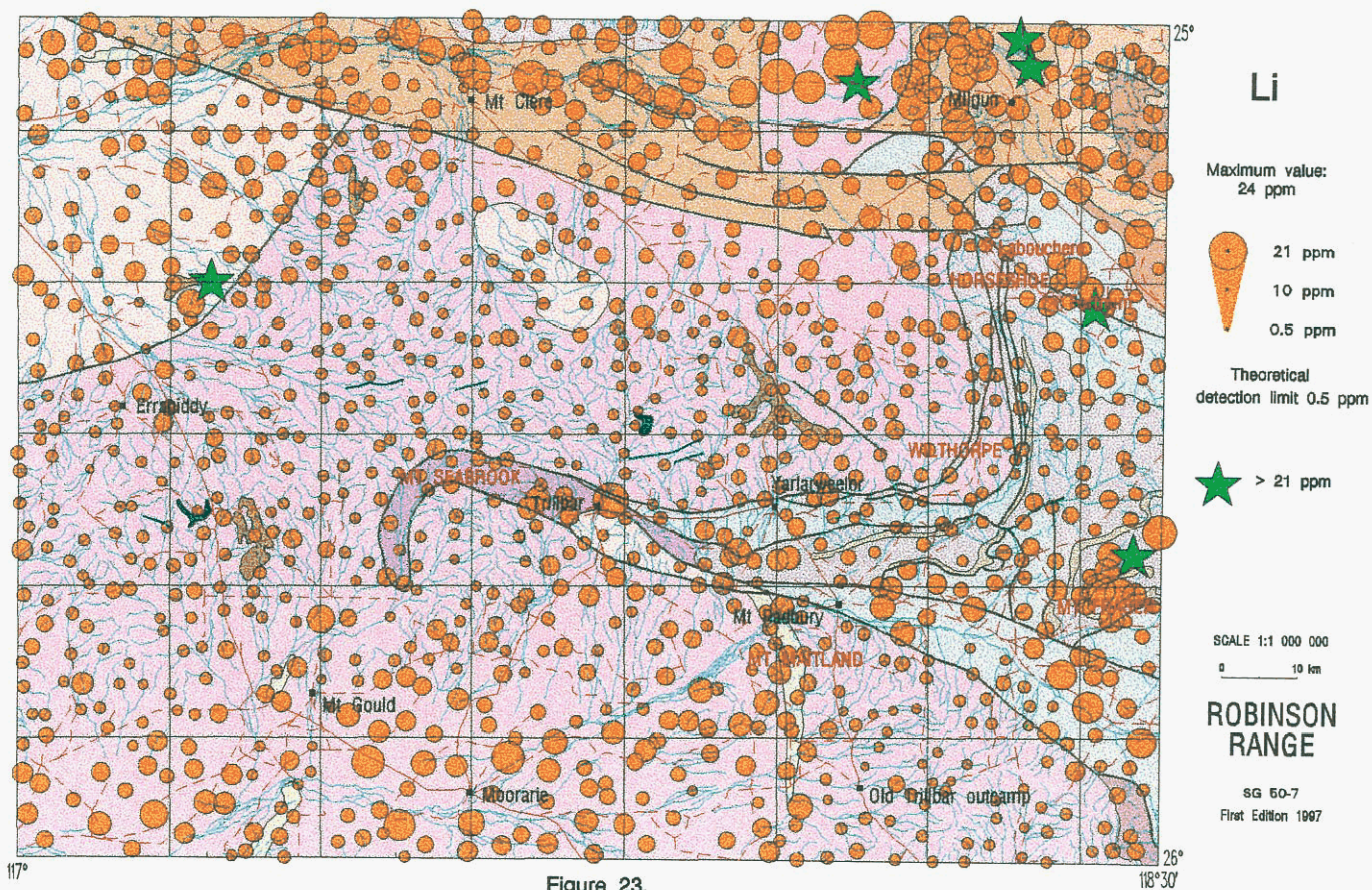


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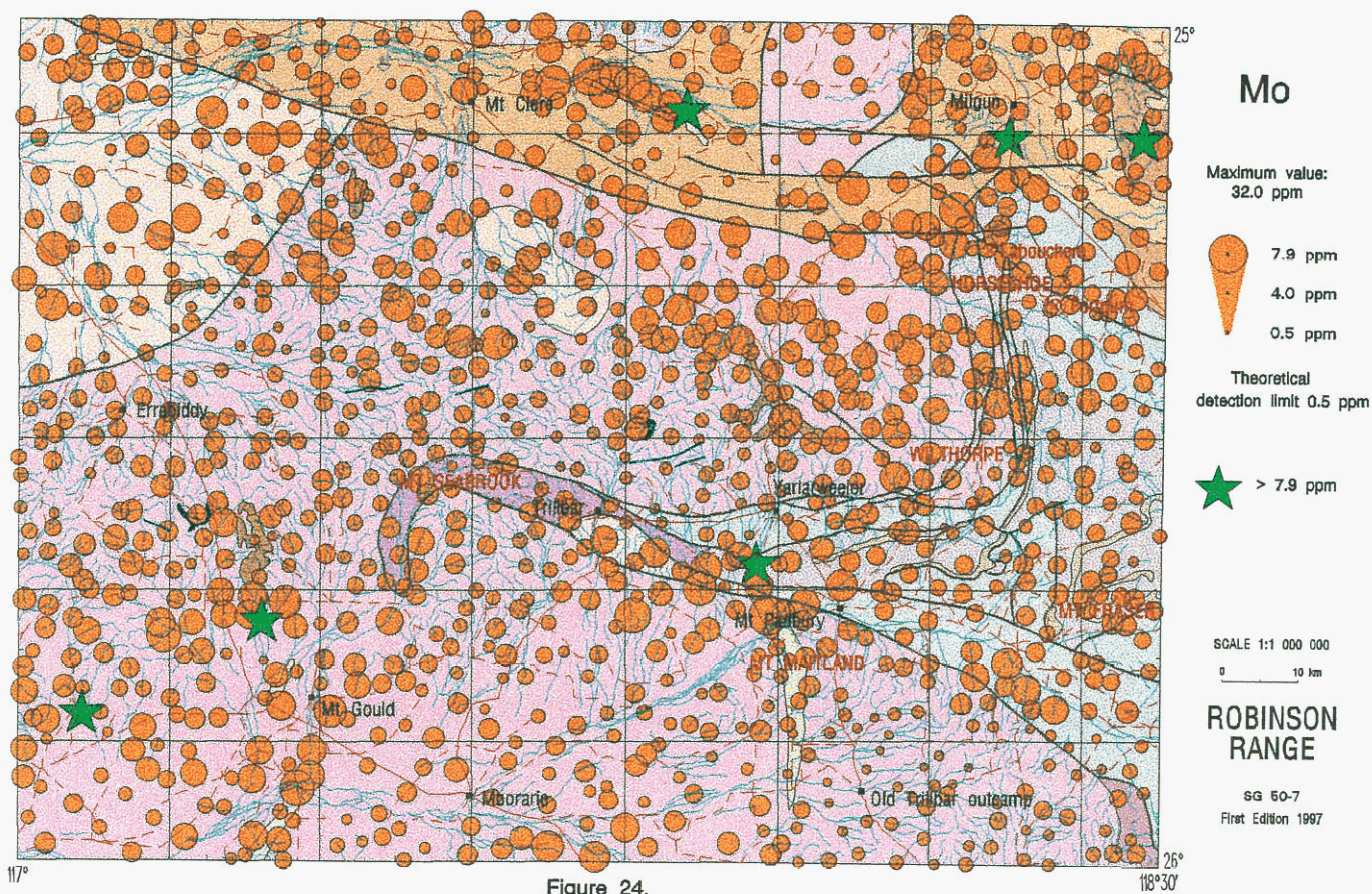


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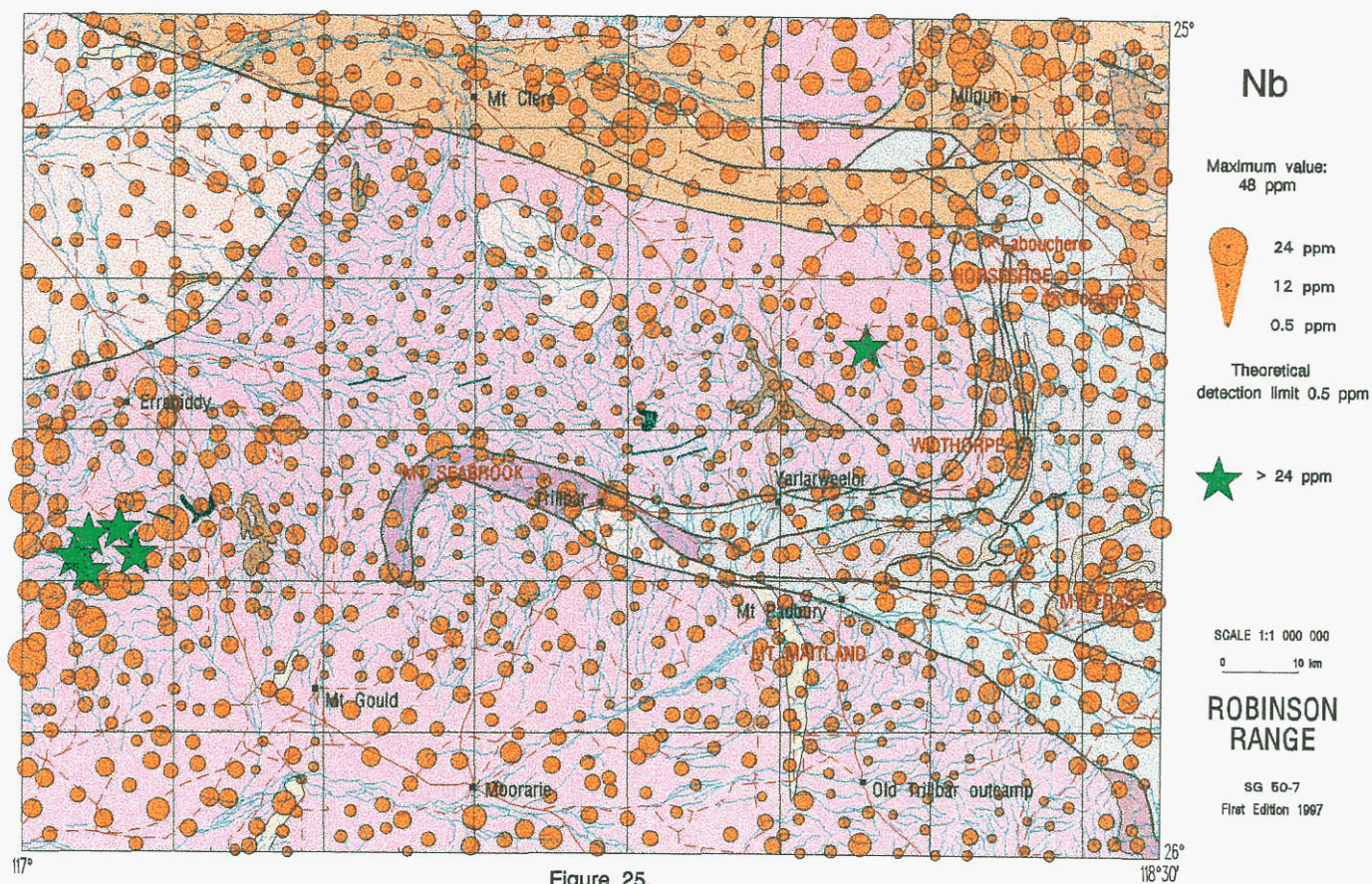
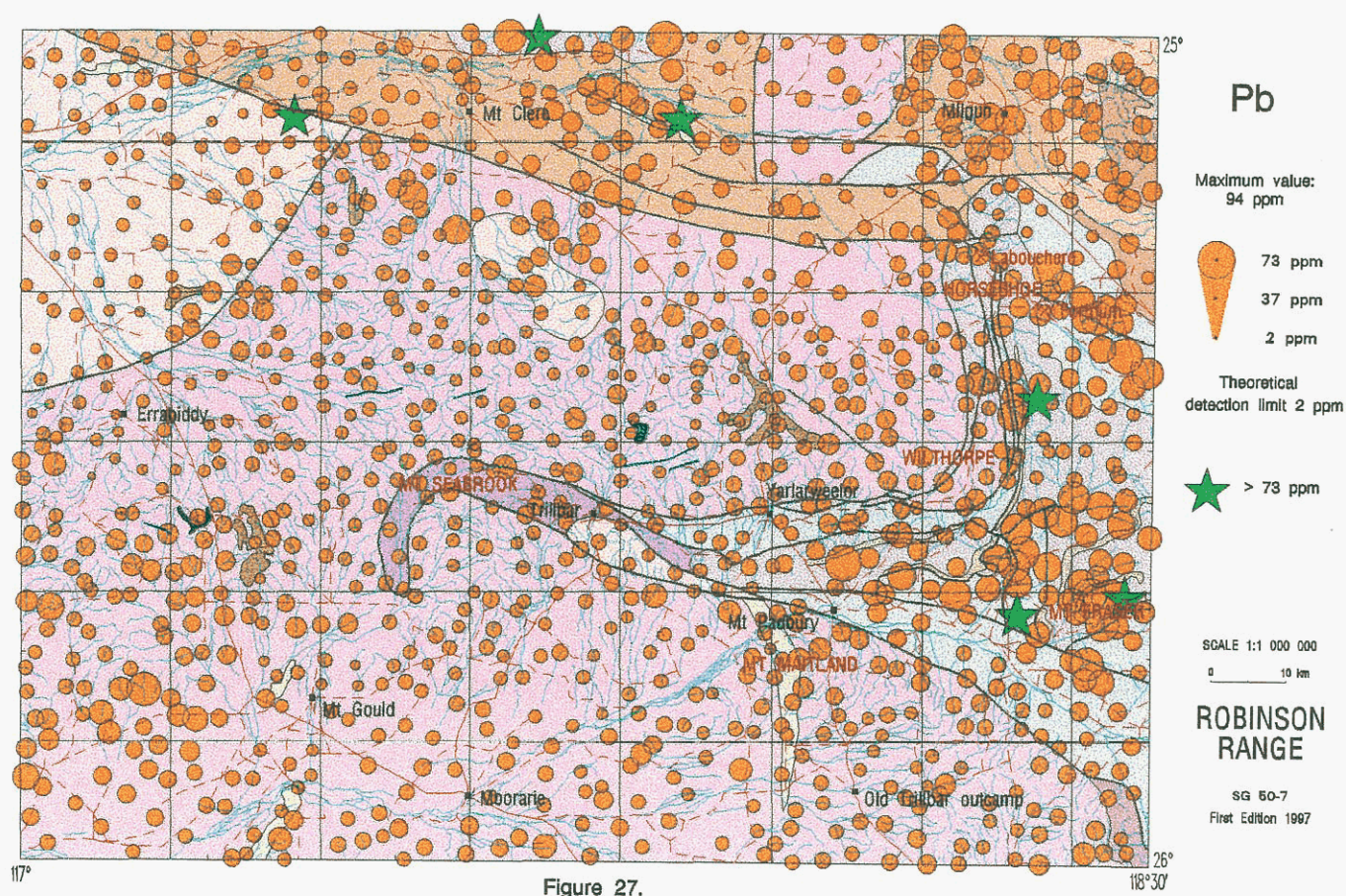
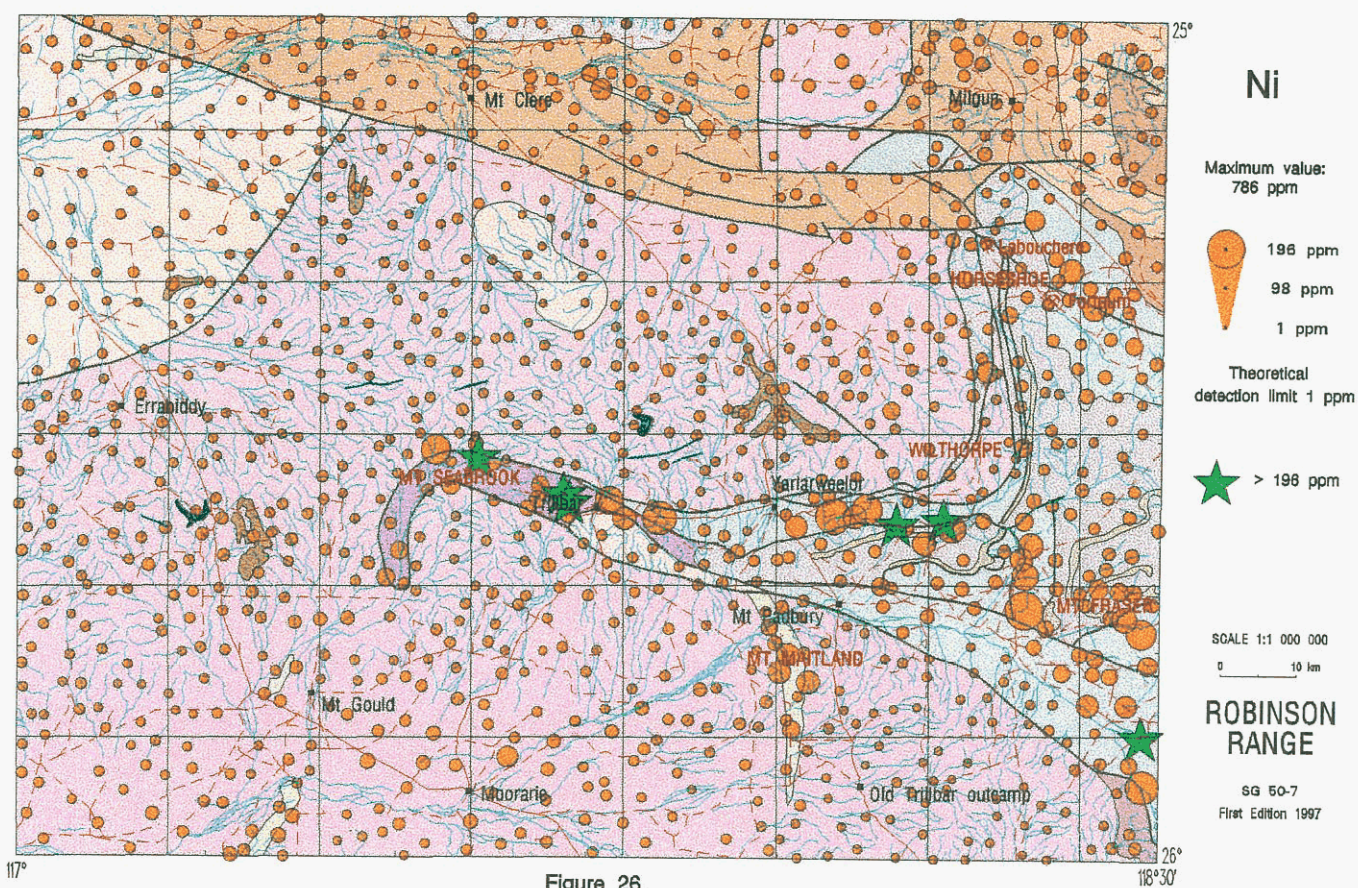
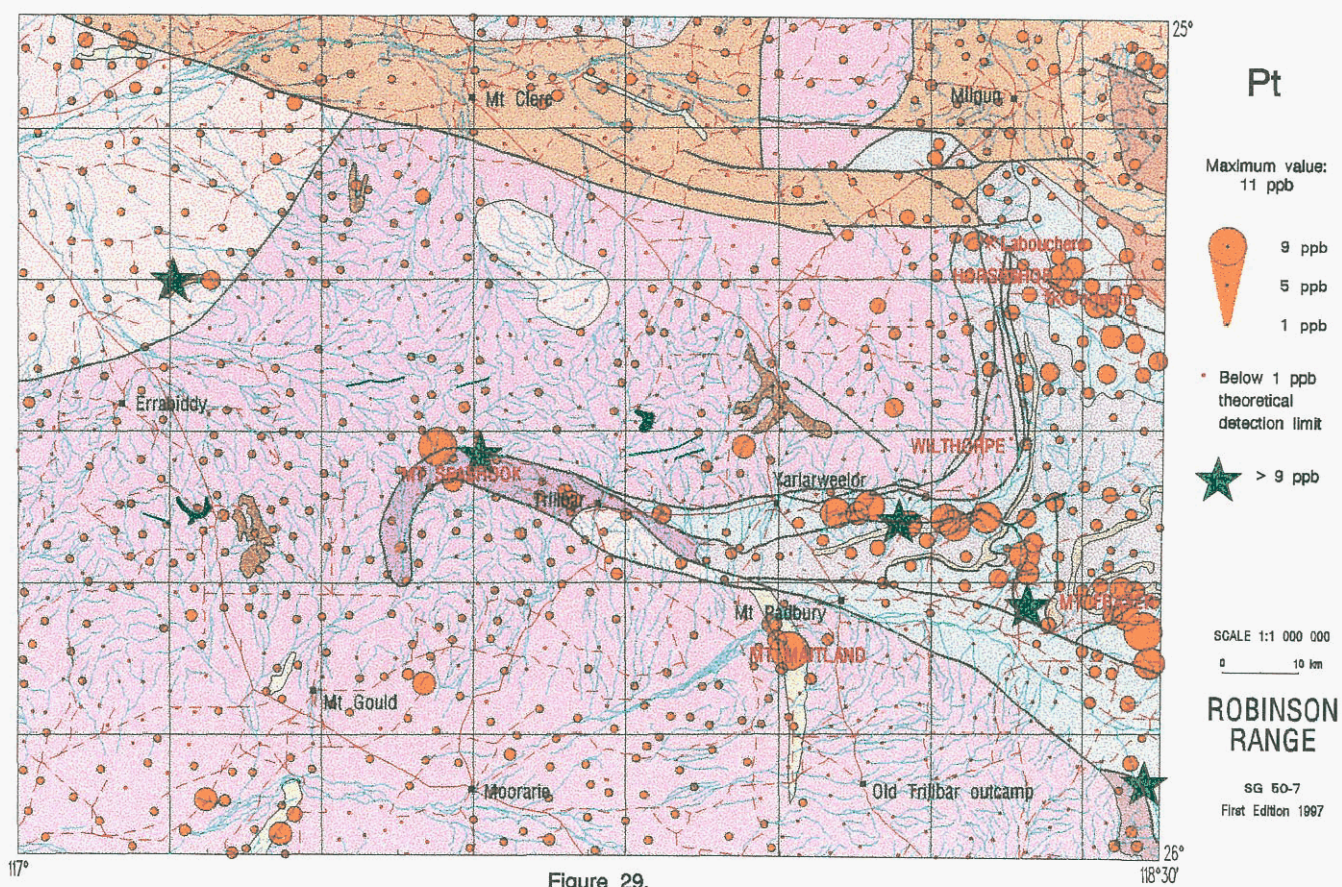
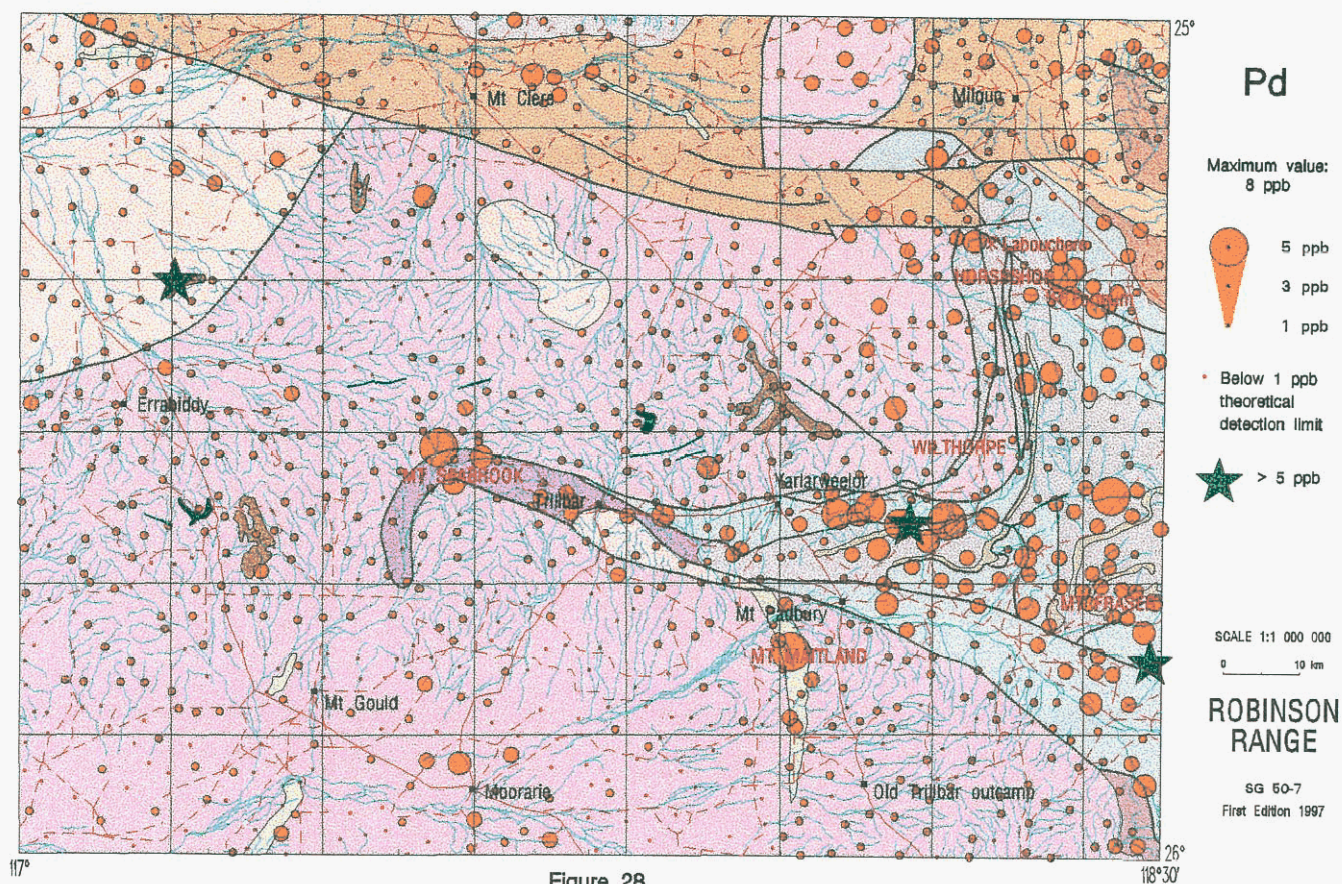


Figure 25.





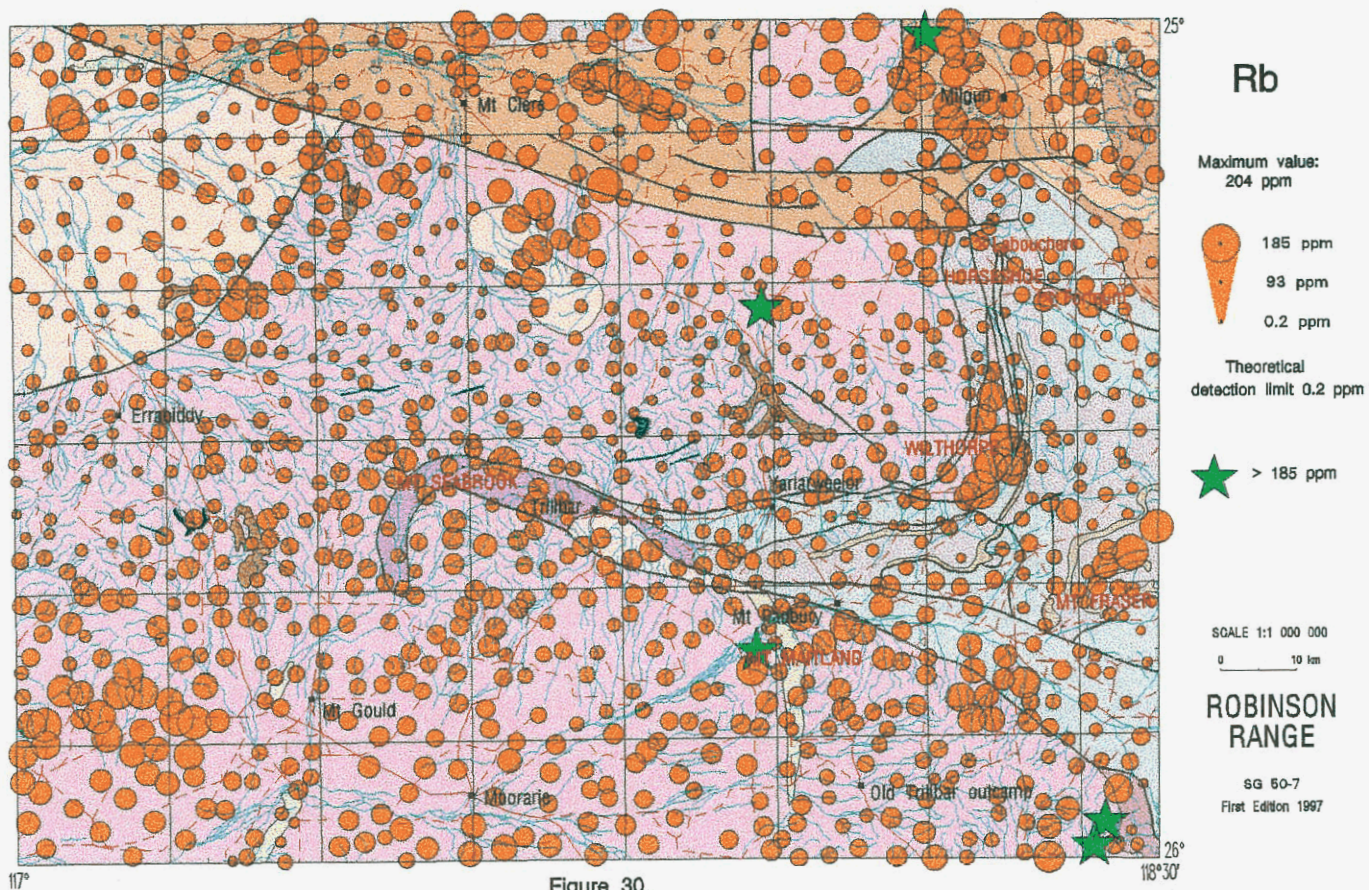


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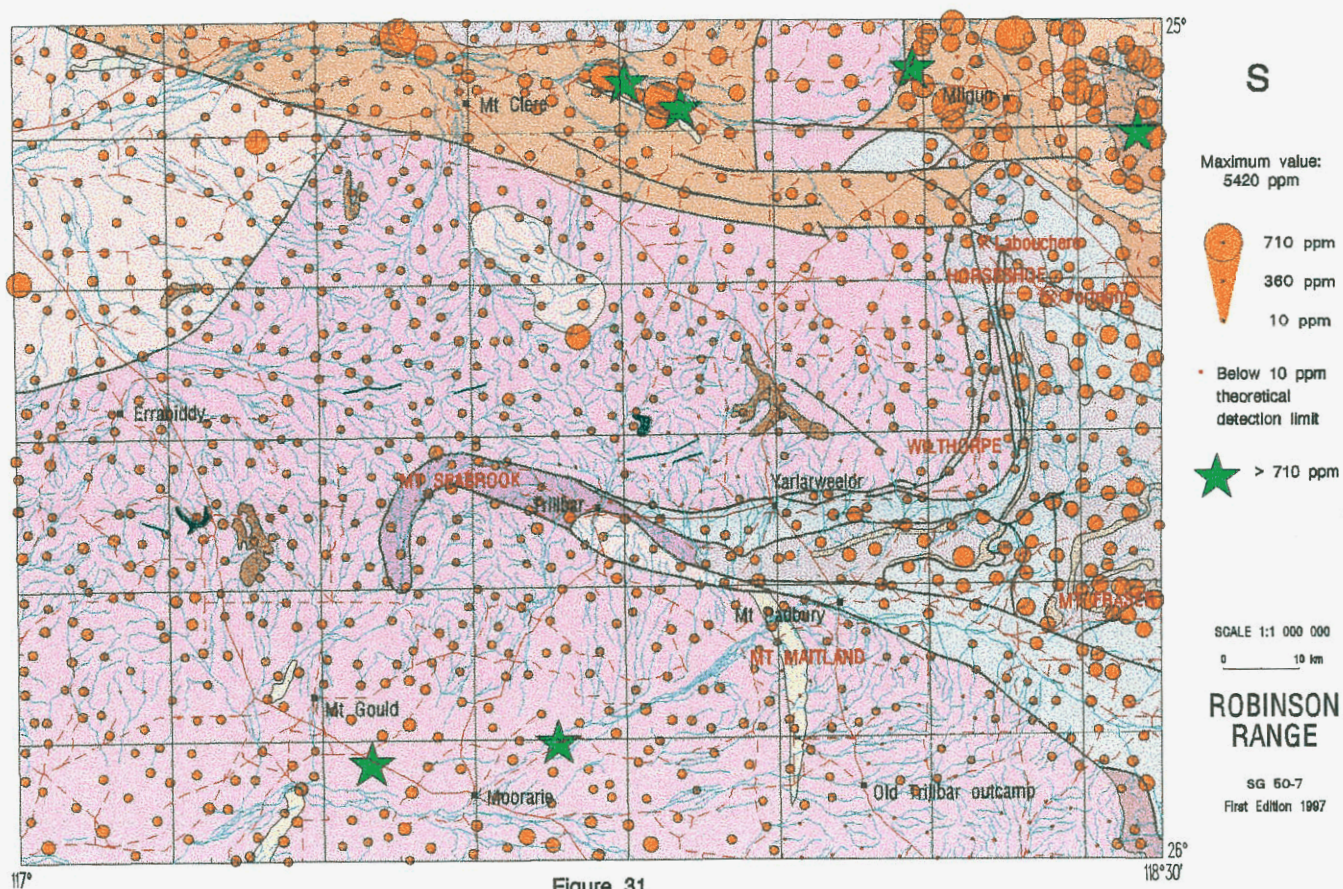


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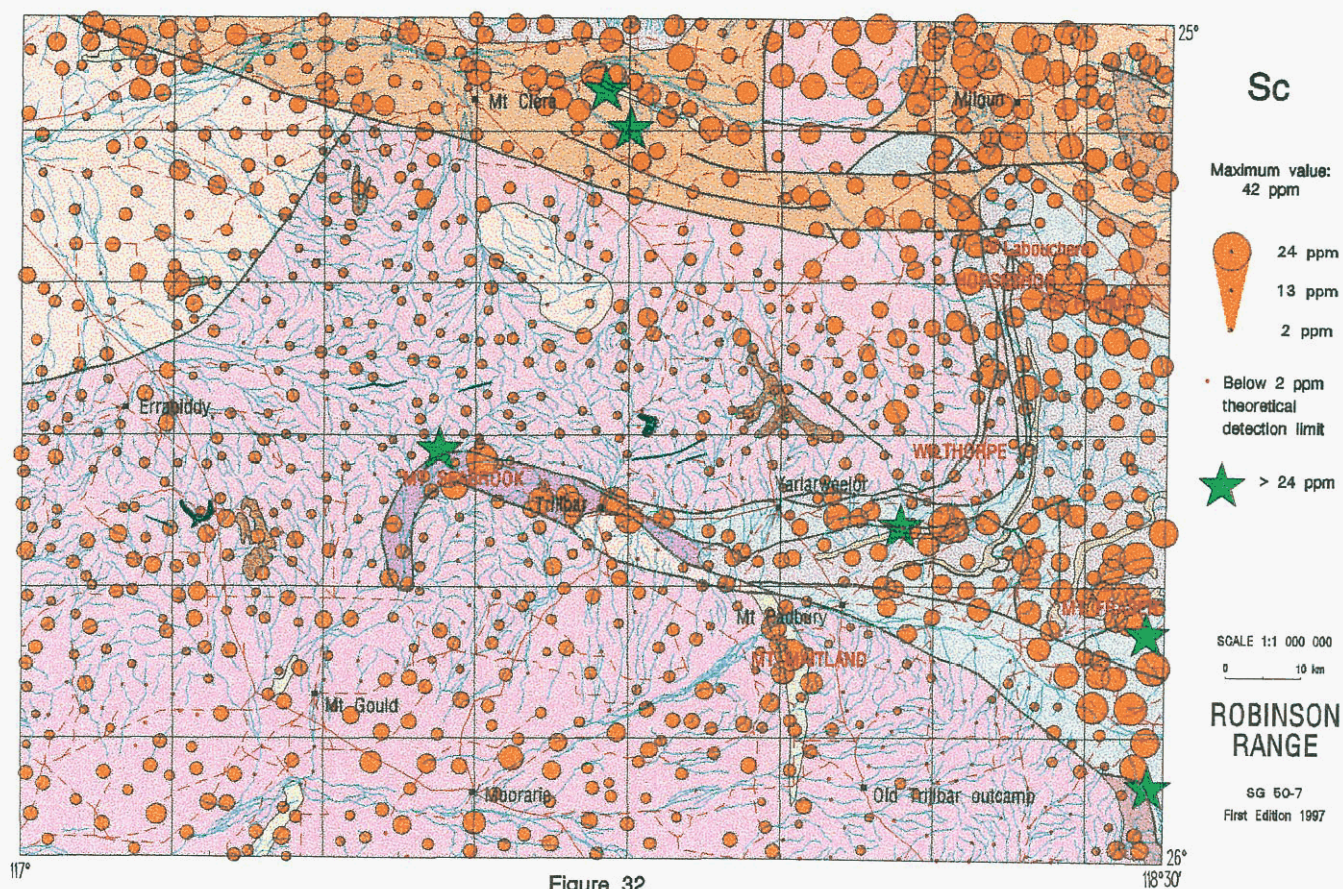


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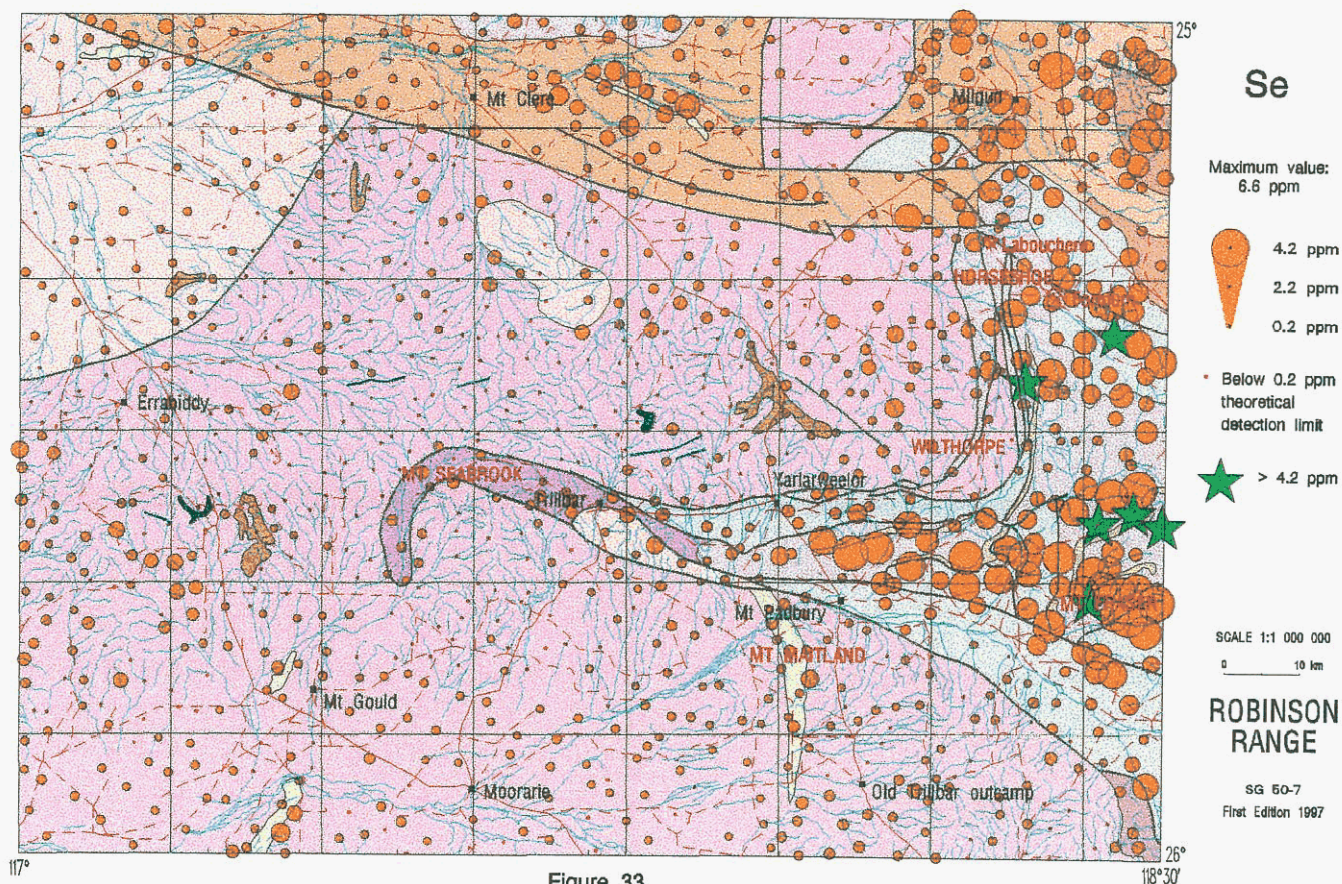
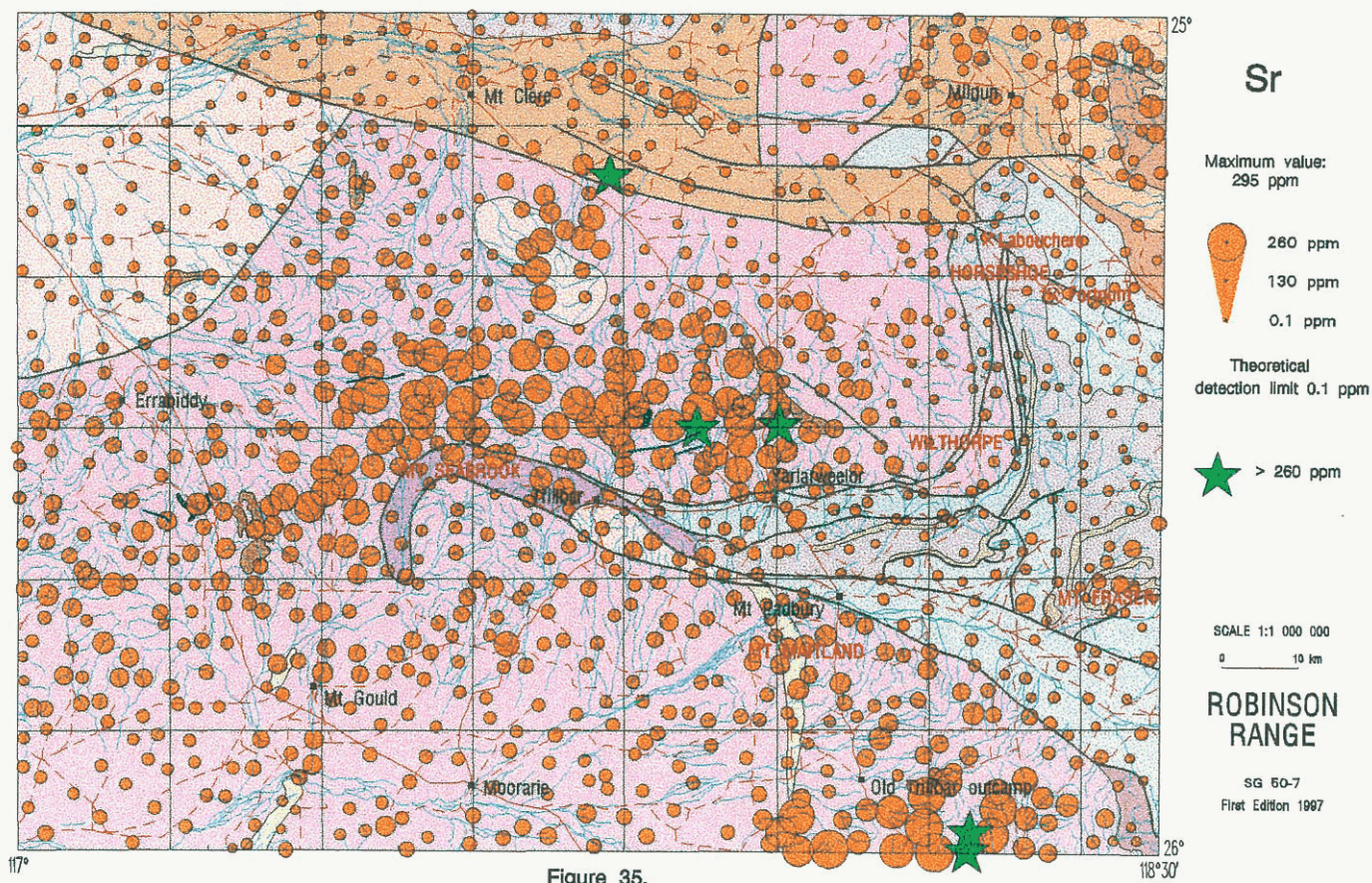
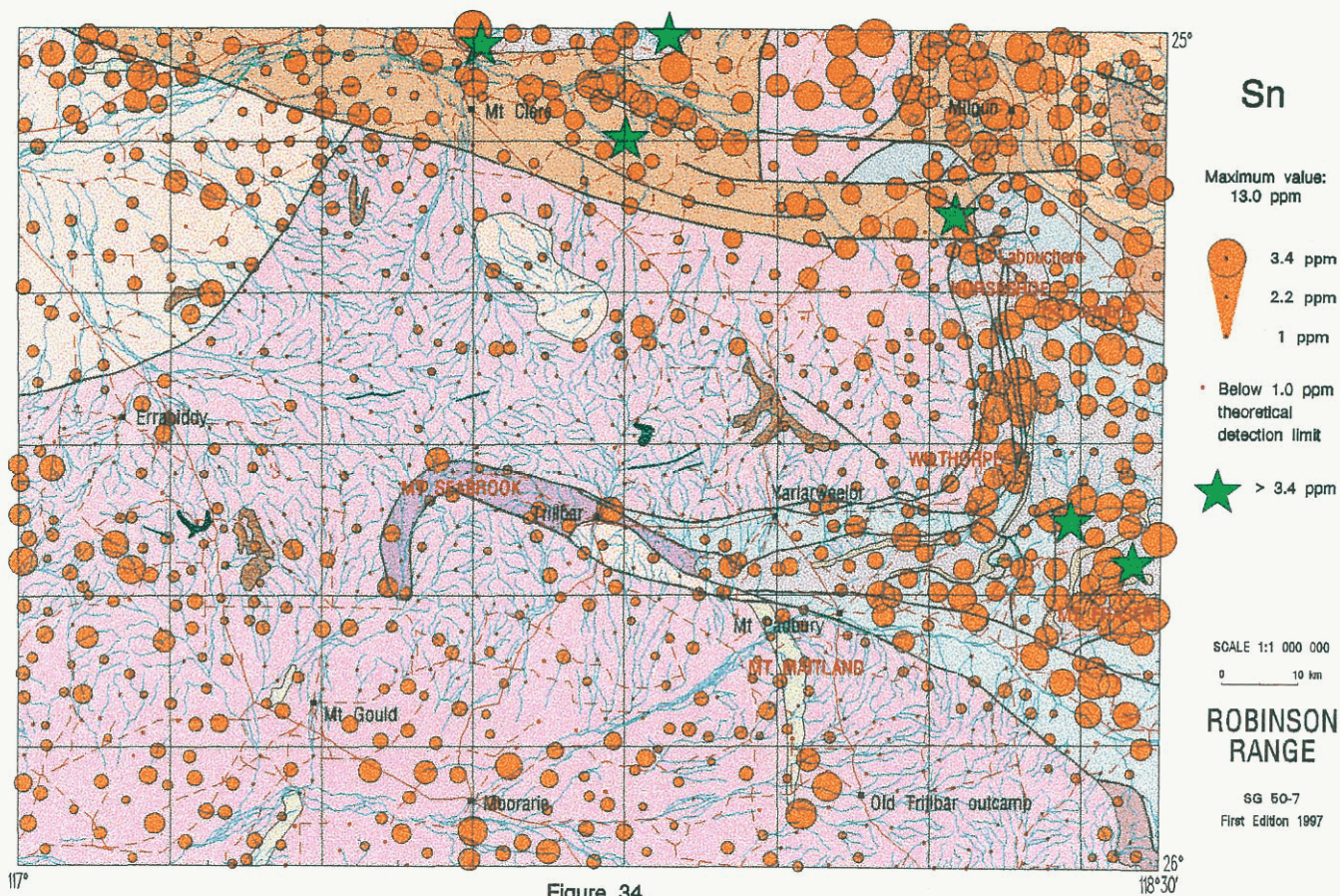


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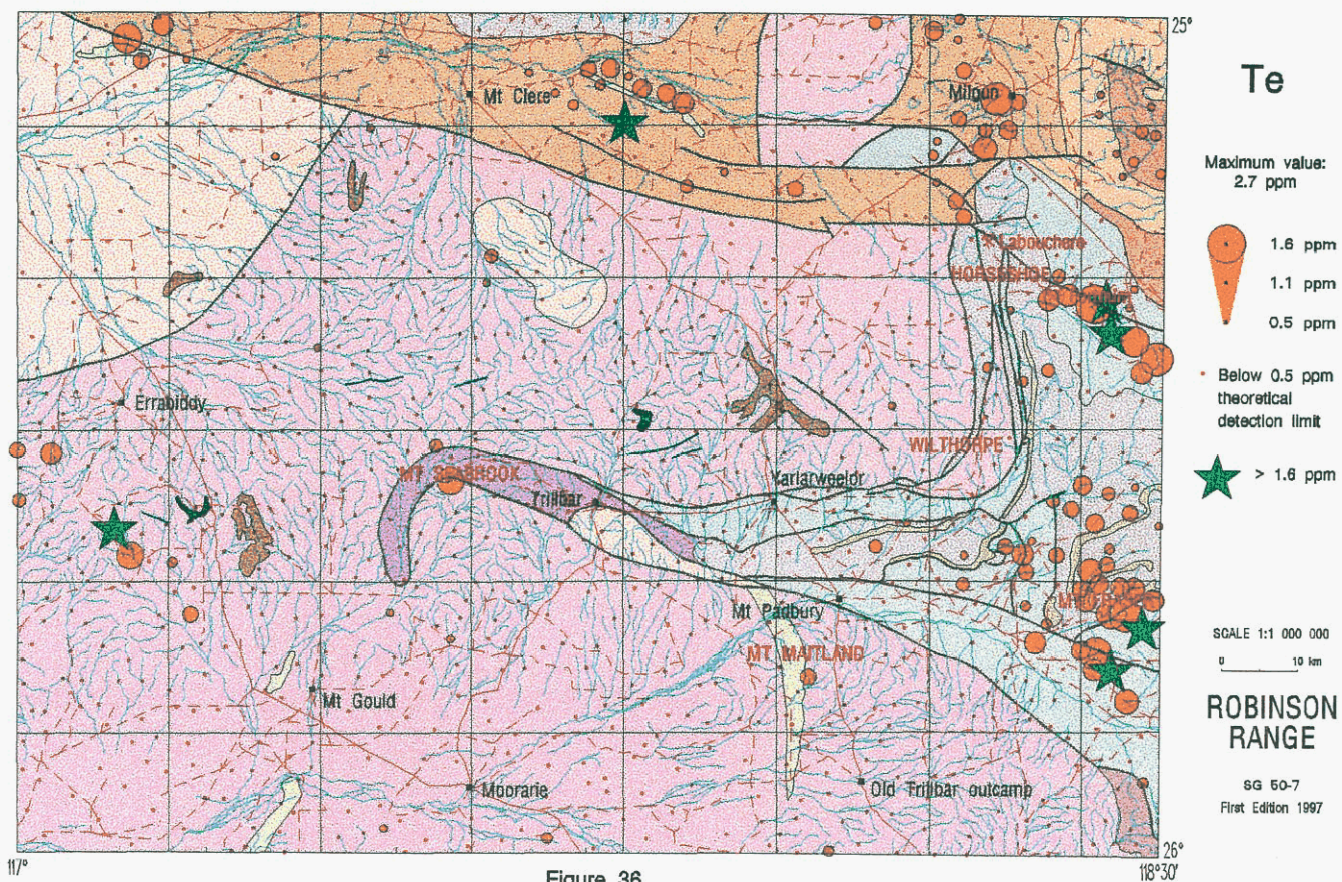


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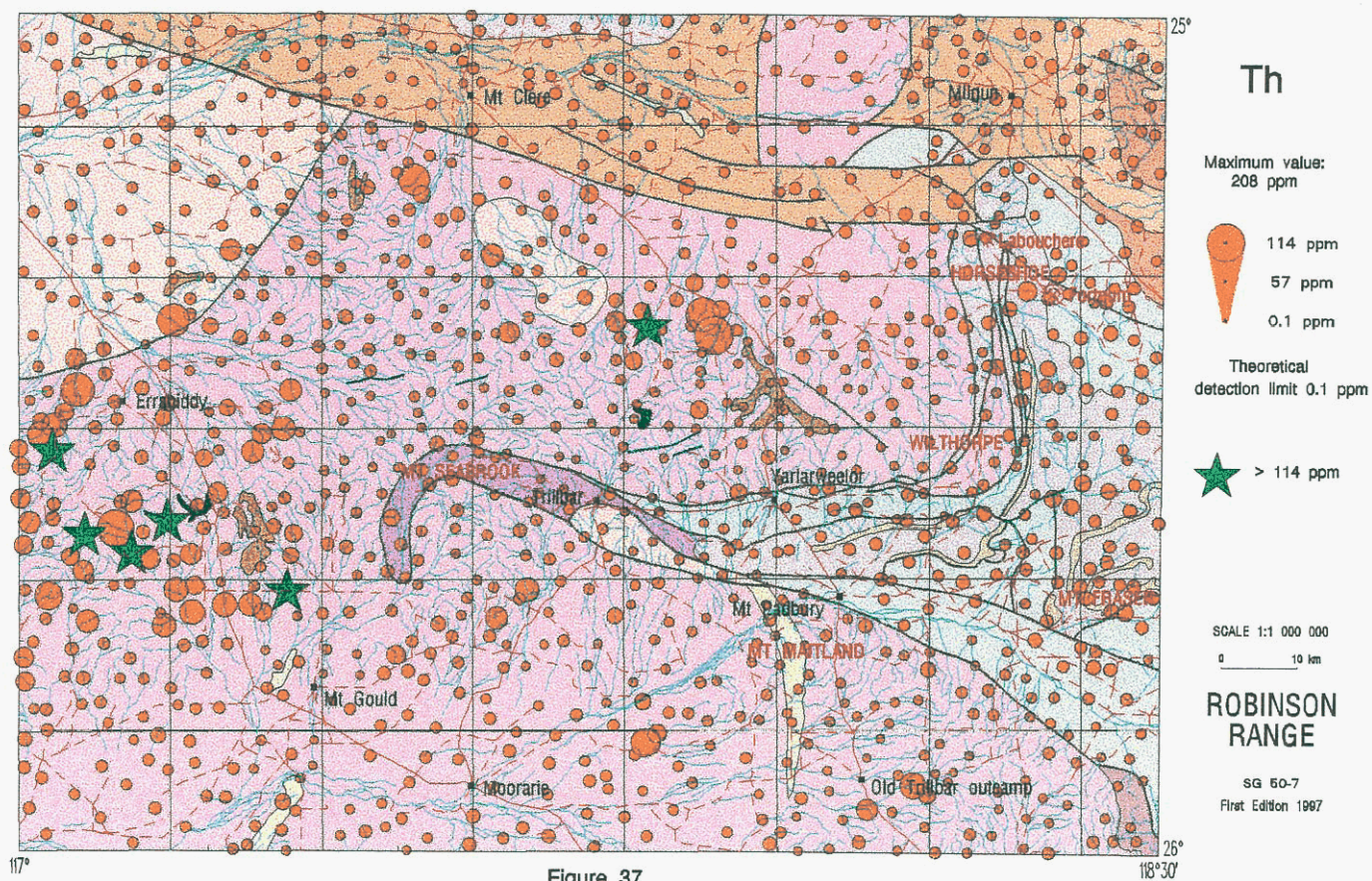
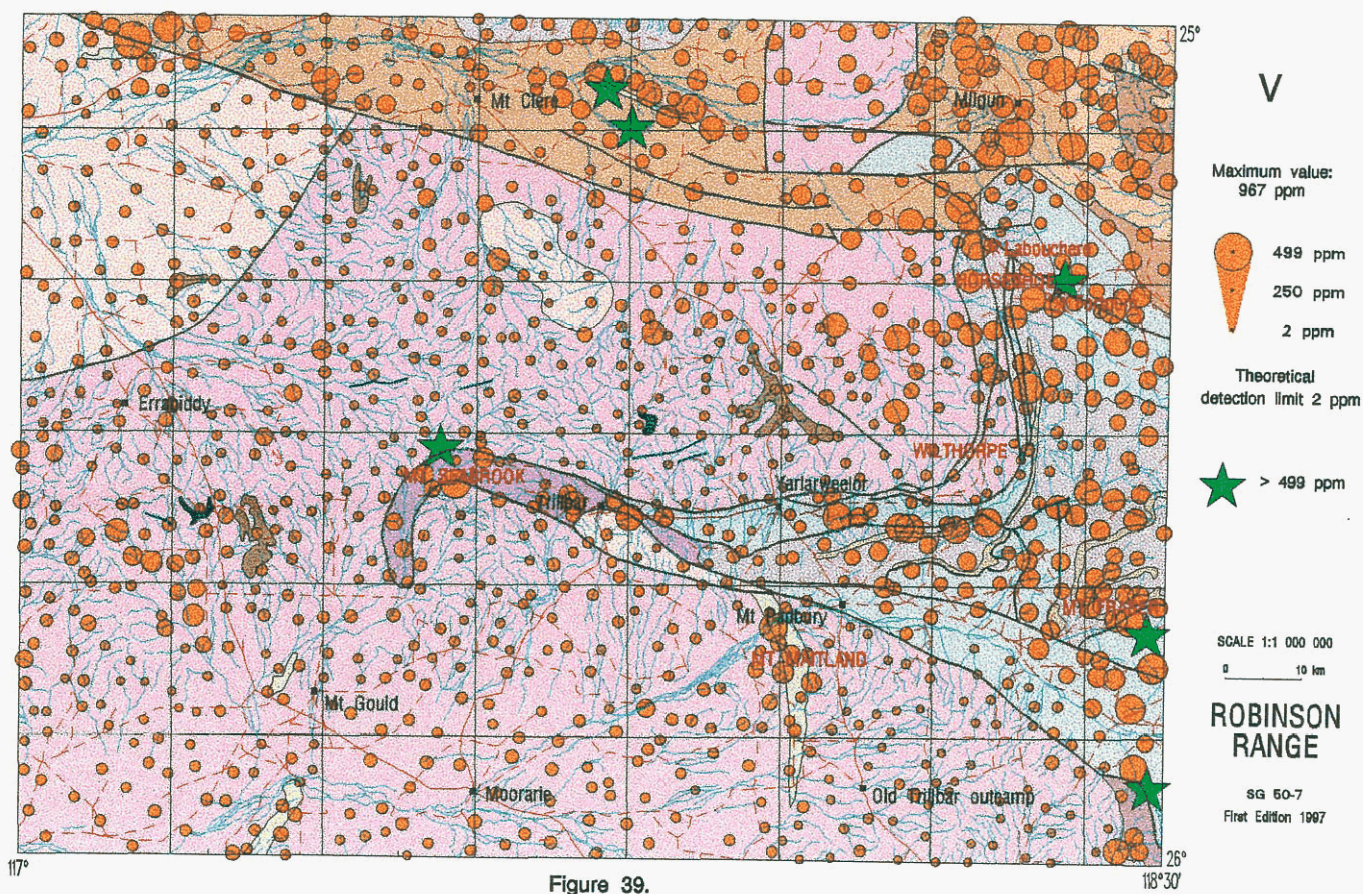
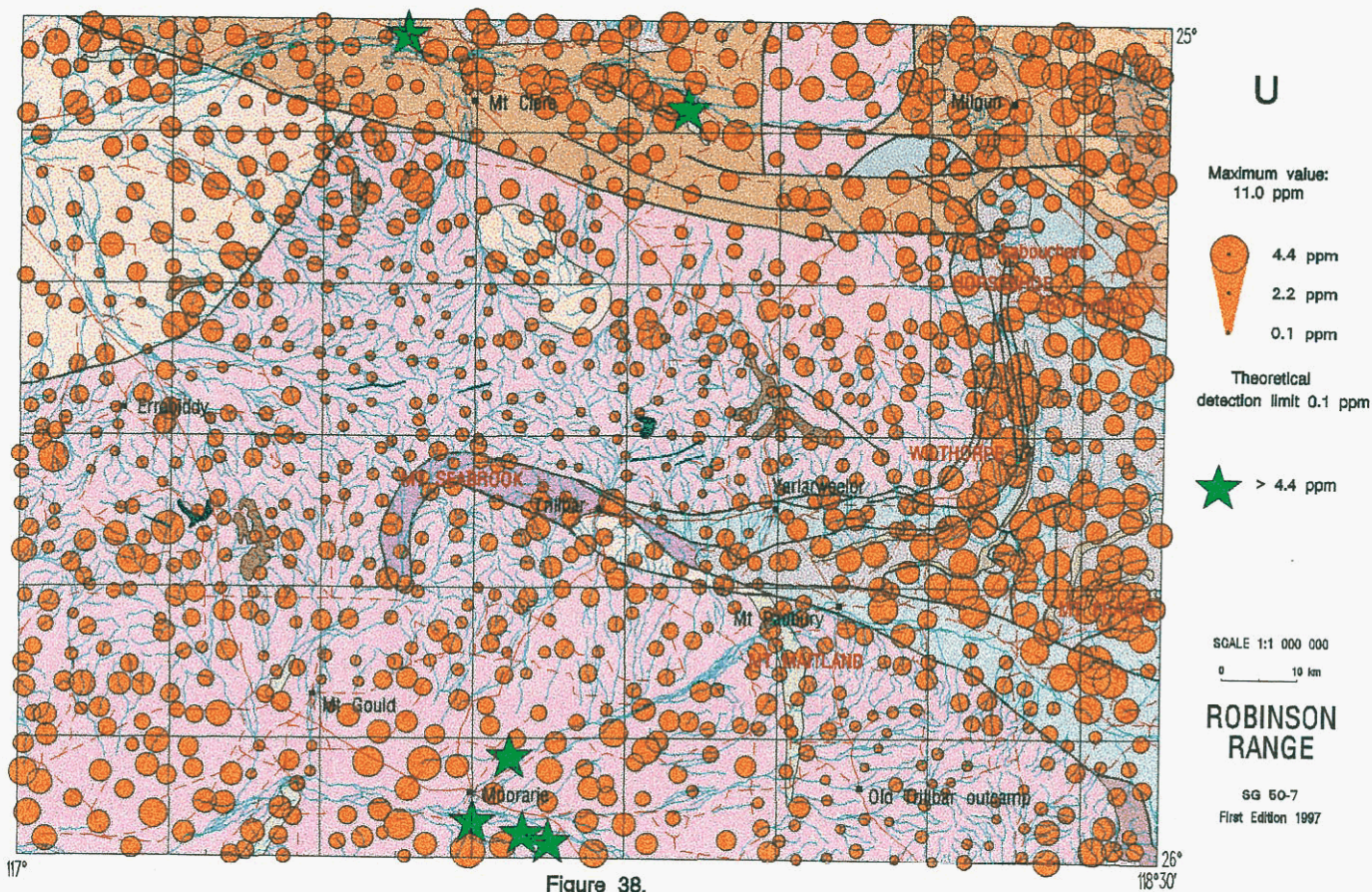


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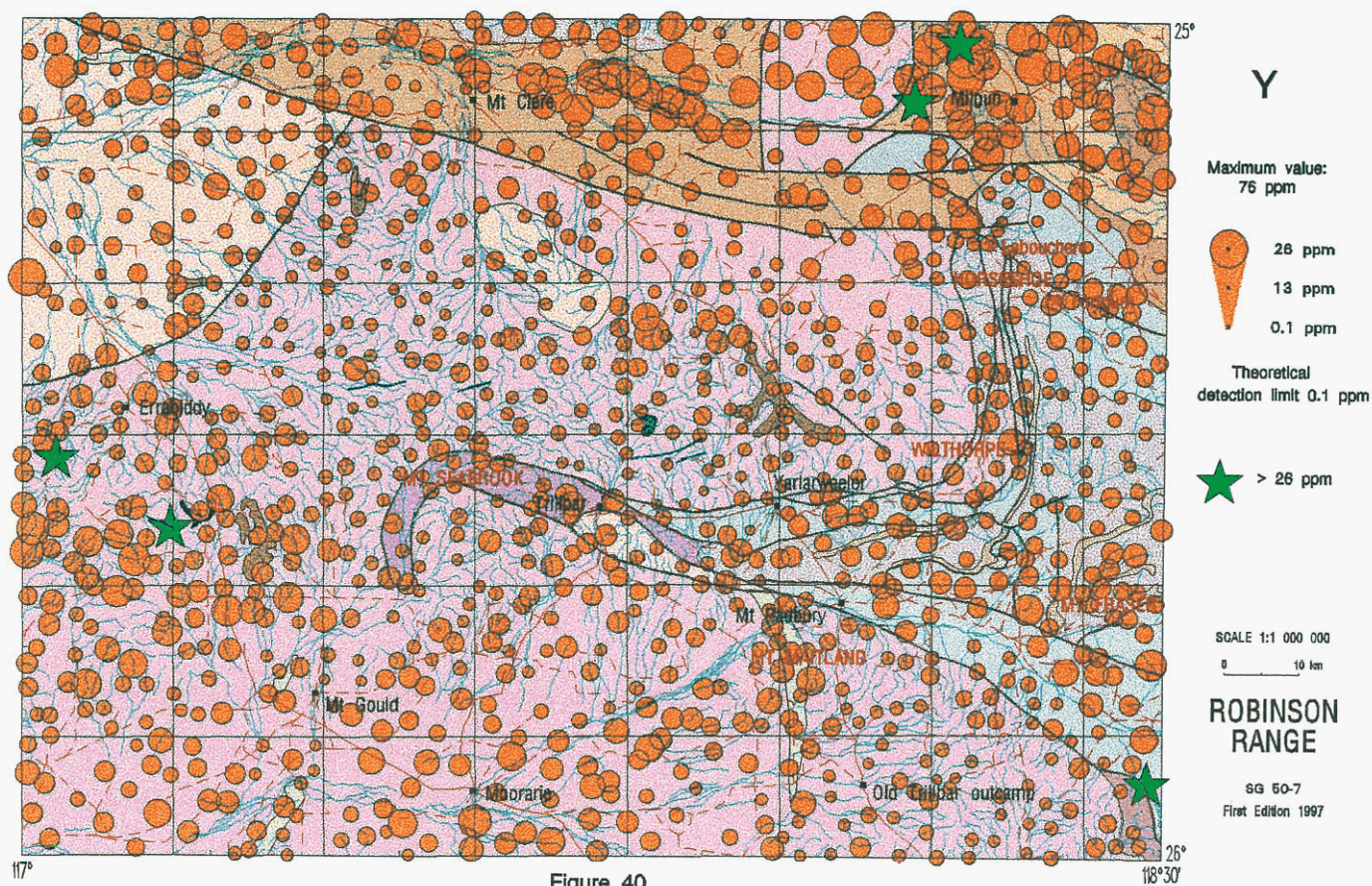


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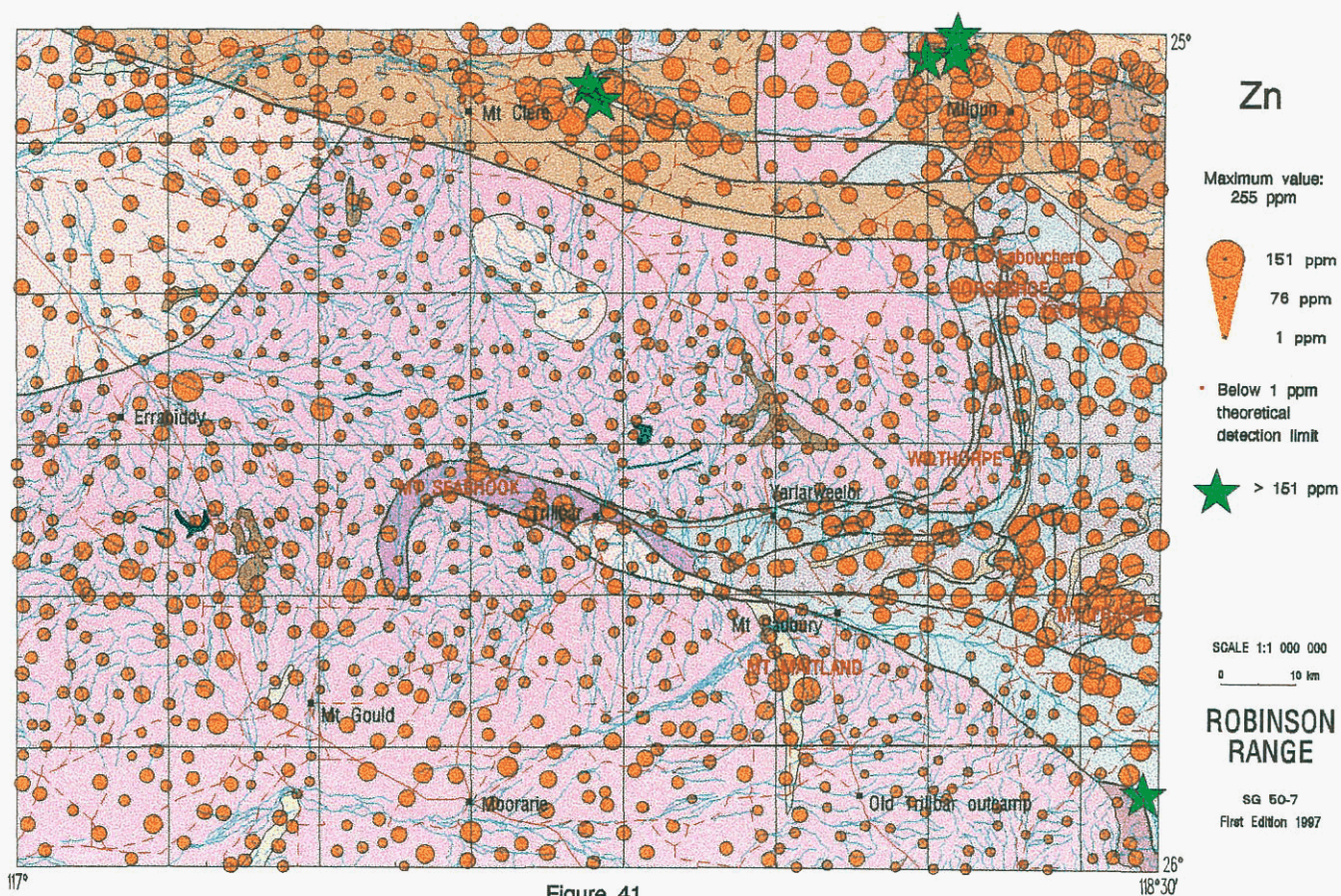


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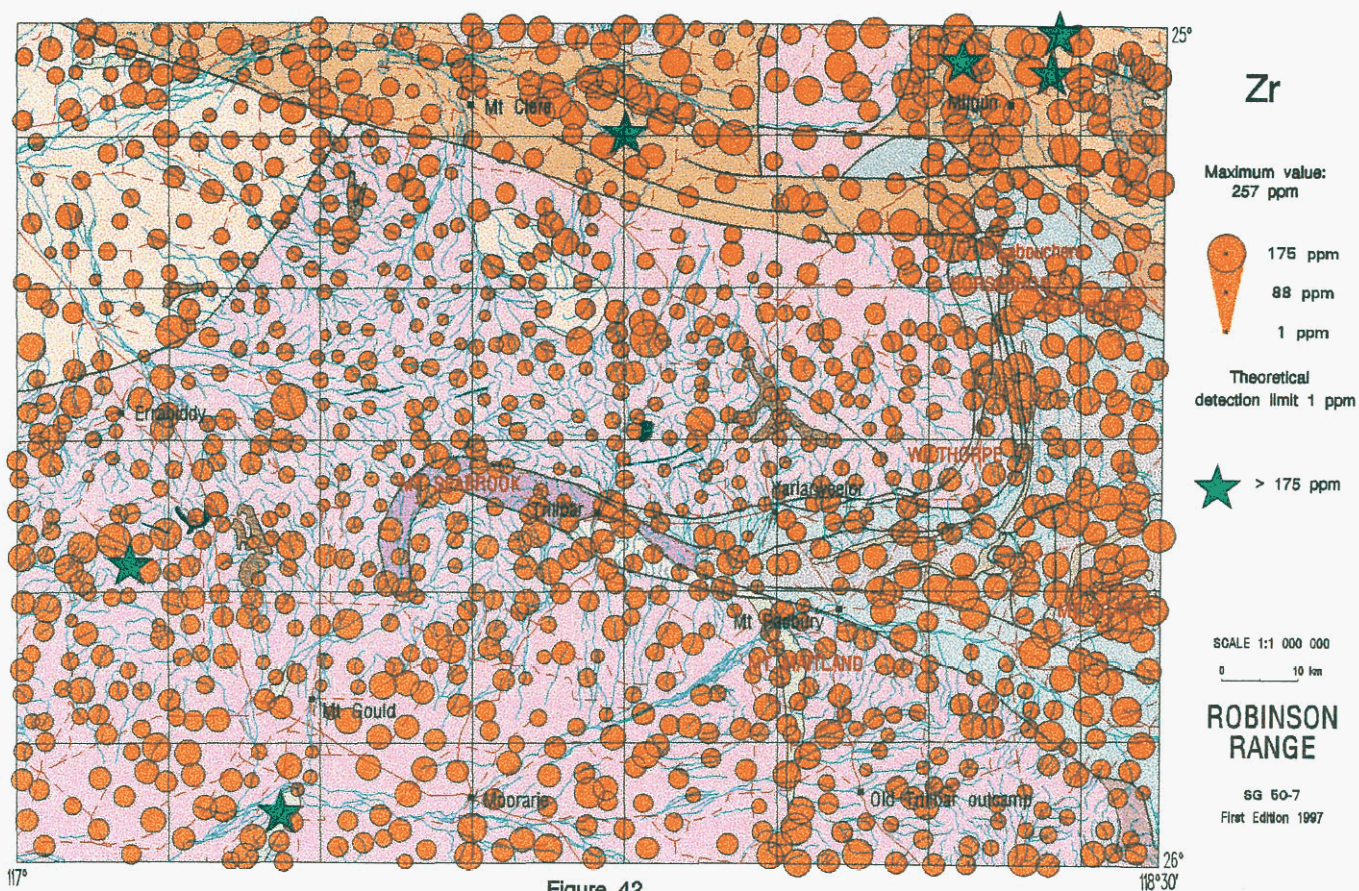


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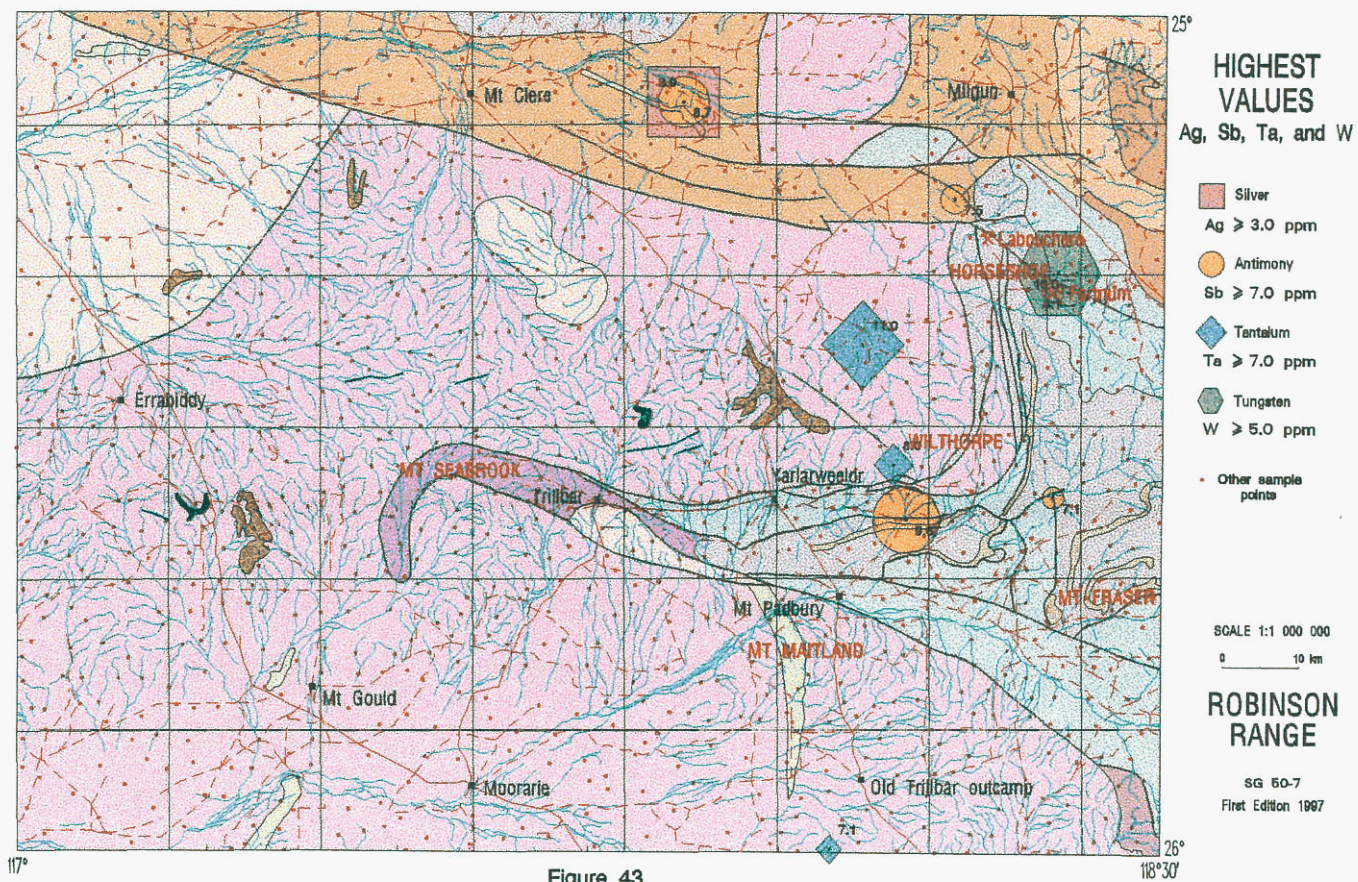


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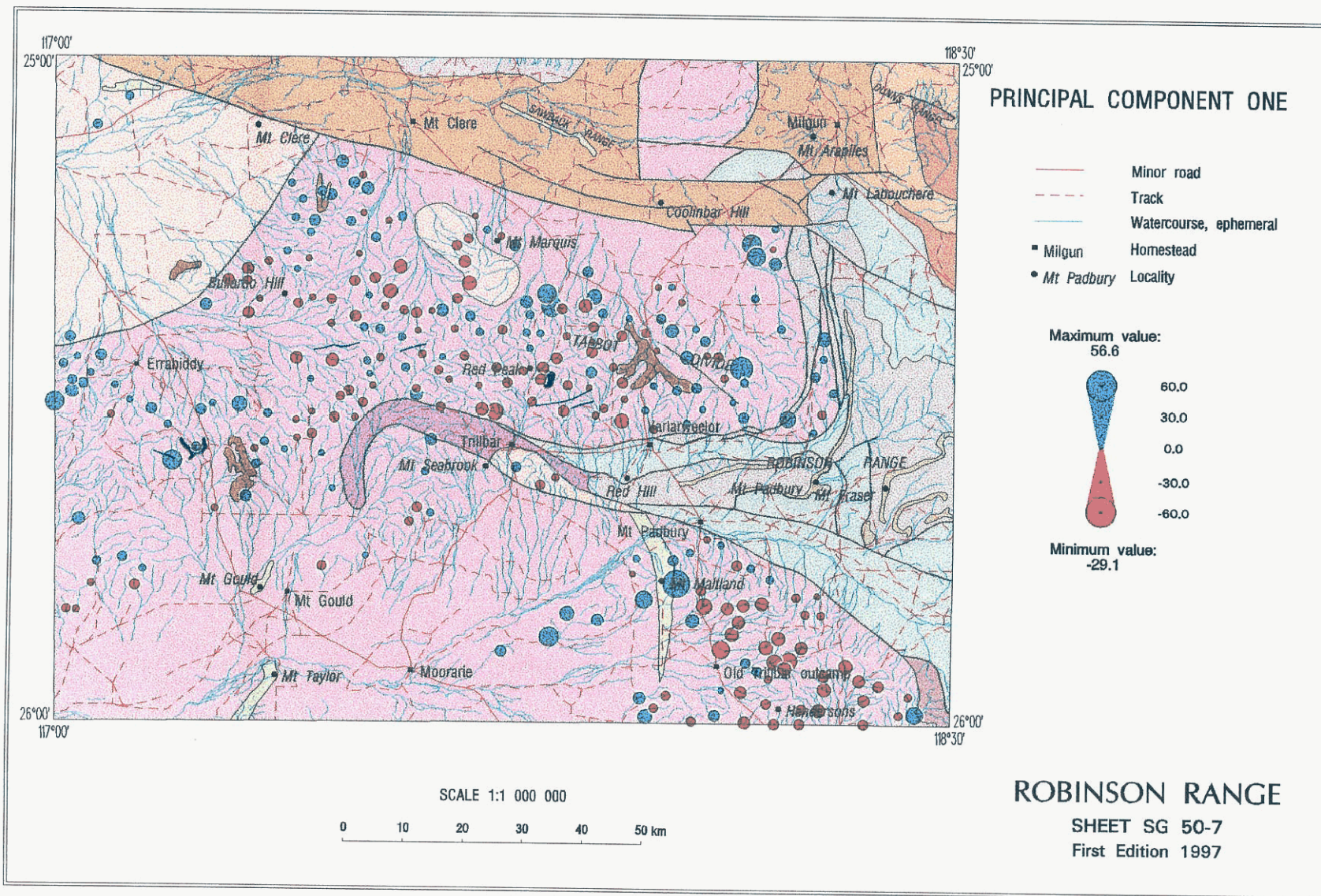
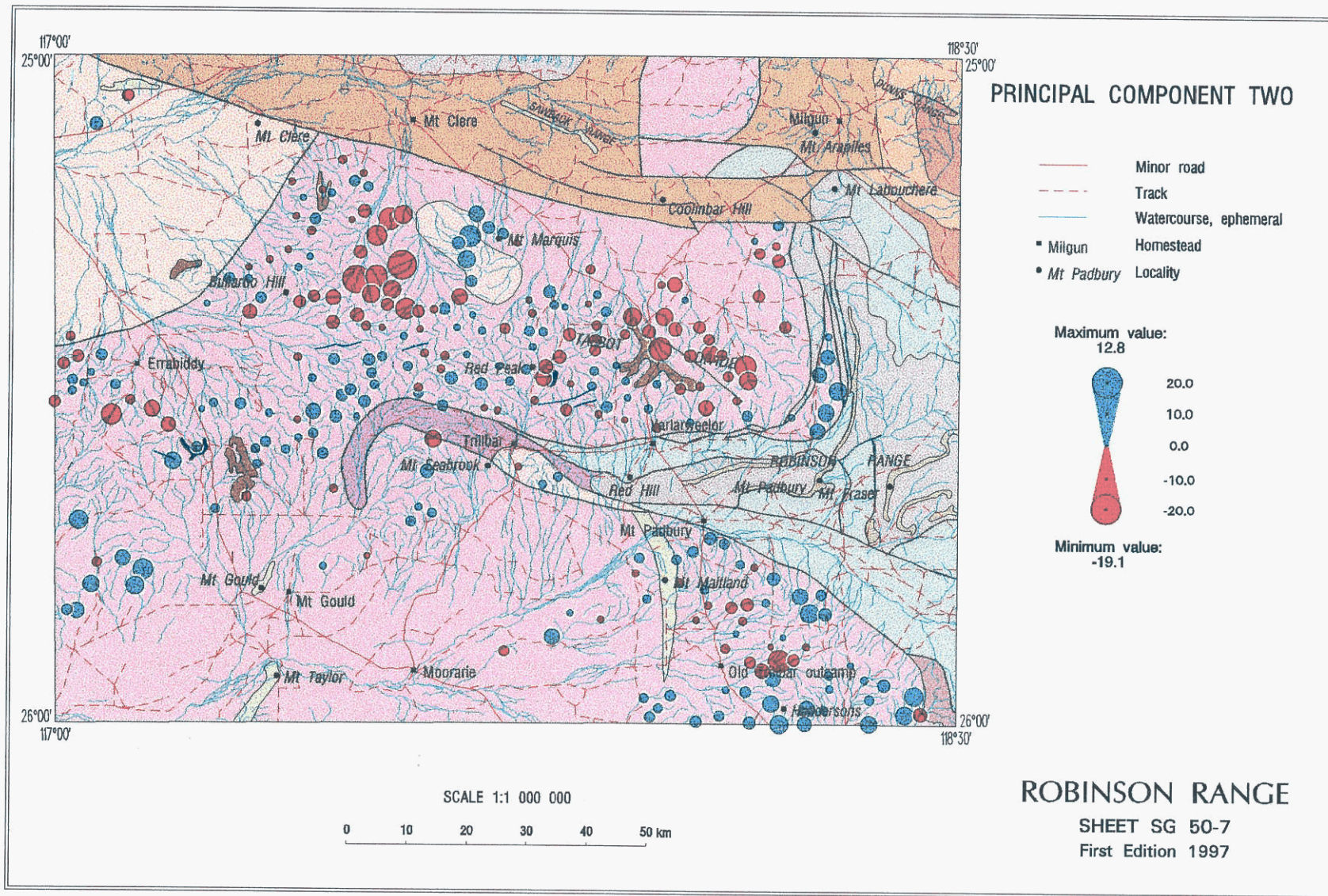


Figure 44.

Figure 45.



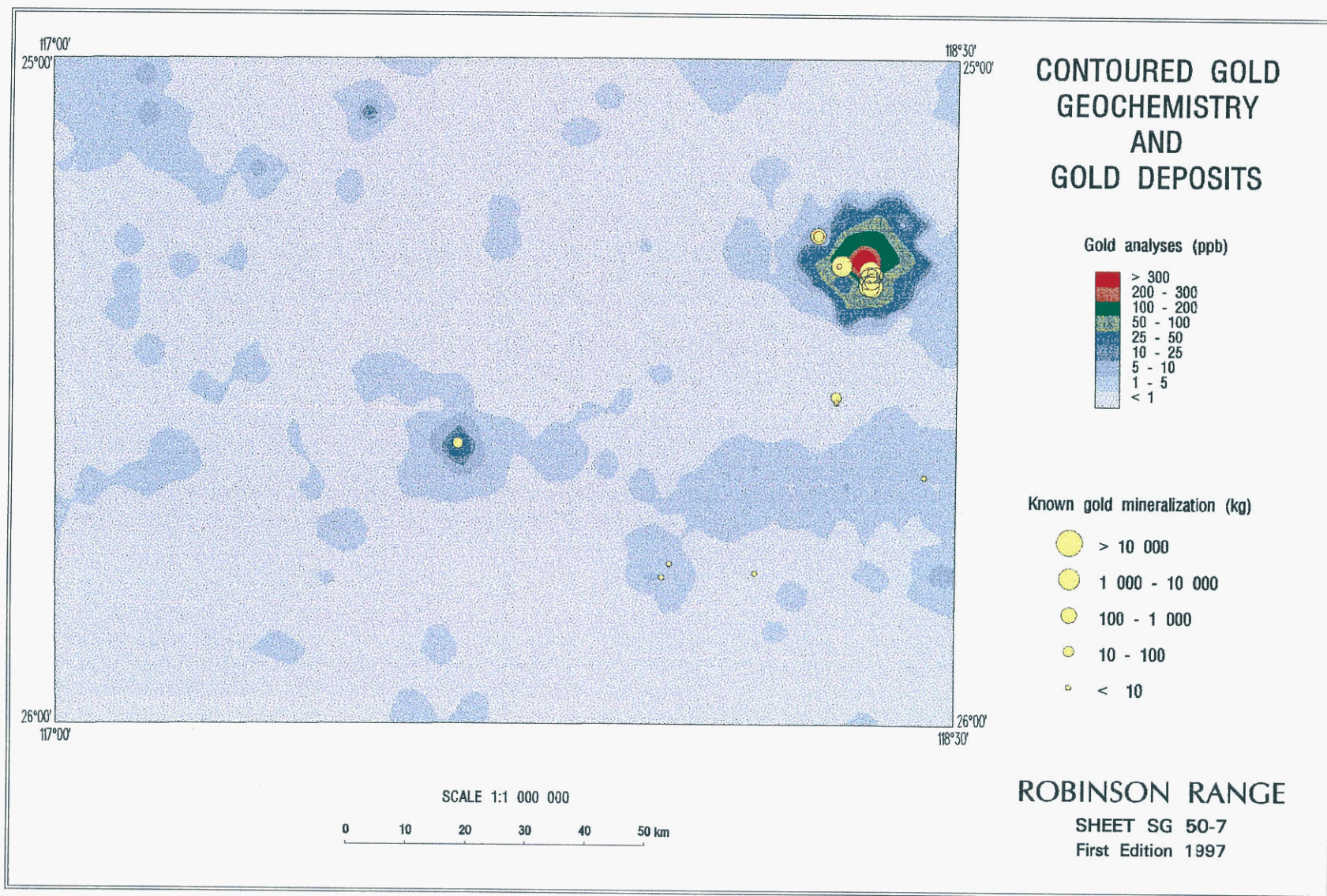
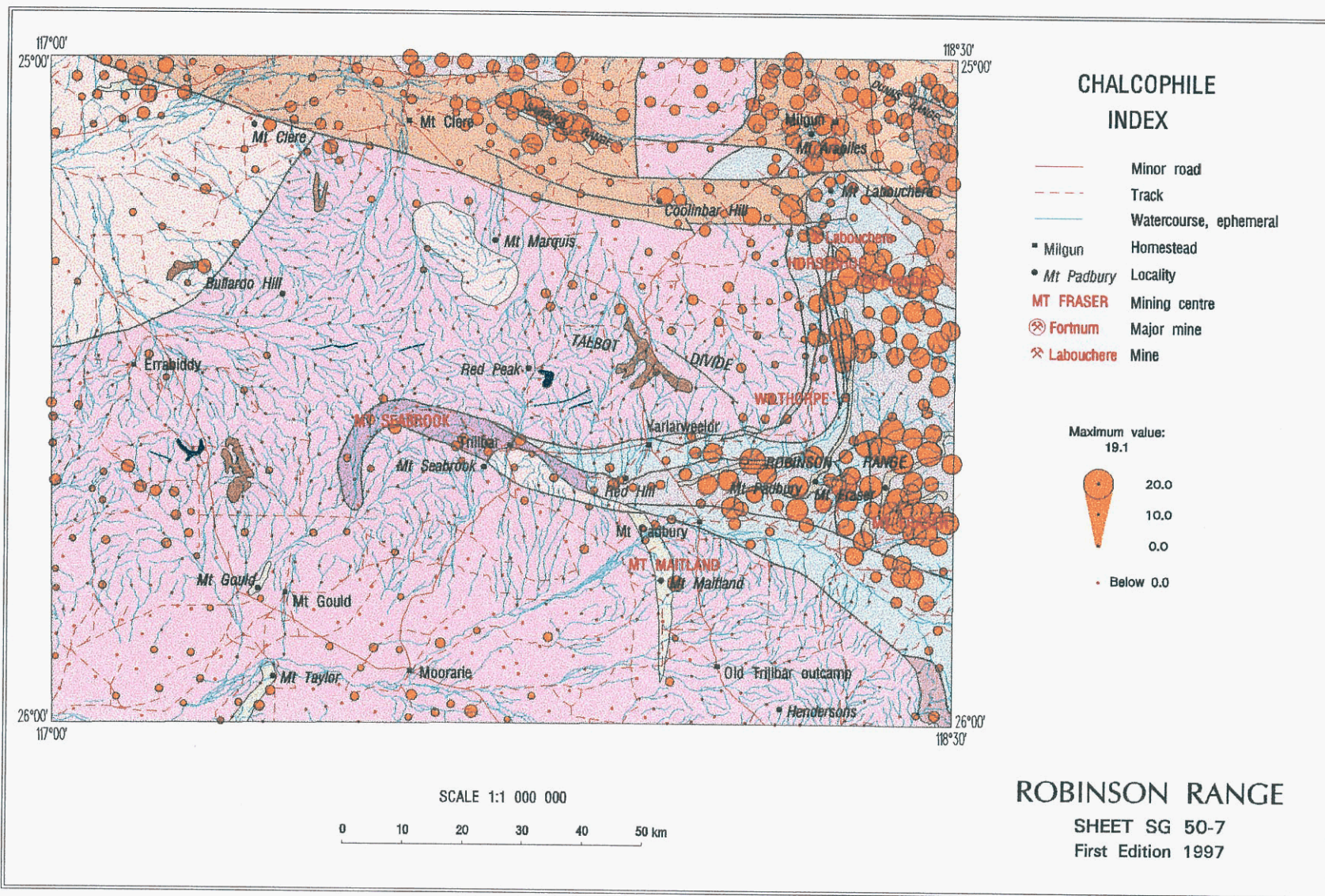


Figure 46.

Figure 47.



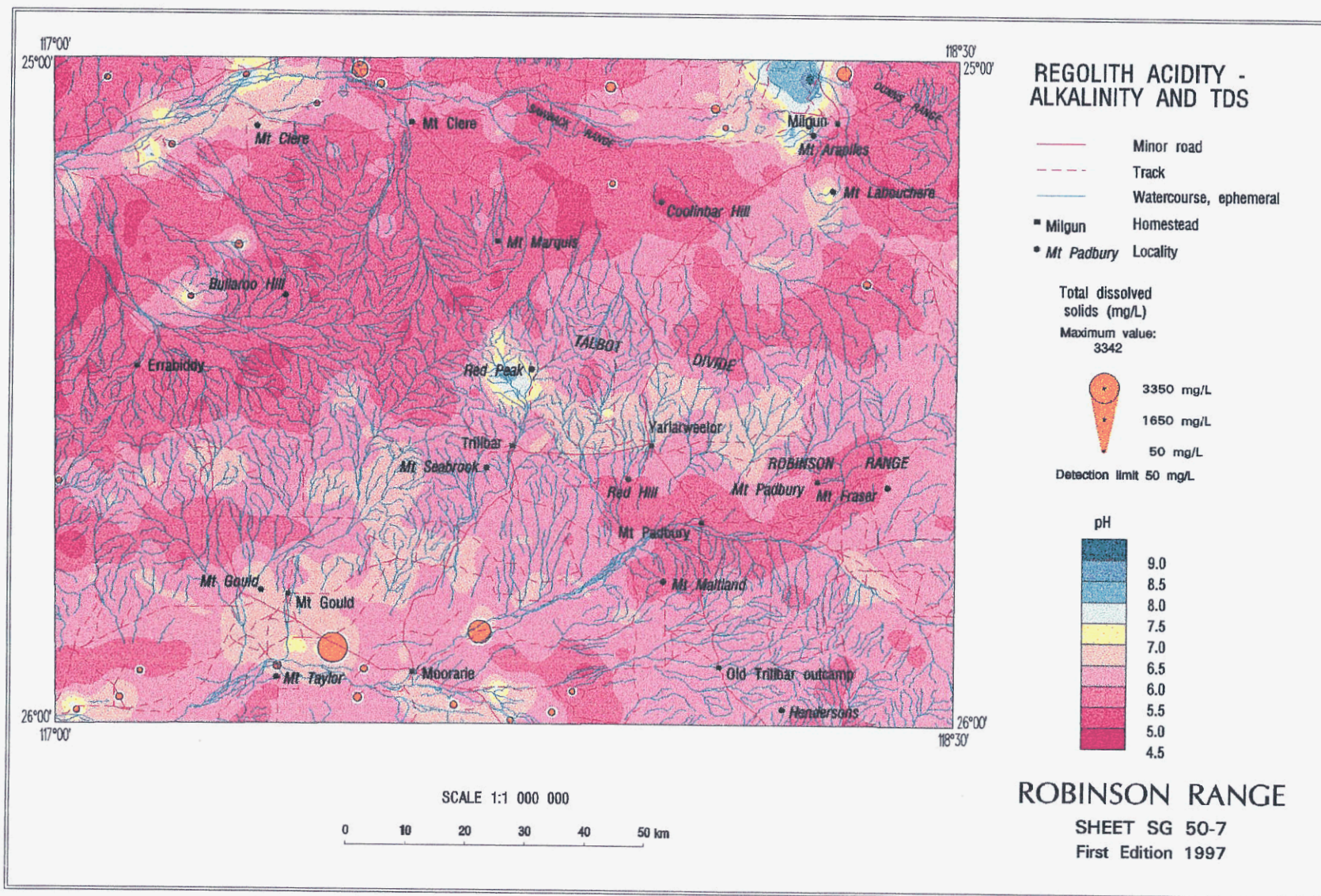
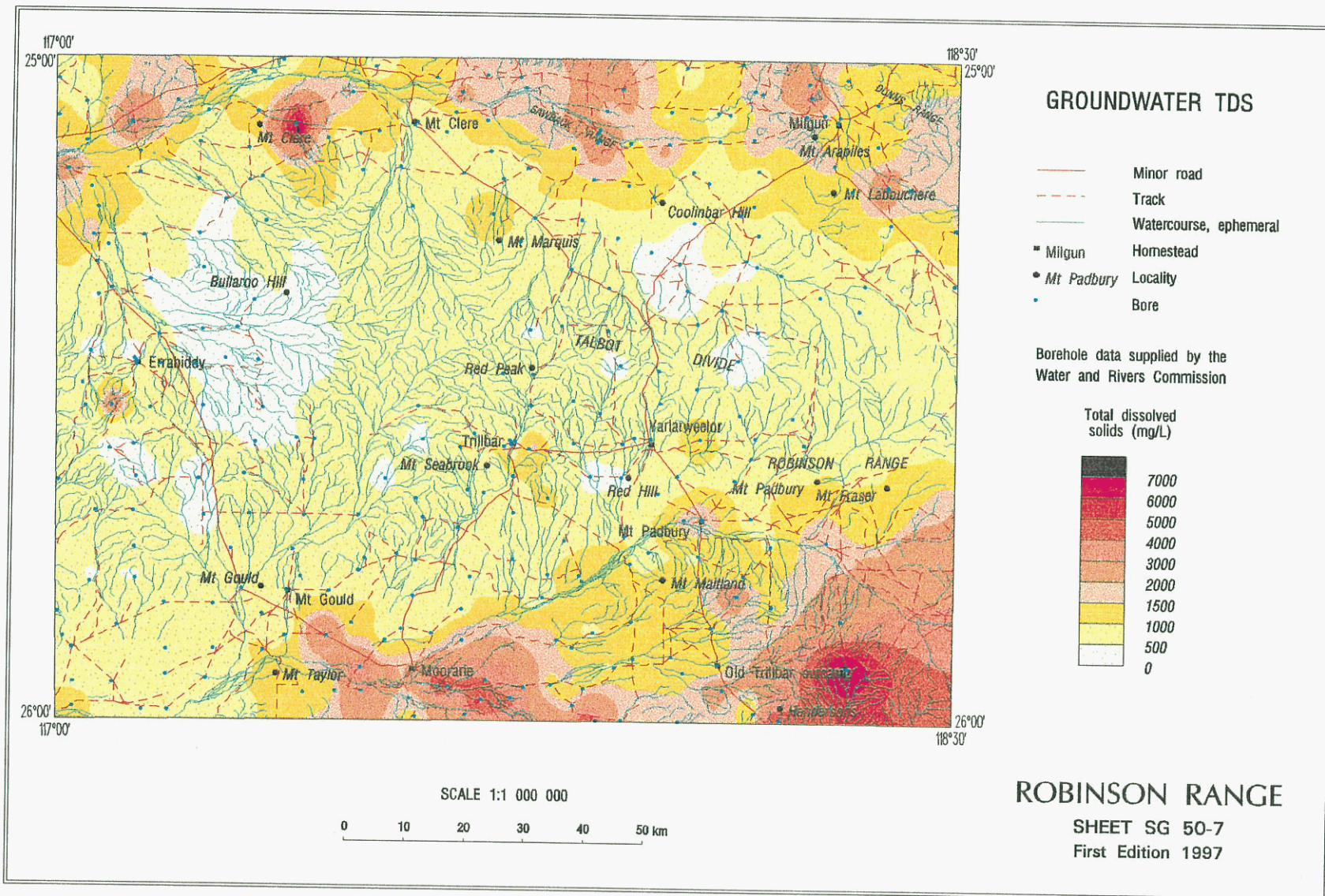
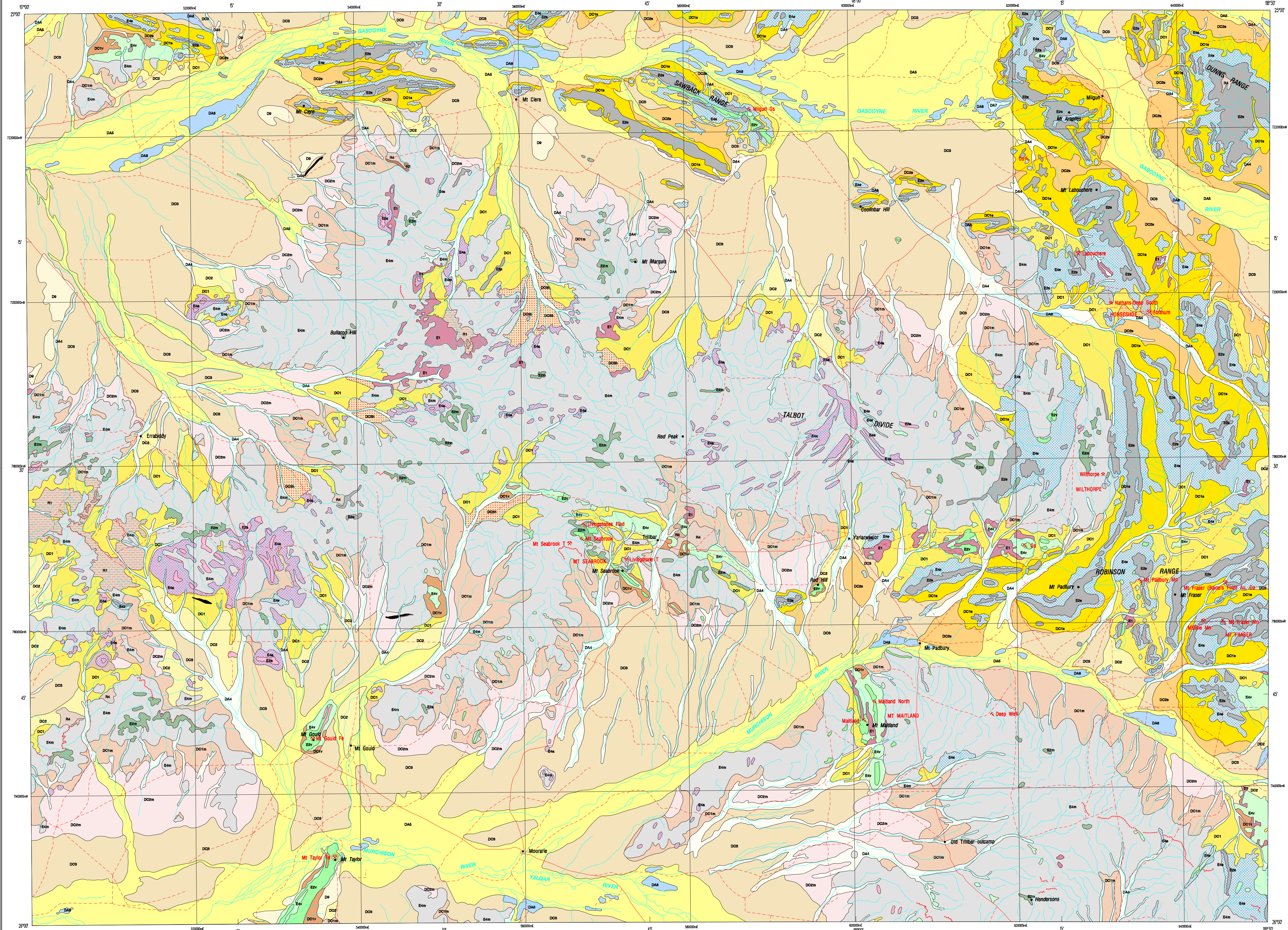


Figure 48.

Figure 49.





RELICT REGIME

- R1 Farmhouse patches and nodules
- R2 Iron-rich duricrust forming remnant land surfaces
- R3 Siltstone (commonly weakly ferruginized) and siltified rock
- R4 Quartz-rich sand overlying presumed or known R1-R3 material

EROSIONAL REGIME

- E1 Mottled zone and saprolite
- E2v Outcrop of saprock and bedrock areas of subcrop with locally derived sandy clay, coarse (bouldery) lag may be present adjacent to prominent ridges, derived from greenstones and other mafic rocks
- E2s As E2v but derived from sedimentary rocks
- E2m As E2v but derived from metamorphic rocks, predominantly granitic gneiss
- E2a As E2v but derived from amphibolite
- E4v Lag of locally derived ferruginous and/or siliceous fragments, bedrock is a sandy clay matrix associated with actively eroding outcrops; derived from greenstones and other mafic rocks
- E4s As E4v but derived from sedimentary rocks
- E4m As E4v but derived from metamorphic rocks, predominantly granitic gneiss
- E4a As E4v but derived from amphibolite
- q Quartz vein

DEPOSITIONAL REGIME

DOMINANTLY COLLUVIAL

- DC1 Medium- to coarse-grained detritus, mainly of siliceous or ferruginized siliceous clasts (most >20 mm) in colluvium with a sand or sandy clay matrix
- DC1v DC1 derived from greenstones
- DC1s DC1 derived from sedimentary rocks
- DC1m DC1 derived from metamorphic rocks, predominantly granitic gneiss
- DC1a DC1 derived from amphibolite
- DC2 Fine- to medium-grained detritus (clasts 4-25 mm) mainly of siliceous or ferruginized siliceous origin, in a red sandy clay columnar matrix, or quartz in a sandy clay matrix
- DC2s DC2 derived mainly from sedimentary rocks
- DC2m DC2 derived mainly from metamorphic rocks, predominantly granitic gneiss
- DC3 Sand- and clay-dominated colluvium or sheetwash (<1-10 m); merges into alluvial plains (DA5)
- DC3m Consolidated colluvium (hardpan) with a ferruginous or silica-rich cement, reddish brown and poorly bedded

DOMINANTLY ALLUVIAL

- DA Gravelly sands and sandy clays of active alluvial channels with mixtures of siliceous, non-siliceous, and variably altered siliceous fragments
- DA5 Sand- or clay-rich alluvium and colluvium on broad drainage floors, including overbank alluvial deposits and terraces, includes non-siliceous clays, caliche fragments
- DA7 Silty clays and sandy clays of plays talus, commonly lacking vegetation
- DA8 Extensive and continuous calcareous outcrop in broad drainage floors (valley caliche)
- D9 Sandplain, silt in origin; forms dunes and this sheet

SYMBOLS

- Regolith boundary
- Breakaway
- Minor road
- Track
- Watercourse, ephemeral
- Homestead
- Locality
- Mining centre
- Major mine (see, unless otherwise indicated)
- Mine
- Minor mine
- Prospect
- Mineral occurrence
- Au Gold
- Cu Copper
- Fe Iron ore
- Gs Variscite
- Mn Manganese
- T Talc

GEOLOGICAL INTERPRETATION

Geological interpretation: After Ellis and Williams (1980); Myers, Occhipinti, and Swager (1996, pers. comm.)

PROTEROZOIC

- Bangemall Group
 - Quartz arenite; minor wacke, siltstone, conglomerate, shale, and dolomite
 - Shale and siltstone; minor chert, claystone, dolomite, and sandstone
 - Chert, arenite, and siltstone; minor dolomite and shale
- Padbury Group
 - Wacke, siltstone, conglomerate, shale, quartz arenite, and calcareous sedimentary rocks
 - Granular and banded iron-formation, and hematitic shale
- Bryah Group
 - Sedimentary rocks, mafic and ultramafic volcanic and intrusive rocks, and banded iron-formation
- Yerrida Group
 - Quartz arenite, shale, and quartz-pebble conglomerate
- Trilbar Complex
 - Mafic to ultramafic volcanic and plutonic rocks

ARCHEAN

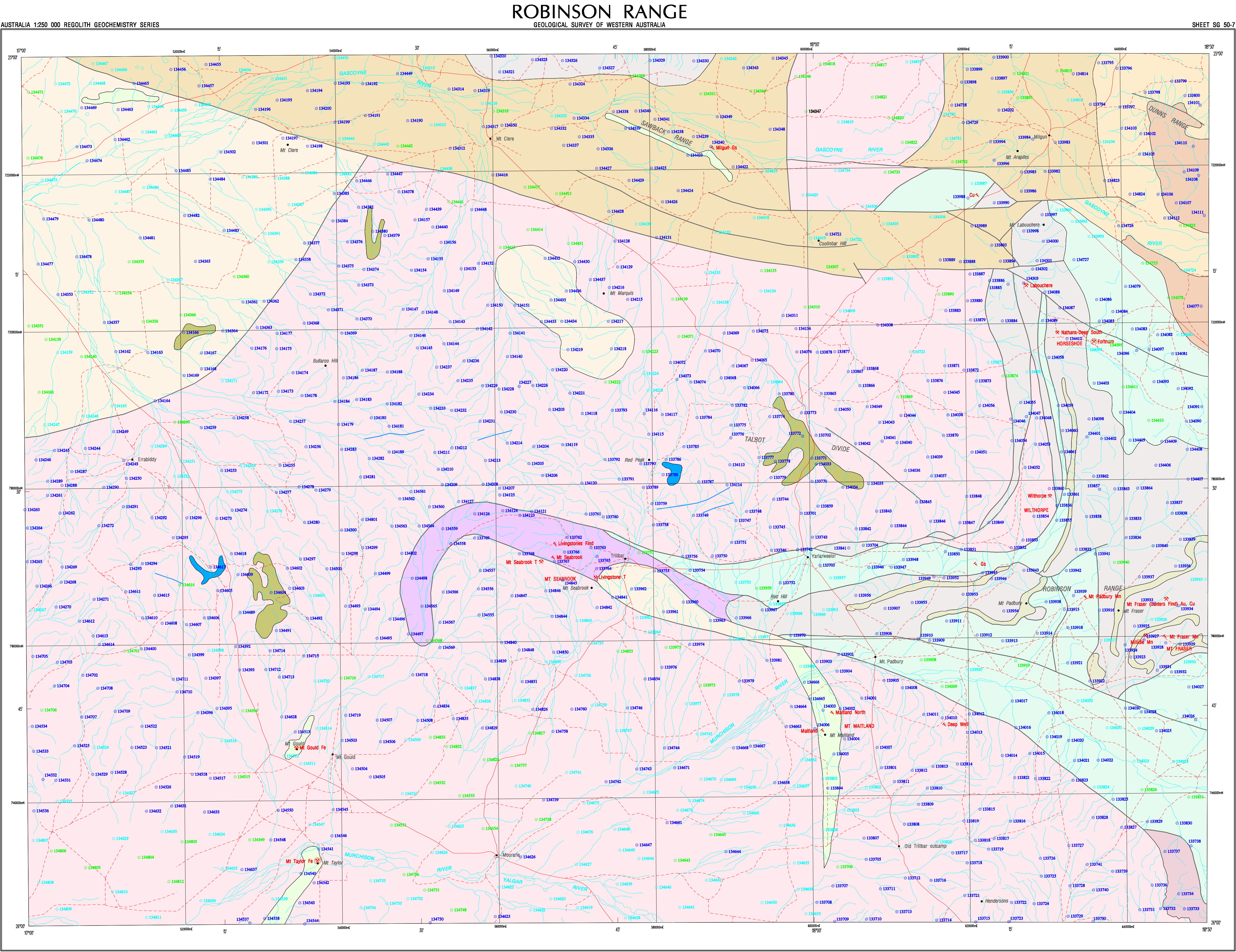
- Volcanic and sedimentary rocks (includes greenstones)
- Granite and granitic gneiss
- Banded iron-formation
- Amphibolite

SYMBOLS

- Geological boundary
- Major fault or shear

SHEET INDEX

MOUNT PHILLIPS SG 50-2	MOUNT EGBERTON SG 50-3	COLLIER SG 50-4
GLENNBURGH SG 50-5	ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8
BYRO SG 50-10	BEILEE SG 50-11	GLENNHARRY SG 50-12



SAMPLE LOCATIONS

- Sample point references
- Stream sample
 - Soil sample
 - Sheetwash sample
- Minor road
- Track
- Watercourse, ephemeral
- Homestead
- Locality
- Mining centre
- Major mine (incl. other otherwise indicated)
- Mine
- Minor mine
- Prospect
- Mineral occurrence
- Gold
- Copper
- Iron ore
- Variscite
- Manganese
- Talc

GEOLOGICAL INTERPRETATION

- Bangemall Group
- Quartz arenite; minor wacke, siltstone, conglomerate, shale, and dolomite
 - Shale and siltstone; minor chert, claystone, dolomite, and sandstone
 - Chert, arenite, and siltstone; minor dolomite and shale
 - Granite
- Padbury Group
- Wacke, siltstone, conglomerate, shale, quartz arenite, and calcareous sedimentary rocks
 - Gneiss and banded iron-formation, and hemetitic shale
- Bryah Group
- Sedimentary rocks, mafic and ultramafic volcanic and intrusive rocks, and banded iron-formation
- Yerrida Group
- Quartz arenite, shale, and quartz-pebble conglomerate
- Trillibar Complex
- Mafic to ultramafic volcanic and plutonic rocks
- ARCHAEO
- Volcanic and sedimentary rocks (includes greenstone)
 - Granite and granitic gneiss
 - Banded iron-formation
 - Amphibolite
- Geological boundary
- Major fault or shear



SHEET INDEX		
MOUNT PHILLIPS SG 50-2	MOUNT EBERTON SG 50-3	COLLIER SG 50-4
GLENBURN SG 50-6	ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8
BYRD SG 50-10	BELELE SG 50-11	GLEGARRY SG 50-12

SAMPLE LOCATIONS

REGOLITH GEOCHEMISTRY SERIES
ROBINSON RANGE

SHEET SG 50-7
FIRST EDITION 1997
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Edited by D. Ferdinando and G. Loan
Cartography by G. Jose
Topography from Australian Surveying and Land Information Group Sheet SG 50-7 and roads modified from geological field survey (1996)
This map was compiled digitally from the geochemical database held by the Geological Survey of Western Australia and stored in the ORACLE database management system; compiled and produced using a Geographic Information System, Arc/INFO
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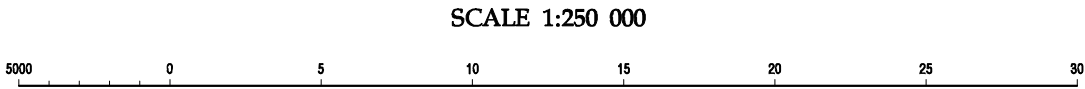
DEPARTMENT OF MINERALS AND ENERGY
K.A. PERRY, DIRECTOR GENERAL



GOVERNMENT OF WESTERN AUSTRALIA
HON. NORMAN MOORE, M.L.C.
MINISTER FOR MINES



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
PIETRO GUJ, DIRECTOR

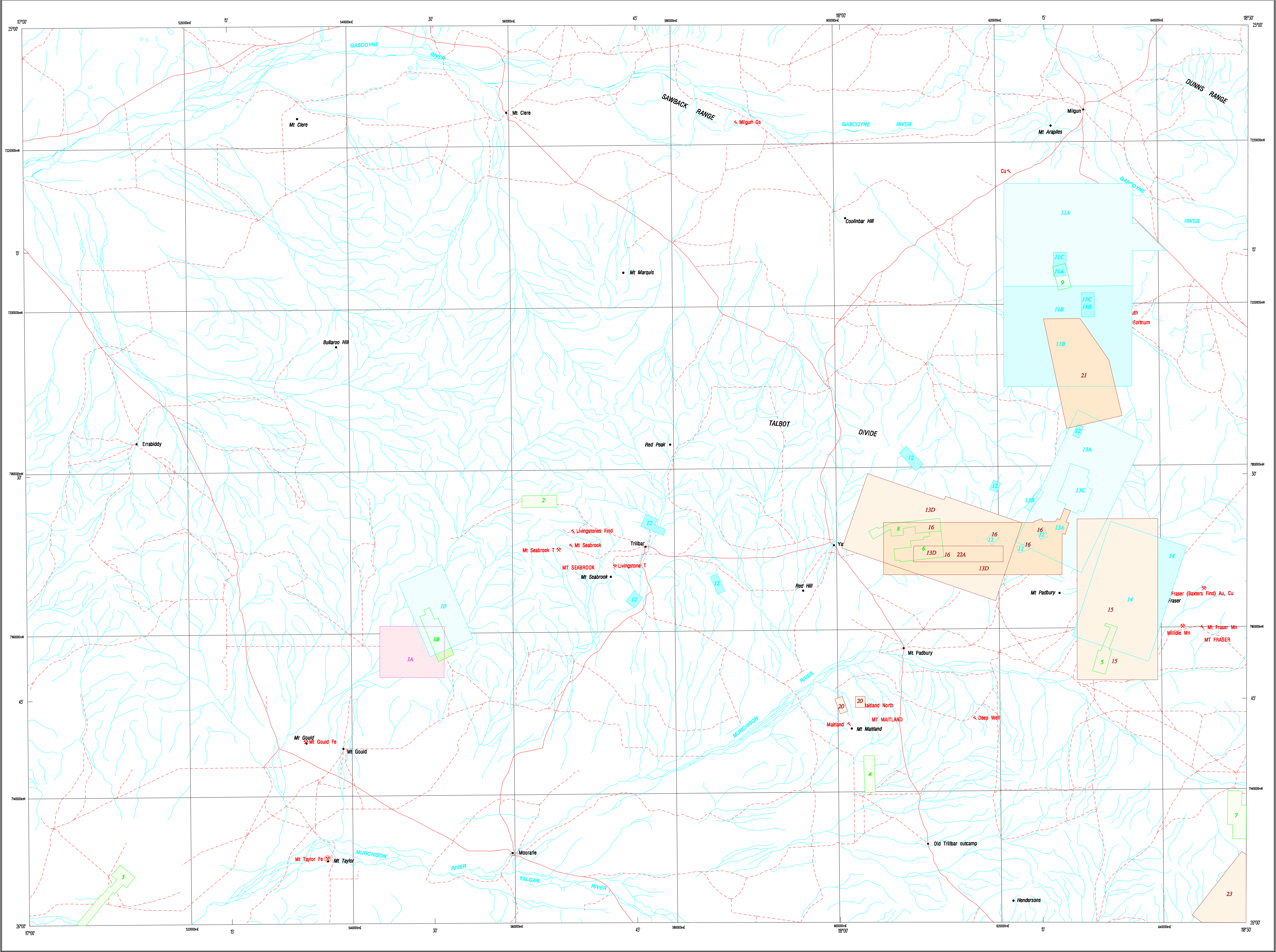


TRANSVERSE MERCATOR PROJECTION
Grid lines indicate 20 000 metre interval of the Australian Map Grid Zone 50

Sampling by J.J. Bradley (GSWA) with assistance from P. Penna, E. Spantali and G. Toiland (Geochimica Australia), 1995
Total sample sites: 1019; 744 stream sediment, 184 sheetwash sediment, and 91 soil
Analyst: Geanalysis Laboratories, Western Australia. Minimum sample size: 1.5 kg.
Size fraction analysed: <2mm<0.45mm
Geological interpretation after: Elias and Williams (1980); J. S. Myers, S. Occhipinti and C. P. Swager (1986, pers. comm.)
The recommended reference for this map is: BRADLEY J.J., FAULKNER J.A., and SANDERS A.J., 1997, Robinson Range, W.A., sheet SG 50-7 - Sample locations: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series, Plate 2

WARNING: Inks are water soluble and will fade with prolonged exposure to light

ROBINSON RANGE
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA



COMPANY PROJECTS WITH SURFACE
GEOCHEMISTRY DATA IN OPEN-FILE
REPORTS (at August 1995)

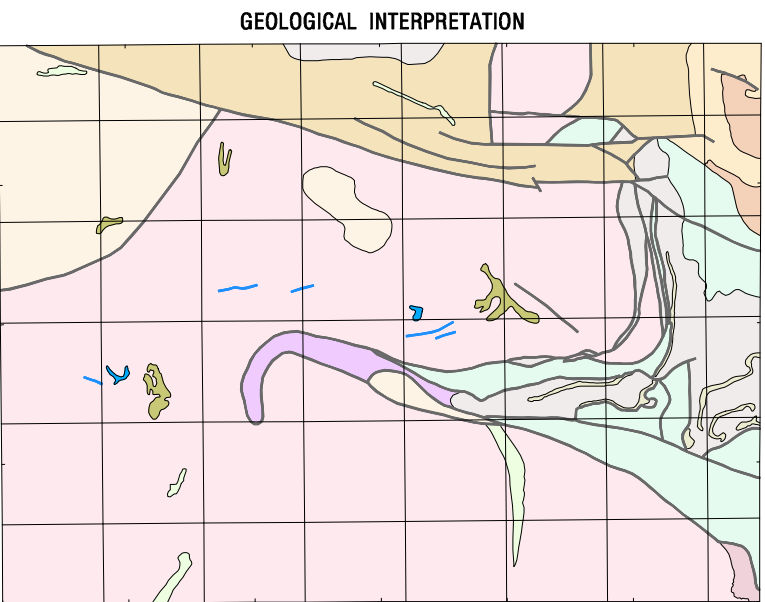
PROJECTS REPORTED BETWEEN 1966 AND 1985

Period Project Reported Within
(Various colour shades used for ease of project identification)

<div></div>	1966 - 1970
<div></div>	1971 - 1975
<div></div>	1976 - 1980
<div></div>	1981 - 1985
<div></div>	1986 - 1990
<div></div>	1991 - 1995

Number within project area is a database ID number (See Appendix 3)

<div></div>	Minor road
<div></div>	Track
<div></div>	Watercourse, ephemeral
<div></div>	Homestead
<div></div>	Locality
<div></div>	Mining centre
<div></div>	Major mine (incl. other otherwise indicated)
<div></div>	Mine
<div></div>	Minor mine
<div></div>	Prospect
<div></div>	Mineral occurrence
<div></div>	Gold
<div></div>	Copper
<div></div>	Iron ore
<div></div>	Variscite
<div></div>	Manganese
<div></div>	Talc



- Geological Interpretation**
- PROTEROZOIC**
- Bangemall Group
 - Quartz arenite, minor wacke, siltstone, conglomerate, shale, and dolomite
 - Shale and siltstone; minor chert, claystone, dolomite, and sandstone
 - Chert, arenite and siltstone, minor dolomite and shale
 - Granite
 - Padbury Group
 - Wacke, siltstone, conglomerate, shale, quartz arenite, and calcareous sedimentary rocks
 - Granular and banded iron-formation, and hematitic shale
 - Bryah Group
 - Sedimentary rocks, mafic and ultramafic volcanic and intrusive rocks, and banded iron-formation
 - Yerrida Group
 - Quartz arenite, shale, and quartz-pebble conglomerate
 - Trilbar Complex
 - Mafic to ultramafic volcanic and plutonic rocks
- ARCHAEO**
- Volcanic and sedimentary rocks (includes greenstones)
 - Granite and granitic gneiss
 - Banded iron-formation
 - Amphibolite
- Geological boundary
Major fault or shear



SHEET INDEX		
MOUNT PHILLIPS SG 50-2	MOUNT EBERTON SG 50-3	COLLIER SG 50-4
GLENBURGH SG 50-6	ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8
BYRO SG 50-10	BELLELE SG 50-11	GLENBARRY SG 50-12

INDEX TO 1:100 000 MAP SHEETS WITHIN ROBINSON RANGE 1:250 000		
ERRABIDDY 2347	MARQUIS 2447	MILGUN 2547
GOULD 2346	MOORARIE 2446	PADBURY 2546

COMPANY PROJECTS WITH SURFACE
GEOCHEMISTRY DATA IN OPEN-FILE
REPORTS (at August 1995)

ROBINSON RANGE
REGOLITH GEOCHEMISTRY SERIES

SHEET SG 50-7
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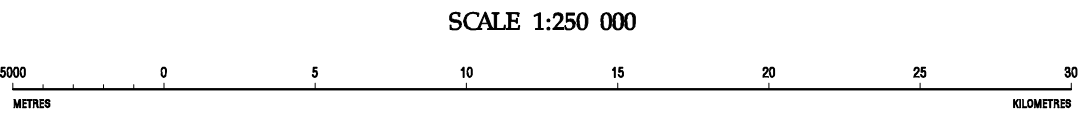
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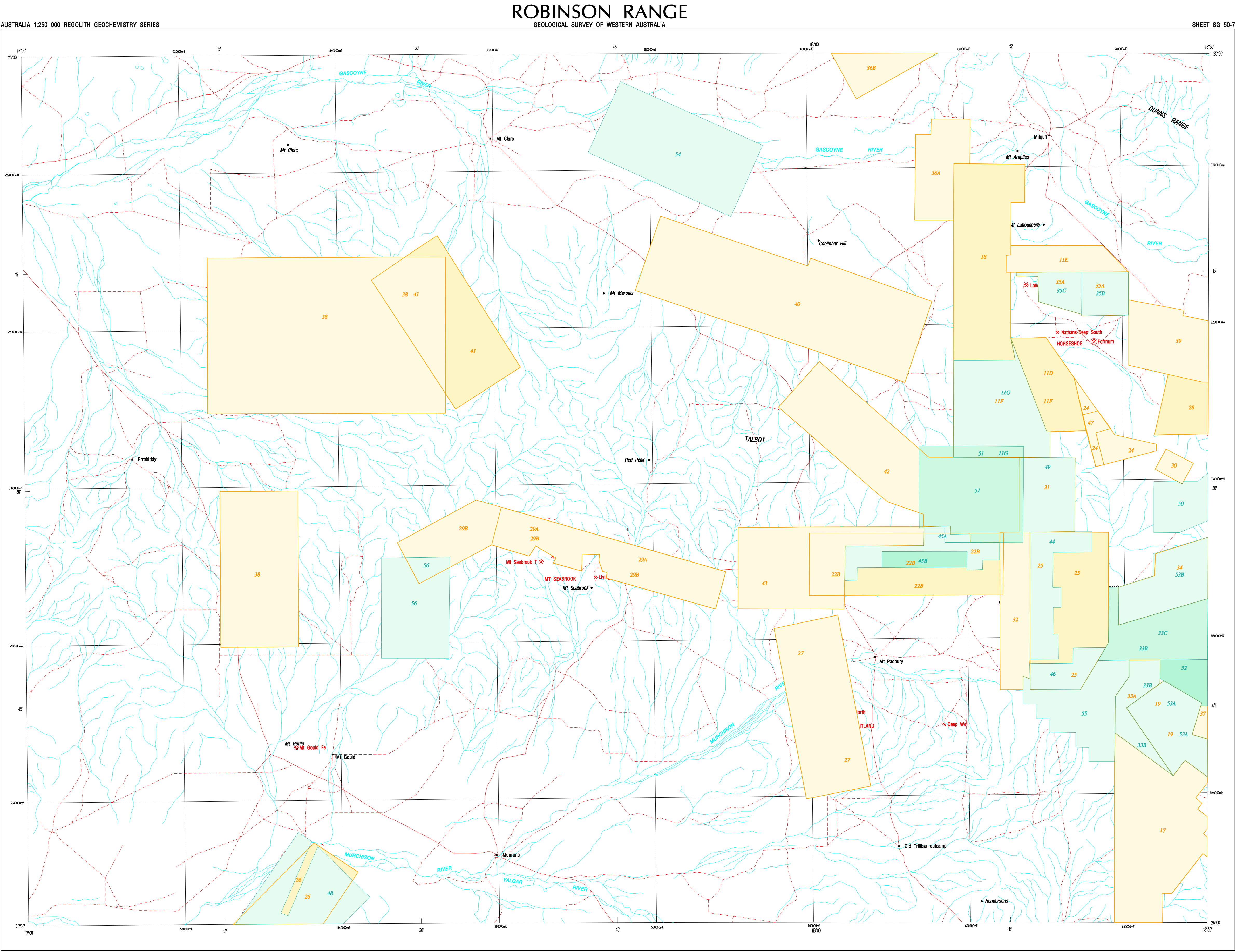
GEOLOGICAL SURVEY OF
WESTERN AUSTRALIA
PIETRO GULL, DIRECTOR



TRANSVERSE MERCATOR PROJECTION
Grid lines indicate 20 000 metre interval of the Australian Map Grid Zone 50

Compiled by: J.A. Faulkner 1996
Compiled from open-file company reports held by Geological Survey of Western Australia
Tenement boundaries have been generalized for the purpose of this map to an accuracy of \pm 50 - 500 metres. Refer to specific project reports for precise boundary descriptions.
The recommended reference for this map is: FAULKNER, J.A., 1996, Robinson Range, W.A. sheet SG 50-7 -- Company projects with surface geochemistry data in open-file reports (at August 1995), projects reported between 1966 and 1985: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series, Plate 3

WARNING: Inks are water soluble and will fade with prolonged exposure to light



COMPANY PROJECTS WITH SURFACE
GEOCHEMISTRY DATA IN OPEN-FILE
REPORTS (at August 1995)

PROJECTS REPORTED BETWEEN 1986 AND 1995

Period Project Reported Within
(Various colour shades used for ease of project identification)

1966 - 1970	See PLATE 3	Minor road
1971 - 1975		Track
1976 - 1980		Watercourse, ephemeral
1981 - 1985		Homestead
1986 - 1990		Locality
1991 - 1995		Mining centre

Number within project area is a database ID number (See Appendix 3)

• Milgum	Major mine (incl. other otherwise indicated)
• Mt Padbury	Mine
✱ Fortnum	Minor mine
✱ Labouchere	Prospect
✱ Withorpe	Mineral occurrence
✱ Maitland	
Au	Gold
Cu	Copper
Fe	Iron ore
Gs	Variscite
Mn	Manganese
T	Talc

GEOLOGICAL INTERPRETATION

Geological interpretation: After Ellis and Williams (1980); Myers, Ochipinti, and Swager (1995, pers. comm.)

PROTEROZOIC

- Bangemall Group
 - Quartz, arenite, minor wacke, siltstone, conglomerate, shale, and dolomite
 - Shale and siltstone, minor chert, claystone, dolomite, and sandstone
 - Chert, arenite and siltstone, minor dolomite and shale
- Padbury Group
 - Wacke, siltstone, conglomerate, shale, quartz, arenite, and calcareous sedimentary rocks
 - Granular and banded iron-formation, and hematitic shale
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 - Sedimentary rocks, mafic and ultramafic volcanic and intrusive rocks, and banded iron-formation
- Yerrida Group
 - Quartz, arenite, shale, and quartz-pebble conglomerate
- Trilbar Complex
 - Mafic to ultramafic volcanic and plutonic rocks

ARCHEAN

- Volcanic and sedimentary rocks (includes gneissosomes)
- Granite and granitic gneiss
- Banded iron-formation
- Amphibolite

Geological boundary
Major fault or shear

SHEET INDEX

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COMPANY PROJECTS WITH SURFACE
GEOCHEMISTRY DATA IN OPEN-FILE
REPORTS (at August 1995)

PROJECTS REPORTED BETWEEN 1986 AND 1995

REGOLITH GEOCHEMISTRY SERIES

ROBINSON RANGE

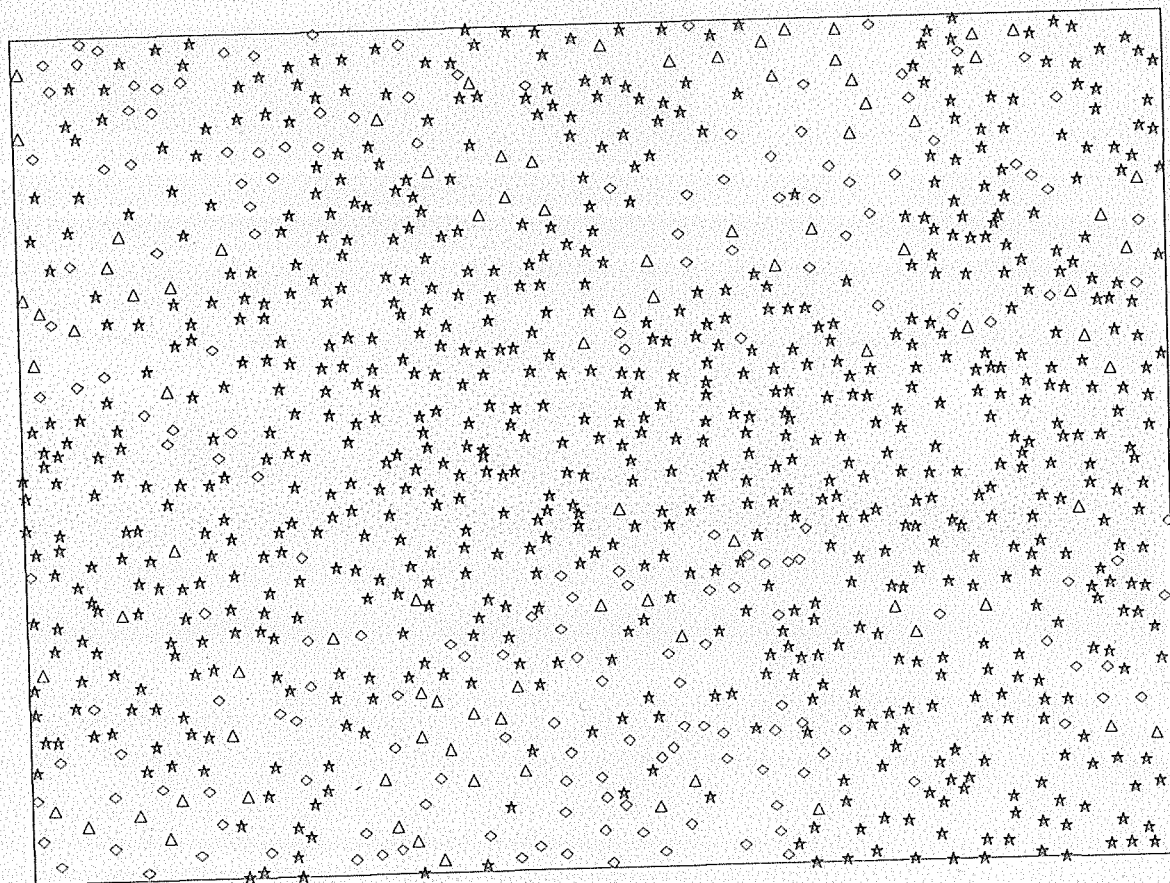
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SAMPLE LOCATIONS

SAMPLE TYPE

- △ Soil
- ★ Stream
- ◇ Sheetwash



SCALE 1:1 000 000

0 10 20 30 40 50 km

ROBINSON RANGE

SHEET SG 50-7
First Edition 1997