EXPLANATORY NOTES

GEOCHEMICAL MAPPING OF THE GLENGARRY 1:250 000 SHEET

by R. A. Crawford, J. A. Faulkner, A. J. Sanders, J. D. Lewis and J. R. Gozzard

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

DEPARTMENT OF MINERALS AND ENERGY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOCHEMICAL MAPPING OF THE GLENGARRY 1:250 000 SHEET

by
R. A. Crawford, J. A. Faulkner, A. J. Sanders, J. D. Lewis, and J. R. Gozzard

Perth 1996

MINISTER FOR MINES
The Hon. Kevin Minson, MLA

DIRECTOR GENERAL
K. R. Perry

DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
Pietro Guj

National Library of Australia Card Number and ISBN 0 7309 6522 8

Revised October 1996

Copies available from:
Mining Information Centre
Department of Minerals and Energy
100 Plain Street
EAST PERTH Western Australia 6004
Telephone (09) 222 3459

Contents

Appendices

Plates (in pocket)

Figures (from p. 57)

Tables

Digital dataset (in pocket)

Geochemical mapping of the Glengarry 1:250 000 sheet

by

R. A. Crawford, J. A. Faulkner, A. J. Sanders, J. D. Lewis, and J. R. Gozzard

Abstract

Regolith and geochemical mapping of GLENGARRY is presented at 1:250 000 scale, based on field observation and regolith sampling at a density of approximately 1 sample per 16 sq. km. A total of 1035 samples was collected, consisting of 528 stream sediments, 504 soil/sheetwash, and three lake sediments. The <2 mm to >0.45 mm fraction of each sample was analysed for 48 components, using 'total' analytical methods. Distribution plots of most elements are presented at 1:1 000 000 scale, and the analytical data are provided in the attached digital file. In addition, 1:250 000 scale maps show the position of those mineral exploration projects on open file where geochemical exploration has been carried out.

The material of soil/sheetwash is not fundamentally different from that of stream sediments. The composition of regolith is, in most cases, closely related to underlying bedrock. Twenty-six regolith units have been delineated.

Geochemical data sharply define the greenstone belts and many of the rock groups within the Proterozoic Glengarry Basin, and also suggest that some 'relict' sands are older eolian material, comparable with recent eolian sand. Areas of different granitic composition are indicated, and there are indications of lithological differences within some larger rock groupings. Discriminant analysis of the chemical data shows the reliance of regolith on underlying rock type and indicates areas that may warrant geological reinterpretation. There is close correspondence of regolith K_2O values with radiometric potassium.

Over most of the Yilgarn Craton there are systematic differences in regolith composition, downslope to the main drainages; this feature is less observable over the Proterozoic rocks where bedrock, in general, appears closer to the surface.

The position of all larger gold mines is reflected by Au detectable in the nearby regolith. By analogy, Au at the ppb level in other samples suggests areas with exploration potential for gold. An association of Au with ppb levels of Pd and Pt occurs over Proterozoic mafic rocks in the Glengarry Basin. A number of other samples display elevated values, or a combination of elevated values, of elements of economic significance.

KEYWORDS: Glengarry, Yilgarn Craton, Glengarry Basin, regolith, multi-element analysis, geochemical maps, regional surveys.

Introduction

The GLENGARRY* 1:250 000 map sheet, (ref: SG50-12), lies between latitudes 26°00' and 27°00'S and longitudes 118°30' and 120°00'E. The area is sparsely populated and the few permanent residents are engaged in the pastoral industry at a number of widely scattered sheep and cattle stations (Fig. 1). The nearest towns are Meekatharra (population 1800) on the western boundary of the area, and Wiluna (population 220) about 25 km east of the sheet boundary. Both towns are important regional service centres for the gold-mining and pastoral industries.

In 1994, the Geological Survey of Western Australia (GSWA) initiated a program of regional geochemical mapping at 1:250 000 scale to aid in mineral exploration and assist monitoring of the environment. The first maps published under this program were MENZIES (Kojan and Faulkner, 1994), LEONORA (Bradley et al., 1995) and PEAK HILL (Subramanya et al., 1995). The GLENGARRY project, together with PEAK HILL and ROBINSON RANGE (Bradley et al., in prep.), is intended to provide complementary geochemical information over the Glengarry Basin and

* Capitalized names refer to standard map sheets

adjacent geological provinces, currently being remapped geologically by the GSWA. Published results from the remapping include Pirajno and Occhipinti (1995), Adamides (1995), Dawes and Le Blanc Smith (1995), and Pirajno et al. (1995).

There are few recent publications on regional geochemical mapping in Australia, apart from the GSWA publications mentioned above, and a stream-sediment survey of the EBAGOOLA 1:250 000 map sheet in Queensland (Cruikshank, 1994). For GLENGARRY, a number of whole-rock analyses of Archaean granitoids and gneisses, and Proterozoic mafic rocks, have been published by Elias et al. (1982).

The aims of the GSWA Regional Geochemical Mapping Program are:

- to provide regional baseline geochemical data to assist in the interpretation of geochemical exploration results;
- to assist in the identification of metallogenic provinces and specific areas with potential for undiscovered mineralization;
- to assist in the identification of rock types and assemblages present, and provide comparison with geological mapping;
- to provide baseline geochemical information for use in agricultural and pastoral activities, and in environmental monitoring and regulation.

Regional geochemical mapping involves the mapping of surficial materials — the regolith — and their sampling and analysis at regular intervals over large areas (Kojan and Faulkner, 1994). Regolith is a general term used to include weathered, clastic and chemically deposited material, either consolidated or unconsolidated, which overlies and conceals unweathered bedrock. It includes both weathered rock in situ and debris that has formed as a result of weathering and erosion. Eolian sediments and chemical deposits, such as hardpan and calcrete, may be intermixed with these materials. Regolith thus includes both residual and transported sediments of various types and from a variety of sources (Anand et al., 1993a).

During Tertiary and Quaternary time, extensive weathering of the land surface produced a variably thick regolith cover, which conceals fresh bedrock and hinders mineral exploration in the Yilgarn Craton and Glengarry Basin. A consequence of the weathering history is a close relationship of regolith materials with both local and regional landforms. Therefore, an understanding of the regolith–landform relationship, and the nature, origins and weathering history of components of the regolith, is important for geochemical exploration and mapping (Anand and Smith, 1994).

Regolith mapping and sampling of the GLENGARRY 1:250 000 sheet area commenced in October 1994, with the assistance of sampling teams provided by Geochemex Australia Pty Ltd, and led by L. Fitzgerald, G. Tolland, and G. Lawrence. Each sampling team consisted of a geologist and field assistant. Chemical analysis of the samples was contracted out to the Chemistry Centre (WA) and AMDEL Laboratories. The contribution of these organizations to this study is acknowledged.

Access

The Great Northern Highway, a major sealed road, provides access from Perth and passes through Meekatharra and the northwestern corner of GLENGARRY. Other well-formed, graded roads include the Meekatharra–Wiluna road and an abandoned railway line to Wiluna, both of which traverse the sheet from west to east. The Sandstone–Wiluna Road traverses the southeast corner of the sheet, and a well-graded station road runs from the Great Northern Highway in the northwest of the sheet to Wiluna. Most of the pastoral stations are serviced by graded roads which provide good access to all except the central areas of the sheet. A network of exploration-company tracks provides good local access to most areas of interest.

Access to some parts of the sheet was impeded by the Finlayson and Glengarry Ranges. The Finlayson Range is over 100 km long and traverses the area from the northwest to the eastern margin of the sheet, presenting major access problems to large areas. A vermin-proof fence is a major man-made impediment, dividing the eastern half of the sheet along a northeast–southwest line with only a limited number of gates. An extension of the fence runs from east to west, close to the southern boundary of the sheet.

Climate

The climate in the GLENGARRY area is semi-arid to arid; the annual average rainfall is 230 mm falling mainly between January and July (Elias et al., 1982). This rainfall is highly irregular and is derived from both northern cyclonic storms and southern winter rains. The area is subject to both drought and localized short-term flooding. Average potential evaporation is between 2400 and 3000 mm.

Vegetation

Seventy-five vegetation communities have been recognized by Mabbutt et al. (1958), including the major categories of woodlands, shrublands, and spinifex grasslands. The upper canopy is dominated by mulga (*Acacia aneura*). Major watercourses are commonly lined with tall river gums (*Eucalyptus camaldulensis*; Beard, 1974) and several mallee species occur in sparse upper storeys in spinifex grasslands (Mabbutt et al., 1958). Most plant communities have well-developed shrub layers with various species of *Eremophila*. This genus has been used by Mabbutt et al. (1958), together with *Acacia aneura*, to designate a number of communities. Areas marginal to drainage floors and salt lakes carry halophytes such as samphire (*Arthrocnemum* sp.), saltbush (*Atriplex* sp.) and bluebush (*Kochia* sp.; Beard, 1974). Sandplains are characterized by spinifex grasslands (*Triodia* sp.) and occasional mallee (*Eucalyptus* sp.). The high variability of rainfall allows the existence of only those perennial species that can withstand periods of several years during which there is insufficient rain to permit a significant period of growth. A number of small, shallow-rooting ephemerals, mainly grasses and composites, are able to grow and mature rapidly following rain.

Physiography

Topography and drainage

The land surface of the GLENGARRY sheet is characterized by generally low relief. The area forms part of the inland plateau of Western Australia and elevation ranges from about 460 m above sea level (ASL) in the southwest, to a broad plateau between 550 and 600 m ASL over much of the central and eastern part of the area. Granitoid rocks of the Yilgarn Craton and Goodin Inlier form low outcrops beneath breakaways but with some rugged outcrops, for example, northwest of Murchison Downs. Archaean greenstone belts are generally characterized by low rugged hills, lithologically controlled, and rarely more than 50 m above the surrounding country. Proterozoic sandstones of the Juderina Formation (Finlayson Member) form a range of low hills traversing much of the area from east to west, and including the highest point of 674 m ASL. Other more rugged areas of the Glengarry Range and Kimberley Range are also formed by outcrops of Proterozoic sedimentary and volcanic rocks.

All streams and lakes on the GLENGARRY sheet are ephemeral and flow only after heavy rain. Major drainages are saline, and are remnants of the extensive Cretaceous–Early Tertiary palaeodrainage network (van de Graaff et al., 1977) developed on an old erosion surface (the 'old plateau' *of* Jutson, 1934). The major north-trending drainage divide through the central part of the sheet separates palaeodrainage systems that flow west to the sea from those that flow southeast towards the Eucla Basin. A small part of the Lake Nabberu catchment, which ultimately flows into the Canning Basin, is present in the northeast corner of GLENGARRY (Elias et al., 1982).

Small second and third order streams are present in areas of more rugged topography, particularly the greenstone belts, and the Finlayson and Glengarry ranges. Large areas in the central parts of the sheet, particularly sandplains developed over granite, are almost devoid of active stream courses.

Landforms and regolith development

Two climatic regimes have been of particular importance since the mid-Mesozoic for the development of landforms and regolith. These were, firstly, the humid, warm to tropical periods during the Cretaceous to mid-Miocene, and secondly, drier climates since the Miocene that have continued to the present (Butt et al., 1991).

The old land surface, formed during the warm to tropical period, consists of a broad undulating surface formed by lateritization. Since the onset of arid conditions in the mid-Miocene, this surface has been extensively dissected and partly stripped to expose fresh rock underneath. The old surface is now preserved as mesas and tablelands of hardened rock or duricrust, most of which are overlain by sandplain and bounded by breakaways.

The development of both laterite and silcrete has been controlled mainly by topography and bedrock, rather than by climatic differences. In sedimentary basins, the original lateritic sediments formed in poorly drained, clayey substrates, and over mafic rocks where there is more iron-rich material. Silcrete formed in more permeable, better drained areas underlain by quartz-rich sandy sediments (van de Graaff, 1983). Over time, the landscape has eroded to leave these more resistant areas representing an inverted topography.

Remnants of the old plateau are best observed above granite breakaways and between hills of resistant Proterozoic sedimentary rocks near the major drainage divides. Much of the surface is now covered by extensive sheets of eolian sand with areas of north–south longitudinal or seif dunes prominent in many places. A spinifex sandplain commonly occupies a position intermediate between the high-relief areas of outcrop and the major valley floors. The sand is eolian and similar to that of the desert areas to the east.

A more recent, largely depositional surface was formed during the Miocene. The gradual change in climate from humid to semi-arid caused a decline in the competence of the streams and resulted in extensive alluviation in the lower parts of the area (Mabutt et al., 1958). Gently sloping pediments of rock fragments in loamy soil surround most areas of outcrop. These pass downslope into extensive sheetwash plains, where soils are thicker and rock fragments less abundant. Broad, ill-defined drainages are filled with colluvium and alluvium and, in their lower reaches, the alluvium has been incised by watercourses typically lined with large eucalypts.

Some drainage systems are still active and are filled with saline clays and silt. In a number of the saline drainages valley calcrete has developed. Hardpan, a desiccated and silicified surface layer of cemented colluvium up to 10 m thick, is found in valleys and on lower parts of the Miocene depositional surface. It thins out gradually on the slopes to a discontinuous crust a few centimetres thick. Hardpan also extends below the red clayey sands of the sand plain on the old plateau (Mabutt et al., 1958).

Soils

Most soils of the GLENGARRY area are leached, coarse-grained red earths and red sands, and are derived mainly from weathered rock on the old plateau. Strictly, most of these soils are so immature and non-stratified that they can be considered as a variety of sheetwash. Hardpan has formed at shallow depths (0.5–2 m) within most of these soils. Shallow red earths with massive hardpan commonly occur on tributary alluvial plains. Low-lying floodplains have calcareous and saline soils. Soils derived from fresh rock material are not extensive; these areas are covered by weathering crusts and weathered rock surfaces (Mabbutt et al., 1958).

Previous geoscientific investigations and data acquisition

Geological mapping

Most early investigations on GLENGARRY were concerned with gold occurrences at Meekatharra and Gabanintha. However, the earliest reference is by Gibson (1908) who worked in the Gum Creek area. Clarke (1916) conducted a comprehensive study of the GLENGARRY area which included descriptions of regional geology, physiography and some hydrogeology. Sofoulis and Mabbutt (1963) provided a more detailed physiographic and geological study of the area between Wiluna and Meekatharra, including GLENGARRY. Later, Hallberg et al. (1976) discussed geochemical variations in rocks of the greenstone belts, whilst Butt et al. (1977) described a uranium occurrence in calcrete and associated sediments between Murchison Downs and Hillview Homesteads. Aeromagnetic and gravity surveys of GLENGARRY have been carried out by the Australian Bureau of Mineral Resources and interpreted by Lambourn (1972).

The first systematic regional mapping of GLENGARRY conducted by the GSWA was completed in 1976–77 by Elias et al. (1982). Studies have also been conducted on the stratigraphy of the Proterozoic rocks of northern GLENGARRY by Bunting et al. (1977), and Hall and Goode (1978). More recently, Gee and Grey (1993) compiled a structural and biostratigraphic summary of the Proterozoic rocks of the GLENGARRY sheet, and a revision of the stratigraphy of the region has been made by Occhipinti et al. (in press), and Pirajno et al. (in press).

In 1993, the GSWA began the remapping of the Proterozoic rocks of the Glengarry Basin. The MOUNT BARTLE 1:100 000 map sheet (Dawes and Le Blanc Smith, 1995) has been published in a preliminary edition.

Water resources

Surface water is contained in stream pools, rock holes and springs for only short periods after rainfall. As a result, water supplies are derived almost entirely from groundwater. Over most of the area, domestic and stock requirements are met from small supplies of fresh or brackish groundwater in colluvium, valley-fill alluvium and calcreted alluvium. Calcrete has the greatest potential for groundwater and large quantities of generally brackish water may be extracted from it. Weathered granitic rocks and fractured or jointed Archaean and Proterozoic rocks are unreliable as aquifers. Depths to the watertable vary from less than 5 m in the main trunk drainages to more than 25 m in the upland areas (Elias et al., 1982). Sanders (1973) indicated that provided normal recharge takes place, up to 3.62×10^6 m^3/year of potable water could be pumped from calcrete on Paroo Station without reducing the volume of water in storage.

Mineral resource and occurrence datasets

Data on historic gold and other metal production (Appendices 1 and 2) are derived from two sources: a 1954 Department of Mines publication of cancelled gold mining leases for mines that have produced gold, and more recent production records kept by the Royalties Division of the Department of Minerals and Energy (DME). The MINEDEX database of the DME supplied records of published, company-reported, in-ground resources. The locations of the major gold producers were provided by the Bureau of Resource Sciences MINLOC database. Resource estimations are taken mainly from company reports to the stock exchange or other published documents.

Geochemical surveys on open-file company reports

A summary of geochemical surveys conducted by exploration and mining companies, and available on open file, is presented as Appendix 3. In compliance with the Mining Act of 1978, company exploration reports are lodged with the GSWA and listed on the WAMEX database. Appendix 3 reports information from surface geochemical exploration, including costean and shallow drilling between zero and four metres from the surface. Projects with fewer than 30 analysed samples were not included in the survey.

Each project has been assigned an identification number, and the project boundaries, together with the appropriate numbers, are shown on Plates 1 and 2. These plates provide an overview of surface-exploration coverage for GLENGARRY. The accuracy of Plates 1 and 2, compiled from DME public plans, is ± 500 m. Most projects cover a single area, although in a few cases this area may comprise two or more blocks of ground. The first column in Appendix 3 contains the identification number. Other fields include project area, year, sample medium, number of samples, and elements analysed.

The projects are tabulated in chronological order and cover the period from 1967 to 1993. 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. There are, however, gaps in the report database. Some tenement holders failed to lodge reports, as required by the Mining Act of 1978. Moreover, prior to 1978, under the Act of 1904, holders of mineral claims were not obliged to report all of their exploration results.

In all, 65 projects are listed in Appendix 3 for GLENGARRY, with a total of 36 006 samples analysed for an average of three elements. The projects are divided by the mineralization targeted into the following categories:

Gold	61%
Copper / nickel	17%
Copper	11%
Copper / lead	11%

Topographic and remote-sensing datasets

The topographic information used in the maps for this report was supplied, under licence, by the Australian Land Information Group (AUSLIG). Landsat Thematic Mapper scenes were obtained from the remote sensing group of the Department of Land Administration (DOLA). Six 1:100 000-scale scenes displaying bands 7, 4, and 1 were used extensively in the interpretation of the regolith-unit boundaries for the regolith-materials map. Aerial photographs were also used in the interpretation for the regolith map (DOLA: SG50-12, job No. 930921, Nov. 1993). Aerial radiometric data were collected in 1992 and processed by the GSWA to give maps of the total count of gamma rays and a composite red–green–blue image corresponding to K, Th, and U. Gamma-ray spectrometry and gravity data are available separately as maps and plans.

Geology

The major geological divisions of the GLENGARRY sheet are the granitoids and greenstones of the Yilgarn Craton, occupying the southern and western half of the sheet, and Proterozoic sedimentary and igneous rocks in the northern and eastern half. A small granitic inlier of the Yilgarn Craton, the Goodin Inlier, extends across the northern boundary of GLENGARRY onto the PEAK HILL sheet. The Yilgarn Craton in this region is assumed by Bunting (1986) to be Archaean in age (>2.5 Ga) although some granites may be a little younger at about 2.4 Ga. The Proterozoic sedimentary and basic volcanic rocks of the Glengarry Basin range from about 2.0 to 1.6 Ga.

Outcrop is limited and rock relationships, especially in areas of granitoids, are difficult to interpret due to deep weathering, lateritization and subsequent erosion and deposition of extensive sheets of sand and gravel. The general geological interpretation shown in Figure 2 is based on a combination of geological mapping by Gee and Grey (1993), recent remapping by Pirajno et al. (1995, in press), and interpretation of aeromagnetic data (Watt, 1995). What follows is a summary account of the geology of GLENGARRY from the available literature. No geological mapping has been undertaken as part of this project.

Archaean

Archaean rocks of the Yilgarn Craton underlie more than half of GLENGARRY, south and west of the outcrop of the Proterozoic sedimentary rocks of the Glengarry Group. Granitoid rocks are most abundant, but there are several north-trending, economically important greenstone belts. The greenstone belts are, from west to east, the Meekatharra belt, the Gum Creek belt and the Joyners Find belt. A number of small, isolated greenstone remnants are present between the Meekatharra and Gum Creek belts. The greenstone belts consist of folded and metamorphosed mafic and ultramafic volcanic rocks and their intrusive equivalents, felsic volcanic and sedimentary rocks, enclosed as narrow keels within a variety of granitoid rocks (Elias et al., 1982).

Granitoid and gneissic granitoid rocks of the Yilgarn Craton

Two main types of granitoid rock are found within the Yilgarn Craton: unfoliated, homogeneous post-tectonic granite and monzogranite forming large composite batholiths; and foliated to gneissic early tectonic granitoids occurring within greenstone belts, near the margins of greenstone belts, and between the post-tectonic batholiths. Gneissic granitoid rocks are tonalite and granodiorite in composition, whereas post-tectonic granite and monzogranite batholiths are more potassic. Chemically the granitoids show a calc-alkaline trend, and a number are similar to the fluorite-bearing, Boreas-type potassic monzogranites from DUKETON, LAVERTON, and SIR SAMUEL (Elias et al., 1982; Bunting and Williams, 1976). Fluorite occurs in thin veins within a granite 7 km north of Murchison Downs Homestead, and Elias et al. (1982) suggest that the Boreas-type granites may form a widespread suite of fractionated potassic granitoids in the northeast Yilgarn Craton.

Greenstone belts

Meekatharra belt

The Meekatharra belt is a regional north to north-northeasterly trending synclinal structure that extends onto the adjoining BELELE sheet. Stratigraphically, it consists of two formations each containing a mafic unit overlain by a felsic volcaniclastic unit (Elias et al., 1982).

The lower mafic unit is exposed along the eastern margin of the belt and consists of tholeiitic basalt and BIF with intercalated schist derived from ultramafic volcanic rocks. The ultramafic rocks are komatiite and basaltic komatiite containing 10–19% MgO (Hallberg et al., 1976). Southeast of Gabanintha, the Copper Hills Ultramafic Complex contains a variety of metamorphosed intrusive and extrusive gabbro, pyroxenite, and peridotite.

The overlying felsic-volcaniclastic unit consists of a sequence of felsic volcanic and tuffaceous rocks, and volcanogenic sedimentary rocks with minor intercalated basalt and a jaspilitic–BIF marker horizon. The rocks are extensively kaolinized and poorly exposed.

The upper mafic unit of Elias et al. (1982) occupies the synclinal core of the belt and consists of an alternating sequence of basaltic komatiite and tholeiitic basalt. This is overlain by the upper felsic-volcaniclastic unit consisting of andesite, dacite and related volcaniclastic rocks. Outcrop of this unit is divided into a small area in the centre of the belt, separated by a major north-northeasterly trending fault from a larger, poorly exposed area east of Gabanintha.

The Archaean sequence has been tightly folded, cross-faulted and intruded by late-Archaean dykes. The central succession is predominantly submarine, although the marginal andesite pile may be partially subaerial. The gold deposits in the Meekatharra belt are restricted to the lower mafic unit and the overlying sedimentary unit (Elias et al., 1982).

Gum Creek belt

The Gum Creek belt on GLENGARRY is the northern termination of the major greenstone belt complex of the Southern Cross Subprovince of the Eastern Goldfields Province (Williams, 1975). The belt is formed by a southerly plunging syncline, intensely sheared and mylonitized along the eastern margin, occupied mostly by metabasalt. Although deformation and metamorphism have destroyed most original textures and structures, some outcrops contain elongate ovoid shapes resembling deformed pillows. Intercalated sedimentary rocks within the lavas also imply submarine volcanicity (Elias et al., 1982). In the northern part of the belt, east of Gum Creek mine, ultramafic intrusive, and possibly some extrusive, rocks occur in the basaltic sequence. Sills of dolerite and gabbro intrude the sequence in the eastern half of the belt. Laminated shale adjoins the metabasalt and passes westwards into felsic fragmental rocks (Elias et al., 1982).

Joyners Find belt

The Joyners Find belt is a narrow, north-trending belt containing two subparallel banded iron-formations. The belt appears to have been continuous with the rocks of the Booylgoo Range on SANDSTONE (Elias et al., 1982), before the fragmentation of greenstone by granitoid intrusion. Strong deformation and lack of facing evidence precludes recognition of a stratigraphic sequence in this belt. However, two components are recognized: an eastern section of mafic and ultramafic rocks containing banded iron-formation, and a western section of pebbly wacke and conglomerate (Elias et al., 1982).

Metamorphism in the Joyners Find belt is accompanied by planar or linear deformation fabrics. However, later static metamorphism is indicated by growth of tremolite needles across such fabrics at Joyners Find mine. This could indicate two separate metamorphic events or, more likely, the continuation of recrystallization after deformation ceased. Similar later growth of tremolite is present in ultramafic schist east of the Gum Creek mine in the Gum Creek belt (Elias et al., 1982).

Gold deposits occur in the centre of the belt at Joyners Find, and close to its eastern margin at the Diorite mine. The eastern margin of the belt approximates to the boundary between the Eastern Goldfields and Southern Cross Provinces, and is strongly sheared (Griffin, 1990).

Smaller greenstone remnants

On the southern margin of GLENGARRY, near Bundle Well (AMG 702260E 7014070N), the northern end of a narrow, north-northwesterly trending greenstone belt is exposed, most of which is on SANDSTONE. The rocks are fine- to coarse-grained amphibolite derived from basalt and dolerite, with some banded iron-formation at the northern end (Elias et al., 1982).

In a zone parallel to, and east of, the Meekatharra greenstone belt, between Hillview Homestead and the old Mistletoe minesite, small greenstone remnants occur as rafts and detached fold cores in both syn- and post-tectonic granitoids. Their distribution suggests a formerly continuous belt now almost entirely engulfed by granitoid. Most remnants are of amphibolite, meta-pyroxenite and metaperidotite and, less commonly, sedimentary rocks, felsic tuff, and volcanogenic sedimentary rocks (Elias et al., 1982).

Goodin Inlier

The Goodin Inlier is a domal body of granitic rock, about one-third of which lies within the northern part of GLENGARRY (Bunting et al. 1977). The inlier is some 35 km wide and is unconformably overlain by outward-dipping sedimentary rocks of the Glengarry Group. The granitoid is cut by a number of easterly trending mafic dykes, none of which cut the overlying rocks of the Glengarry Group (Bunting, 1986). The dome is a portion of Archaean basement reactivated by block faulting during the Early Proterozoic (Elias et al., 1982). Evidence for an Archaean age for the granitoid rocks is outlined by Bunting (1986). Most of the granitoid rocks of the Goodin Inlier are similar to those in the Yilgarn Craton to the south, although a leucocratic muscovite–biotite granite with rare fluorite is present at Utahlarba Spring (Bunting, 1986).

Proterozoic

Stratigraphy and tectonic setting

The Capricorn Orogen (Tyler and Thorne, 1990; Myers, 1993) resulted from the collision of the Yilgarn and Pilbara Cratons at about 1.8–1.9 Ga. Gee and Grey (1993) grouped Proterozoic sedimentary rocks in the southern part of the Capricorn Orogen into the Glengarry Basin (Glengarry Group). These rocks are unconformable on granite–greenstones of the Yilgarn Craton to the south, and are overlain to the east by Proterozoic rocks of the Earaheedy Group (Earaheedy Basin; Fig. 2), and to the north by rocks of the Bangemall Basin. As a result of recent mapping, Pirajno et al. (1995, in press) have argued that Gee and Grey's (1993) Glengarry Basin can be subdivided into three basins and corresponding groups: the Yerrida and Bryah Basins (Yerrida and Bryah Groups), and the Padbury Basin (Padbury Group). The Yerrida Group is in turn subdivided into the Windplain and Mooloogool Subgroups. The Bryah and Yerrida Group are in fault contact, whereas the Padbury Group (which is not developed on GLENGARRY) overlies the Bryah Group. The adopted stratigraphic scheme, and designated groupings in the digital datafile GLENCHEM.CSV are summarized in Appendix 4. The term 'Glengarry basins' is used here to encompass the three basins defined by Pirajno et al. (in press). Within the GLENGARRY sheet area the Glengarry basins can be divided into a stable marginal zone preserving the initial sag sediments, a marine-shelf area, the Paroo Platform of Gee (1990), and a northeasterly trending rift zone in which the sedimentary rocks wrap around the horst of the Goodin Inlier and are moderately tectonized to form the Glengarry Fold Belt (Gee, 1990; Pirajno et al., 1995).

According to Tyler and Thorne (1990), sedimentation in the Glengarry basins took place between 2.3 and 2.0 Ga in a back-arc basin. However, Pirajno et al. (1995, in press) have argued for deposition in a sag basin (Yerrida Group, Windplain Subgroup) developed during a period of crustal extension, followed by a series of rift basins (Yerrida Group, Mooloogool Subgroup) developed in an intracontinental setting. The Bryah Group also represents a rift-basin sequence, but unrelated to development of the Yerrida Group.

In order to reflect changes in lithology (and regolith chemistry), the subdivisions adopted in this study have been modified from Pirajno et al. (in press), as shown in Figure 2. In particular, the Thaduna and Doolgunna Formations are amalgamated, and then subdivided according to the presence of sills of the Killara Formation. In the digital datafile GLENCHEM.CSV and Appendix 4, samples are assigned to these Proterozoic units as follows: Juderina Formation (assigned as Finlayson), Thaduna and Doolgunna Formations (Thadool), Thaduna and Doolgunna Formations with Killara Formation sills (Mixed), Killara Formation (Killara), Killara Formation–Bartle Member (Bartle), Maraloou Formation (Maraloou), Bryah Group–Karalundi Formation (Karalundi), Bryah Group–Narracoota Formation (Narracoota).

Proterozoic outliers on the Yilgarn Craton

Elias et al. (1982) have described a number of outliers of presumed Early Proterozoic age in a sinuous line of outcrop from Polelle to approximately 25 km south of Murchison Downs Homestead. These rocks, of the Mount Yagahong and adjacent outliers, are composed of flat-lying immature sediments and consist of a basal conglomerate and overlying lithic arenite. The conglomerate is fluviatile in origin and ranges from a few metres to more than 30 m thick. It is overlain by about 120 m of dark-grey, laminated shale and mudstone, which is in turn overlain by more than 40 m of arenite and lithic arenite. In most of the outliers, only the basal unit is preserved (Allchurch and Bunting, 1976).

Glengarry basins

The Glengarry basins consist of a varied succession of arenites, arkose, wacke and black shales, with abundant mafic extrusive and intrusive rocks, and minor carbonates and evaporitic deposits.

Windplain Subgroup

The *Juderina Formation (Finlayson Member)* consists of orthoquartzite with minor shale and chert, deposited unconformably on the granitoids of the Yilgarn Craton. The formation has a maximum thickness of a few hundred metres (Occhipinti et al., in press) and outcrops in the range of hills around the southern margin of the Paroo Platform, and in a small area in the northeast corner of GLENGARRY. South-southwest of Mount Russell, the sandstone is overlain by chert breccia formerly assigned to the Maraloou Formation, but now considered to be an extensive lagoonal facies of the basal arenaceous unit (Gee and Grey, 1993).

The *Bubble Well Member,* the uppermost member of the Juderina Formation, is up to 100 m thick and consists of chertified carbonate and evaporitic sedimentary rocks, minor argillite, dolostone and arenite, abundant microbial laminite and chertified stromatolitic carbonate (Occhipinti et al., in press). Small areas of the formation are present in the southeast of the sheet (Gee and Grey, 1993).

Mooloogool Subgroup

The four formations of the Mooloogool Subgroup can be separated according to depositional characteristics. The Thaduna and Doolgunna Formations are dominated by turbiditic sedimentary rocks, whereas the overlying Killara and Maraloou Formations consist of mafic lavas and sills, shales, siltstones, and carbonate rocks. Some evidence for contemporaneous deposition of the two associations is indicated by the presence of blocks of Killara mafic volcanic rocks in the Thaduna Formation (Pirajno et al., in press). The Mooloogool Subgroup represents a sudden change in the nature of deposition, from a sag-basin to a rift-basin setting.

The *Killara Formation* is an extensive unit of extrusive and intrusive tholeiitic basalt with minor chert and volcaniclastic sedimentary rocks. On GLENGARRY, the Killara Formation forms a continuous southwest-dipping arcuate sheet outcropping around the northern rim of, and dipping beneath, the younger sedimentary rocks of the Paroo Platform (Gee and Grey, 1993). The Killara Formation was probably deposited on substantially thinned continental crust (Hynes and Gee, 1986; Pirajno et al., 1995), and in the southeastern part of the region is dominated by a chemically uniform succession of tholeiites of unknown thickness.

The *Bartle Member* is a distinctive, discontinuous chert up to 30 m thick at the top of the Killara Formation. The unit comprises chertified evaporitic rocks, breccia, minor pyroclastic rocks, and probably hot-spring deposits (e.g. sinter). The presence of evaporitic minerals indicates a sodic, lacustrine setting during the closing phases of volcanism, prior to rapid basinal deepening, which drowned the member under anoxic carbonaceous argillites of the Maraloou Formation (Dawes et al., in prep.; Occhipinti et al., in press). This unit is sufficiently distinctive for separate representation in Figure 2.

The relationship of the Killara Formation to other rock units is complex. East of the Goodin Inlier it interdigitates with the Doolgunna and Thaduna Formations within the Glengarry Group. On the Paroo Platform, the Killara Formation is presumed to overlie the Juderina Formation, and is itself overlain by the Maraloou Formation (Occhipinti et al. in press).

The *Maraloou Formation* comprises the black shale, marl and minor dolomite that conformably overlies the distal greywackes of the Thaduna Formation and the chert cap (Bartle Member) of the Killara Formation on the Paroo Platform (Gee and Grey, 1993). Drilling has indicated that the basal succession of carbonaceous black shales is substantially more extensive than previously defined, and towards the top is intercalated with the upper, carbonate-rich units. The maximum observed thickness is 60 m, on the flanks of Mount Russell, but drilling indicates at least 350 m (Occhipinti et al., in press).

Bryah Group

The Bryah group is divided into the Karalundi and Narracoota Formations (Fig. 2, Appendix 4). Only a small area of *Karalundi Formation* outcrops in the northwest of GLENGARRY, flanking the outcrop of the Narracoota Formation. The Karalundi Formation consists of shale, ferruginous quartz arenite with quartz-pebble conglomerate and chert lenses, and chert breccia (Adamides, 1995). Drillhole data show the upper part of the Karalundi Formation to be interfingering with the basal flows of the overlying Narracoota Formation (Occhipinti et al., in press).

The *Narracoota Formation* consists of tholeiitic metabasalt. In places there are pillow structures, vent breccias and dolerite dykes and sills. It also contains mafic schist, including amphibolite and actinolite–tremolite schist (Pirajno and Occhipinti, 1994). The unit shows considerable variations in thickness. Gee (1979) estimated a total thickness of approximately 6 km.

Earaheedy Group

Overlying the Maraloou Formation in the vicinity of Paroo and Yandil Homesteads are small outliers of the younger Earaheedy Basin. These are assigned to the *Yelma Formation* and consist of a basal sandstone member overlain by a brecciated dolomite–shale–chert unit. The sandstone may be distinguished from the similar sedimentary rocks in the Juderina Formation by the coarser grain size, thicker bedding, weaker cementation and abundance of trough cross bedding (Gee and Grey, 1993). The dolomite and chert breccia phases can be readily distinguished from the Juderina Formation by their stromatolite morphology (Gee and Grey, 1993).

Mineralization

Current mining activity on GLENGARRY is restricted to Paddys Flat, part of the Meekatharra mining centre. Historically, gold, silver and copper have been mined at a number of other locations, and non-economic deposits of iron ore, titanium/vanadium, uranium and graphite are also known. Most mineralization is concentrated along the margins of the greenstone belts, in zones up to 1.5 km wide. Mineralization is particularly associated with transverse fissuring, but in the Meekatharra mining area is also associated with axial faulting (Mabutt et al., 1958).

Mineral production details of all mining centres from 1897 to 1994, for 56 individual mines and group sites, are presented in Appendices 1 and 2. A group site is defined as an area where two or more tenements that have produced minerals overlap. The various amounts produced have been summed and the total labelled with the name of the largest producer. The coordinates given are the centre of the collective region. The mineral deposits have been assigned to mining centres for statistical purposes. In total, GLENGARRY has yielded about 59 t of gold, with 88% of this amount coming from the Meekatharra Mining Centre and 9% from the Gabanintha Mining Centre. The Gabanintha Mining Centre also produced 360 t of copper, and the western third of the sheet in total has yielded approximately 340 kg of silver.

Appendices 1 and 2 are a collation of all available data from published and unpublished sources for gold, copper and silver production, as reported to DME. All mineral-production statistics for Western Australia date from 1897; earlier production was not systematically recorded. 'Sundry claims', as listed in Appendix 2, refers to prospects covering small shows permitted to treat only 50 t of ore per year. Grouped data are listed where mining companies reported production as the total for a mining centre, without a mine-by-mine breakdown.

For 15 individual mines and group sites, the published 'total demonstrated resources', taken from the DME database MINEDEX, are also listed in the appendices. The 'Australian Code for Reporting of Identified Mineral Resources and Ore Reserves' is generally used in the compilation of MINEDEX. The total demonstrated resources are the sum of measured and indicated resources. All of the demonstrated resources used in the appendices are classified as in situ, that is, the total resource that occurs in the ground, without taking dilution factors into account for mineability.

Gold

Gold was first discovered in 1891 at Nannine on the adjoining BELELE sheet. Subsequent discoveries were made during the middle and late 1890s in other centres of the Meekatharra and Wiluna districts (Mabbutt et al., 1958). A compilation of the major mining centres of the Murchison Province has been published by Watkins and Hickman (1990). Mines in the Meekatharra and Gabanintha areas have been the largest producers of gold and silver on GLENGARRY, with most production between 1910 and 1920. Production figures for gold to the end of 1987 show that Meekatharra has produced 36 516.3 kg of gold and is the most productive mining centre on GLENGARRY. This gold has come from two parallel north-northeasterly trending zones; one east of the town at Paddys Flat, and the other to the north at Haveluck. Nearly all gold in the Meekatharra area is contained in a network of quartz veins closely associated with a sheet of felsic porphyry (Noldart, 1962). The porphyry appears to have intruded along a strike fault that intersects metabasalt, ultramafic schist and abundant chlorite schist. At the Gabanintha–Star of the East group, total gold production has been 5294.8 kg. Gold, and associated copper, appears to be hosted by a band of fragmental-textured ultramafic rock in a mafic–ultramafic sequence.

In the Gum Creek belt, the Gum Creek mine is located in basaltic amphibolite. In the Joyners Find belt, the Joyners Find and Diorite mines are in ultramafic schists adjacent to banded iron-formation (Elias et al., 1982).

Silver has been produced as a byproduct of gold mining; the Gabanintha mine, with a production of 211.1 kg, is the only significant mine. In addition, 'grouped data' show that a total of 133 kg of silver has been produced in the Meekatharra area, some of it probably from claims on the adjacent BELELE sheet.

Other minerals

Copper has been mined at Gabanintha, from the Mountain View and Tumblegum mining groups, which together form the Star of the East group where Cu is associated with Au and Ag, and also from the Lady Alma mining group, 5 km to the southeast in the Copper Hills ultramafic complex (Elias et al., 1982). Total production is given in Appendix 2. A cupriferous 'pseudogossan' is located about 3 km northeast of Killara Homestead in lateritized Glengarry sequence rocks (Butt, 1979).

Nearly-pure hematite is found north of Joyners Find as a secondary enrichment of Archaean banded iron-formation. Massive titaniferous magnetite is contained in a basic intrusive complex west of Gabanintha. Only small tonnages are present, though the high content of titanium and vanadium make it an attractive prospect. The metals are concentrated in cumulate magnetite bands within anorthositic gabbro, west of Gabanintha. Indicated reserves are 8.56 million tonnes of ore containing 1.24% V_2O_5 and 15.5% TiO_2 (Elias et al., 1982).

Uranium mineralization occurs in calcrete in a saline drainage that extends from southeast of Murchison Downs to south of Hillview (Butt et al., 1977). The deposit of carnotite in voids in valley calcrete is similar to that at Yeelirrie on SANDSTONE. Smaller uranium prospects are found in calcreted channels near Limestone Well (AMG 775710E 7025300N) and Gnaweeda Outcamp (AMG 672520E 7051150N; Butt et al., 1977).

Graphite occurs as graphite schist interbedded with schistose amphibolite in the Gum Creek belt, east of German Well. The schist, derived from carbonaceous shale, consists of fine-grained quartz, feldspar, chlorite and sericite and contains 4.5% free carbon in the form of minute graphite flakes (Elias et al., 1982).

In 1993, RGC Exploration announced the discovery of a large lead carbonate and oxide deposit (cerussite $PbCO_3$ and plattnerite PbO_2) east of Mount Russell. Preliminary estimates indicate 220 Mt of ore (Le Blanc Smith et al., 1995).

Regolith-materials mapping

Regolith terminology

For the purpose of geochemical interpretation it is useful to consider landforms, and the regolith units overlying them, in terms of residual, erosional and depositional regimes, as defined by Anand et al. (1993a, b). The term *relict* is used in lieu of the term *residual* to indicate 'old' or 'former', but with no genetic connotation. The relict regime consists predominantly of upland surfaces developed prior to the more recent and continuing period of downcutting and erosion. The granitoid plateau areas and lateritic breakaways and mesas are assigned to the relict regime. The greenstone hills, dissected plateau and granitoid rises make up the erosional regime. In these areas active erosion is taking place, with a net removal of weathered and eroded material. The remaining land-form types are assigned to the depositional regime; in these areas, aggradation exceeds degradation. Regolith includes both deeply weathered lateritic profiles consisting of duricrust, saprolite and saprock, and also Cainozoic to Recent sediments derived from erosion of the weathered rock and underlying bedrock.

Regolith-materials map units

A regolith-landform unit is defined by Anand et al. (1993a,b) as an area on a map bounding a particular association of regolith materials, bedrock geology and landforms. Emphasis is given to the materials which constitute the surface regolith. The units used on the regolith-materials map (Plate 3) are described in Table 1.

Relict regime

The relict regime is subdivided into four map units (Table 1): R1–R4. Unit R1 consists of sand with variable amounts of ferruginous pisoliths and nodules, mostly associated with granite and gneiss. Unit R2, duricrust, forms isolated mesas and plateau remnants within the greenstone belts, and is also associated with basalts, granites, and some ferruginous sedimentary rocks. A number of these mesas are present on GLENGARRY, but many are small and not all can be represented on Plate 3. Other weathering crusts enriched in limonite and hematite form on the more resistant jaspillites and sandstones. Unit R3, silcrete and silicified granite, is confined to breakaways and erosional remnants of former plateau areas. Unit R4 occurs as a blanket of sand on the backslope of granitic breakaways on the old plateau. There are few, or no, pisoliths present in this unit but it has been assumed that, because of the relict nature of the backslope, lateritic material underlies the sand.

Mabutt et al. (1958) described these relict units as typically forming duricrusts above kaolinized and porcelanized pallid zones.

Table 1. Regolith codes and description

Regolith code	*Description*
RELICT REGIME	
R1	Ferruginous pisolites and nodules
R2	Iron-rich duricrust forming remnant land surfaces
R3	Silcrete (often weakly ferruginized): mainly overlies granitoid and sedimentary rocks
R4	Quartz-rich sands and silts overlying presumed or known R1–R3 material
EROSIONAL REGIME	
E1	Mottled zone and saprolite; generally poorly exposed
E2g	Outcrop of saprock and bedrock; subcrop areas have locally derived sands and sandy clays; coarse (bouldery) lag locally bounds prominent ranges; derived from granitoid rocks
E2s	As E2g but derived from sedimentary rocks
E2v	As E2g but derived from volcano-sedimentary greenstone and mafic rocks
E4g	Lag of locally derived ferruginous and/or lithic fragments, and/or feldspar in a sandy clay to sand-rich matrix associated with actively eroding outcrop/subcrop; derived from granitoid rocks
E4s	As E4g but derived from sedimentary rocks
E4v	As E4g but derived from volcano-sedimentary greenstones and mafic rocks
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
DC1g	DC1 derived mainly from granitoid rocks
DC1s	DC1 derived mainly from sedimentary rocks
DC1v	DC1 derived mainly from volcano-sedimentary greenstones and mafic rocks
DC2	Fine- to medium-grained detritus (most clasts 4–25 mm) mainly of ferruginized lithic origin, or quartz in a sandy clay matrix
DC2g	DC2 derived mainly from granitoid rocks
DC2s	DC2 derived mainly from sedimentary rocks
DC2v	DC2 derived mainly from volcano-sedimentary greenstone and mafic rocks
DC3	Variably feldspathic sand- and clay-rich colluvium or sheetwash; merges into alluvial plains (DA5)
DC3f	Detritus, mainly non-lithic ferruginous (most clasts <10 mm) possibly magnetic in red sandy clay; includes buckshot gravel
	Dominantly alluvial
DA4	Gravelly sands and sandy clays of active alluvial channels with mixtures of ferruginous and variably altered lithic fragments
DA5	Sand- or clay-rich alluvium and colluvium on broad drainage floors, including overbank alluvial deposits and terraces; includes non-saline claypans; calcrete fragments
DA7f	Sediments of former freshwater claypans
DA8	Valley calcrete, in places silicified
	Dominantly eolian
D9	Sandplain, eolian in origin, may form dunes or thin sheets; overlies sheetwash, soil or 'bedrock'

Erosional regime

The erosional regime is divided into three map units: E1, E2, and E4. Unit E1 corresponds to exposed mottled zone or saprolite and is widespread throughout the moe dissected granitoid areas of the southern half of the sheet in deeply incised terrains and below breakaways. However, at the scale of Plate 3, this unit is generally too small to be represented. Unit E2 consists of residual lags, sands and clay developed over eroding mottled zone, saprolite, saprock and bedrock. This unit is found over landforms of relatively high topographic relief or in areas with relatively abundant outcrop. Unit E4 represents a lag of locally derived ferruginous or lithic fragments, commonly with feldspar, over a sandy-clay to sand-rich matrix. Unit E4 is associated with actively eroding outcrop or subcrop, and is typically downslope from E2. Units E2 and E4 have been further subdivided into three sub-units related to the parent rock type. A suffix indicates the presumed source rock; g: granitoid; v: greenstones and other mafic igneous rocks; and s: (meta) sedimentary rocks. Thus, E2g indicates the area is underlain by granitoids, E2v by greenstones or mafic igneous rocks, etc.

Depositional regime

This regime is divided into nine map units. Units DC1, DC2, DC3, DC3f are predominantly colluvial in origin, those marked DA4 and DA5 consist mainly of alluvial materials, and D9 is largely of eolian origin. Units DA7f and DA8 are found in topographically low areas and include mixed lacustrine and chemical deposits.

Unit DC1 represents coarse-grained, locally derived material found close to its source. It is closely associated with the E4 erosional unit on the footslopes of landforms of relatively high relief. DC1 material derived from granites is composed mainly of quartz and feldspar. Colluvium from a greenstone origin is commonly ferruginized, and that from sedimentary rocks has a highly variable composition, reflecting the variety of sedimentary lithologies present on GLENGARRY. Clasts derived from granitic sources, and from sedimentary rocks such as siltstone and shale, break down rapidly. In such areas DC1, if present, is not extensive. Coarse clasts from greenstone, mafic units and some sedimentary rocks survive transportation for quite a distance from their source and thus there are larger DC1 units surrounding these units.

Unit DC2 represents sheetwash sands and gravels derived from the further disintegration of DC1 material. It contains medium-grained material that is commonly more ferruginized than that of DC1. These sheetwash-derived sediments occur as plains in upland granitic terrains and as marginal colluvial plains in areas of lower relief. In areas of higher relief, the DC2 units are closely associated with, and normally downslope from, the DC1 and E4 units; in areas of lower relief they are found on higher ground than the adjoining DC3 and DA5 units.

Units DC1 and DC2 have been further divided into three sub-units relating to parent rock type. These sub-units are defined by the addition of the same suffixes as those used for the erosional units.

The DC3 and DC3f (ferruginous) units lie at the distal end of wide sheetwash fans that abut and lead into broad valleys. Commonly the units occupy broad, shallow channels with poorly defined banks that are identified by the increased vegetation associated with them. Both units occur in, or on, alluvial plains. Unit DC3 comprises mainly sand, clay, and some feldspar. Unit DC3f has a prominent surface lag of ferruginous (mostly <10 mm) detritus, supported in red sandy clay. This lag is non-lithic, and many grains are magnetic (i.e. maghemite). The unit includes buckshot gravel and detritus derived from chemically precipitated iron oxides and its position in the landform is comparable with that of the DC3 unit. Valleys hosting the DC3 units form part of major drainages and finally merge with the alluvial plains (DA5) or claypans (DA7f).

Alluvial units are divided into four categories. Unit DA4 comprises the sediments of active, middle-order alluvial channels. Consequently, the unit is normally found in areas of higher relief. Its extent is commonly exaggerated on the regolith map (Plate 3). Unit DA5 consists of sand- or clay-rich soils on wide alluvial flood plains and includes some colluvium.

Units DA7f and DA8 include chemically precipitated deposits; unit DA7f categorizes claypan sediments. On GLENGARRY, lakes are small and their sediments are fresh- to brackish-water clays, unlike the higher salinity clays and silts of lake sediments in the major drainages of the Eastern Goldfields (Kojan and Faulkner, 1994; Bradley et al., 1995). Minor areas of this unit are found on MOUNT BARTLE (1:100 000) near valley calcrete developed on drainage floors. In addition, a former lake sediment is suggested by four samples collected west of the Karalundi Aboriginal Community. Unit DA8 represents valley calcrete, which occurs as elongate sheets along the axes of broad, shallow valleys in the internal drainage system. Calcrete has formed by cementation and replacement of valley-fill by calcite precipitated from percolating carbonate-bearing groundwater. A thin layer of alluvial and eolian sediments generally overlies a calcrete platform. Coarse calcrete nodules are commonly found on the surface, and calcrete is exposed in many creek beds.

Unit D9 comprises mainly eolian sandplain material forming thin sheets and dunes. Where dunes are present, they are aligned parallel to the prevailing north-northeast wind direction. Unit D9 may overlie bedrock, any relict or erosional unit, or DC1 or DC2 units.

Geochemical mapping

Sampling

For the purpose of geochemical mapping, samples of stream and lake sediments, sheetwash or soil were collected at a nominal density of one sample per 16 sq. km. The rationale for this density, which is comparable with similar surveys, is given in Kojan and Faulkner (1994). A total of 1035 samples were collected in covering the GLENGARRY 1:250 000 sheet. The samples are located on Plates 4 and 5. Plate 4, at 1:250 000 scale, indicates sample type and number; Plate 5, at 1:1 000 000 scale, is provided as an overlay for use with the element-distribution maps. At each sample site geological and geomorphological information was recorded for use in the compilation of the regional regolith map.

Sample-site selection

Choice of sample sites was made by overlaying a 4 × 4 km grid, aligned with the AMG grid, over each of the six 1:100 000 maps making up GLENGARRY. After consideration of topography, geology, satellite imagery and other information, a sample site was selected within each square. Stream courses were sampled wherever possible. Most of the sites were uniformly distributed across the sampling area, although a minor bias was allowed towards greenstone belts and other areas of particular mineralogical or geophysical interest. The selected locations were digitized, and site-reference numbers and AMG coordinates printed for field use. The site-location data, coded according to the 1:100 000 map sheet, also served as a reference number for subsequent database operations.

In the field, sites were located using Garmin 75 and Trimble Ensign global positioning system (GPS) units set to the Ausgeo84 datum and accurate to ±100 m. The field geologist was allowed some discretion to relocate to a better sample site if the designated site proved unsuitable.

The preferred sample medium for geochemical mapping is active first- to third-order stream sediments

(Fordyce et al., 1993; Darnley, 1993). However, in some areas the ideal catchment size of 16 sq. km was not always achieved and alternative sample media were used to achieve full coverage of the sheet. Where streams were absent, soils were the most common medium sampled. Samples collected from vegetated or partly vegetated, consolidated sheetwash found in the centre of shallow valleys and other depressions were also classified as soil, after inspection of the analytical results. Three samples were collected from fresh- to brackish-water lake sediments.

Sample-site form

A copy of the sample-site form used on GLENGARRY is provided as Appendix 5. The form was modified from that used in earlier studies in this series. Categories of information recorded are the sample number and location, sample type, and landform type. The form has space for the identification of clasts including their relative abundance, secondary coatings, also sample matrix, site geology, stream description, sample fraction, distribution, and depth from which the sample was collected. The form incorporates a number of options to be selected by ticking the appropriate box. This format was chosen to ensure that the geologist recorded all key information with minimum effort, and to facilitate its later transference into a computerized database.

Sampling methods

Two samples were collected from each site, one for geochemical analysis, the other as an archive sample. In addition, at every fiftieth site a duplicate sample was collected in the same manner for quality control. Wherever possible the samples were sieved in the field, with the sample for analysis consisting of approximately 1.5 kg of <2 mm to >0.45 mm material, and the archive sample comprising 3 to 4 kg of the complete <2 mm fraction. An estimate of the proportion of under- and oversize material was recorded on the sample-site form as an indication of the degree of sorting of the sediment. The size fraction for chemical analysis was chosen to minimize heterogeneity associated with larger size fractions, and to minimize the proportion of eolian sand present in large quantities in the 0.1–0.2 mm fraction. This rationale was determined consequent to an orientation study by Davy (in prep.) in the Glengarry Basin.

At each site the top 10 cm of sediment, which included vegetation, other organic debris and windblown sand, was removed before sample collection. A pit or channel was then excavated to a depth of between 10 and 40 cm before collection of the sample. Sample material from streams was taken either by channel sampling between the stream banks or, if the stream was narrow, along the axis of the stream bed. In general, in active channels, the eolian sand was scraped off and a trench dug between 10 cm and 20 cm deep across the channel. Where no active channel was present, and in areas of soil and sheetwash, three pits arranged in a triangular fashion 50 m apart were dug to a depth of 20–40 cm. In areas with a discernible slope, two pits were dug across the direction of movement and one downslope. The sample material from the different pits or channels was composited to form a single sample.

Both analytical and archive samples were labelled externally with a GSWA sample number. Tags showing the sample number were placed inside each bag; a paper tag for the geochemistry sample and an aluminium tag for the archive sample.

The GSWA sample number was recorded on the sample-site form together with the site reference number and the site coordinates obtained from the GPS unit. The GSWA number was also written on an aluminium tag that was riveted to an aluminium stake driven into the ground, thus enabling the site to be relocated for quality control or follow-up purposes.

Sample-site checks

Fifty randomly selected sites were revisited to ensure that the sample-site location was appropriate, that the sample had been collected correctly, and that the location and regolith details had been correctly and consistently recorded. The site suitability was also assessed, both for sampling and for potential contamination that could affect the geochemical analysis.

Chemical analysis

Samples were analysed by the Mineral Science Laboratory, Chemistry Centre (WA), East Perth (CCWA), except for Au, Pd and Pt, which were determined by AMDEL Laboratories Ltd. Samples were dried at 105°C and pulverized in a Labtechnics chrome-free bowl to a nominal <75 µm. Sub-samples were removed using a Jones riffle.

Forty-eight different constituents were determined:

- Ten major elements, reported as oxides: SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, MnO, P_2O_5.
- Loss on ignition (LOI).
- Three anions: Cl, F, and S.
- Thirty-four trace elements: Ag, As, Au, Ba, Be, Bi, Cd, Ce, Co, Cr, Cu, Ga, In, La, Li, Mo, Nb, Ni, Pb, Pd, Pt, Rb, Sb, Sc, Se, Sn, Sr, Th, U, V, W, Y, Zn, and Zr.

Check analyses for all but Au, Pd, and Pt were carried out by AMDEL Laboratories Ltd. Check analyses for Au, Pd, and Pt were carried out by Genalysis Laboratories. Each laboratory used similar analytical methods.

Analytical methods

Five different analytical methods were used:

- *X-ray fluorescence spectrometry using an alkaline flux (Sigma Chemicals 5743 flux: 57% $Li_2B_4O_7$, 43% $LiBO_2$) for fusion:* The sample was incorporated into a glass disk using 5743 flux. Fusion was carried out at 1050°C in Pt/Au crucibles on an AFT 'Prometheus' fusion unit. Samples were measured on a Phillips PW1480 XRF sequential spectrometer equipped with a scandium/molybdenum dual anode X-ray tube. Elements analysed by this method were Fe, Ca, K, Ti, Mn, S, P, Al, Si, Na, and Mg.

- *Inductively coupled plasma atomic emission spectrometry (ICP-AES):* The pulverized sample was digested in a mixture of hydrochloric, nitric, hydrofluoric, and perchloric acids in a closed teflon beaker at 200°C for at least 24 hours, evaporated to fume dryness, and dissolved in dilute nitric acid. Any residue remaining was filtered off and fused with alkaline flux, dissolved in nitric acid and returned to the digested sample. The solution was analysed using an ARL 3520 sequential ICP-emission spectrometer equipped with a single tube peristaltic pump and a V-groove nebuliser for the elements Co, Cr, Cu, Li, Ni, Sc, V, and Zn.

- *Inductively coupled plasma mass spectrometry (ICP-MS):* The ICP-AES solutions were further diluted to give a solution with approximately a ×2500 dilution factor from the original sample. The solution concentrations were read using a VG Plasmaquad II ICP-mass spectrometer equipped with a MiniPuls 3-tube peristaltic pump and a Meinhard nebuliser. This method was used to analyse for Ag, As, Ba, Be, Bi, Cd, Ce, Ga, In, La, Mo, Nb, Pb, Rb, Sb, Se, Sn, Sr, Th, U, W, Y, and Zr.

- *Pyrohydrolysis and selective ion electrodes* using a fused mixture of bismuth trioxide, sodium tungstate and vanadium pentoxide were used for determining chlorine and fluorine.

- *Fire assay extraction and graphite furnace atomic absorption spectroscopy (GFAAS):* A lead collection fire assay was made using a 50 g sample. The prill was dissolved in acid and concentrations quantified using GFAAS. Au, Pt, and Pd were analysed using this method.

Detection limits (and the number of samples with values below detection) are given in Table 2.

Quality control

Quality control procedures are designed to monitor the variability associated with sampling and analytical methods to ensure that the results reflect genuine geochemical variations and are not artefacts of the analytical technique or sampling method. Reproducible results should normally be obtainable from the same sample site. Similarly, individual analytical determinations should be reproducible within set limits, except that variability will inevitably increase close to the detection limit. Quality-control data are not included with the digital datafile that accompanies these notes but are available for inspection in the Geochemistry Section of the GSWA.

Table 2 Detection limits and number of samples below detection

Element	*Detection limit*	*Number of values at or below the detection limit*
	percentage	
SiO_2	0.05	0
TiO_2	0.01	0
Al_2O_3	0.05	0
Fe_2O_3	0.05	0
MnO	0.01	475
MgO	0.01	1
CaO	0.01	539
Na_2O	0.01	306
K_2O	0.01	0
P_2O_5	0.01	279
S	0.01	864
	parts per million	
Cl	20	495
F	20	52
Ag	1	933
As	0.5	9
Au	0.001	972
Ba	1	0
Be	0.5	196
Bi	0.5	385
Cd	0.5	964
Ce	0.5	1
Co	1	32
Cr	1	1
Cu	1	5
Ga	0.5	1
In	0.5	1 017
La	0.5	5
Li	1	6
Mo	0.5	40
Nb	0.5	2
Ni	1	45
Pb	2	1
Pd	0.001	825
Pt	0.005	959
Rb	1	1
Sb	0.5	531
Sc	1	99
Se	0.5	351
Sn	0.5	35
Sr	1	5
Th	0.5	3
U	0.5	31
V	2	4
W	0.5	89
Y	0.5	23
Zn	1	5
Zr	0.5	1

Five main quality-control procedures were employed for the analytical part of the program:

- submission of duplicate samples from the same site;
- submission of GSWA geochemical standards for analysis;
- inclusion of in-house laboratory standards and duplicates on a regular basis;

- repeat analyses for gold and anomalous values of other elements;
- check samples analysed by a different laboratory.

Submission of duplicate samples from the same site

A second complete analytical sample was collected at 19 different sites throughout the study area to gain a measure of the overall reproducibility of the sampling and analytical process. Some duplicates were included in the same batch as the primary sample, whereas others were included in later batches.

Data were compared using the 'paired t-test' (Koch and Link, 1970), which computes a confidence interval for the population mean of the differences between the duplicate sample results. Critical values for the 5% and 10% confidence levels with 18 degrees of freedom were compared with the t-statistic generated by EXCEL for each of the duplicate pairs.

Owing to the high number of values close to the detection limit, the t-values were not meaningful for Au, Ag, Be, Bi, CaO, Cd, In, MnO, P_2O_5, Pd, Pt, S, and Sb. Minor variation in the accuracy of the analytical process is evident for Ba, Ce, Li, Rb, Y, and Zr; in each case the second analysis consistently yielded higher results. Duplicate sample pairs analysed in the same batch tend to show marginally closer results than pairs analysed in separate batches.

Results for the other elements were within the critical values, indicating the pairs were geochemically consistent, and thus supporting the reproducibility of sampling and analytical processes at the confidence levels tested.

Submission of GSWA geochemical standards

The GSWA submitted 17 secondary external standard samples to monitor analytical accuracy within, and between, analytical laboratories. The standards were incorporated randomly throughout the batches of samples sent to the CCWA; some were included with batches for check analysis sent to AMDEL Laboratories.

For each element within each standard, the actual values, means, standard deviations and relative standard deviations (RSD) were reported. Consistent results were achieved for the major elements, with low RSDs at most levels of concentration, although some variation was apparent at levels approaching the detection limits. Results for the trace elements were mixed. Consistency across all standards was good for Cu, Co, Cr, Ni, Sc, Sn, and V, but Zn, S, Ag, Cd, In, Pd, and Pt had most values near the limit of detection and so were not meaningful. Results for the remaining elements varied, depending on the range of concentration, and were occasionally affected by high or low values.

Inclusion of laboratory standards and duplicates

Each laboratory included both secondary, in-house standards and primary, external standards in each batch of samples analysed. An internal standard was analysed every 20 samples, and an external standard every 100 samples. The external standards analysed were reported as SRM-128, SRM-129, SRM-130, and SRM-131, corresponding to Standard Reference Materials (SRM) CANMET STSD-1, STSD-2, STSD-3, and STSD-4 (Potts et al., 1992). A laboratory duplicate, involving a repeat of the entire analytical procedure, was analysed every tenth sample.

The precision and accuracy of analyses of each SRM were examined statistically, both for the group as a whole and for analyses within each batch. The values, means, standard deviations and RSDs were reported for each element and for each standard. Consistent results were achieved for the major elements at most levels of concentration, whereas results for trace elements were mixed. Some variation between batches was apparent. Batches 3, 4, and 5 yielded the most consistent results and resulted in the lowest RSDs, whereas batches 1, 2, and 6 had a higher frequency of anomalous values and consequently produced higher RSDs. Furthermore, batches 1, 2, and 6 have many samples that recorded values for Ga, Mo, Nb, Sb, Se, Th, and U, whereas most samples from batches 3, 4, and 5 report these trace elements below detection. This indicates some variation in analytical precision between batches.

Repeat analyses

Genalysis Laboratories carried out repeat analyses for Au, Pd and Pt on four samples, and AMDEL laboratories carried out complete analyses of a further nineteen samples. These samples were chosen because they recorded high concentrations of Au, U, Sb, As, and Bi.

Check analyses

Laboratory duplicates of 16 samples were sent to AMDEL for analysis of the same 48 components. Data from CCWA and AMDEL were compared using the 'paired t-test'. Because of the high number of values close to the detection limit, results are not meaningful for Ag, Be, Bi, Cd, Cl, F, In, S or Sb. AMDEL consistently yielded higher values than CCWA for TiO_2, Al_2O_3, Fe_2O_3, P_2O_5, As, Ba, Ce, La, Nb, Ni, Rb, Sr, Th, U, Y, Zn, and Zr and lower values for Co. The AMDEL results were generally higher than those from CCWA. However, the consistent nature of the variation suggests that although there are some absolute differences the precision of each laboratory is acceptable.

XRD mineralogy

Table 3 lists minerals identified by X-ray diffraction (XRD) at CSIRO, Perth, from 30 samples representing a variety of regolith types and areas of geological interest.

Table 3. XRD mineralogy

GSWA No.	*Regolith Unit*	*Sample*	*Quartz*	*Kaolinite*	*K-feldspar*	*Plagioclase*	*Hematite*	*Goethite*	*Pyroxene*	*Amphibole*	*Phlogopite*	*Muscovite*	*Chlorite*	*Dolomite*	*Garnet*	*Anatase*	*Total*
									percent								
129194	R1	soil	61	21	1	–	4	10	–	–	–	–	–	–	–	–	97
129204	E2v	soil	39	36	6	1	–	13	–	–	–	–	–	–	–	–	95
129226	DA5	stream	52	25	5	1	–	8	–	–	3	–	–	–	–	–	94
129240	DA5	soil	66	20	7	–	–	5	–	–	–	–	–	–	–	–	98
129269	E4s	soil	65	20	3	–	10	–	–	–	–	–	–	–	–	–	98
129325	DC2s	soil	39	27	3	–	13	17	–	–	–	–	–	–	–	–	99
129508	DC2s	soil	48	25	4	–	6	14	–	–	–	–	–	–	–	–	97
129511	DA7f	lake	77	10	3	–	4	3	–	–	–	–	1	–	–	–	98
129512	DA5	stream	24	27	5	1	5	6	12	–	–	–	–	–	5	–	85
129514	DC3f	lake	43	31	6	–	4	4	–	–	–	–	–	–	5	1	94
129560	R3	soil	70	18	4	1	–	4	–	–	–	–	1	–	–	–	98
129561	E4g	stream	58	6	22	11	–	1	–	–	–	–	–	–	–	–	98
129567	E4v	stream	20	25	1	–	2	48	–	–	–	–	–	–	–	–	96
129571	E4g	stream	67	9	10	3	–	9	–	–	–	–	–	–	–	–	98
129577	DC3	soil	73	15	6	1	–	3	–	–	–	–	–	–	–	–	98
129726	E4g	stream	66	6	12	9	–	2	–	–	–	–	–	–	3	–	98
129736	E4g	soil	56	–	27	13	1	–	–	–	–	–	–	–	–	–	97
129792	DC3f	soil	40	25	–	–	15	20	–	–	–	–	–	–	–	–	100
129793	DC3f	stream	50	15	–	–	15	20	–	–	–	–	–	–	–	–	100
129810	DC3	stream	83	10	4	–	1	1	–	–	–	–	–	–	–	–	99
129818	DC1s	stream	67	8	14	4	–	6	–	–	–	–	–	–	–	–	99
129844	E4g	stream	66	15	6	6	–	4	–	–	–	–	–	–	–	–	97
129940	DC1v	stream	64	16	5	1	–	12	–	–	–	–	–	–	–	–	98
129989	E2v	stream	65	10	5	5	15	–	–	–	–	–	–	–	–	–	100
130002	E2v	stream	13	20	–	–	15	17	–	25	–	–	–	7	–	–	97
130062	E2v	stream	65	–	5	10	–	–	–	20	–	–	–	–	–	–	100
130124	DC3	soil	69	16	9	1	–	4	–	–	–	–	–	–	–	–	99
130127	DC1g	soil	70	16	8	–	–	4	–	–	–	–	–	–	–	–	98
130128	E2s	stream	66	17	4	–	3	2	–	–	–	6	–	–	–	–	98
130155	DC1g	stream	84	4	6	3	–	1	–	–	–	–	–	–	–	–	98

The results are discussed later under **'Erosion versus weathering'**.

Data presentation

Maps and plans

Products generated from the GLENGARRY regional geochemical mapping program include the maps, tables, and digital data files that accompany these notes, and similar maps at 1:250 000 scale which can be inspected and purchased at Mineral House.

Products include a regolith-materials map (Plate 3) and sample-location plan (Plate 4) at 1:250 000 scale, generalized geology and regolith maps (Figs 2 and 3), a sample-location overlay (Plate 5), and element-distribution maps at 1:1 000 000 scale (Figs 4–44), and a contoured gold geochemistry plan (Fig. 45). The sample-location plan shows the location and GSWA sample number of each sample site and sample type (soil/sheetwash, stream sediment, lake sediment).

Element-distribution maps for a given element generally show the complete range of concentrations, from the detection limit to the highest value, represented by circles, with a diameter proportional to the concentration. However, on some maps, when the distribution of an element has a strong positive skew, the highest values are represented by 'stars', in order to facilitate an easier comparison of low values.

In addition to the contoured plot of gold values in the regolith, Figure 45 shows the location of gold mines and prospects for GLENGARRY; symbol size indicates the total contained gold resource of each mine and prospect. Figure 46 shows discriminant analysis of regolith over parts of the Yerrida Group. Figures 47 to 49 compare airborne radiometric data with regolith K_2O, Th, and U concentrations. Figure 50 is a contour plot of a base-metals index.

Precise values for each element at a particular location can be obtained from the GSWA number and the digital datafile (GLENCHEM.CSV) included with these Notes. This text-file contains all the key data obtained from the GLENGARRY geochemical mapping project for all 1035 samples. In addition to the analytical data, the file contains sample type, geology (listed as Component in Table 4), AMG coordinates for each sample, and regolith code (as displayed on the regolith map).

All recent and current GSWA geology, regolith and geochemistry map products are produced from digital data. All data collected for the project are stored electronically, including data for the regolith-materials map (Plate 3) and the sample sites (Plate 4). A basic GIS dataset is available, consisting of the regolith and generalized geology maps, sample locations with major- and trace-element values, and the M-Series (open file) report coverage. Other relevant datasets may also be available; the availability and pricing of such products are indicated in the 'Digital data information index' of the Department of Minerals and Energy.

Results and discussion

Where possible stream sediments were sampled, otherwise, samples of sheetwash/soil, and (rarely) lake sediments were collected. All samples fall under these three headings. A well-developed soil profile has not been recognized; most soils are skeletal, unstratified and lack appreciable organic matter. Samples of sheetwash and soil in any given area appear to have no significant compositional differences attributable to sample type and, accordingly, have been grouped under the category of soil. There are no samples which are classified as ultrasaline, and samples recognized as lake sediment are from fresh- or brackish-water lake deposits and are designated DA7f. These lake sites occupy the lowest drainage areas on GLENGARRY and are closely related to calcrete-bearing areas. Analyses for Cl for four samples west of the Karalundi Aboriginal Community indicate that the area is more saline than most, and may represent the remnants of an otherwise unrecognized, brackish to saline, lake.

Stream sediments (DA4) have been assigned the code of the surrounding regolith. In erosional areas, subdivision of units into subgroups indicating source-rock derivation has been relatively easy. Such subdivision is more difficult as sediment is transported farther from its source and becomes mixed with materials from different source areas. As described earlier, most units have been provided with a suffix based on the source rocks, known or inferred as contributing to the unit.

Erosion versus weathering

Mineralogical studies, including results from XRD determinations (Table 3), inspection of material at sample sites by hand lens, or in the laboratory under a binocular microscope, indicate that in the majority of samples fresh feldspar is present. Other primary minerals such as chlorite, mica and pyroxene are also present, depending on the source rock. Kaolinite and iron oxides (hematite and goethite) were detected in every sample analysed by XRD. These minerals occur as secondary weathering products over granite, but may be present as relict primary constituents over sedimentary rocks. Quartz, of both residual and eolian origin, has been detected as the main constituent in almost every sample. The mineralogical signature therefore results from a combination of both erosion and the weathering process.

Geochemical interpretation methodology

The generalized geological map (Fig. 2), has been compiled using the work of Elias et al. (1982), Gee and Grey (1993), Occhipinti et al. (in press) and Pirajno (1995, in press), and has also been added as a sublayer

Table 4. Geometric means of the composition of the regolith over individual major geological groups

Component (a) *sample nos.*	*Yilgarn* *380(b)*	*Goodin* *8(b)*	*Remnant* *23*	*Meekatharra* *63(b)*	*Gum Creek* *24(b)*	*Joyners* *9*	*Finlayson* *69(b)*	*Maraloou* *150(b)*	*Thadool* *94(b)*	*Karalundi* *5*	*Killara* *34(b)*	*Mixed* *65(b)*	*Bartle* *27*	*Narracoota* *3*	*Yagahong* *2*	*Yelma* *9*
								percentage								
SiO_2	84	80	79	64	52	53	73	60	73	58	42	63	41	62	85	61
TiO_2	0.23	0.39	0.26	0.61	0.63	0.50	0.42	0.77	0.50	0.87	1.2	0.74	1.1	0.53	0.12	0.62
Al_2O_3	6.6	7.5	8.1	8.1	9.1	9.3	8.9	11	7.3	9.3	11	8.6	11	12	7.0	10
Fe_2O_3	2.4	5.0	3.8	12	21	19	6.8	15	8.7	19	31	17	32	12	1.5	13
MnO	0.01	0.01	0.02	0.05	0.05	0.04	0.01	0.04	0.03	0.09	0.08	0.05	0.09	0.12	0.02	0.04
MgO	0.15	0.14	0.15	0.32	0.30	0.24	0.20	0.25	0.19	0.33	0.35	0.27	0.32	0.89	0.20	0.28
CaO	0.03	0.02	0.04	0.08	0.14	0.03	0.01	0.03	0.02	0.51	0.23	0.08	0.22	6.1	0.14	0.06
Na_2O	0.12	0.08	0.23	0.09	0.07	0.04	0.03	0.02	0.04	0.12	0.08	0.06	0.07	0.45	1.3	0.03
K_2O	1.0	0.29	1.4	0.58	0.34	0.45	0.82	0.57	0.55	0.51	0.28	0.42	0.25	0.38	1.9	0.4
P_2O_5(c)	0.02	0.01	0.02	0.04	0.05	0.06	0.04	0.07	0.04	0.08	0.07	0.05	0.07	0.04	0.01	0.06
								parts per million								
Cl(c)	30	22	33	26	46	73	21	31	18	13	23	25	24	10	16	40
F(c)	69	76	77	56	62	123	150	158	84	88	95	78	102	40	54	173
As	3	5	7	16	16	26	10	16	11	13	11	13	12	7	2	16
Ba	216	76	377	196	112	115	141	114	145	125	137	136	118	101	381	125
Be	0.7	0.9	1.1	0.8	1.1	1.2	0.9	1.2	0.8	1.1	1.2	1.1	1.2	0.7	1.1	1.1
Bi	0.5	0.8	0.7	0.5	1.0	0.6	0.6	1.0	0.7	0.4	0.8	0.7	1.0	0.3	0.7	0.9
Ce	15	11	17	19	8	11	14	19	18	24	21	16	18	20	18	23
Co(c)	5	7	7	17	24	20	8	17	12	30	30	20	31	27	5	17
Cr	66	123	106	721	721	595	184	303	244	472	331	250	285	204	56	217
Cu	9	11	15	23	60	48	19	46	30	63	73	51	84	71	10	50
Ga	10	12	12	13	19	16	15	19	14	19	22	18	20	16	10	18
La	8	6	9	8	3	5	7	8	9	6	8	5	6	8	10	9
Li	6	5	7	7	7	6	9	11	7	7	9	8	8	6	7	11
Mo(c)	1.4	1.8	2.1	1.9	2.8	2.0	2.2	3.3	1.9	2.3	1.7	2.4	1.6	0.8	1.1	2.4
Nb	7	13	7	7	7	8	10	12	10	21	12	11	10	4	6	9
Ni(c)	8	10	13	67	55	43	11	24	20	54	32	27	33	46	12	24
Pb	19	23	23	23	19	22	23	27	21	18	26	20	25	7	21	52
Rb	53	24	60	36	10	17	35	23	32	15	14	17	12	16	101	16
Sb(c)	0.3	0.4	0.4	0.8	0.8	1.4	0.8	1.8	0.8	1.2	0.8	1.0	0.7	0.8	0.3	1.2
Sc(c)	3	4	4	11	14	9	6	12	8	18	19	13	14	23	1	11
Se(c)	0.7	0.8	0.9	1.9	1.9	1.4	1.0	1.2	0.6	1.9	1.0	1.1	0.8	1.6	0.3	0.9
Sn(c)	1.3	1.9	1.1	1.7	1.7	1.9	2.1	2.4	1.8	2.2	1.8	2.0	1.8	1.1	1.1	1.7
Sr	18	8	31	23	11	9	12	13	14	20	16	11	13	104	41	13
Th	7	12	7	8	5	7	7	8	9	5	10	6	6	3	6	7
U(c)	1.6	1.5	1.5	2.0	1.6	2.4	1.9	2.2	1.9	1.8	1.6	1.6	1.5	0.7	1.6	1.9
V	39	97	66	177	400	264	122	323	182	325	645	344	598	218	27	257
W(c)	1.2	0.8	1.5	1.7	3.9	3.1	2.0	2.4	1.6	11	2.1	2.0	2.0	1.9	1.2	1.9
Y	3	4	4	6	3	4	4	6	6	4	9	5	7	16	4	8
Zn	13	14	21	33	40	35	19	41	29	45	43	38	49	43	16	45
Zr	96	153	110	99	77	83	128	173	124	114	194	155	183	42	53	175

(a) Component names used in GLENCHEM.CSV
(b) Denotes that regolith units DA7f, DA8 and D9 are not included in the calculation
(c) Denotes that a number of values for this element are at or below detection level

to the element/oxide distribution maps (Figs 4–44). Highest values for Ag, Be, Bi, and Sn are provided in Figure 44. Data for SiO_2, loss on ignition (LOI), Cd, and In are not presented as element-distribution maps, although the numerical data are included in the dataset GLENCHEM.CSV, which accompanies this report. Silica and LOI do not show any features of significance, and all but a few values for Cd and In are below the detection limit.

As part of the interpretation, the regolith samples have been classified in terms of the underlying bedrock by overlaying a sample-location plan on the simplified geology map. The compositional geometric mean values for samples classified in this manner, and the number of samples, are given in Table 4. As in previous studies, the geometric mean is used to reduce the effects of outlying high or low values. The mean values may be used as general baseline data for the regolith over that specific rock unit and, together with the standard deviations, provide a base from which anomalous samples within any given group may be recognized. Units DA7f, DA8 and D9 are excluded from this table since, as chemical or eolian deposits, they are not necessarily derived from underlying bedrock. The element-distribution maps have been scanned for differences within the groups, which may help distinguish separate lithological units. Inspection of the table suggests that there are clear differences in mean regolith composition over the major rock groups.

Table 4 ignores the effects of any systematic variation of regolith composition as it travels downslope. Accordingly, Tables 5 to 7 use the geometric mean values of differing regolith units over selected major rock units to illustrate elemental behaviour with distance from source.

Discriminant analysis has been used to highlight potential areas of misclassed bedrock (Fig. 46), and the effectiveness of the CHI-6*X and Peg-4 indices after Smith et al. (1989) as indicators of areas of economic interest has been assessed.

Overlays of regolith values for K_2O, Th, and U on the respective processed airborne radiometric data for GABANINTHA (1:100 000) are presented in Figures 47 to 49.

Finally, the Cl distribution has been used to indicate areas that have the potential to become saline and thereby affect pastoral use.

The regolith and major rock units

Inspection of the element-distribution maps (Figs 4–44) indicates three main chemical groupings in terms of bedrock — Archaean greenstones, Archaean granitoids, and the Proterozoic rocks of the Glengarry Basin. Distinction between regolith over greenstones and that over granitoids is expected from the primary compositions of the two bedrock types. The boundary between the Glengarry Basin and the Archaean rocks is best defined by components such as TiO_2, P_2O_5, As, Cr, Cu, Ga, Ni, Rb, V, and Zn (Figs 4, 12, 13, 19, 20, 22, 27, 31, 39, and 42).

Table 4 presents mean values of regolith over 16 rock groups. There are five or fewer samples over the Narracoota Formation (3), Karalundi Formation (5), and Yagahong Formation (2); thus the mean values for regolith over these groups may not be representative of the units as a whole. Most of the Narracoota Formation and rocks equivalent to the Yelma Formation outcrop on PEAK HILL, and reference should be made to Subramanya et al. (1995) for more adequate mean values for, or additional analyses over, these groups. Components are omitted from this table where, within any group, over one half the samples are below detection; thus S, Ag, Au, Cd, In, Pd, and Pt are omitted from this table. Components for which a substantial number of values are below detection level are indicated in Table 4. Elements affected in most groups include CaO, Na_2O, Be, Bi, Cl, Sb, and Se. Elements affected for one or two groups only are MnO (Finlayson/Thadool), F (Meekatharra/Gum Creek), Mo (Goodin), Sn (Meekatharra), W (Meekatharra/Goodin), and Y (Gum Creek).

The table indicates major differences between the groups. As expected, the greenstone belts and Proterozoic mafic rocks generally show higher values of TiO_2, Fe_2O_3, Cr, Ni, and V, whereas the granitoids show no consistently high values for any component other than SiO_2. However, regolith over the sedimentary Maraloou Formation displays something of a mixed mafic–felsic character, with relatively high values of TiO_2, Fe_2O_3, As, Co, Cr, Cu, Sb, Sc, V, and Zn as well as relatively high SiO_2 (60%) and Li.

Regolith units derived from Archaean granitoids

Samples over the Goodin Inlier have very low values for many components, especially K_2O, Ba, and Sr, all of which are substantially lower than corresponding values over the Yilgarn granitoids. However, outcrop is limited and the dominant regolith materials are residual and eolian sands. At the same time Fe_2O_3, Cr, and V values are slightly higher than expected over granitoids, reflecting a mafic component made up by mafic dykes, and which in places amounts to 15–20% of the inlier.

The mean values for R4 and D9 sands (Table 5) will be discussed later. They show very similar compositions, quite distinct from the composition of water-transported sediments.

Elias et al. (1982) distinguish two main types of granitoid on GLENGARRY — post-tectonic granitoids; and older, gneissic granitoids. Regolith materials surrounding or overlying areas of outcropping granite generally correspond to the highest concentrations of Na_2O. Regolith over *Agb* and *Agl* suggests that bedrock is predominantly granodiorite to monzogranite, except that *Agl*, southwest of Yanganoo, may be sodic granodiorite to tonalite. Regolith over *Ag*, *Agm*, and *Agn* also suggests a predominantly granodioritic composition, which in some areas is sodic; e.g. southwest of

Table 5. Geometric means for regolith units over Yilgarn granitoids

Component	*R3*	*R4*	*E2g*	*E4g*	*DC1g*	*DC2g*	*DC3*	*DA5*	*DA8*	*D9*	*DC1s*	*DC2s*	*DC1v*	*DC2v*
Sample nos.	*7*	*51*	*7*	*54*	*56*	*66*	*80*	*35*	*8*	*30*	*5*	*6*	*1*	*10*
							percentage							
SiO_2	86	89	90	84	85	84	83	79	81	89	77	85	34	68
TiO_2	0.27	0.20	0.14	0.17	0.17	0.25	0.27	0.33	0.34	0.18	0.39	0.21	0.94	0.49
Al_2O_3	5.8	4.5	4.6	6.8	6.4	7.3	7.4	7.8	7.6	4.5	9.1	6.6	14	9.0
Fe_2O_3	2.9	2.0	1.3	1.8	1.8	2.3	2.6	4.2	3.8	1.8	4.7	2.4	41	10
MnO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.05	0.02
MgO	0.15	0.12	0.14	0.15	0.14	0.15	0.14	0.21	0.27	0.13	0.22	0.14	0.21	0.24
CaO	0.01	0.01	0.02	0.04	0.04	0.03	0.02	0.03	0.06	0.01	0.02	0.03	0.01	0.04
Na_2O	0.03	0.02	0.11	0.43	0.30	0.14	0.10	0.10	0.05	0.03	0.13	0.22	0.01	0.05
K_2O	0.26	0.26	0.91	1.4	1.4	1.4	1.3	1.3	1.2	0.70	1.6	1.3	0.12	0.62
P_2O_5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.01	0.03	0.01	0.09	0.04
							parts per million							
Cl	13	19	15	28	32	26	42	46	51	22	43	26	10	51
F	69	52	51	55	52	80	87	80	106	63	136	124	93	76
As	5	3	2	2	2	3	3	6	4	2	7	3	33	10
Ba	69	61	199	285	311	277	251	281	214	116	367	332	55	159
Be	0.4	0.4	0.7	0.8	0.7	0.8	0.8	1.0	0.6	0.4	1.2	0.8	1.1	1.1
Bi	0.4	0.5	0.9	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.7	0.4	2.5	1.0
Ce	10	8	11	14	15	16	16	24	19	9	24	16	12	15
Co	3	3	2	4	4	5	5	8	8	3	8	5	32	12
Cr	69	65	39	47	45	58	69	131	114	60	144	57	3150	344
Cu	8	7	6	7	8	9	11	17	14	7	18	10	88	24
Ga	10	7	8	10	10	11	10	12	12	6	14	10	31	16
La	6	4	7	7	8	9	9	12	10	5	12	9	1	8
Li	5	5	6	5	6	7	7	9	9	6	8	7	12	9
Mo	1.8	1.3	1.4	1.4	1.4	1.6	1.2	1.8	2.0	1.2	1.5	1.2	5.8	2.9
Nb	9	6	7	7	6	9	8	8	7	6	10	8	21	9
Ni	6	7	3	4	6	7	9	16	14	7	8	5	195	31
Pb	10	11	23	20	20	20	23	22	24	13	26	22	25	20
Rb	24	20	54	60	68	73	62	63	46	40	81	59	4	28
Sb	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.3	0.4	0.4	1.5	0.6
Sc	3	2	2	2	2	3	3	6	4	2	6	2	39	8
Se	0.6	0.7	0.5	0.7	0.7	0.7	0.7	0.8	0.7	0.6	1.7	0.5	5.5	1.2
Sn	1.6	1.1	1.1	1.1	1.1	1.6	1.3	1.7	1.5	1.3	1.8	1.3	2.6	2.1
Sr	8	6	16	22	25	21	21	27	22	9	27	26	4	19
Th	7	5	6	6	7	7	7	10	7	5	10	5	16	10
U	1.3	0.9	1.2	1.4	1.6	1.7	1.7	3.0	2.1	1.0	1.9	1.6	2.5	2.2
V	44	35	24	30	29	35	41	68	59	28	85	39	871	173
W	1.4	1.0	1.3	1.1	1.0	1.2	1.1	1.7	1.4	1.0	2.1	1.1	52	2.3
Y	4	2	3	2	3	4	4	7	5	3	6	3	2	5
Zn	10	8	9	11	12	14	15	27	23	10	24	14	38	27
Zr	78	77	82	91	90	96	117	97	133	75	119	105	140	106

Yanganoo and southeast of Bourke Find. Silcreted granitoids give rise to sediment low in both K_2O and Na_2O. Calcium (CaO) is almost totally leached over all granitoids.

Rubidium follows K_2O, except in the mixed *Agl/Agel/Agl* area running from the Mistletoe area to south of Killara, where K_2O is relatively high and Rb relatively low. Both Ba and Sr are relatively high in this area. In general, Rb, Sr, and Ba all appear higher in the west and northwest of the area of granitoids. Barium is higher north and west of the Meekatharra–Wiluna road. Over the southeast part of the sheet, values for Ba, Rb, and Sr all tend to be low. The maximum Ba values over granitoids occur east of Bourke Find. The two highest Y values (30–35 ppm) are coincident with high Sr north of Yanganoo.

Cerium and La are low east of a line from Yanganoo to Hill View. Their distribution is somewhat variable west of this line and they, with Li, seem to collect in the main drainages. No values are particularly high. Zirconium is an element generally believed to be higher in granitoids than, for example, mafic rocks. Results from this study show no preference over granitoids except perhaps over the Goodin Inlier; the highest values are, in fact, over the Glengarry Basin rocks.

Regolith units derived from Archaean greenstone belts

Regolith derived from the three greenstone belts on GLENGARRY — the Meekatharra, Gum Creek and Joyners Find belts — is geochemically well defined. The remnant greenstone belt between the Meekatharra and Gum Creek belts is poorly defined.

As expected from the geology of the Gum Creek and Joyners Find greenstone belts, the chemical signature of regolith over these rocks is more mafic than that over the Meekatharra belt and is characterized by higher Fe_2O_3, Co, Cu, V, and W, and lower Ba, Ce, La, Rb, and Sr. This is despite a probable eolian contribution to the regolith, estimated at 5–15% in the analysed fraction, shown optically by frosted quartz grains and chemically by mean SiO_2 values of about 53% over both the Gum Creek and Joyners Find belts.

Regolith over rocks of the Meekatharra belt has slightly higher average concentrations of MgO and Y compared with that over the Gum Creek and Joyners Find belts. Regolith with a high MgO component is related to the high-Mg basalts and ultramafic rocks within the sequence in the region of the Gabanintha–Star of the East group. The highest Y concentrations lie along the north-northeasterly trending synclinal structure of the Meekatharra belt; other high Y values are found south of the Gabanintha–Star of the East group where detritus is shedding south from ultramafic rocks into a trunk drainage. High TiO_2 ($\leq$13.8%) is also related to the same band of ultramafic rocks, with high concentrations of Co ($\leq$224 ppm) in stream samples taken on the southwest side of the complex.

In comparison with the other greenstone belts, regolith over the Gum Creek belt has the highest concentrations of Cu, Ga, Sc, V, and W. The highest values of these elements, with the exception of Sc, are found along the western side of the intensely sheared eastern contact of the belt with the adjacent granitoid. Scandium is most concentrated around the northern part of the belt and towards the northern and central drainage areas of the belt. In both cases, high Sc is related to nearby outcrops of greenstone. A single high value of F occurs on the northwestern side of the belt. This sample has a generally granitic signature and was collected near an exposed contact between greenstone and a mylonitic hornblende granodiorite/tonalite (Elias et al., 1982). Regolith over the Gum Creek belt has lower average concentrations of K_2O, Ba, Ce, La, Pb, Rb, Th, and Zr than over other greenstone belts. The lower concentrations of these elements over the Gum Creek belt may be due to lower amounts of felsic or granitic material within, or adjacent to, the belt.

Regolith over the Joyners Find belt contains the highest geometric means for P_2O_5, F, As, and Nb. The regolith is partly contaminated by nearby granitoids and has higher concentrations of K_2O, Ce, La, Pb, Rb, Th, and Y compared with that over the Gum Creek belt, but is lower in Cr and Ni than the other greenstone belts.

Samples collected in the vicinity of the smaller greenstone remnants show the effects of contamination from nearby granitoids and in consequence have very high levels of SiO_2, K_2O and other felsic elements compared with regolith over the larger greenstone belts.

Regolith derived from Proterozoic volcanic rocks

Mafic rocks on GLENGARRY are grouped into the Narracoota and Killara Formations. The Bartle Member, at the top of the Killara Formation, is treated as a separate group by virtue of its high concentration of contained chert (Occhipinti et al., in press). Compared with other units on GLENGARRY, regolith derived from the Killara Formation contains the highest geometric means for Fe_2O_3 and V. The three samples of regolith over the Narracoota Formation have the highest MnO, MgO, CaO, Sc, Sr, and Y (Table 4). Surprisingly, in view of the prevalence of chert, regolith over the Bartle Member has low SiO_2 compared with other units on the map sheet.

In comparison with the Narracoota Formation, the Killara Formation has higher geometric means for As, Cr, F, Ga, Li, Mo, Nb, Pb, Th, U, V, and Zr. Apart from the lower SiO_2 content (balanced by a higher Fe_2O_3 content) there are few significant compositional differences between regolith over the Bartle unit and the Killara Formation proper. Copper and Zn are slightly higher, and K_2O and Rb slightly lower over the Bartle Member compared with that over the remaining Killara Formation. The data support Hynes and Gee (1986), who recognized that the unit now known as the Killara Formation is geochemically different from the Narracoota Formation, to which it was previously assigned. The three samples of regolith from the Narracoota Formation have very high CaO contents (6%), and values for MgO, Na_2O, Pd, Pt, Sc, Sr, and Y are well above average for the sheet. However, the small number of samples limits their statistical significance. Parts of the Thaduna and Doolgunna Formations have high concentrations of Killara Formation sills, and these areas have been designated 'Mixed' in Table 4 and in the digital datafile GLENCHEM.CSV. This unit has higher Fe_2O_3, MgO, Cu, Ga, Mo, Ni, Sc, V, Zn, and Zr compared with other parts of the Thaduna and Doolgunna Formations ('Thadool' in GLENCHEM.CSV), reflecting the relatively high proportion of mafic intrusive rocks.

Regolith derived from Proterozoic sedimentary rocks

Proterozoic sedimentary rocks on GLENGARRY include the Juderina, Karalundi, Maraloou, and Yelma Formations and the Yagahong outlier. Samples from over the newly defined Bubble Well Member in the Finlayson Ranges have been included within the Juderina Formation (Fig. 2) pending completion of the current remapping program (Pirajno et al., 1995). Samples from the Juderina Formation are designated 'Finlayson' in GLENCHEM.CSV. There are only two samples derived from the Yagahong outlier, and five from the Karalundi Formation (Table 4). Mean values are provided but are not statistically significant.

Regolith from these areas reflects the nature of the rock below, except that regolith over the Karalundi Formation seems to reflect the upstream Narracoota Formation rather than the composition of the Karalundi Formation proper. Regolith over the Maraloou Formation has the highest Al_2O_3. Other sedimentary units are arenaceous and reflected in the regolith by higher values for SiO_2.

Of all regolith on GLENGARRY, that over the Maraloou Formation has the highest mean value for Mo, Sb and Sn, and the highest mean value for Pb where large numbers of samples have been taken. Results suggest that the Maraloou Formation contains a number of lithofacies varieties. Regolith composition over the west central portion reflects underlying sulfidic shale. A large proportion of samples have high values for chalcophile elements (Fe_2O_3, As, Cu, Ni, and Zn), although mean values for TiO_2, Sc, and V are also high and suggest a contribution from mafic rocks. This pattern is not evident in the Paroo–Diamond Well area, where the regolith type is predominantly DC3 or DC3f, and most elements noted as high above, together with Ce and La, are much lower. In many places in this area the regolith composition shows no obvious contribution derived from mafic rock, although mafic input from the Killara Formation is probable east of Yandil (e.g. CaO, Fe_2O_3, V), and to some extent north of Paroo (e.g. Sc). Some areas with carbonate rocks are recognized by high MgO in the regolith. In addition, there is a narrow strip with low values for many elements between the Juderina Formation (Finlayson Member) and the Maraloou Formation; these low values may be attributable either to input via lag from the highly siliceous Juderina Formation (Finlayson Member) crossing the boundary to overlie the Maraloou Formation or, possibly, to an unrecognized lithological variant within the Maraloou Formation.

Regolith over the Juderina Formation and Glengarry sequence does not have a distinctive composition, though the mean values for K_2O and F over the Juderina Formation (Finlayson Member), and for Th over the Glengarry sequence, are high. Results over the Glengarry sequence are patchily distributed with isolated samples with high values for various elements. Remapping of the geology is in progress and the divisions within these rocks are being reformulated.

Samples over the Yelma Formation have high mean values for TiO_2, Ce, F, Pb, and Zn. There appears to be some difference in composition between regolith in the Yandil area, with that near Mount Russell; the former shows a more mafic character.

Chromium values in all regolith over these Proterozoic sedimentary rocks appear high on a worldwide basis (cf. Vinogradov, 1959).

Regolith derived from Proterozoic outliers on the Yilgarn Craton

Two samples from the vicinity of the Yagahong outlier have high Na_2O, K_2O, Ba, and Rb (Table 4), suggesting that the source is either arkosic, or possibly from the surrounding granitoid.

Compositional changes with distance from source

As in previous explanatory notes of this series, an attempt has been made to follow sediment from its source region through to the main drainages. Earlier reports from the Yilgarn (Kojan and Faulkner, 1994; Bradley et al., 1995) suggested a clear pattern of alteration and chemical development from the upper levels of the landscape down to the edge of the main drainage floors. In contrast, Subramanya et al. (1995) found relatively little variation between regolith units E2 to DC3 for a given geological unit.

In the following discussion, regolith units characterized by fewer than five samples are not considered to be adequately represented.

Regolith over Yilgarn Craton

Tables 5 and 6 suggest that there are progressive changes in composition from erosional areas to DC3, but that relict and eolian products are substantially different from water-moved sediment, and that floodplain and main-drainage sediments contain admixed material from subsidiary or separate sources.

(a) Granitoids

Fifty-one samples have been assigned to unit R4 (residual sands), and 30 samples have been assigned to unit D9 (eolian sands). The mean compositions of the two units are virtually identical (Table 5), except for higher K_2O, Ba, and Rb in unit D9. The two units would be identical if R4 were, in fact, partially consolidated eolian sand from an earlier weathering and erosional episode rather than remnant in soluble material. The compositions displayed by these units are very much lower for components such as Na_2O, K_2O, Ba, Ce, Cl, La, Pb, Rb, and Sr than are those of clearly erosional or depositional units. The data suggest either that distinction between R4 and D9 is unwarranted, and the two units should be treated as a totally separate grouping, or that different geological processes ultimately produce compositional convergence.

The mean compositions of R4 and E2g have similarities, but differ in components such as K_2O, Ba, Cr, Pb, Sr, and V. Unit E2g, which has a mean SiO_2 content of 90%, shows greater differences with E4g, and probably reflects a greater degree of silicification (silcretization) in E2g.

Mean compositions for units E4g to DA5 (Table 5) are quite different from those for R4/D9 and E2g, but show internal family similarities. As examples, the SiO_2 content is lower, and the K_2O, Ba, Ga, Pb, Rb, Sr, and Zn contents are all higher. Within the group there is a greater difference between DC3 and DA5 than between the remaining erosional and colluvial units, though for many elements there are consistent trends from E4g to DA5. For example, TiO_2, Fe_2O_3, Cr, Cu, Sc (among others) increase with distance from source through to DA5. Trends for some components, for example Zr, cease at DC3. These patterns can be interpreted as reflecting an actively eroding environment with subsequent systematic alteration. The slight differences in composition in DA5, in the wide-valley drainages, may indicate input from mafic rocks from greenstone areas or from mafic enclaves within the granitoids.

Units DA5 and DA8 have also similar mean compositions. The material collected from DA8 is extremely low in CaO and MgO which, though higher than over other regolith units, is much lower than might be expected for material from a carbonate source. The sediment analysed appears to be either a 'terra rossa' residue left after weathering dissolution of carbonate from that size fraction, or is simply overbank flood material comparable in nature to DA5.

For completeness, Table 5 includes regolith over the Yilgarn granitoids that is inferred to have its origin in rocks other than granites. For example, differences in the three DC1 units are quite marked.

(b) Greenstones

There are samples from six different regolith units over the Meekatharra belt. The mean compositions, particularly the SiO_2, K_2O, and Fe_2O_3 contents (Table 6), suggest that the higher ground is capped by siliceous material, including both silicified mafic/ultramafic rocks and felsic rocks. The lower erosional slopes appear to have tapped into fresher mafic/ultramafic rocks with a lower SiO_2 content and extremely high Cr, Ni, and V. There are generally systematic trends of mean values between E4v and DC3, in many cases through to DA5. Sediment over calcrete is little different in composition from DA5, and there is little indication of carbonate present at the surface. Such differences as exist between DA8 and DC3/DA5 suggest an increased granitic component in DA8.

There are samples from only two regolith units over the Gum Creek greenstones. Mean values (not reproduced) for most components in DC1v and DC2v are similar; however, the DC2v unit appears enriched in SiO_2 at the expense of Al_2O_3 and Fe_2O_3.

Table 6. Geometric means for regolith units over Meekatharra greenstone belt

Component	*E2v*	*E4v*	*DC1v*	*DC2v*	*DC3*	*DA8*
Sample nos.	*11*	*11*	*7*	*5*	*14*	*3*
			percentage			
SiO_2	63	51	51	50	77	77
TiO_2	0.69	0.90	1.2	1.8	0.35	0.26
Al_2O_3	8.5	10	8.9	8.3	7.2	7.1
Fe_2O_3	13	25	24	23	7.4	3.9
MnO	0.08	0.07	0.07	0.12	0.02	0.02
MgO	0.73	0.56	0.31	0.58	0.20	0.27
CaO	0.47	0.19	0.06	0.31	0.02	0.05
Na_2O	0.30	0.07	0.05	0.14	0.05	0.13
K_2O	0.52	0.39	0.42	0.34	0.53	1.4
P_2O_5	0.05	0.08	0.06	0.06	0.03	0.02
			parts per million			
Cl	19	29	15	36	35	65
F	33	54	69	70	81	64
As	14	59	18	33	11	6
Ba	172	116	153	144	246	281
Be	0.7	1.0	0.8	0.8	0.8	0.7
Bi	0.4	0.5	0.7	0.4	0.7	1.2
Ce	16	17	20	28	18	17
Co	22	34	34	67	9	9
Cr	686	1 595	1 416	1 337	543	214
Cu	41	37	28	20	17	10
Ga	15	13	12	12	11	10
La	7	9	9	11	8	7
Li	7	8	7	6	7	5
Mo	1.3	1.6	3.1	2.0	2.3	2.6
Nb	6	8	10	12	5	8
Ni	79	188	122	198	37	5
Pb	16	23	27	28	25	21
Rb	23	28	33	34	38	71
Sb	1.4	2.5	1.1	1.3	0.5	0.3
Sc	15	17	14	13	8	4
Se	1.6	4.2	3.6	1.8	1.4	1.4
Sn	1.1	2.2	2.4	2.7	1.6	2.1
Sr	35	22	15	22	22	26
Th	5	7	11	8	9	7
U	1.4	2.0	2.6	2.1	1.9	2.5
V	218	318	374	343	119	59
W	1.8	3.0	1.7	2.1	1.1	2.6
Y	7	10	8	14	4	4
Zn	41	54	47	52	22	23
Zr	83	95	103	131	116	85

Regolith over the Glengarry Basin

There appear to be relatively few major compositional differences between erosional and depositional regolith over the sedimentary units in the Glengarry Basin. This is illustrated by regolith over the Maraloou Formation (Table 7), the group with the largest number of samples. This table shows that the larger number of highest mean values is shared between units DC2s and DA5, but that differences between all regolith units are not great. The only consistent trends from DC1s to DA8 are those of SiO_2 (which gradually decreases) and Ni (which increases). Unit DC3 has some of the lowest mean values for Al_2O_3, Cr, Cu, Ga, Nb, and Zr. The Maraloou Formation is in places covered by iron-rich detritus (DC3f), and although this unit has more Fe_2O_3 than the normal DC3 units the differences are not large. However, for DC3 and DC3f to be considered a single regolith unit implies increasing abundance of chalcophile elements (Fe, Co, Cu, Zn, etc) in areas of lower relief. It appears that regolith cover over the formation, even including those areas with extensive valley floors (DA5), is not thick, and that contributions from the source rock are present in all units. Consequently the patterns of variation caused by mobilization/reprecipitation, or by concentration of immobile components shown over Yilgarn rocks, are substantially reduced.

Results for the various regolith units over other bedrock groups (not shown) show relatively small differences in composition. For example, over the Juderina Formation (Finlayson Member) there is little compositional difference between all three regolith units (E2s, DC1s, and DC2s) apart from E4s. Over the 'Mixed' unit there is very little difference in composition between E2s and E4s units. Over the Bartle Member, E4v and DC3 have similar compositions, but DC3f may be partly misdefined since it averages less Fe_2O_3 than the normal DC3; there are

Table 7. Geometric means for regolith over the Maraloou Formation

Component	*DC1s*	*DC2s*	*DC3*	*DC3f*	*DA5*	*DA8*
Sample nos.	22	46	25	29	22	5
			percentage			
SiO_2	67	61	58	58	58	54
TiO_2	0.63	0.78	0.68	0.89	0.87	0.78
Al_2O_3	10	11	8.9	13	13	13
Fe_2O_3	11	17	16	17	15	16
MnO	0.03	0.03	0.04	0.07	0.08	0.08
MgO	0.26	0.24	0.21	0.26	0.33	0.55
CaO	0.03	0.02	0.03	0.04	0.06	0.14
Na_2O	0.03	0.02	0.03	0.02	0.03	0.04
K_2O	0.58	0.58	0.43	0.56	0.74	0.73
P_2O_5	0.05	0.08	0.06	0.09	0.09	0.10
			parts per million			
Cl	32	32	24	25	41	16
F	152	188	106	158	185	222
As	14	21	13	12	16	24
Ba	123	102	119	95	152	164
Be	1.3	1.0	0.8	1.4	1.5	2.2
Bi	0.9	1.2	0.8	1.0	0.8	1.1
Ce	18	19	18	15	24	28
Co	14	13	16	23	24	19
Cr	221	360	284	326	287	271
Cu	35	44	42	57	55	48
Ga	16	20	16	20	22	22
La	7	9	7	6	10	12
Li	10	10	9	13	15	17
Mo	2.9	5.0	2.5	2.5	2.9	6.6
Nb	11	13	11	12	14	13
Ni	21	21	23	28	29	34
Pb	24	30	25	26	25	32
Rb	19	26	19	22	30	25
Sb	1.4	3.4	1.5	1.1	1.4	3.3
Sc	10	11	10	15	17	12
Se	1.2	1.2	0.9	1.2	1.6	1.9
Sn	2.1	2.7	2.3	2.4	2.5	2.5
Sr	12	12	11	12	18	19
Th	7	9	7	7	8	9
U	1.7	2.4	1.8	2.5	2.5	2.5
V	212	377	328	360	296	334
W	2.0	3.0	1.9	2.3	2.5	2.7
Y	5	5	5	5	7	7
Zn	37	35	34	50	59	72
Zr	148	189	150	183	176	184

smaller differences for trace elements between the three units. The indications are that mechanical breakdown rather than weathering and alteration has controlled dispersion, and that there have been bedrock contributions to each regolith unit.

Though the element distribution maps (Figs 4–44) and discriminant analysis (Fig. 46) show that there is some transport of regolith materials over boundaries between geological groups, in general this is not extensive. Consequently, the composition of the various DA5 units retains to a large degree an affinity with that of other regolith units in the vicinity and with the underlying bedrock. There is therefore no easy way to obtain an integrated regional background value for regolith of the sheet. What constitutes an anomalous sample for exploration purposes will, therefore, vary depending on the bedrock group. Copper will be anomalous at a much lower absolute value over Yilgarn granitoids than over the Maraloou Formation.

Discriminant analysis of regolith over major rock groupings

Discriminant analysis (Davis, 1986; Rock, 1988) has been applied to the analytical results, using the software package STATISTICA. Each regolith sample was allocated to a category corresponding to the inferred underlying rock unit. After elimination of those elements for which most values were below the limit of detection the discriminant program was run, using a backward stepwise analysis, to compare samples and match like with like. As a result, a number of samples were reassigned to other classifications, as indicated in Table 8. The purpose of the analysis was to compare the area of the geological unit with the extent of the regolith developed from it, on the assumption that regolith is developed from the underlying rock unit and retains any distinctive chemical character of the original rock.

Although not further detailed here, discriminant analysis shows that the regolith over greenstone belts is distinct from that over granitoid rocks, and that the Meekatharra, Gum Creek and Joyners Find belts are chemically distinct from each other. In each case, regolith derived from the rock unit is largely confined to the area of the unit as marked on Figure 2. In addition, regolith developed over the Yilgarn granitoids is distinguished from that over the Goodin Inlier, probably as a result of the greater proportion of dolerite dykes in the latter.

Discriminant analysis applied to regolith over the sedimentary and volcanic rocks of the Glengarry Basin proved to be of greatest interest. For this purpose, the Maraloou and Killara Formations were chosen, as there is some doubt as to the distribution of geological units. The Killara Formation, as marked on Figure 2, was combined with the Thaduna–Killara Formation ('Mixed' in Table 4 and GLENCHEM.CSV), a unit of interbedded sedimentary and mafic volcanic rocks along the northwestern margin of the Maraloou Formation, as the difference is possibly only in the proportion of mafic volcanic rocks. The Bartle Member was retained as a separate unit. Figure 46 shows the resultant discriminant analysis of the regolith over the northeastern part of GLENGARRY, overlain on the geology of Figure 2.

The area occupied by 'Maraloou type' regolith is rather smaller than the area of the formation marked on Figure 2. Near Diamond Well there are small areas which suggest the boundary between the Killara and Maraloou Formations is wrongly drawn. Elsewhere it is evident that regolith with a Killara or Bartle signature has moved downslope from its origin and now overlies the Maraloou Formation. In the south, it is probable that regolith derived from the Juderina Formation has encroached on the Maraloou Formation. Small areas of Maraloou-type regolith near Karalundi may indicate downstream transport of sediment with this character, but a number of other small areas within the Meekatharra greenstone belt and east of the Goodin Inlier are the result of isolated anomalous samples, as are the apparent 'holes' within the Maraloou-type regolith.

Table 8. Reclassification of regolith samples after discriminant analysis

Original classification	*No. of samples*	*Percent correct*	*Discriminant classification (a)* Yilgarn	*Remnant*	*Killara*	*Mixed*	*Thadool*	*Finlayson*	*Maraloou*	*Bartle*	*Yelma*	*Goodin*	*Meekatharra*	*Gum Creek*	*Joyners*
Joyners	9	56	1	2	0	0	0	1	0	0	0	0	0	0	5
Gum Creek	25	56	2	5	0	2	0	1	0	0	0	0	0	14	1
Meekatharra	66	55	14	5	0	0	3	2	2	0	0	1	36	2	1
Remnant	23	48	7	11	0	0	3	2	0	0	0	0	0	0	0
Yilgarn	418	64	266	71	0	2	17	39	2	0	0	17	2	1	1
Goodin	12	75	3	0	0	0	0	0	0	0	0	9	0	0	0
Finlayson	75	60	14	5	2	0	3	45	3	0	3	0	0	0	0
Maraloou	159	60	12	0	8	12	9	14	96	8	0	0	0	0	0
Killara	34	68	0	0	23	4	0	0	0	7	0	0	0	0	0
Mixed	68	65	1	1	6	44	5	4	5	1	0	1	0	0	0
Bartle	27	63	0	0	7	0	1	0	2	17	0	0	0	0	0
Thadool	100	55	8	2	1	9	55	10	7	0	0	6	0	2	0
Yelma	9	22	0	0	1	1	0	0	3	2	2	0	0	0	0
Total	1025	61	328	102	48	74	96	118	120	35	5	34	38	19	8

(a) Discriminant classification placed equal weighting on each geological unit (a priori=0.077)

In the vicinity of Paroo and Yandil Homesteads there is an area of mixed regolith, with individual and small groups of samples having the character of the Killara or Maraloou Formations, or the Bartle Member, in close proximity. The Earaheedy Group rocks are, for the most part, completely swamped by regolith from the surrounding units. It is evident, too, that regolith derived from the Bartle Member not only overlies large areas of known Maraloou Formation, but extends north to the sheet boundary over areas mapped as Killara Formation. The extent of outcrop of the Bartle Member is contentious, but the geochemical evidence supports the northward extension of the outcrop recently mapped by Dawes et al. (in prep.).

The area occupied by Killara-type regolith is much reduced from the area shown on Figure 2, not only by the excision of large areas in the north where Bartle-type regolith is present, but by large 'gaps' in the western area of mixed mafic and sedimentary rock. It is probable that two contrasting regolith types are present, related to the mafic volcanic and sedimentary rocks respectively, and that the area delineated as Killara-type regolith covers the predominantly volcanic rocks. A final point of interest is in the northeast corner of GLENGARRY, mapped as Finlayson Formation by Elias et al. (1982) but now shown to be overlain by Killara-type regolith. There are outcrops of sedimentary rocks in the area, but it appears that Killara-type regolith has moved downslope and blanketed the area.

In summary, discriminant analysis of the regolith geochemistry has been shown to be a powerful tool for interpreting both the extent of bedrock units in areas of poor outcrop, and the extent of downslope movement of regolith. The utility of the resultant maps tends to confirm the original assumption that regolith in the Glengarry Basin retains the character of the rocks from which it was derived.

Comparisons of airborne radiometric data with regolith results, GABANINTHA 1:100 000 sheet

Comparison has been made between the K_2O, Th, and U values obtained from the regolith sampling program and airborne radiometric data for the GABANINTHA 1:100 000 sheet, in the southwest corner of GLENGARRY. Results are shown in Figures 47 to 49. Each of the three elements has different chemical behaviour. Uranium is rapidly leached near the surface, K_2O is partly leached and partly transported mechanically as K-feldspar, and Th is essentially insoluble and moves almost wholly mechanically.

The maps show a generally good correspondence of K_2O with that indicated radiometrically for potassium, and provides useful support for the validity of the present sampling procedure.

There is some variation in regolith Th compared with the airborne radiometric Th. In the Meekatharra area, southeast of Meekatharra and southwest of Gabanintha mine, the correspondence is generally good, possibly because high relief allows movement of monazite into drainages. However, high radiometric Th north of Murchison Downs Homestead, in upland granitic outcrop areas, is not reflected in the regolith analyses, though there is better correspondence south of Murchison Downs. Instead, the results of this study tend to show the migration of Th into the main drainage southwest of the station. Areas of low radiometric Th show little Th in regolith. The reasonably close relationship between measured Th and radiometric Th suggests that the acid attack used to digest the samples has, in fact, dissolved most Th.

Airborne radiometric U is high over the granitic outcrop areas northwest of Murchison Downs and east of Hillview Homestead, and in the two main drainages on the sheet. Correspondence between radiometric and regolith U is good in the drainages, but relatively poor in outcrop areas. Radiation measured for U is, in fact, derived from daughter products whose mobility is substantially different from U itself. Little elemental U may be left near the surface in the upland areas, and the measured radiation may be derived from radium or radon.

Additional studies of the relationships of radiometric data to regolith distribution and regolith composition, are in progress (Sanders, in prep.).

Elements of economic interest

Gold, palladium, platinum, and silver

The overall distributions of Au, Pd, and Pt are quite similar (Figs 14, 29, and 30). All three elements are present in regolith over the Meekatharra and Gum Creek greenstone belts, over the Narracoota and Karalundi Formations, and over the Killara Formation/Bartle Member. Traces of Au and Pd are present in the remnant greenstones and the Joyners Find greenstone belt. Platinum is absent from most of the Joyners Find and remnant greenstones, but detectable in other areas carrying Au and Pd.

Except in the vicinity of known gold mines, Au values are low. The maximum value is 135 ppb, south of Meekatharra, but outside the greenstone belts values are rarely higher than 1 or 2 ppb. Exceptions are values of 56 ppb over the Karalundi Formation in the northwest of the sheet, and 13 ppb over the Killara Formation northeast of Paroo Homestead.

The contoured Au distribution map (Fig. 45) shows the position of the larger present and former mining areas, in particular those of Meekatharra and Gabanintha. Smaller anomalies are present in the vicinity of the Gum Creek, Joyners Find and Diorite mines, and a single, low-valued sample reflects the Bourke Find and Reward mines. There are no samples directly related to the small Mistletoe mine. Comparison of values in these known mining areas with those elsewhere suggests the possibility of further economic discoveries, although most of the higher values occur singly, or in groups of samples with barely detectable Au.

Palladium and Pt are present at low levels (up to 9 and 12 ppb respectively) over greenstone belts and the basic volcanic rocks of the Narracoota and Killara Formations. Platinum over the Killara Formation is up to 10 ppb and commonly found close to the contact with the Maraloou Formation. There is little Pt directly associated with the Maraloou Formation, the few values recorded resulting from regolith moving downslope from the Killara Formation. Distribution of Pd generally follows that of Pt, with values being highest where Pt values are high. Low values (1–4 ppb) of Pd are widely distributed throughout regolith over the Maraloou Formation, and probably derived from the black shales within this formation.

The association of Au, Pd, and Pt with the Killara Formation is supported by the same association on PEAK HILL (Subramanya et al., 1995). Values for all three elements appear slightly lower on GLENGARRY than on PEAK HILL. This may be a regional variation or an artefact of determination, as the analytical laboratory was different for the two sheets. The association of these elements with the Narracoota Formation continues onto PEAK HILL (Subramanya et al., 1995). One sample near Murchison Downs contains 9 ppb Pd.

Silver has been obtained as a byproduct of goldmining at various goldmines in the Meekatharra and Gabanintha areas (Appendix 1). There are traces of Ag in regolith in the Gabanintha area, but values are close to the detection limit and of uncertain accuracy. Figure 44 shows the position of samples with Ag in excess of 5 ppm. Most samples have no high values of any other elements and the significance of the Ag values is uncertain.

Copper and zinc

There are no active copper or zinc mines on GLENGARRY. A small quantity of Cu has been extracted as a byproduct from gold-mining in the Gabanintha area (Appendix 2), although regolith Cu values in this area are very low (Fig. 20). The distribution of the two metals in regolith is quite similar (Figs 20 and 42). The higher values, >75 ppm Cu, >55 ppm Zn, are almost all over Archaean greenstones, Proterozoic mafic rocks, and the Maraloou Formation. The main difference between the elements is a greater proportional concentration of Zn in the main drainages in the northwest of the sheet, and in the Murchison Downs/Hill View area. There is also a larger number of Zn-rich, as compared with Cu-rich, samples over the Meekatharra greenstone belt and the Glengarry sequence sedimentary rocks. Maximum values are low with Cu at 167 ppm and Zn at 150 ppm.

Lead

A maximum value of 559 ppm Pb has been found in regolith collected near the boundary of the Maraloou and Yelma Formations in the eastern part of the sheet (Fig. 28). This sample was collected in an area where other high values (>50 ppm) are associated mainly with the Maraloou and Juderina Formations. A major lead prospect was reported in this vicinity in 1993 (Le Blanc Smith et al., 1995). Values in the order of 50 ppm Pb were determined in samples in the western Maraloou Formation and in isolated samples over granitoids.

Uranium and thorium

The two highest values reported for U are 18.9 and 16.4 ppm (Fig. 38) in samples from the drainage running southwest from Murchison Downs past the Hill View Homestead. This area has previously been recognized as prospective by Butt et al. (1977), who reported U values up to 170 ppm in calcrete and 40 ppb in well water. There are no high values in regolith in the vicinity of two other minor U occurrences reported by these authors. Uranium at about the 5 ppm level was recorded in samples taken from the presumed former lakebed west of Karalundi and in the main drainage northeast of Mount Bartle. The only other site reporting more than 10 ppm U is northeast of Yanganoo, close to the contact of Juderina Formation with Yilgarn granitoids. A sample from the same general area returned 8 ppm.

Thorium values are not high (maximum 27.5 ppm, Fig. 37); regions with relatively high values include the central west of the Maraloou Formation and parts of the Glengarry sequence, especially those that drain the Goodin Inlier.

Molybdenum, niobium, and tungsten

In general, values are not high for Mo (generally <20 ppm), Nb (<30 ppm) and W (<10 ppm). Maximum values of 31 ppm Mo, 52 ppm Nb, and 227 ppm W were recorded in the western-central part of the Maraloou Formation (Figs 25, 26, and 40). Elsewhere, the three elements are largely unrelated, with higher values of Nb (20–40 ppm) north of Paroo Homestead and in the Karalundi Formation, higher values of W in the Gum Creek greenstones (≤52 ppm), and in the Karalundi area (19–30 ppm). High values for Mo (5–31 ppm) occur as a broad zone over the southern part of the Maraloou Formation, probably reflecting the presence of sulfidic bedrock shales. A few values up to 15 ppm are present over the Juderina Formation. All other high values of Mo (>10 ppm) are in isolated samples, two of which, containing about 15 ppm Mo, occur with As northeast of Gnaweeda, north of the Meekatharra–Wiluna road.

Titanium and vanadium

A resource of Ti and V has been described in the Gabanintha area (Appendix 2). The presence of this resource is suggested by four samples, west of Gabanintha, which have TiO_2 values between 2.4 and 13.8% (Fig. 4). However, the known V resource is not reflected in regolith values and the maximum for V is 1310 ppm at Gum Creek (Fig. 39).

Other elements

The highest values of As, Cr, and Ni all come from samples from the Meekatharra greenstone belt (Figs 13, 19, and 27). Values of Ni (≤590 ppm, south of Gabanintha) and Cr (≤3617 ppm, west of Bourke Find) are not high enough to suggest significant mineralization, but parts of the Meekatharra Belt and the Gum Creek belt clearly contain ultramafic rocks that may repay further prospecting.

All samples with As higher than 100 ppm lie over the Meekatharra greenstone belt. However, the element plot for As shows elevated values over all greenstone belts, including the greenstone remnant near the former Mistletoe mine, and over the west-central part of the Maraloou Formation. Antimony values are not high (Fig. 33); areas that show some enrichment include the Meekatharra belt and the Maraloou Formation.

The highest Li values (Fig. 24; maximum value 30 ppm) are restricted to three of the main drainages; values in the drainage east of the Meekatharra greenstone belt are little higher than background. The maximum value for Sn is 11 ppm, from a group of samples that report >5 ppm (Fig. 44); a possible source is the siliceous facies of the Killara/Bartle Formation.

Highest values of F (≥1000 ppm, Fig. 21) come from creeks draining the granitoid–greenstone contact of the Gum Creek belt. The known fluorite veins north of Murchison Downs Homestead are not reflected in the regolith analyses.

Areas with associations of economic elements

The following areas, or point samples, with some of the higher values of elements of economic interest have been noted:

- the central-west part of the Maraloou Formation (As, W, Pb, Mo, U, Th, Sb)
- the Meekatharra greenstone belt (As, Sb, Au, base metals)
- the Gum Creek greenstone belt (Au, base metals, W)
- south and west of Gabanintha (Ti, Co, W)
- east of Gnaweeda (As, Mo)
- northeast of Paroo, east of vermin-proof fence (As, Nb)

Economic indices

Results have been applied against the CHI-6*X and Peg-4 indices devised by Smith et al. (1989) for testing the economic potential of lateritic material. Results were inconclusive and are not reproduced.

A 'base metals index' composed of the sum of the standard scores for As, Bi, Cu, Pb, Sb, and Zn has been plotted in Figure 50, and may suggest areas favourable for base-metal enrichments, especially the Maraloou Formation.

Environmental concerns

Chlorine values are not high (Fig. 17); the maximum is 2897 ppm, and there are no extensive saline lakes or drainages except for the former lake west of the Karalundi Aboriginal Community. However, there are indications that Cl could increase, especially near bores and in some drainages. Two of the higher values (≤1000 ppm) were recorded near bores east of Gnaweeda, and another near a bore southeast of the abandoned No-ibla Homestead on the Sandstone–Wiluna road. Most of the remaining higher values are in drainages of various sizes, but as isolated values. Extensive clearing or degradation of the vegetation cover could allow watertables to rise and increase the size of saline areas as well as overall salinity of soils.

There is some coincidence of higher values of Cl with F near the Sandstone–Wiluna road, southeast of the No-ibla Homestead, and north of Joyners Find.

Summary and conclusions

Regolith on GLENGARRY has been mapped and sampled at an approximate density of 1 sample per 16 sq. km. A total of 1035 samples, consisting of 528 stream sediment, 504 soil/sheetwash, and three claypan (lake) sediments was collected. The <2 mm to >0.45 mm fraction of each sample was analysed for 48 components, using 'total' methods.

Results are provided on a digital datafile, and as a regolith-materials map and element-distribution maps. In addition, maps are provided that show the location of geochemical-exploration projects reported on open-file at DME. Data relevant to that exploration are summarized in Appendix 3. A map is included that compares Au determinations in this study with known gold mineralization.

GLENGARRY is not as geologically diverse as PEAK HILL (Subramanya et al., 1995). Nevertheless, even the simplified geological map has twelve separate units including Archaean granitoids and greenstones, and various Proterozoic mafic igneous and sedimentary rocks. Even within the greenstone group, individual belts have their own lithological and chemical characteristics. Regolith units are equally diverse; twenty-six have been delineated, most of which relate in varying degree to underlying bedrock.

Regolith over the Yilgarn Craton and the Goodin Inlier is the most extensively leached. Over greenstones and Proterozoic rocks weathering appears much less intensive, and it is inferred that bedrock is present at shallow depth in many places not noted as outcrop by Elias et al. (1982) in the Glengarry Basin. Many samples are mixtures of eroded rock, altered but recognizable rock, alteration products (including ferruginized material), and eolian sands. Perceived regolith movement from one rock source over another has not been so extensive, in most places, as to conceal the individual relationship of regolith to underlying bedrock. As in other studies of this series, there appears to be no significant compositional difference between sheetwash/soil and stream sediment, though the 'catchment' of the sheetwash/soil is much more localized.

On GABANINTHA, comparison of regolith chemical data with radiometric measurements, in particular those for potassium, shows an essential similarity of pattern, thus validating the sampling style and distribution.

The mean composition of regolith over the main geological groups is distinctive and different (Table 4). Discriminant analysis, applied to classify the regolith in terms of bedrock, has shown that the majority of samples do indicate their presumed source. However, in a few places the analysis has indicated localities where re-examination of the present geological interpretation is warranted.

Examination of the element-distribution plots has shown that in some geological formations a variety of lithologies, each with its own chemical signature, may be present. Regolith over the Yilgarn Craton reflects the compositions of the granitic bodies contributing to the sediments, and over the Maraloou Formation highlights the position of the known sulfidic black shales.

Over the Yilgarn Craton there appears to be no significant differences in average composition between units R4 and D9, suggesting that the unit called R4 may in fact be partly consolidated eolian sand, slightly older than the still-mobile D9 sands, rather than relict sand left after leaching of bedrock. Over many units there is little difference between DA5 and DA8, suggesting that the material collected over calcrete may in fact be detritus left by major flooding and comparable to that of unit DA5. Over Archaean rocks clear patterns of chemical change are evident in sediments moving from the lower erosional slopes to the main drainages. Upland erosional slopes, and regolith over them, appear silicified in comparison with lower slopes. Over Proterozoic rocks such patterns are less evident, though not totally absent, a reflection of less intense weathering and more shallow bedrock. Patterns of weathering include almost total loss of MnO, CaO, Na_2O and Sr, with only limited reprecipitation downstream.

Known gold mineralization is restricted to Archaean greenstone belts, mainly to shear zones within, or along, the margins of the belts. All former or present mines or prospects, with the exception of Mistletoe, have indications of Au in nearby regolith at the 2 ppb level or better. A number of other occurrences of Au in regolith over both Archaean and Proterozoic rocks may point to other mineralization. The association of Au, Pd, and Pt at ppb levels, identified in Proterozoic mafic igneous rocks on PEAK HILL by Subramanya et al. (1995), is continued onto GLENGARRY in the northeast and northwest parts of the sheet. The significance of the few isolated values of Ag at the ppm level is unknown.

The samples collected give no indication that Cu was mined at Gabanintha, or that in the Gabanintha area there is a vanadium resource. However, TiO_2 values in regolith in the same area reflect the known titanium resource. High Pb values have been found in a general area in the Glengarry Basin, from which a lead resource has been announced. Previously known, above-average concentrations of U in the drainage near Hill View Homestead have been confirmed.

In a number of areas isolated samples or pairs of samples have element associations, such as As with Mo, Pb with As, or Sb and Bi, indicative of at least weak mineralization. Some of these areas, such as the central-west part of the Maraloou Formation, may be worthy of further exploration.

There are no salt lakes on GLENGARRY. No sediment collected is highly saline, and salt currently presents few problems for pastoralists. The survey has shown that an area west of the Karalundi Aboriginal Community is weakly saline, and could represent the site of a former brackish water lake. Samples taken near some bores and wells show elevated Cl, possibly reflecting a rise in the watertable due to overgrazing around the bore.

References

ADAMIDES, N. G., 1995, Doolgunna, W.A.: Western Australia Geological Survey, 1:100 000 Geological Series (preliminary edition).

ADAMIDES, N. G., in prep., Geology of the Doolgunna 1:100 000 sheet: Western Australia Geological Survey, 1:100 000 Geological Series Explanatory Notes.

ALLCHURCH, P. D., and BUNTING, J. A., 1976, The Kaluweerie Conglomerate: Proterozoic fluviatile sediment from the Yilgarn Block: Western Australia Geological Survey, Annual Report 1975, p. 83–87.

ANAND, R. R., CHURCHWARD, H. M., SMITH, R. E., SMITH, K., GOZZARD, J. R., CRAIG, M. A., and MUNDAY, T. J., 1993a, Classification and atlas of regolith landform mapping units: CSIRO/ AMIRA Project P240A, Exploration and Mining, Restricted Report 440R.

ANAND, R. R., PHANG, C., SMITH, R. E., and MUNDAY, T. J., 1993b, Excursion 3: The regolith and its exploration and economic significance, *in* Crustal evolution, metallogeny and exploration of the Eastern Goldfields Excursion Guidebook *edited by* P. R. WILLIAMS and J. A. HALDANE: Australian Geological Survey Organisation, Record 1993/53.

ANAND, R. R., and SMITH, R. E., 1994, Classification, origin and geochemistry of laterites and ferruginous regolith materials in the Yilgarn Craton: implications for exploration: Geological Society of Australia, Abstracts no. 37, 12th Australian Geological Convention, p. 7–8.

BEARD, J. S., 1974, The vegetation of the Great Victoria Desert area: Explanatory memoir to map sheet 3, vegetation survey of Western Australia: Nedlands, University of Western Australia Press.

BRADLEY, J. J., FAULKNER, J. A., and SANDERS, A. J., in prep., Robinson Range, W.A.: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series Explanatory Notes.

BRADLEY, J. J., SANDERS, A. J., VARGA, Z. S., and STOREY, J. M., 1995, Leonora, W.A.: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series Explanatory Notes, 86p.

BUNTING, J. A., 1986, Geology of the eastern part of the Nabberu Basin, Western Australia: Western Australia Geological Survey, Bulletin 131, 102p.

BUNTING, J. A., COMMANDER, D. P., and GEE, R. D., 1977, Preliminary synthesis of Lower Proterozoic stratigraphy and structure adjacent to the northern margin of the Yilgarn Block: Western Australia Geological Survey, Annual Report 1976, p. 43–48.

BUNTING, J. A., and WILLIAMS, S. J., 1976, Sir Samuel, W.A.: Western Australia Geological Survey, 1:250 000 Geological Series Explanatory Notes, Record 1976/8.

BUTT, C. R. M., 1979, Geochemistry of a pseudo-gossan developed on a black shale–dolerite contact, Killara, Western Australia: Journal of Geochemical Exploration, v. 11, p. 131–156.

BUTT, C. R. M., GRAY, D. J., LINTERN, M. J., ROBERTSON, I. D. M., TAYLOR, G. F., and SCOTT, M., 1991, Gold and associated elements in the regolith-dispersion processes and implications for exploration: Australia CSIRO Division of Exploration Geoscience, Report 167R (unpublished).

BUTT, C. R. M., HORWITZ, R. C., and MANN, A. W., 1977, Uranium occurrences in calcrete and associated sediments in Western Australia: Australia CSIRO Division of Mineralogy Minerals Research Laboratories, Report no. FP16.

CLARKE, E. de C., 1916, The geology and ore deposits of Meekatharra, Murchison Goldfield: Western Australia Geological Survey, Bulletin 68, 342p.

CRAIG, M. A., and ANAND, R. R., 1993, Kalgoorlie–Kurnalpi regolith-landforms, 1:250 000 Special Edition: Australian Geological Survey Organisation.

CRUIKSHANK, B. I., 1994, Stream sediment geochemistry of the Ebagoola 1:250 000 sheet area, Cape York Peninsula, north Queensland: Australian Geological Survey Organisation, Record 1994/8.

DARNLEY, A. G., 1993, Some notes on the importance of airborne gamma-ray spectrometry in International Geochemical Mapping: Journal of Geochemical Exploration, v. 49, p. 201–212.

DAVIS, J. C., 1986, Statistics and data analysis in geology (2nd edition): New York, John Wiley and Sons, Inc.

DAVY, R., in prep., Report on forty-eight samples of hardpan and stream sediments from the Glengarry Basin: Western Australia Geological Survey, Record.

DAWES, P., and LE BLANC SMITH, G., 1995, Mount Bartle, W.A.: Western Australia Geological Survey, 1:100 000 Geological Series (preliminary edition).

DAWES, P., PIRAJNO, F., and LE BLANC SMITH, G., in prep., Geology of the Mount Bartle 1:100 000 sheet: Western Australia Geological Survey, 1:100 000 Geological Series Explanatory Notes.

ELIAS, M., BUNTING, J. A., and WHARTON, P. H., 1982, Glengarry, W.A.: Western Australia Geological Survey, 1:250 000 Geological Series Explanatory Notes, 27p.

FORDYCE, F. M., GREEN P. M., and SIMPSON, P. R., 1993, Simulation of regional geochemical survey maps at variable sample density: Journal of Geochemical Exploration, v. 49, p. 161–175.

GEE, R. D., 1979, The geology of the Peak Hill area: Western Australia Geological Survey, Annual Report for 1978, p. 55–62.

GEE, R. D., 1987, Peak Hill, W.A.: Western Australia Geological Survey, 1:250 000 Geological Series Explanatory Notes, 24p.

GEE, R. D., 1990, Nabberu Basin, *in* Geology and mineral resources of Western Australia: Western Australia Geological Survey, Memoir 3, p. 202–210.

GEE, R. D., and GREY, K., 1993, Proterozoic rocks on the Glengarry 1:250 000 sheet — stratigraphy, structure and stromatolite biostratigraphy: Western Australia Geological Survey, Report 41, 33p.

GIBSON, C. G., 1908, Report upon the auriferous deposits of Barrambie and Errols (Cue District) and Gum Creek (Nannine District) in the Murchison Goldfield; also Wiluna (Lawlers District) in the East Murchison Goldfield: Western Australia Geological Survey, Bulletin 34, 44p.

GRIFFIN, T. J., 1990, Southern Cross Province, *in* Geology of Western Australia: Western Australia Geological Survey, Memoir 3, p. 60–77.

HALL, W. D. M., and GOODE, A. D. T., 1978, The Early Proterozoic Nabberu Basin and associated iron-formations of Western Australia: Precambrian Research, v. 7, p. 129–184.

HALLBERG, J. A., CARTER, D. N., and WEST, K. N., 1976, Archaean volcanism and sedimentation near Meekatharra, Western Australia: Precambrian Research, v. 3, p. 577–595.

HYNES, A., and GEE, R. D., 1986, Geological setting and petrochemistry of the Narracoota Volcanics, Capricorn Orogen, Western Australia: Precambrian Research, v. 31, p. 107–132.

JUTSON, J. T., 1934, The physiography (geomorphology) of Western Australia: Western Australia Geological Survey, Bulletin 95, 366p.

KOCH, G. S., and LINK, R. F., 1970, Statistical analysis of geological data: New York, John Wiley and Sons, Inc.

KOJAN, C. J., and FAULKNER, J. A., 1994, Menzies, W.A.: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series Explanatory Notes, 83p.

LAMBOURN, S. S., 1972, Aeromagnetic survey of the Glengarry, Wiluna and Kingston 1:250 000 sheet areas, W.A., 1970: Australian Bureau of Mineral Resources, Record 1972/120.

LE BLANC SMITH, G., PIRAJNO, F., NELSON, D., and GREY, K., 1995, Base-metal deposits in the Early Proterozoic Glengarry terrane, Western Australia: Western Australia Geological Survey, Annual Review 1993–94, p. 59–62.

MABBUTT, J. A., LITCHFIELD, W. H., SPECK, N. H., SOFOULIS, J., WILCOX, D. G., ARNOLD, J. M., BROOKFIELD, M., and WRIGHT, R. L., 1958, General report on lands of the Wiluna–Meekatharra area, Western Australia: CSIRO Australia, 1963, Land Research Series, no. 7.

MYERS, J. S., 1993, Precambrian history of the West Australian craton and adjacent orogens: Annual Review Earth and Planetary Science, v. 21, p. 453–485.

NOLDART, A. J., 1962, Report on exploratory diamond drill hole No. PF1, site A, Paddy's Flat, Meekatharra, Murchison Goldfield: Western Australia Geological Survey, Annual Report 1960, p. 39–40.

OCCHIPINTI, S., GREY, K., PIRAJNO, F., ADAMIDES, N., BAGAS., L., DAWES, P., and LE BLANC SMITH, G., in press, Stratigraphic revision and new nomenclature of the Glengarry and Padbury groups and the lower part of the Earaheedy Group: Western Australia Geological Survey, Record.

PAIN, C., CHAN, R., CRAIG, M., HAZELL, M., KAMPRAD, J., and WILFORD, J., 1991, RTMAP BMR regolith database field handbook: Australia BMR, Record 1991/29, 125p.

PIRAJNO, F., ADAMIDES, N., OCCHIPINTI, S. A., SWAGER, C., and BAGAS, L., 1995, Geology and tectonic evolution of the Early Proterozoic Glengarry Basin, Western Australia: Western Australia Geological Survey, Annual Review 1994–95, p. 71–80.

PIRAJNO, F., BAGAS, L., SWAGER, C.P., OCCHIPINTI, S., and ADAMIDES, N., in press, A reappraisal of the Glengarry Basin: Western Australia Geological Survey, Annual Review 1995–96.

PIRAJNO, F., and OCCHIPINTI, S., 1994, Bryah, W.A.: Western Australia Geological Survey, 1:100 000 Geological Series (preliminary edition).

PIRAJNO, F., and OCCHIPINTI, S., 1995, Base metal potential of the Palaeoproterozoic Glengarry and Bryah Basins, Western Australia: Australian Institute of Geoscientists, Bulletin 16, p. 51–56.

POTTS, P. J., TINDLE, A. G., and WEBB, P. C., 1992, Geochemical reference material compositions: CRC Press, 313p.

ROCK, N. M. S., 1988, Numerical geology: Berlin, Springer-Verlag, 427p.

SANDERS, A. J., in prep., Improving geological mapping by relating remotely sensed signatures to on-ground regolith geochemistry: Western Australia Geological Survey, Record.

SANDERS, C. C., 1973, Hydrogeology of a calcrete deposit on Paroo Station, Wiluna and surrounding area: Western Australia Geological Survey, Annual Report 1972, p. 15–26.

SMITH, R. E., BIRRELL, R. D., and BRIGDEN, J. F., 1989, The implications to exploration of chalcophile corridors in the Archaean Yilgarn Block, Western Australia, as revealed by laterite geochemistry: Journal of Geochemical Exploration, v. 32, p. 169–184.

SOFOULIS, J., and MABBUT, J. A., 1963, Geology of the Wiluna–Meekatharra area, *in* General report on lands of the Wiluna–Meekatharra area, Western Australia: Australia CSIRO Land Research Series 7, p. 93–106.

SUBRAMANYA, A. G., FAULKNER, J. A., SANDERS, A. J., and GOZZARD, J. R., 1995, Peak Hill, W.A.: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series Explanatory Notes, 84p.

TYLER, I. M., and THORNE, A. M., 1990, The northern margin of the Capricorn Orogen, Western Australia — an example of an Early Proterozoic collision zone: Journal of Structural Geology, v. 12, p. 685–701.

van de GRAAFF, W. J. E., 1983, Silcrete in Western Australia — geomorphological settings, textures, structures, and their genetic implications, *in* Residual deposits — surface related weathering processes and materials *edited by* R. C. L. WILSON: Oxford, Blackwell Scientific Publications (for the Geological Society of London), p. 159–166.

van de GRAAFF, W. J. E., CROWE, R. W. A., BUNTING, J. A., and JACKSON, M. L., 1977, Relict Early Cainozoic drainages in arid Western Australia: Zeitschr. für Geomorphologie N.F., v. 21, p. 379–400.

VINOGRADOV, A. P., 1959, The geochemistry of rare and dispersed chemical elements in soils: New York, Bur. Enterprises Consultants, 209p.

WATKINS, K. P., and HICKMAN, A. H., 1990, Geological evolution and mineralization of the Murchison Province Western Australia: Western Australia Geological Survey, Bulletin 137, 267p.

WATT, J. H., 1995, Glengarry total magnetic intensity image: Western Australia Geological Survey, 1:250 000 Series (preliminary edition).

WILLIAMS, I. R., 1975, Eastern Goldfields Province, *in* Geology of Western Australia: Western Australia Geological Survey, Memoir 2, p. 33–54.

Appendix 1

Production and resources of gold and silver prior to 31 December 1994

Mining centre	*Mines and prospects*	*Location (AMG) Easting*	*Northing*	*Production Ore (t)*	*Gold (kg)*	*Alluvial/dollied (kg)*	*Published resources Tonnage*	*Gold (kg)*	*Total silver (kg)*	*Total gold (kg)*
Gabanintha	Copper King	666900	7016700	14.74	0.049	0.000	–	–	0.000	0.049
	Gabanintha Gold (a)	663400	7020700	1 570 745.80	5 293.017	1.802	–	–	(b) 211.147	5 294.819
	Gledich A	660900	7038700	0.00	0.000	0.216	–	–	(b) 0.016	0.216
	Lady Maud	669000	7019600	123.98	4.737	0.000	–	–	0.000	4.737
	Mount Bungar	669000	7020900	154.47	2.639	0.000	–	–	0.000	2.639
	New Australia	659400	7036400	165.00	0.532	0.505	–	–	(b) 0.032	1.037
	Syme RD	659300	7035900	1 153.00	6.039	0.000	–	–	(b) 0.317	6.039
	Meeka Pools data (c)	661000	7035000	350.58	8.947	0.088	–	–	0.000	9.035
	Sundry claims (b)			5 478.00	93.932	8.842	–	–	(b) 0.322	102.774
	Total			**1 578 185.57**	**5 409.892**	**11.453**	**–**	**–**	**211.834**	**5 421.345**
Gum Creek	Cardiff (a)	736300	7027900	42.68	0.128	0.000	–	–	0.000	0.128
	Cardigan (a)	734743	7029461	908.87	42.151	0.119	–	–	0.000	42.270
	Connecticut (a)	733933	7027995	130.11	13.504	1.256	–	–	0.000	14.760
	Gladsome (a)	730861	7023519	(d) 600.61	17.053	0.000	–	–	0.000	17.053
	Jupiter (a)	733081	7026881	739.75	26.466	0.000	–	–	0.000	26.466
	Kearry (e)	736013	7030762	0.00	0.000	0.000	549	833	0.000	833.000
	Omega (e)	736887	7027327	0.00	0.000	0.000	50	630	0.000	630.000
	Toedter (e)	733145	7030358	0.00	0.000	0.000	861	1 564	0.000	1 564.000
	Sundry claims (f)			747.00	20.405	2.775	–	–	0.000	23.180
	Total			**2 568.41**	**119.707**	**4.150**	**1 460**	**3 027**	**0.000**	**3 150.857**
Meekatharra	93 (a)	649600	7057500	7 937.31	131.314	1.648	–	–	0.000	132.962
	Albury Heath (a)	656400	7035600	1 839.62	68.119	0.409	–	–	0.000	68.528
	Commodore GM Co. NL (a)	650700	7057400	15 639.04	739.155	2.507	844 000	2 004	(b) 0.007	2 745.662
	Consols Extended	649800	7055800	889 487.52	11 236.304	0.000	–	–	0.000	11 236.304
	Empire (a) (g)	649400	7054800	889.60	50.340	3.243	–	–	0.000	53.583
	Fenian Leases (a)	649800	7055500	338 400.05	8 716.251	0.000	–	–	0.000	8 716.251
	Fenian West (a) (g)	649400	7055800	350.34	1.390	0.000	–	–	(b) 0.008	1.390
	Fishers	661100	7047600	890.00	1.319	0.000	–	–	0.000	1.319
	Five Mile Well	653600	7064900	0.00	0.000	0.000	215 000	515	0.000	515.000
	Golden Bracelet	653900	7051700	1 187.52	31.311	0.840	–	–	0.000	32.151
	Halycon (a)	650900	7057800	30 567.14	168.810	4.572	150 000	390	(b) 0.478	563.382
	Haveluck (a)	649700	7060300	15 862.29	202.917	2.394	–	–	(b) 0.091	205.311
	Haveluck South (a)	649500	7059700	2 526.67	31.667	0.000	–	–	0.000	31.667
	Heckelpeckel	649800	7058900	10.92	2.364	0.000	–	–	0.000	2.364
	Ingliston Extended GMs Ltd (a)	650200	7056400	126 603.54	2 117.032	1.111	390 000	3 833	0.000	5 951.143
	Ingliston South (a)	650300	7056900	80 377.46	1 687.429	15.499	1 406 000	2 010	(b) 10.720	3 712.928
	Gold Jay (a)	649500	7054900	80.28	7.936	0.377	3 264 000	5 835	0.000	5 843.313

Appendix 1 (continued)

Mining centre	*Mines and prospects*	*Location (AMG)* Easting	Northing	*Production* Ore (t)	Gold (kg)	*Alluvial/dollied (kg)*	*Published resources* Tonnage	Gold (kg)	*Total silver (kg)*	*Total gold (kg)*
Meekatharra (cont.)	Gwalia (a) (g)	649400	7054600	18 537.36	503.324	0.332	21 000	27	(b) 0.454	530.656
	Lake View and Oroya Expl Ltd (a)	649700	7056200	123 665.80	1 504.546	0.117	1 533 000	4 654	0.000	6 158.663
	Little Mary (a) (g)	649400	7055300	179.37	4.181	0.000	–	–	0.000	4.181
	Maid Marion	658700	7071900	0.00	0.000	0.000	228 000	388	0.000	388.000
	Marmont	649600	7055400	61 407.72	1 343.620	2.778	–	–	0.000	1 346.398
	Marmont Extended	649600	7055100	1 931.86	60.445	0.000	–	–	0.000	60.445
	Mount Ralph	650500	7061200	0.00	0.000	0.620	–	–	0.000	0.620
	Multum in Parvo	650500	7061000	333.46	68.814	0.000	–	–	0.000	68.814
	New Australia	657600	7043000	47.51	12.695	3.461	–	–	0.000	16.156
	New Orleans	651700	7059200	94.00	1.098	0.000	–	–	0.000	1.098
	Phoenix No. 1 (a)	649900	7058000	704.73	9.302	0.000	–	–	0.000	9.302
	Pioneer (a)	650100	7058000	7 290.07	200.774	1.199	–	–	0.000	201.973
	Pioneer South (a)	649900	7057800	227.64	4.982	2.442	–	–	0.000	7.424
	Rough Up (a)	649700	7060200	13 800.76	91.734	0.236	–	–	0.000	91.970
	St George (a)	650100	7057600	1 412.62	18.618	0.000	–	–	0.000	18.618
	Tartan	650200	7060500	10.31	5.864	5.857	–	–	0.000	11.721
	Wayback (a)	653400	7061900	97.15	2.374	0.039	–	–	0.000	2.413
	Grouped data (g)			11 470 435.00	22 686.449	7.325	–	–	(b) 119.683	22 693.774
	Sundry claims (g)			33 400.00	368.884	80.836	–	–	(b) 1.667	449.720
	Total			**13 246 224.66**	**52 081.362**	**137.842**	**8 051 000**	**19 656**	**133.109**	**71 875.204**
Mistletoe	Easingwold	682700	7091500	0.00	0.000	0.129	–	–	0.000	0.129
	Munarra	682800	7092500	423.67	15.121	0.000	–	–	0.000	15.121
	Sundry claims			33 400.00	368.884	80.836	–	–	0.000	449.720
	Total			**338 423.67**	**384.005**	**80.965**	**–**	**–**	**0.000**	**464.970**
Star of the East	Star of the East, Ltd (h)	659400	7019100	27 458.33	625.811	0.000	–	–	0.000	625.811
	Grouped data			352.52	8.711	0.000	–	–	0.000	8.711
	Sundry claims			130.00	2.954	0.000	–	–	0.000	2.954
	Total			**27 940.85**	**637.476**	**0.000**	**–**	**–**	**0.000**	**637.476**
Wiluna	Brilliant North (a)	795300	7041100	12 421.77	142.169	0.880	–	–	0.000	143.049
	Channings Group	795300	7042700	0.00	0.000	0.000	151 000	679	0.000	679.000
	Gloaming (a)	794500	7041800	486.28	4.362	0.000	–	–	0.000	4.362
	Linden (WA) Gold, NL (a)	793500	7032800	24 624.49	246.189	0.000	–	–	0.000	246.189
	Total			**37 532.54**	**392.720**	**0.880**	**151 000**	**679**	**0.000**	**1 072.600**

Source: Department of Minerals and Energy (DME), unpublished records; DME, MINEDEX database, 9 October 1995; Department of Mines, 1954

Notes:
(a) Group site
(b) Byproduct of gold production
(c) Old mining centre within Gabanintha — very approximate location
(d) Incomplete data
(e) Data published 30 June 1995
(f) Figures may include some SANDSTONE (SG50–16) data
(g) Figures include some BELELE (SG50–11) data
(h) Listed under Nannine centre in DME records
Expl: Exploration

Appendix 2

Production and resources of copper, titanium and vanadium prior to 31 December 1994

Mining centre	*Mine, prospect, deposit*	*Location (AMG)*		*Production (t)*		*Published resources (t)*		*Total metal (t)*
		Easting	*Northing*	*Ore*	*Metal*	*Tonnage*	*Metal*	
COPPER								**Total copper**
Gabanintha	Leviathan (a)	663000	7021200	60.16	11.68	-	-	11.68
	Mountain View (a)	662900	7021400	141.04	39.57	-	-	39.57
	Rinaldi Dominic (a)	666800	7017400	243.92	18.01	-	-	18.01
	Rinaldi LV (a)	666900	7016700	1 298.78	96.00	-	-	96.00
	Tumblegum (a)	663600	7020000	4 914.33	160.88	-	-	160.88
	Sundry claims			274.29	32.02	-	-	32.02
	Total			**6 932.52**	**358.16**	-	-	**358.16**
TITANIUM								**Total titanium**
Gabanintha	Gabanintha Vanadium	662562	7018963	0.00	0.00	8 599 000	1 326 000	1 326 000
	Total			**0.00**	**0.00**	**8 599 000**	**1 326 000**	**1 326 000**
VANADIUM								**Total vanadium**
Gabanintha	Gabanintha Vanadium	662562	7018963	0.00	0.00	8 599 000	74 000	74 000
	Total			**0.00**	**0.00**	**8 599 000**	**74 000**	**74 000**

Source: Department of Minerals and Energy(DME), unpublished records; DME, MINEDEX database, 9 October 1995; DME, TENGRAPH system
Note: (a) Group site

Appendix 3

Open-file geochemistry 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 1 and 2)
Area (sq km)	Project area. When the project extends outside the GLENGARRY 1:250 000 sheet boundaries 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 report reference number. There may be repetition of A numbers within some projects listed in the table overleaf since a single report may contain the reference maps for a number of other 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 BLEG: Bulk leach extractable gold ETA: Electrothermal analysis gen: generation ICP-OES: Inductively coupled plasma–optical emission spectroscopy PDV: Portable digital voltameter XRF: X-ray fluorescence AS: Australian Selection CC: Classic Comlabs PL: Pilbara Labs P/L RD: Resource Development RW: Rapley Wilkinson
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

Notes: For public use all open-file company reports 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)*	*Yr*	*Medium*	*No.*	*Ag*	*As*	*Au*	*Ba*	*Co*	*Cr*
1	2644		Australian Selection P/L	258	310	1352-53	67	Soil	1274						
					"	1486									
2	2644	8	Western Mining Corp	597	1229	1830-33	72	Percussion	3					X	X
								Soil	2850					X	
								"							
3	2644	42	Australian Anglo American Ltd	645	1524	3225-27	71	Soil	3000						
4	2644		Dominion Mining Ltd	705/2	4769	31897	90	RAB	53			X			
			Dominion Mining Ltd	705/8	6136	28602	88	Soil	1345			X			
					"	28605									
			Dominion Mining Ltd		6136	32174	90	RAB	52			X			
								"			X				X
5	2644	8	Dominion Mining Ltd	705/4	5165	26105-6	88	RAB	92			X			
								Soil	312			X			
								"	136			X			
			Dominion Mining Ltd		5165	34597	91	RAB	21			X			
								"			X				X
								Soil	139			X			
6	2644	6	Dominion Mining Ltd	705/7	5988	31840	90	RAB	9		X	X			
								RC	3			X			
								Soil	600			X			
								"	65			X			
								"			X				
7	2644	2	Black Horse Mining NL	705/9	6231	24637	88	Rock Chip	39			X			
								Vacuum	228			X			
								"			x				
								"							x
8	2644		Dominion Gold Operations P/L	705/10	6575	28603	88	Soil	140			X			
			Dominion Mining Ltd		6575	32173	90	RAB	65			X			
								"			X				X
			Dominion Mining Ltd		6575	34732	91	RAB	11			X			
								"	30			X			
9	2644		Dominion Mining Ltd	705/11	6655	32057	90	RAB	33			X			
								"			X				X
			Dominion Mining Ltd		6655	34737-38	91	RAB	49			X			
								"			X				X
								"	91			X			

geochemistry survey as at February 1995

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
X				X				X	Perchloric/ AAS	AS		
X				X							Y	D:0-1.5m
												D: 0.15m
X				X					Cold extraction			
X				X							Y	
										Analabs	Y	D:0-4m, DL:0.02ppm
									Bulk cyanide leach	ALS		Wt:3-4kg, DL:50ppt
									ETA	Genalysis	Y	D:0-4m, DL:1ppb
X				X	X			X	AAS	"		
									Aqua regia/ AAS	ALS	Y	D:0-4m, DL:0.02ppm
									Bulk cyanide leach	"		Recon, Wt:1-3kg, DL:50ppt
									Aqua regia/ AAS	SGS		Infill, DL:2ppb
									ETA	Genalysis	Y	D:0-4m, DL:1ppb
X				X	X			X	AAS	"		
X										Genalysis		Mesh:-2mm
											Y	D:0-4m
									AAS			D:0-1m, DL:0.01ppm
									Aqua regia/ AAS	SGS		Wt:3-4kg, DL:2ppb
									ETA	Genalysis		Mesh:-2mm, Wt:2kg, DL:1ppb
									AAS	"		
									PDV		Y	
									PDV			D:0-4m
									Hydride generation	Genalysis		
x					x				AAS	"		
									Bulk cyanide leach	ALS		Wt:3-4kg, DL:50ppt
									ETA	Genalysis	Y	D:0-4m, DL:1ppb
X				X	X			X	AAS	"		
X										Genalysis	Y	D:0-3m
									ETA	"		D:0-4m, Wt:2kg, DL:1ppb
									ETA	Genalysis	Y	D:2-4m, DL:1ppb
X				X	X			X	AAS	"		
									ETA	Genalysis	Y	D:0-4m, DL:1ppb
X				X	X			X	AAS	"		
X										Genalysis		D:0-3m

Appendix 3

ID No.	*Map Sheet*	*Area sqkm*	*Company*	*M No.*	*Item No.*	*A No.(s)*	*Yr*	*Medium*	*No.*	*Ag*	*As*	*Au*	*Ba*	*Co*	*Cr*
9	2644		Norgold Ltd	705/12	7311	21417-18	87	RAB	116			X			
cont								"			X				
								"		X					
								Soil	267	X	X	X			
			Norgold JV	705/12	7311	31626	90	RAB	93		X	X			
								RC	4			X			
10	2644	6	Kennecott Expl Aust P/L	861	1790	2566	71	Gossan	21						
								Soil	287						
11	2744	10	Cosmos Expl & Minerals NL	960	1792	2808	72	Rock Chip	32						X
12	2744	13	International Nickel Aust Ltd	1038	163	3180	71	Soil	714						
			International Nickel Aust Ltd		163	3767	72	RAB	3						
			International Nickel Aust Ltd		163	5131	74	Auger	23						
								RAB	2	X		X			
								Soil	240						
13	2645	19	International Nickel Aust Ltd	1072	1794	3216	71	Soil	606						
			International Nickel Aust Ltd		1794	3855	73	RAB	5						
								Rock Chip	13						
14	2844	98	Asarco Aust Ltd	1191	4	4179	73	Rock Chip	1376	x		x			X
15	2644		Aust Consolidated Minerals NL	1557	1482	10594	71	Gossan	183						
			Aust Consolidated Minerals NL		1482	11776	71	RAB	168						
			Aust Consolidated Minerals NL		1482	4754	72	RAB	2						
16	2644	8	Whim Creek Consolidated NL	1605/16	3253	10735	81	Rock Chip	44	X	X	X		X	
								"	15			X			
17	2744	200	AMAX Expl Aust Inc	1892	1185	7170	77	Rock Chip	84	X				x	x
			AMAX Expl Aust Inc		1185	8061-62	78	Rock Chip	433	X					X
18	2645	40	CSIRO	1972	642	6776	76	Rock Chip	62					X	
	2745							"	31	X	X		X	X	X
			CSIRO		642	8059	78	Auger	46		X			X	X
								RAB	7		X			X	X
								Soil	339		X			X	X

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
									Fire assay/ AAS	RD	Y	D:0-4m, DL:0.005ppm
									Hydride generation	"		
X									Perchloric/ AAS	"		
X									AAS	Genalysis		Mesh:-2mm, Wt:1kg
X					X				Percholoric/ AAS	Analabs	Y	D:0-4m
X												D:0-1m
X				X								
X				X					Perchloric/ AAS	Geomin		
X				X				X	Multi-acid digest			
X				X				X	Perchloric/ AAS			D:0.15m
X				X				X			Y	D:0-1.5m
X					X			X			Y	D:0-4m
X					X			X				D:0-1.5m
X					X			X				
X				X				X	Perchloric/ AAS			D:0.15m
X				X				X			Y	D:0-2m
X				X				X				
X				X	x			X	AAS			
X				X				X			Y	
X				X							Y	D:0-1.5m
X				X							Y	D:0-1.5m
X		X			X			X		Genalysis		Also for Bi, Cd
									AAS			
X				x	x			x	Perchloric digest	Analabs		
X				X	X			X		Analabs		
X		X		X	X			X	Hydrofluoric/ AAS			No 'real' location of grid
X	X	X		X		X	X	X	XRF \			Also for Bi, Cd, Ce, Ge, Ga, Sr, V
X	X	X		X	X			X			Y	Also for V, D:0-1.5m, No 'real' location of grid
X	X	X		X	X			X				Also for Ca, S, Sr, V, Zr, D:0-4m, No 'real' location of grid
X	X	X		X	X			X				Also for V, D:0-0.15m, No 'real' location of grid

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Yr	Medium	No.	Ag	As	Au	Ba	Co	Cr
19	2644	2	International Nickel Aust Ltd	2005	589	6863	77	Rock Chip	11	X		X			
								Soil	65			X			
20	2644	6	Pacminex P/L	2052	567	7070	77	Rock Chip	84	X				X	
21	2745	150	Pacminex P/L	2129	2017	7791	78	Rock Chip	245	X		X		X	
22	2644	18	International Nickel Aust Ltd	2164	592	7393	73	Drilling	9						
	2645							Soil	367						
23	2645		Samedan of Aust	2248	669	8166	77	Rock Chip	36					X	
	2745							Stream	6						
24	2745	70	Noranda Aust Ltd	2257	571	7701	78	Rock Chip	256	X					
	2845														
25	2644	124	Esso Aust Ltd	2277	1186	8314-15	79	Rock Chip	375	X					
	2645							"	163						
26	2745	400	Chevron Expl Corp	2586	1252	9385-87	80	Percussion	19	X		X		X	
	2845							Rock Chip	46	X				X	
27	2644		Shell Minerals Expl	2968	1632	11039	74	Auger	150						
					"	11560		Rock Chip	9						
			Shell Minerals Expl		1632	13654	75	Rock Chip	50						
28	2645	66	CRA Expl P/L	3348	3102	13069	84	Ironstone	23	X		X		X	
								RAB	1	X		X			
								Rock Chip	67			X			
29	2645	40	Austamax Resources Ltd	3416/2	6080	14576	84	RC	6			X			
								Rock Chip	11	x	x	X	x		
								"	36	X	X	X			
			Austamax Resources Ltd		6080	29091	89	Soil	78			X			
											X				
								"	4			X			
								"			X				
								Stream	2			X			
								"			X				
30	2744		Cyprus Minerals Aust Co	3542/2	3798	28167	89	RAB	258			X			

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
X				X				X				
												4 traverses
X		X		X	X			X				4 traverses
X					X			X	Perchloric/ AAS	PL		
X					X			X			Y	D:0-2m
X					X			X	AAS			
X	X	X		X	X		X	X	XRF	Analabs		Also for F, Nb, P, Th, U, V
	X	X					X		XRF	"		Also for Nb, Th, U, V, Fractional analysis
X					X			X				
X					X						Y	2m channels
X					X			X				2m channels
X	X	X			X			X			Y	D:0-2m
X		X		X	X			X				
X				X	X			X	Perchloric/ AAS	Labtech	Y	D:2-4m
X		X		X	X			X		"		
X		X		X	X			X		MGV		
X			X	X	X	X	X	X			Y	
X					X		X	X				D:0-2m
X					X		X	X				2m channels from shallow costeans
											Y	D:0-3m
X					X			X		Analabs		Also for W
X					X		X	X		SGS		
									BLEG/ ETA	Genalysis	Y	Mesh:-2mm
X					X			X	AAS	"		
									Mixed acid/ ETA	"		Mesh:-2mm, DL:1ppb
X					X			X	AAS	"		
									BLEG	"		Mesh:-2mm, Wt:6-8kg, DL:0.1ppb
X				X	X			X	AAS	"		
									Aqua regia/ AAS		Y	D:0-3m, DL:0.05ppm

Appendix 3

ID No.	*Map Sheet*	*Area sqkm*	*Company*	*M No.*	*Item No.*	*A No.(s)*	*Yr*	*Medium*	*No.*	*Ag*	*As*	*Au*	*Ba*	*Co*	*Cr*
31	2744		Arimco NL	3614/2	5776	31043	90	Soil	133			X			
32	2645	52	Homestake Aust Ltd	3638/4	4040	18394	86	Rock Chip	193			X			
			Homestake Aust Ltd		4040	29223	89	Pisolite	14			X			
								RAB	21			X			
								Rock Chip	7			X			
								Soil	83			X			
								"	229			X			
								Stream	27			X			
33	2645	932	Carpentaria Expl Co P/L	3679	3232	14935	83	Rock Chip	38						
	2745							Soil	40	X				X	
								Stream	48						
			Carpentaria Expl Co P/L		3232	14933-34	84	Diamond Drill	5	X		X			
								RAB	4	X					
								Rock Chip	255	X					
								Soil	210	X					
								Stream	257						
			CRA Expl P/L		3232	16518	85	Diamond Drill	1	X	X	X	X		
34	2644	27	Pancontinental Mining Ltd	4038	2842	16502	85	Rock Chip	28		x	x		x	x
								Stream	41		x	X			X
35	2644	102	Greenbushes Tin Ltd	4101/2	2710	17363	85	Ironstone	112	X	X	X	X	X	X
	2645							RAB	16		X	X			
								Rock Chip	20	x	x	X			
								Soil	174		X	X			
36	2644	26	Austamax Resources Ltd	4125/2	3508	18517	86	Dolerite	8			X			
			Aust Consolidated Minerals Ltd	4247	3267	18544	86	Stream	5		X				
								"		X		X			
			Austamax Resources Ltd	4125/2	3508	21072	87	Ironstone	16			X			
								"			X				
								"							X
								Rock Chip	17			X			
								"		X	X				
								Soil	16	X		X			
								"			X				
								"				X			
								Stream	5	X		X			
								"			X				
								"							

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
									BLEG	Genalysis		Mesh:-6mm, Wt:0.5kg, DL:1ppb
									Fire assay			
											Y	
X				X								D:0-4m
									BLEG	ALS		Mesh:-1.3mm, D:blw0.2m, Wt:6-8kg, DL:0.5ppb
									ETA			Infill
									BLEG			
X					X			X				
X					X			X	Multi acid/ AAS	Amdel		D:0.15m, Fractional analysis
X					X			X				
X					X			X			Y	D:0-2m
X					X			X				D:0-2m
X					X			X		PL		
X					X			X	AAS	"		
X					X			X				
X					X			X			Y	D:0-2m
				x								Also for Pd, Pt
x				x								Also for Pd, Pt
X	x	x	X	X	X	X	X	X			Y	Also for Be, Bi, Cd, Nb, Se, Ta, V, W
X			X		X	X	X	X				Also for Bi, W, D:2-4m,
			x			X						Also for W
X			X		X	X	X	X		Analabs		Also for Bi
												DL:0.01ppm
X					X	X		X		SGS		Recon, 2.5 samples/ sq km
X									Bulk leach extraction	Amdel		
									Fire assay	SGS		
									XRF	"		
X	X	X		X	X			X	AAS	"		
									Fire assay	ALS		
X					X			X	AAS	"		
X									Bulk leach extraction	Amdel		
									XRF	SGS		
X					X			X	AAS	"		
X									Bulk leach extraction	Amdel		Wt:5kg
						X			Hydride generation	SGS		
X					X			X	AAS	"		

Appendix 3

ID No.	*Map Sheet*	*Area sqkm*	*Company*	*M No.*	*Item No.*	*A No.(s)*	*Yr*	*Medium*	*No.*	*Ag*	*As*	*Au*	*Ba*	*Co*	*Cr*
36	2644	26	Aust Consolidated Minerals Ltd	4125/2	3508	21359	87	Ironstone	18		X	X			X
cont								Soil	21	X		X			
								"	18			X			
								"			X				
			Aust Consolidated Minerals Ltd	4247	3267	20847	87	Ironstone	183			X			
								"							
								Rock Chip	3		X	X			
								"	2	X	X	X			
								Soil	183						
								"				X			
								"			X				
								"		X		X			
								Stream	32						
								"			X				
								"		X		X			
			Aust Consolidated Minerals Ltd		3267	21397	87	RAB	72			X			
								"			X				
								Soil	541			X			
								"			X				
37	2644	8	City Resources Ltd	4685	4920	21038	87	RAB	3			X			
								"		X	X				X
								Rock Chip	10			X			
								"			X				
								"		X					X
			City Resources Ltd		4920	25006	88	Soil	462			X			
								"			X				
38	2644	84	Dominion Mining Ltd	4775/2	5250	32413	90	RAB	105			X			
	2645							"			X				
								Soil	307			X			
39	2844		Sipa Resources Ltd	4823/2	5804	21611	87	Soil	170			X			
								"							X
								"			X				
			Sipa Resources Ltd		5804	33683-85	91	Pisolites	155			X			
								"		X	X			X	
								Soil	2751			X			
								"			X				
								"							
								Soil	56			X			
40	2644	95	Dominion Mining Ltd	4840	6186	26026	88	RC	34			X			
	2645							Rock Chip	86			X			
								Soil	173			X			
								"			X				
								"							

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
X	X	X		X	X			X		SGS		Wt:0.5-0.75kg, Collected from 10 sqm zone around site
X									Bulk leach extraction	Amdel		
									Aqua regia digest	SGS		
X					X			X		"		
									Fire assay/ AAS	SGS		Wt:0.5-0.75kg, DL:0.01ppm
X					X			X	Mixed acid/ AAS	"		
X					X			X		Analabs		
X					X			X		ALS		
X					X			X	Mixed acid/ AAS	SGS		Fractional analysis
									Aqua regia/ AAS	"		DL:0.1ppm
									XRF	"		
X									Bulk leach extraction	Amdel		
X					X			X	AAS	SGS		Fractional analysis
						X			Hydride generation	"		
X									Bulk leach extraction	Amdel		
									Fire assay	AAL	Y	D:0-2m, DL:0.01ppm
									AAS	"		
									Aqua regia/ AAS	SGS		Wt:0.75kg, DL:2ppm
									XRF	"		
									Fire assay	AAL	Y	D:0-4m, DL:0.01ppm
X				X	X	X		X	AAS	"		
									Fire assay/ AAS	Analabs		Also for W (colourimetry), DL:8ppb
									Hydride generation	"		
X					X			X	Perchloric/ AAS	"		
									Fire assay/ ETA	Genalysis		D:0.1-0.2m, Recon & infill, DL:1ppb
						x			AAS	"		Also for W (colourimetry)
									AAS	CC	Y	D:0-4m, DL:0.02ppm
									XRF	"		
									Bulk cyanide leach	ALS		Recon, Mesh:-2mm, Wt:2kg, DL:50ppt
									Aqua regia/ ETA	Analabs		D:0.05-0.15m, Wt:2kg, Mesh:-5mm, DL:1ppb
X				X	X				AAS	"		
			X						XRF	"		Also for W (XRF)
									Aqua regia/ ETA	Genalysis		Wt:0.25kg, Mesh:+2mm, Pan & brush collection, DL:1ppb
X					X	X		X	Aqua regia/ AAS	"		Also for Bi (aqua regia/ AAS)
									Aqua regia/ ETA	Analabs		Recon, Wt:2kg, Mesh:-6mm, DL:1ppb
									XRF	"		
X					X				Perchloric/ AAS	"		
									BLEG	ALS		Follow-up, D:0.15-0.6m, Wt:3-5kg Mesh:-7.5mm, DL:50ppt
									Fire assay	CC	Y	D:0-1m
									Aqua regia/ AAS	AS		
									BLEG/ ETA	CC		
									XRF	"		
X					X			X	AAS	"		

Appendix 3

ID No.	Map Sheet	Area sqkm	Company	M No.	Item No.	A No.(s)	Yr	Medium	No.	Ag	As	Au	Ba	Co	Cr
40	2644	95	Outokumpu Exp Aust P/L	4840	6186	34530	91	Gossan	30			X			
cont	2645							"		X					
			Outokumpu Exp Aust P/L		6186	35402	92	RC	7	X	X				X
								Rock Chip	4	X	X				X
41	2644	10	Western Mining Corp	4988	3348	22249	87	Lag	298		X	X			
								"	302			X			
								Rock Chip	48		X	X			
42	2844	32	Mitchell Expl Co	5140/1	4579	22713	87	Rock Chip	12			X			
	2845							"		X					
								"					x		
			Mitchell Expl Co		4579	25345	88	Rock Chip	13			X			
								"		X					
								Soil	150			X			
								"		X					
								Soil/ Rock	41			X			
								"							
43	2645	107	BHP Minerals	5208	3665	22923	87	Lag	273			X			
								"			X				
								RAB	13			X			
								"		X	X				
								Rock Chip	45		X	X			
			BHP Minerals		3665	25674	88	Soil	201			X			
44	2644	2	Dominion Gold Operations P/L	5481	5597	23583	88	Soil	111			X			
45	2644	8	Renison Goldfields Cons Ltd	5492	5924	24027	87	RC	5			X			
								"							
			RGC Expl P/L		5924	30730	90	Soil	763			X			
			RGC Expl P/L		5924	33984	91	RC	14			X			
								Rock Chip	21			X			
								Soil	33			X			
46	2745		Pioneer Resources NL	5553	4836	24400	88	Stream	30			X			
								"				X		X	
47	2645	2	Mr WR Richmond	6050/3	6099	33468	91	Soil	168			X			

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
									Aqua regia/ AAS	RW		
X					X			X	AAS	"		
		X		X						"		
X	X	X	X	X	X	X		X		Classic	Y	D:0-4m Also for Bi, Cd, P, V
X	X	X	X	X	X	X		X		"		Also for Bi, Cd, P, V
X				X								Mesh:-6mm+10#
					x			x				Also for Bi but not all
X				X								Also for Bi
									Fire assay	RD		DL:5ppb
x					X	x		X	AAS	"		Also for Bi, Cd
									ICP-OES	"		Also for Be, F, P, Si
									Aqua regia/ ETA			DL:1ppb
X					X			X	AAS			
									Aqua regia/ ETA			DL:1ppb
X					X			X	AAS			
									Aqua regia/ ETA			DL:1ppb
								X	AAS			
									Fire assay	Analabs	Y	Lithic, Mesh:-8mm, Wt:2kg, DL:5ppb
									Hydride gen/ AAS	"		
									Fire assay	"		D:0-4m, DL:5ppb
X				X	X			X	AAS	"		
X				X	X			X		"		
									BLEG			Traverses, Mesh:-2mm, Wt:2kg, DL:0.1ppb
									AAS	RDG		Wt:1kg, D:blw 0.1m, DL:0.02ppm
									Aqua regia	ARM	Y	D:0-2m, DL:0.05ppm
x									Perchloric/ AAS	"		
									Aqua regia/ ETA	SGS		Traverses, DL:2ppb
X									Mixed acid/ AAS	"		
X											Y	D:0-2m
X												
X												
									Bulk cyanide leach	ALS		Mesh:-3.1mm, Wt:2-3kg, DL:50ppt
X				X	X	X		X		"		Also for Hg
									ETA	Genalysis	Y	DL:1ppb

Appendix 3

ID No.	*Map Sheet*	*Area sqkm*	*Company*	*M No.*	*Item No.*	*A No.(s)*	*Yr*	*Medium*	*No.*	*Ag*	*As*	*Au*	*Ba*	*Co*	*Cr*
48	2644	11	Invincible Gold NL	6321/4	6314	33366-67	91	RAB	14		X				
								"	420		X	X			
								Rock Chip	45			X			
								"			X				
49	2644	66	Sons of Gwalia NL	6321/5	6559	33275-76	91	RAB	31			X			
								"	1500		X	X			
								Rock Chip	90			X			
								"			X				
			Giralia Resources NL		6559	33855	91	Stream	28			X			
								Rock Chip	42	x	X	X			
50	2745	987	Reynolds Aust Metals Ltd	6328/1	5127	28946	89	Stream	5			X			
	2845							Rock Chip	66	X	X	X			
			Reynolds Aust Metals Ltd	6328/3	4439	28848	88	Rock Chip	8			X			
			Reynolds Aust Metals Ltd	6328/3	4439	30910	90	RAB	6			X			
51	2644	16	Carpenteria Expl Co P/L	6379	4007	28646	89	Soil	116			X			
								Stream	87			X			
52	2744	66	Pancontinental Mining Ltd	6403	6615	31146-47	90	RC	30			X			
								Rock Chip	44			X			
								Soil	140			X			
								"	79			X			
			Pancontinental Mining Ltd		6615	32044	90	Laterite	64	x	x	X	x	x	x
								Soil	53			X			
53	2644	350	Dominion Gold Operations P/L	6505	5592	29770-71	89	Soil	1108			X			
54	2744	1 068	ACM Gold Ltd	6681	4540	30957	90	Rock Chip	24			x			
	2745				"	31081-85		"			X				
	2845							"							
								Soil	394	X		X			
								"	71	X		X			
								"	480			X			
								"			X				
								"							
								Stream	177	X		X			
								"	177		X				
								"		X					

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
X											Y	D:0-3m
X												D:0-4m
									Fire assay/ ETA	RW		DL:1ppb
X									Acid digest/ AAS	"		
											Y	D:0-3m
												D:0-4m
									Fire assay/ ETA	RW		DL:1ppb
x									Acid digest/ AAS	"		
									BLEG	AAL	Y	Mesh:-1mm, Wt:5kg
x					x			x		"		
										Minlab		DL:0.01ppm
X		x		X	X			X		"		Also for W
										Minlab		DL:0.01ppm
									Aqua regia/ AAS	Minlab	Y	DL:0.01ppm, D:0-4m
									BLEG	ALS		D:0.05-0.2m, Composite over 100m, Wt:5kg, DL:50ppt
									BLEG	"		Mesh:-4mm, Wt:5kg, DL:50ppt
										Analabs	Y	D:0-1m
										"		
									BLEG	Genalysis		
X			X		X	x	x	X		Genalysis		Also for Bi, W
									Aqua regia/ ETA	"		DL:1ppb
									BLEG	Analabs		Wt:3kg
									Aqua regia/ AAS	SGS		DL:2ppb
									XRF	"		
X					X			X	Mixed acid/ AAS	"		
X									BLEG			Wt:2kg, Composite over 100m
X									BLEG			Wt:2kg, Composite over 1km
									Aqua regia/ AAS	SGS		DL:2ppb
									XRF	"		
X					X			X	Mixed acid/ AAS	"		
X									BLEG			
			X			X	X		XRF	SGS		
X					X			X	Mixed acid/ AAS	"		

Appendix 3

ID No.	*Map Sheet*	*Area sqkm*	*Company*	*M No.*	*Item No.*	*A No.(s)*	*Yr*	*Medium*	*No.*	*Ag*	*As*	*Au*	*Ba*	*Co*	*Cr*
55	2645	150	ACM Gold Ltd	6702	6795	31080	90	Rock Chip	53			X			
	2745							"			X				
								"							
								Soil	119	X		X			
								"	119		X				
								"							
								Stream	54	X		X			
								"	54	X					
								"			X				
			ACM Gold Ltd		6795	34421	91	Soil	113						
56	2644	198	Homestake Aust Ltd	6917	5349	32767	91	Rock Chip	8			X			
								Soil	16			X			
								Stream	173			X			
57	2645	25	Sons of Gwalia NL	7036	5787	33986	91	Auger	218			X			
								Rock Chip	52		X	X			
								Soil	155			X			
								Stream	15			X			
								"							
58	2645	50	MIM Expl P/L	7174	7521	34807	91	Rock Chip	47			X			
								"							
								"		X	X				
								"	10						
								"	11						
59	2744	3	Trefari P/L	7194	5764	34727	91	Soil	101			X			
					"	34729		"			X				X
								Vacuum	6			X			
								"			X				X
60	2744		Trefari P/L	7242	6458	34945	91	Soil	289			X			
								"			X				X
								Vacuum	44			X			
								"			X				X
61	2644	85	Sons of Gwalia Ltd	7573	6922	36539	92	RAB	186		X	X			
								"	11		X				
								Rock Chip	56			X			
								"			X				
			Sons of Gwalia Ltd		6922	38334	93	RAB	2			X			
								RC	4			X			
								Soil	97			X			

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
									Aqua regia/ AAS			DL:0.01ppm
									Hydride gen/ XRF			
X					X			X	AAS			
X									BLEG			Wt:2kg, Composite over 100m
									Hydride generation			
X					X			X	AAS			
X									BLEG			
X					X			X	Mixed acid/ AAS	SGS		
			X			X	X		XRF	"		
X					X			X	AAS	RW	Y	Wt:2kg
									Fire assay/ AAS	Analabs		DL:5ppb
									BLEG	ALS		Wt:4-6kg, Composite over 100m
									BLEG	"		DL:50ppt, Wt:5-7kg
									Aqua regia/ ETA	Genalysis		D:0-1m, Wt:1kg, DL:1ppb
X					X			X		Analabs		
									Aqua regia/ ETA	Genalysis		Mesh:-2mm, Composite over 25m, DL:1ppb
									BLEG	"		Mesh:-2mm, DL:0.1ppb
x					x			x	Mixed acid/ AAS	"		
									Fire assay	Classic		DL:0.01ppm
X					X			X	AAS	"		
							X		XRF	"		
X					X			X	AAS	"		
					X				XRF	"		
									ETA	Genalysis	Y	D:0.2m, DL:1ppb
X					X			X	AAS	"		
									ETA	"		D:1.8-3m, DL:1ppb
X					X			X	AAS	"		
									ETA	Genalysis	Y	D:0.2m, DL:1ppb
X					X			X	AAS	"		
									ETA	"		D:0-3m, DL:1ppb
X					X			X	AAS	"		
X										RW	Y	D:0-4m
X					X			X		"		D:0-4m
									Fire assay/ ETA	"		DL:1ppb
									Acid digest/ AAS	"		
										RW	Y	D:0-4m
												D:0-4m
									Fire assay	RW		Mesh:-2mm, Composite over 100m, DL:1ppb

Appendix 3

ID No.	*Map Sheet*	*Area sqkm*	*Company*	*M No.*	*Item No.*	*A No.(s)*	*Yr*	*Medium*	*No.*	*Ag*	*As*	*Au*	*Ba*	*Co*	*Cr*
62	2844		Helix Resources NL	7844	6769	37713	93	Pisolite	68			X			
								"			X				
								Soil	30			X			
								"			X				
								"	286			X			
								"	44			X			
								"			X				
63	2745	289	Mr BW Menzel	8159	7127	38954	93	Soil	126						
64	2645	348	Geopeko	8316	7528	39410	93	Rock Chip	23			X			
	2745							"		X	X			X	
								Stream	36			X			
								"		X	X			X	
65	2644		Battle Mountain Inc	8385	7230	39917	93	Rock Chip	6			X			
	2744							Soil	118			X			
								Stream	6			X			

SOURCE: Department of Minerals and Energy, WAMEX database, 21 February 1995

(continued)

Cu	*Fe*	*Mn*	*Mo*	*Ni*	*Pb*	*Sb*	*Sn*	*Zn*	*Method*	*Analyst*	*DD*	*Comment on Samples*
									ETA	Genalysis		DL:1ppb
									AAS	"		
									BLEG/ AAS	Analabs		Mesh:-1.8mm, Wt:2kg, DL:0.1ppb
									Hydride generation	"		
									BLEG/ AAS	Genalysis		Mesh:-1.8mm, Wt:2kg, DL:0.2ppb
									BLEG, ETA	"		Mesh:-1.8mm, Wt:2kg, DL:1ppb
									AAS	"		
X											Y	
									Aqua regia/ ETA	Genalysis		
X	X	X	X	X	X			X	AAS	"		Also for Bi
									Aqua regia/ ETA	Genalysis		Mesh:-4mm
X	X	X	X	X	X			X	AAS	"		
										Minlab		
										ALS		Mesh:-2mm, Wt:0.5kg, DL:1ppb
									BLEG	"		Mesh:-2mm, Wt:3kg

Appendix 4

Stratigraphy of the Yerrida and Bryah Basins on GLENGARRY

(after Pirajno et al., in press)

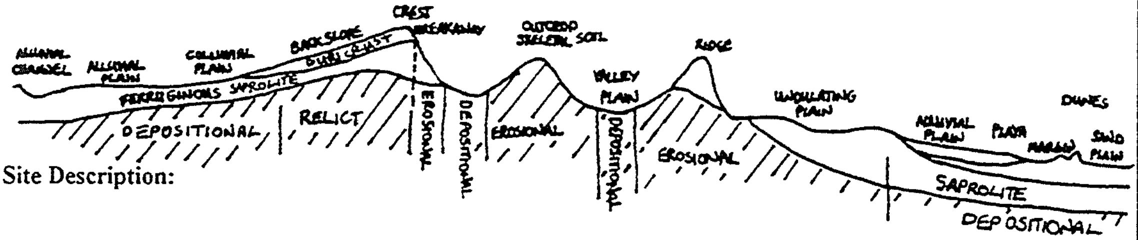
	Subgroup	*Formation*	*Rock type*	*Headings in GLENCHEM.CSV*
BRYAH BASIN Bryah Group		Narracoota	mafic–ultramafic volcanic and sedimentary rocks	*Narracoota*
		Karalundi	conglomerate, quartz wacke	*Karalundi*
			Faulted contact	
YERRIDA BASIN Yerrida Group	Mooloogool	Maraloou	black shale, siltstone, carbonate	*Maraloou*
		Killara including Bartle Member	mafic extrusive and intrusive rocks	*Killara* *Bartle*
		Doolgunna	mixtite and clastic rocks	*Thadool* (Thaduna and Doolgunna) *Mixed* (Thaduna, Doolgunna and Killara sills)
		Thaduna	lithic wacke, siltstone, shale minor arkose	
	Windplain	Johnson Cairn		not sampled
		Juderina (Bubble Well and Finlayson Members)	arenite, conglomerate, minor carbonate	*Finlayson*

Appendix 5

Sample-site form

Sheet ________ Zone ________	Loc/n No ____________	GSWA No ____________	Date ________
Site Ref ________________	________________ E	________________ N	Sampler ______

Channel ☐ Pit/Hole ☐	Single point ☐ Mult/Point ☐	Shtwash ☐ Creek ☐ Soil ☐ Lake ☐
Landform	Photo Y / N (Describe)	Surrounding Regolith Code ________



Site Description:

CLASTS	Gravel (2-5mm) ☐ Stones (5-64mm) ☐ Cobbles (64-256mm) ☐ Boulders (>256mm) ☐

Abundant : >30% Common : 5-30% Rare : 1-5% Trace : <1%

Lat Abnt/ Comn / Rare/ Tr ☐	Non-Lat Abnt/Comn/Rare/Tr ☐	Lithic Abnt/ Comn / Rare/ Tr ☐
☐ Lateritic Pisoliths	☐ Gossan fragments	☐ Saprolite fragments
☐ Lateritic Nodules	☐ Ferrug lithic fragments	☐ Ferruginous Saprolite frag's
☐ Brown Ferrug. duricrust	☐ Black ferrug granules	☐ Saprock Fragments
☐ Black ferrug. duricrust	☐ Brown ferrug granules	☐ Fresh B'rock frag's (below)
☐ Black pisolitic ferrug duricrust	☐	☐ Quartz ☐ Other Silica

Non-Lith Abnt/Comn/Rare/Tr ☐	Clast Lithology		
☐ Feldspar	☐ *Mafic*	☐ *BIF*	☐ Carbonate
☐ Calcrete	☐ *Ultramafic*	☐ *Sandstone*	☐ *Pyroclastics*
☐ Hardpan	☐ *Felsic*	☐ *Ark / Gwk*	☐ Other
☐ MnO_2	☐ *Granite*	☐ *Shale*	________
☐ Silcrete ☐ Other : ______	☐ Quartzite	☐ *Chert*	________

Secondary coating	☐ Fe / Mn	☐ Siliceous	☐ Calcareous	☐ Clay

- 2 mm Material ☐ Sand (0.1 - 2mm) ☐ Clay ☐ Other ____________ Colour ____________

Rock O/c Dist Direct	Secondary Units Nearby	Heading ________ Width: ______ m
__________ ____ m _____	Hardpan ☐ Consolidated Collvm ☐	Single ☐ Braided ☐ Incised ☐
__________ ____ m _____	Calcrete ☐ Duricrust ☐	Sieved to Size Y/N Depth-____
__________ ____ m _____	Mot Zone ☐ Saprolite ☐ Saprock ☐	Osize - ____ % Usize - ____ %
__________ ____ m _____	Gyps Dune ☐ Sand Dune ☐ Salt ☐	Stream Order (GSWA use only)

REMARKS

____

____

____

Figures

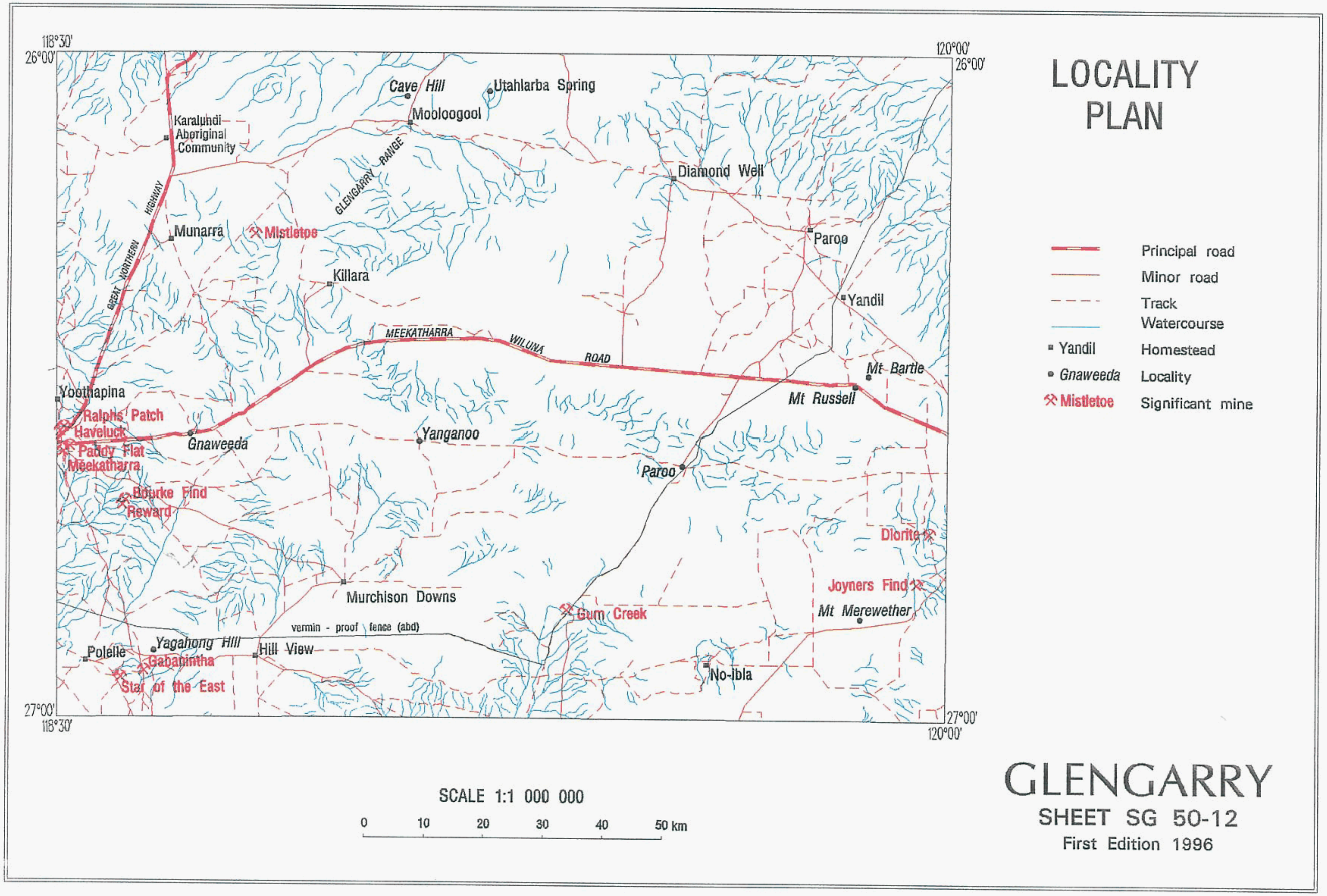
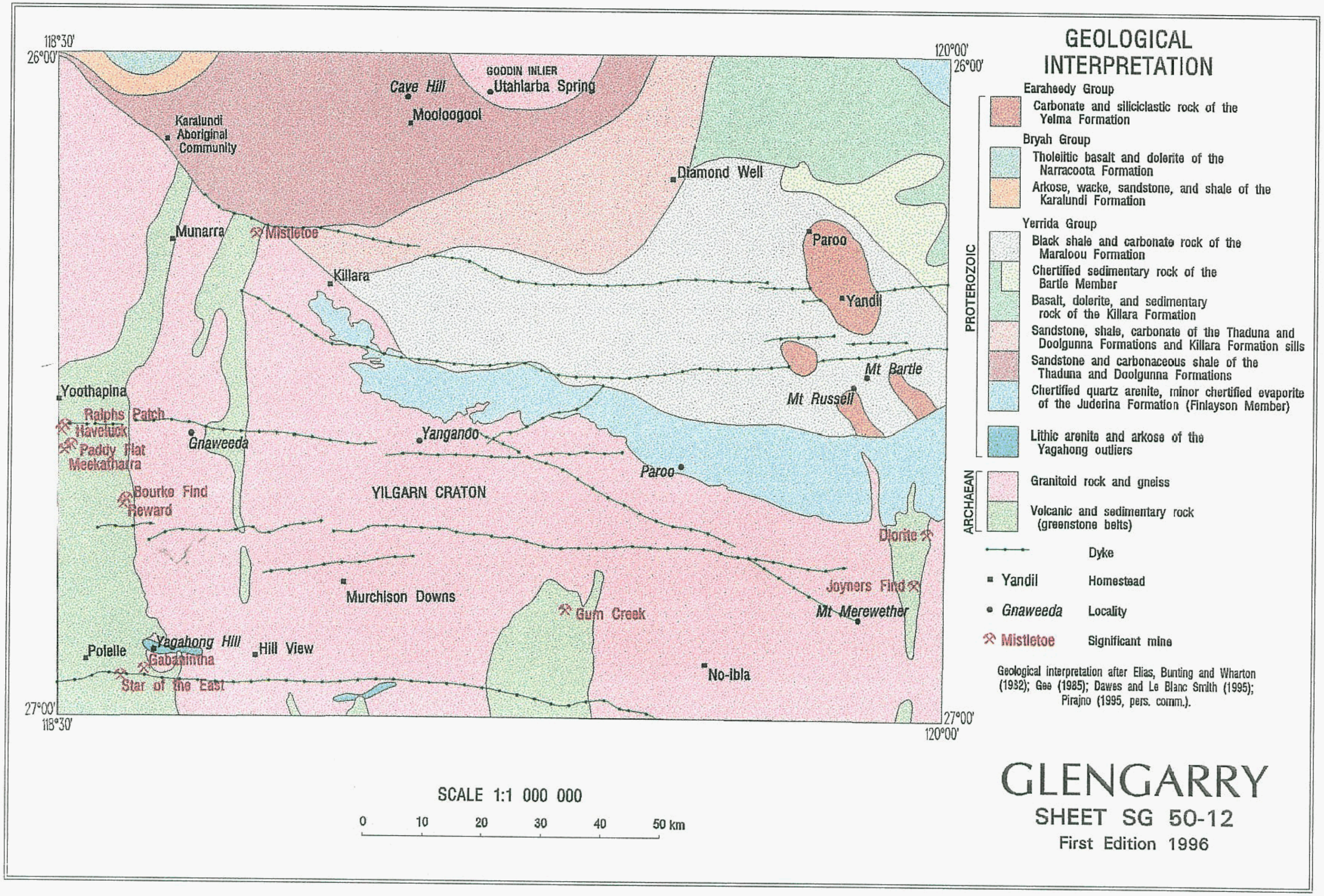

LOCALITY PLAN
118°30'
26°00'
120°00'
27°00'
Cave Hill
Utahlarba Spring
Mooloogool
Karalundi Aboriginal Community
GLENGARRY RANGE
GREAT NORTHERN HIGHWAY
Diamond Well
Munarra
Mistletoe
Paroo
Killara
Yandil
MEEKATHARRA WILUNA ROAD
Mt Bartle
Mt Russell
Yoothapina
Ralphs Patch
Haveluck
Paddy Flat
Meekatharra
Gnaweeda
Yanganoo
Paroo
Bourke Find
Reward
Diorite
Joyners Find
Murchison Downs
Gum Creek
Mt Merewether
vermin - proof fence (abd)
Polelle
Yagahong Hill
Hill View
Gabanintha
Star of the East
No-Ibla
Principal road
Minor road
Track
Watercourse
Yandil
Homestead
Gnaweeda
Locality
Mistletoe
Significant mine
SCALE 1:1 000 000
0
10
20
30
40
50 km
GLENGARRY
SHEET SG 50-12
First Edition 1996

Figure 1.



GEOLOGICAL INTERPRETATION
Earaheedy Group
Carbonate and siliciclastic rock of the Yelma Formation
Bryah Group
Tholeiitic basalt and dolerite of the Narracoota Formation
Arkose, wacke, sandstone, and shale of the Karalundi Formation
Yerrida Group
Black shale and carbonate rock of the Maraloou Formation
Chertified sedimentary rock of the Bartle Member
Basalt, dolerite, and sedimentary rock of the Killara Formation
Sandstone, shale, carbonate of the Thaduna and Doolgunna Formations and Killara Formation sills
Sandstone and carbonaceous shale of the Thaduna and Doolgunna Formations
Chertified quartz arenite, minor chertified evaporite of the Juderina Formation (Finlayson Member)
Lithic arenite and arkose of the Yagahong outliers
PROTEROZOIC
Granitoid rock and gneiss
Volcanic and sedimentary rock (greenstone belts)
ARCHAEAN
Dyke
Yandil
Homestead
Gnaweeda
Locality
Mistletoe
Significant mine
Geological interpretation after Elias, Bunting and Wharton (1982); Gee (1985); Dawes and Le Blanc Smith (1995); Pirajno (1995, pers. comm.).
GLENGARRY
SHEET SG 50-12
First Edition 1996
SCALE 1:1 000 000
0
10
20
30
40
50 km
118°30'
26°00'
120°00'
27°00'
GOODIN INLIER
Cave Hill
Utahlarba Spring
Mooloogool
Karalundi Aboriginal Community
Diamond Well
Munarra
Mistletoe
Killara
Paroo
Yandil
Mt Bartle
Mt Russell
Yoothapina
Ralphs Patch
Havelock
Paddy Flat
Meekatharra
Gnaweeda
Yangando
Paroo
Bourke Find
Reward
YILGARN CRATON
Diorite
Joyners Find
Murchison Downs
Gum Creek
Mt Merewether
Polelle
Yagahong Hill
Hill View
Gabanintha
Star of the East
No-ibla

Figure 2.

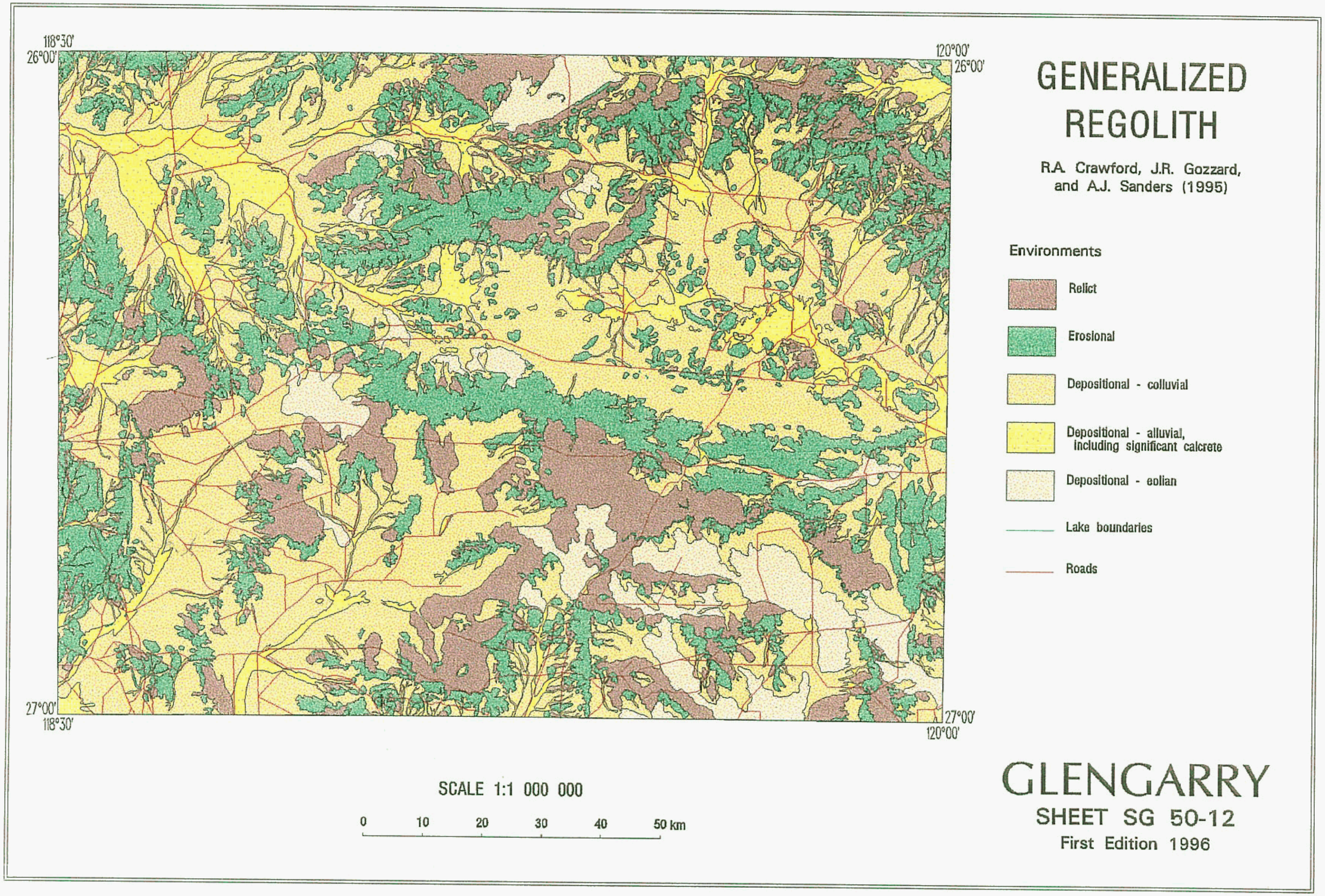

118°30'
26°00'
120°00'
26°00'
27°00'
118°30'
27°00'
120°00'
GENERALIZED
REGOLITH
R.A. Crawford, J.R. Gozzard, and A.J. Sanders (1995)
Environments
Relict
Erosional
Depositional - colluvial
Depositional - alluvial, including significant calcrete
Depositional - eolian
Lake boundaries
Roads
SCALE 1:1 000 000
0
10
20
30
40
50 km
GLENGARRY
SHEET SG 50-12
First Edition 1996

Figure 3.

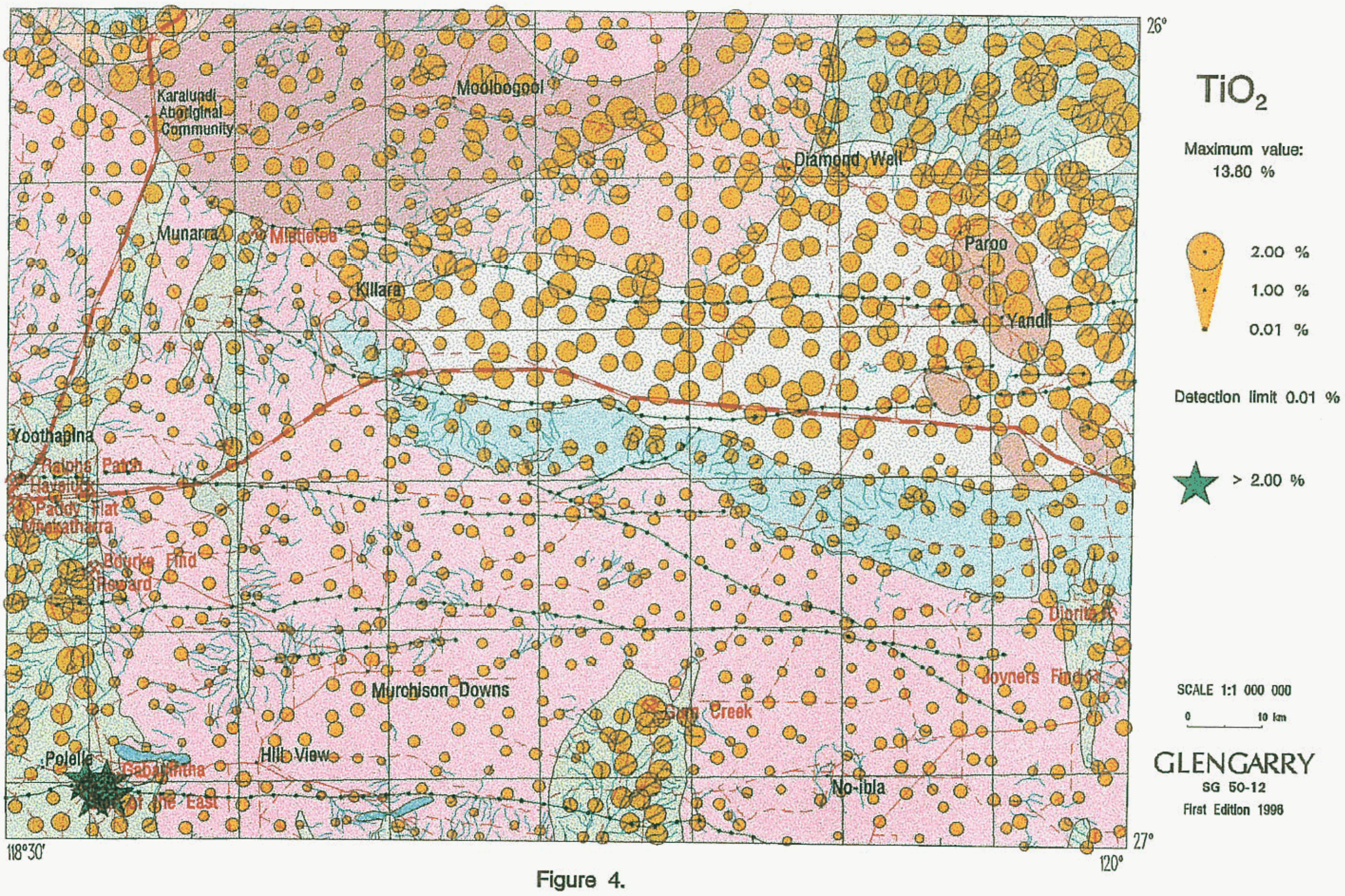


Figure 4.

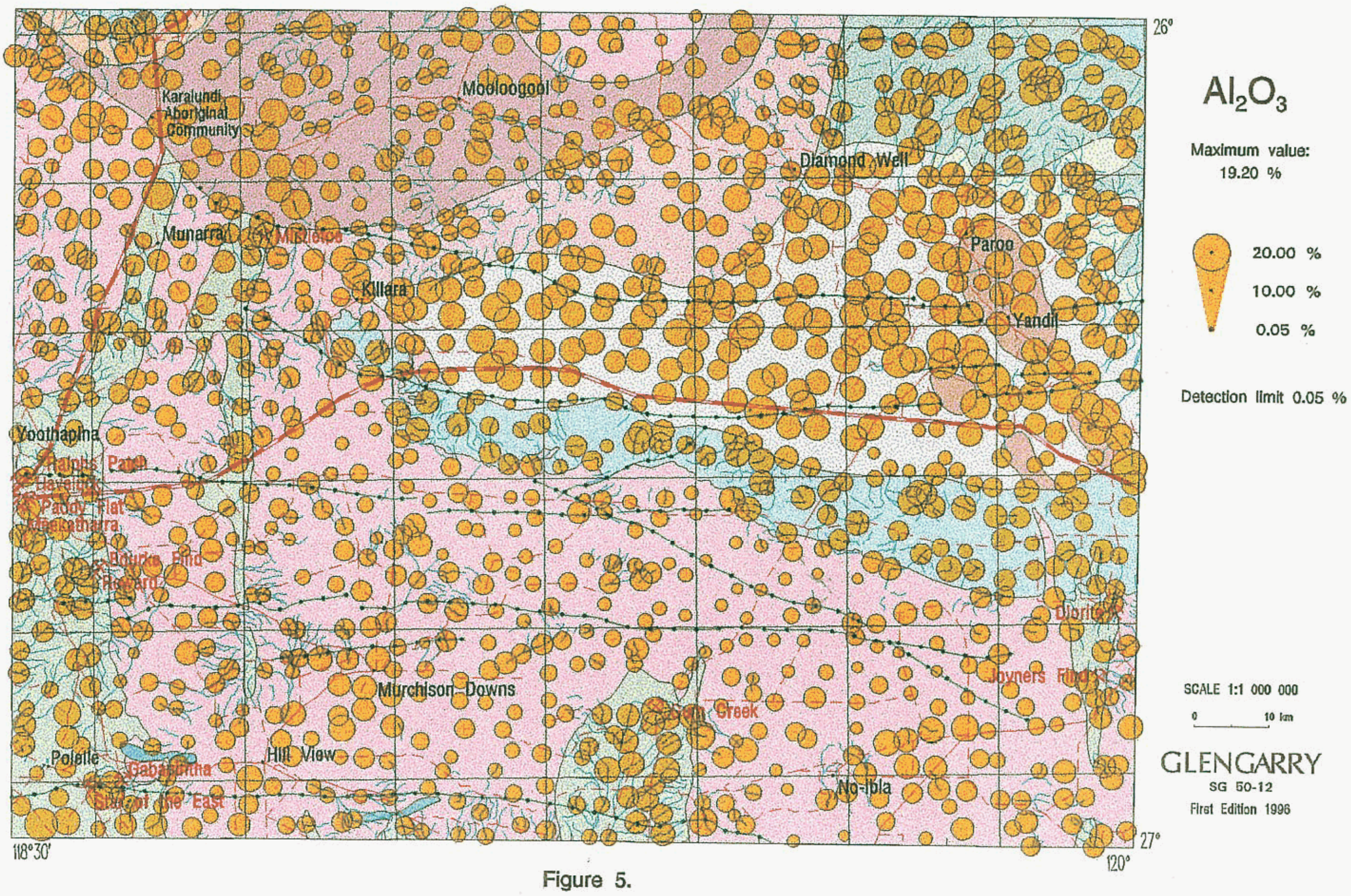


Figure 5.

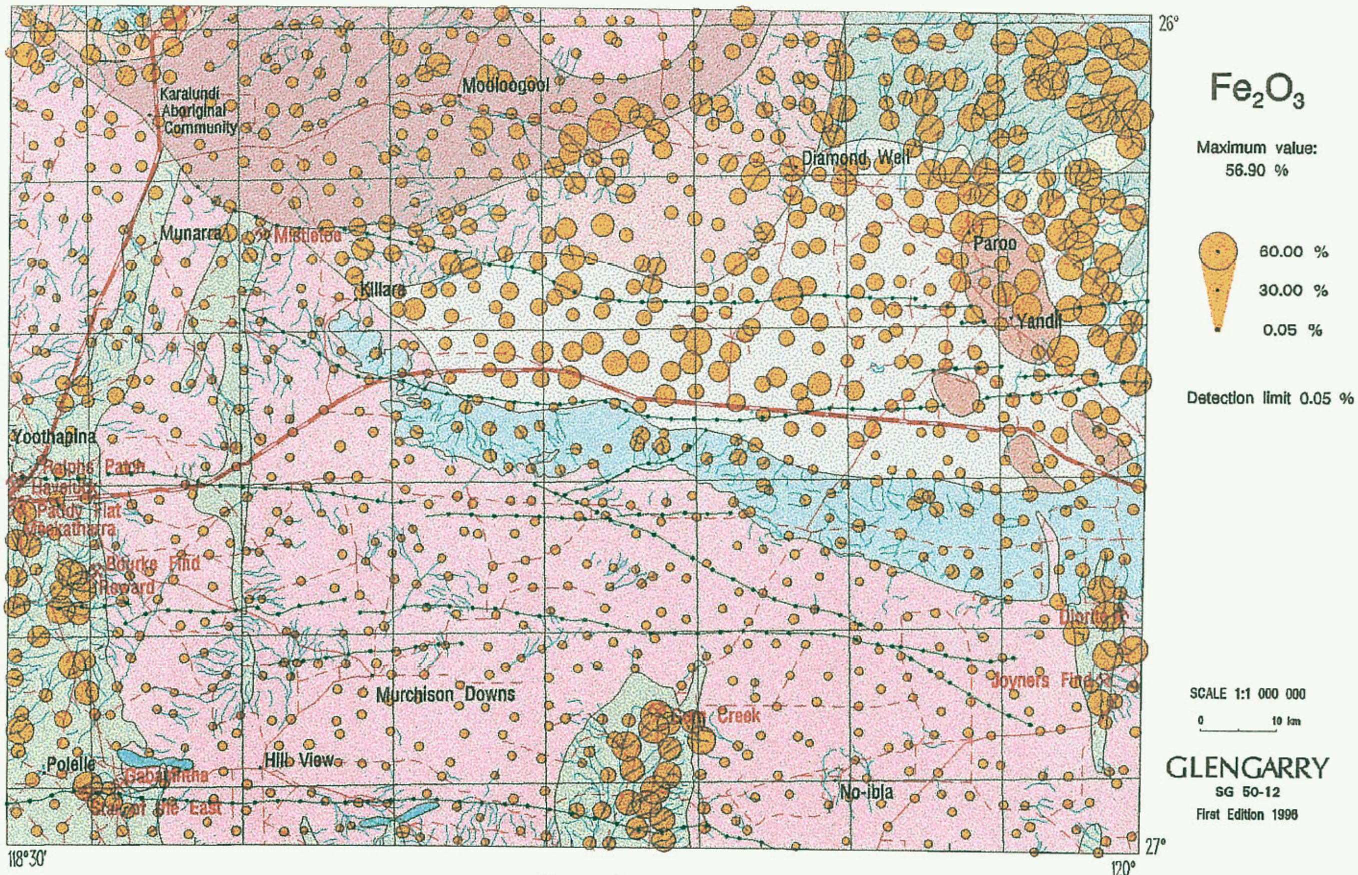


Figure 6.

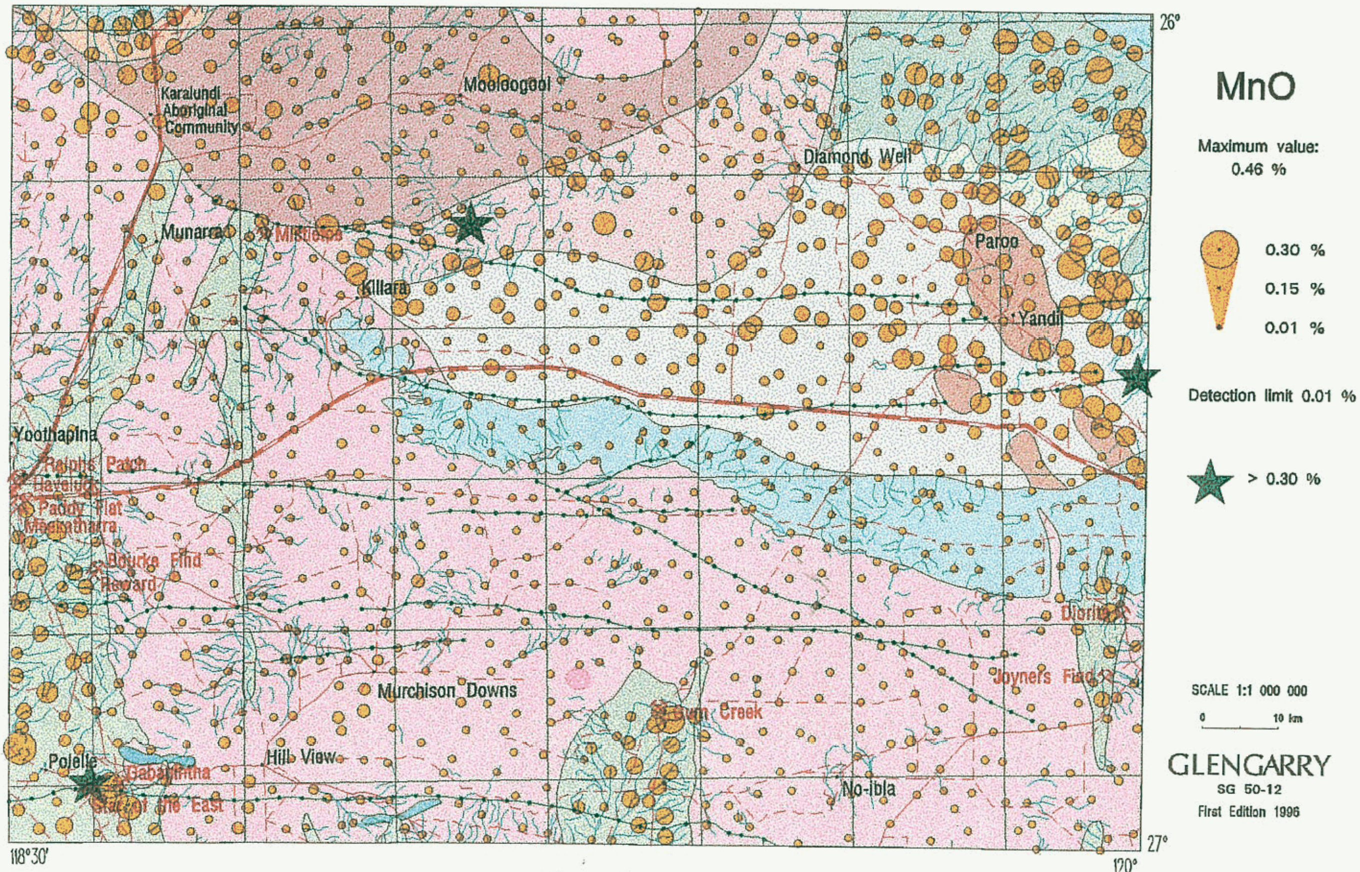


Figure 7.

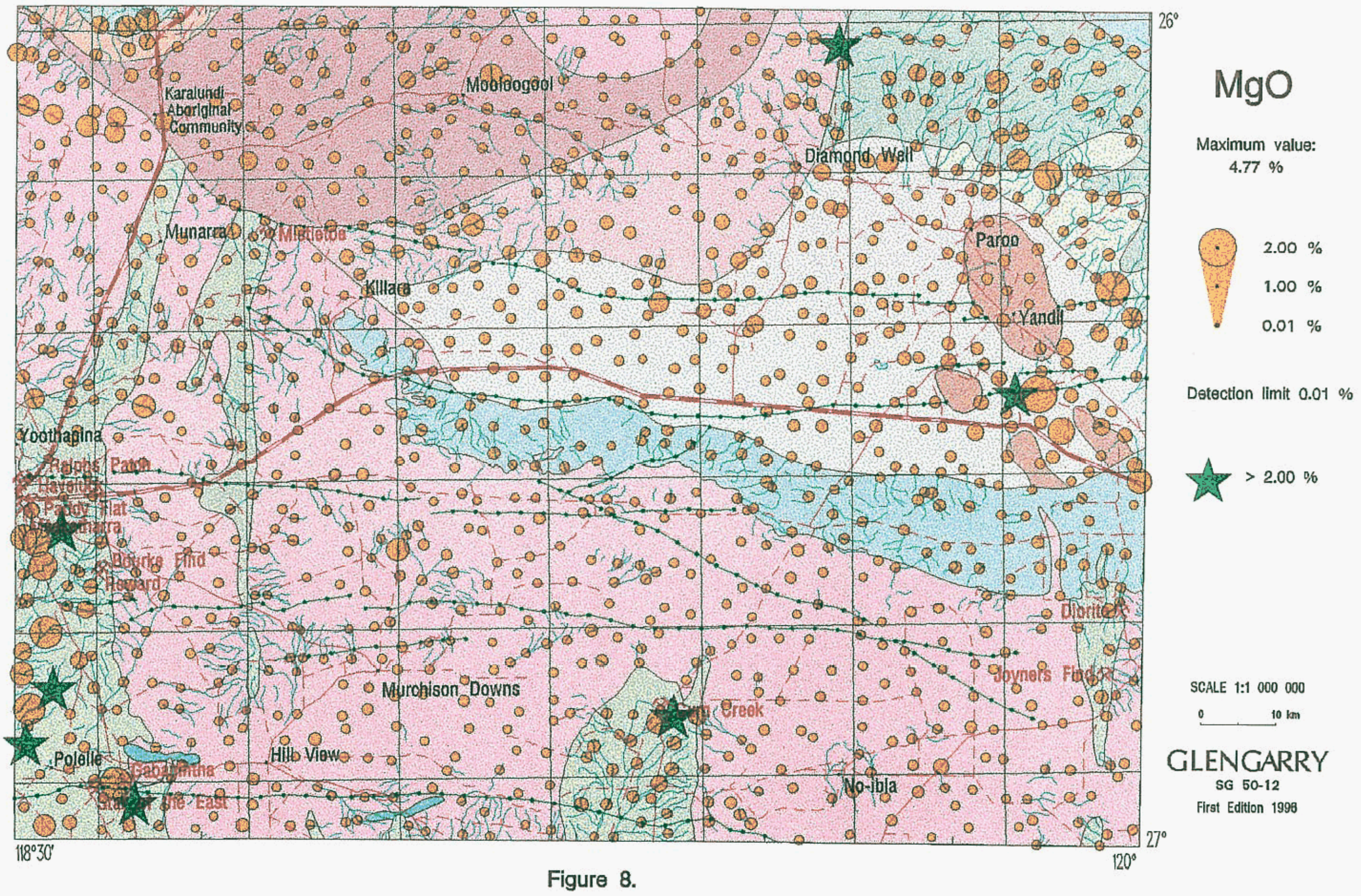


Figure 8.

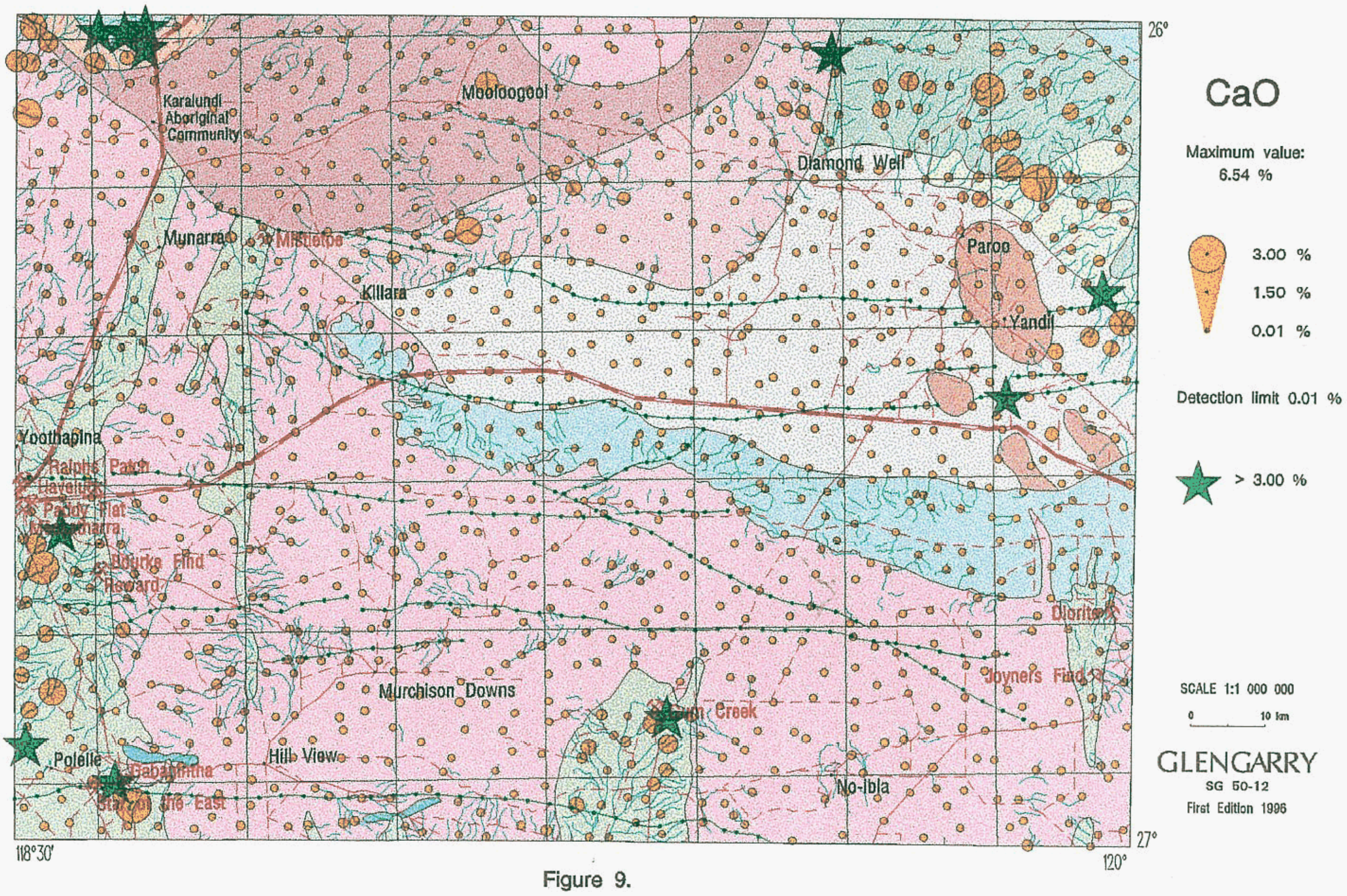


Figure 9.

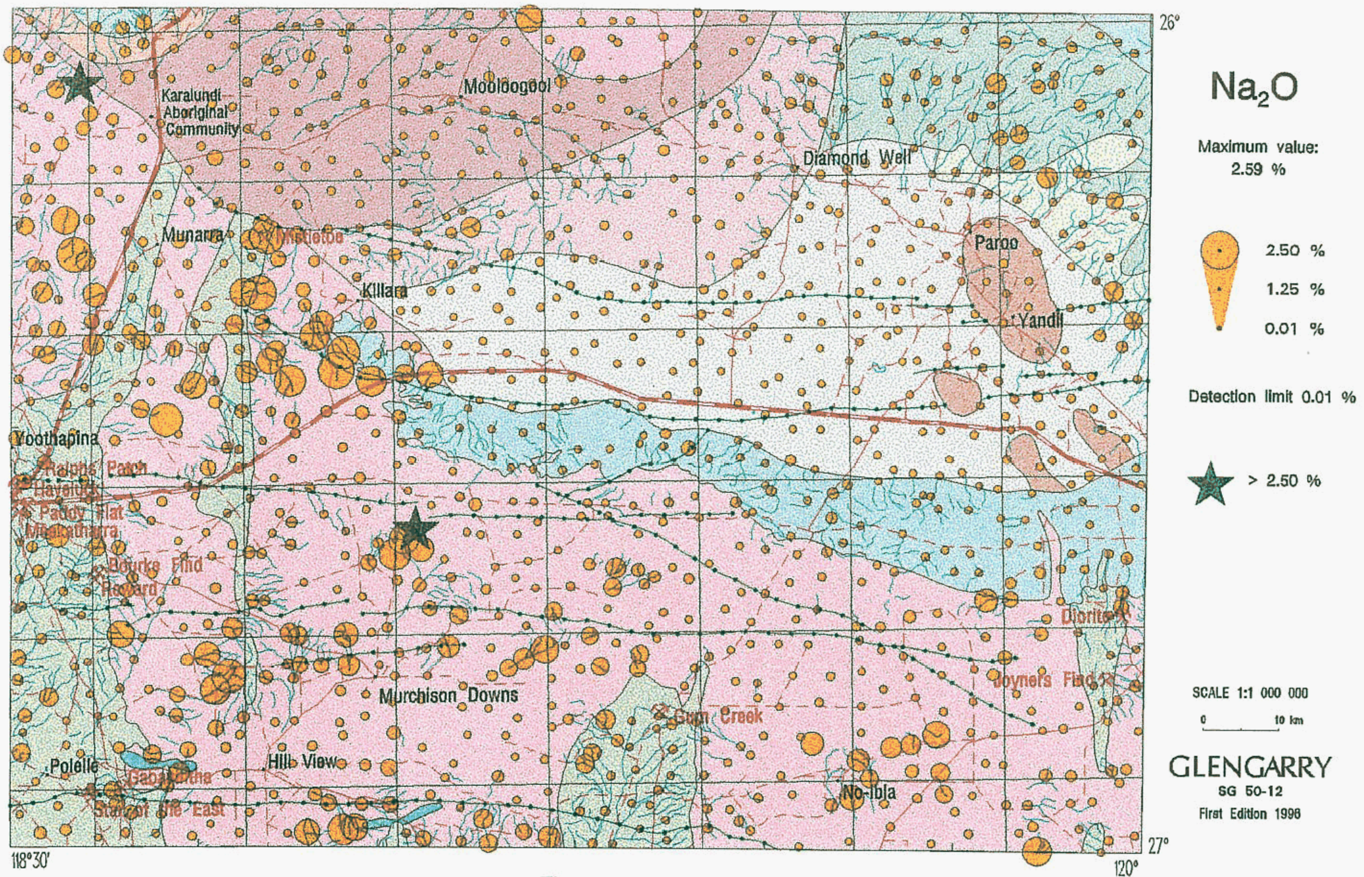


Figure 10.

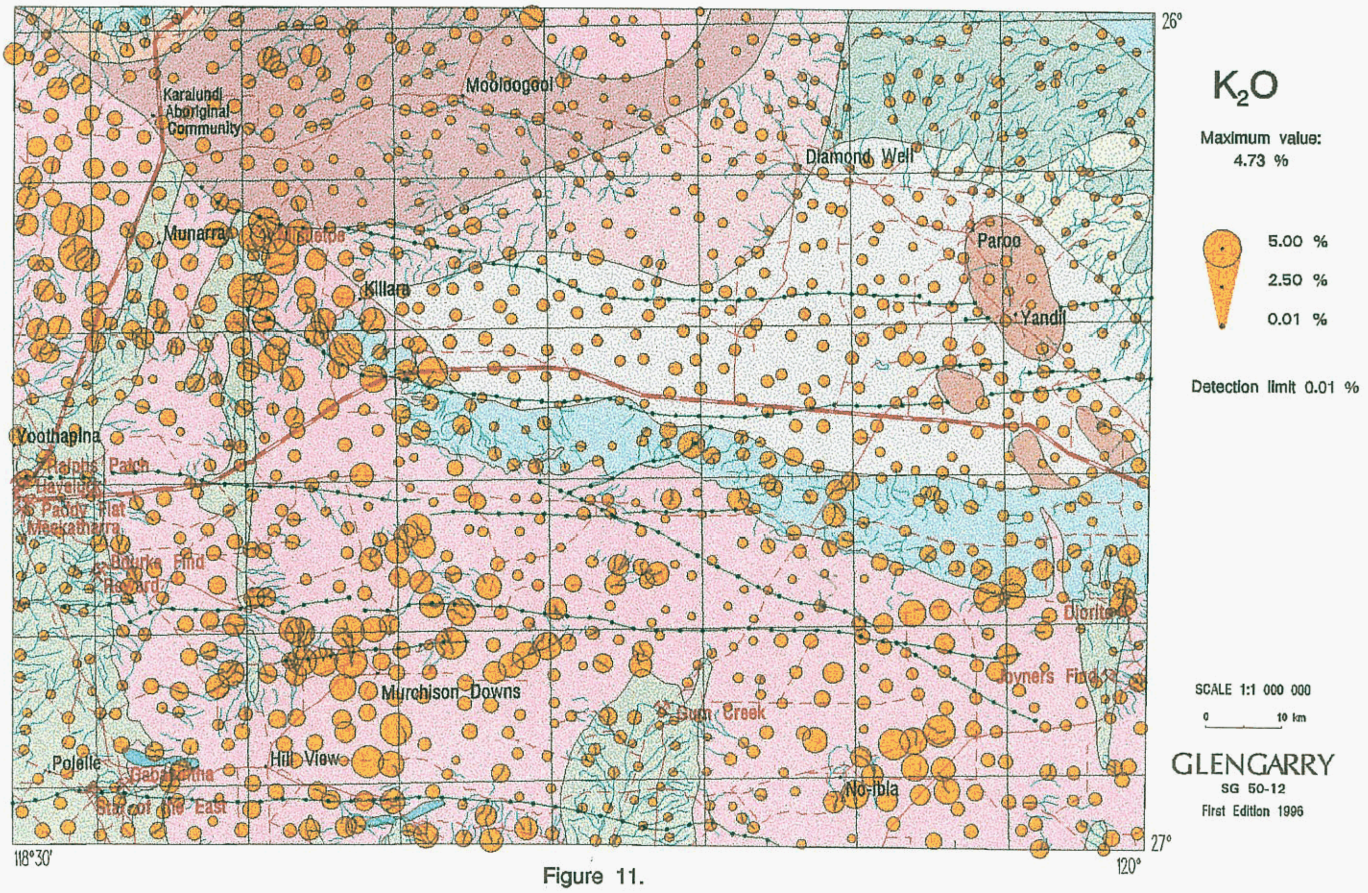


Figure 11.

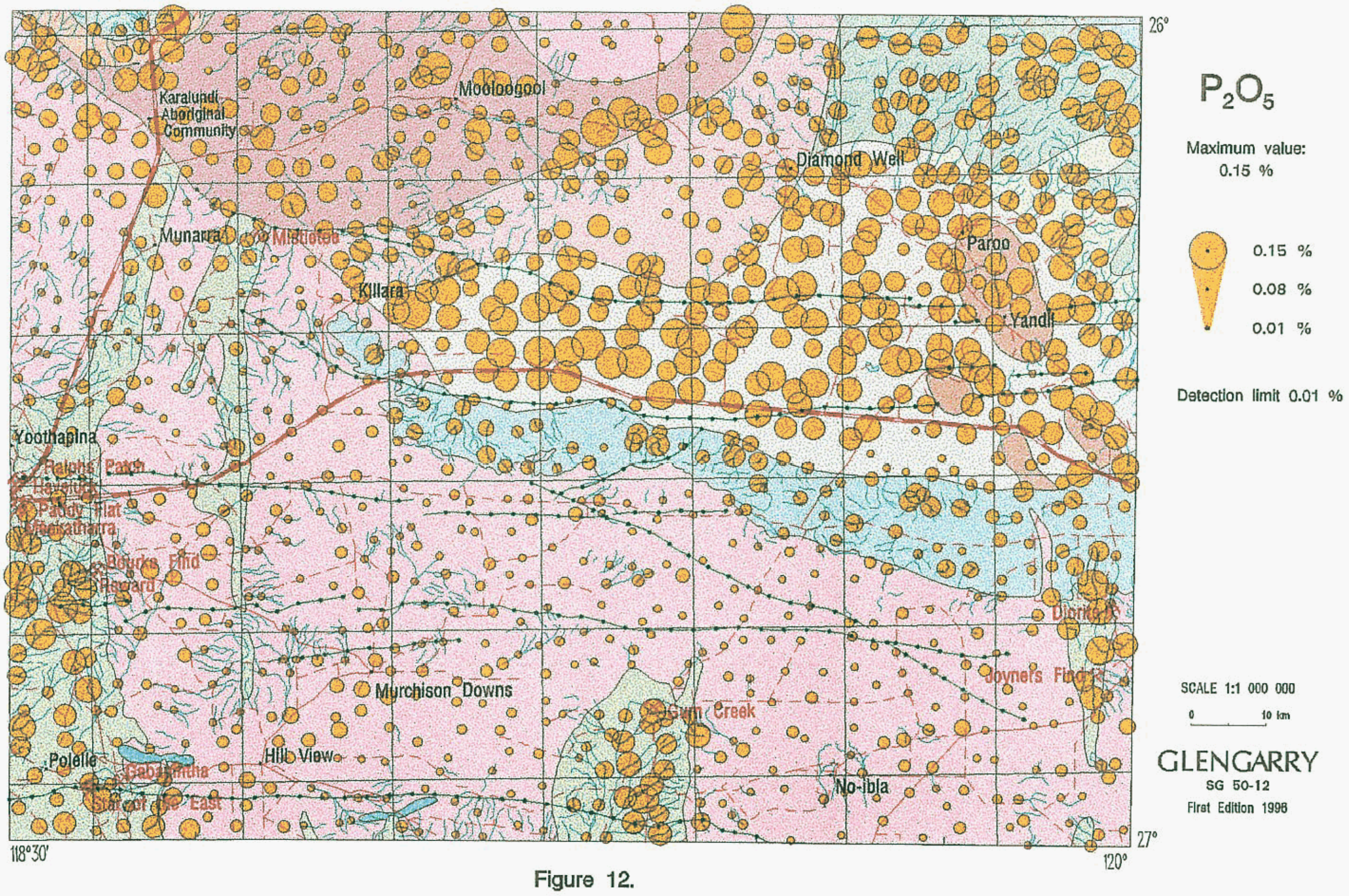


Figure 12.

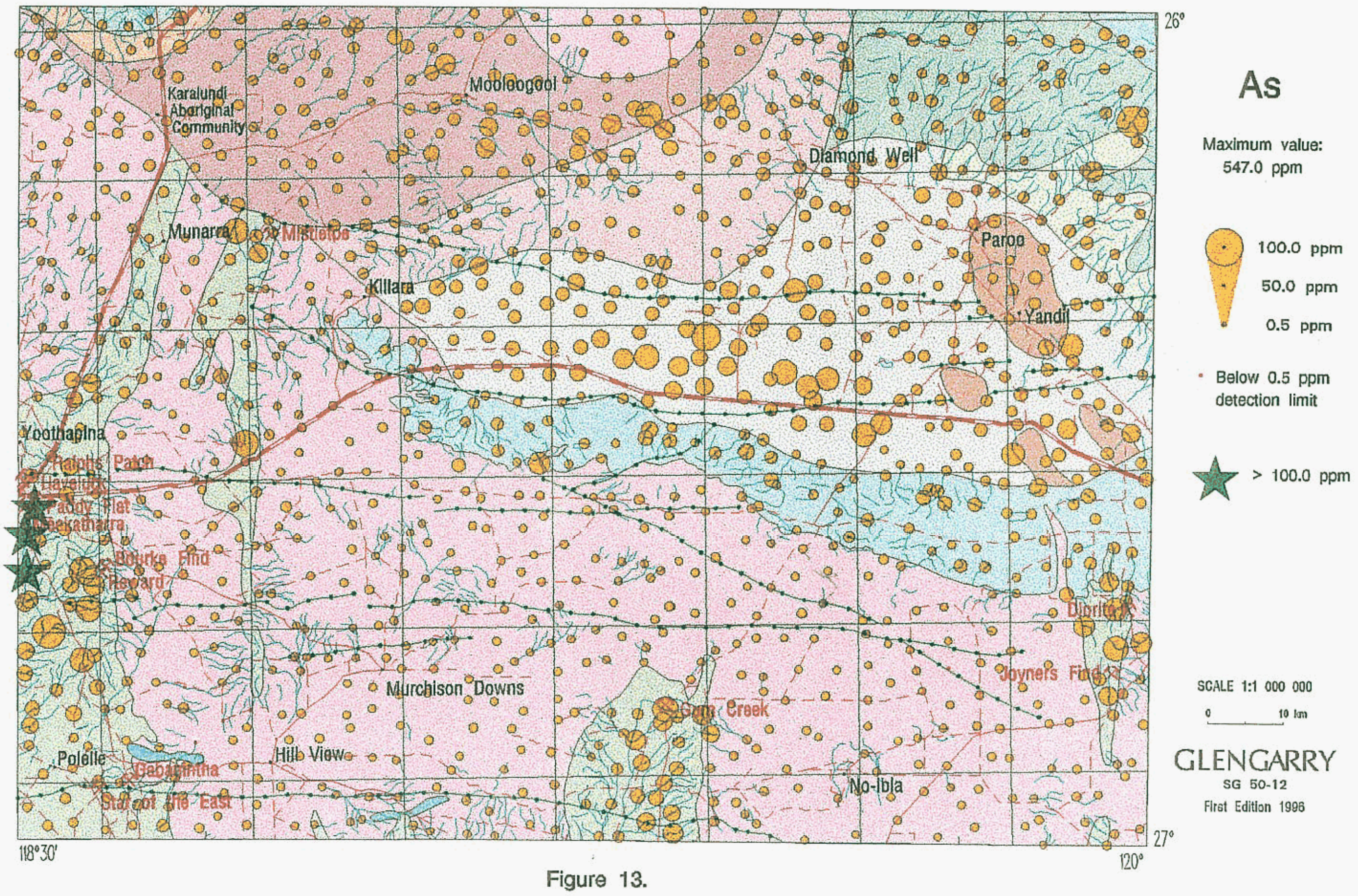


Figure 13.

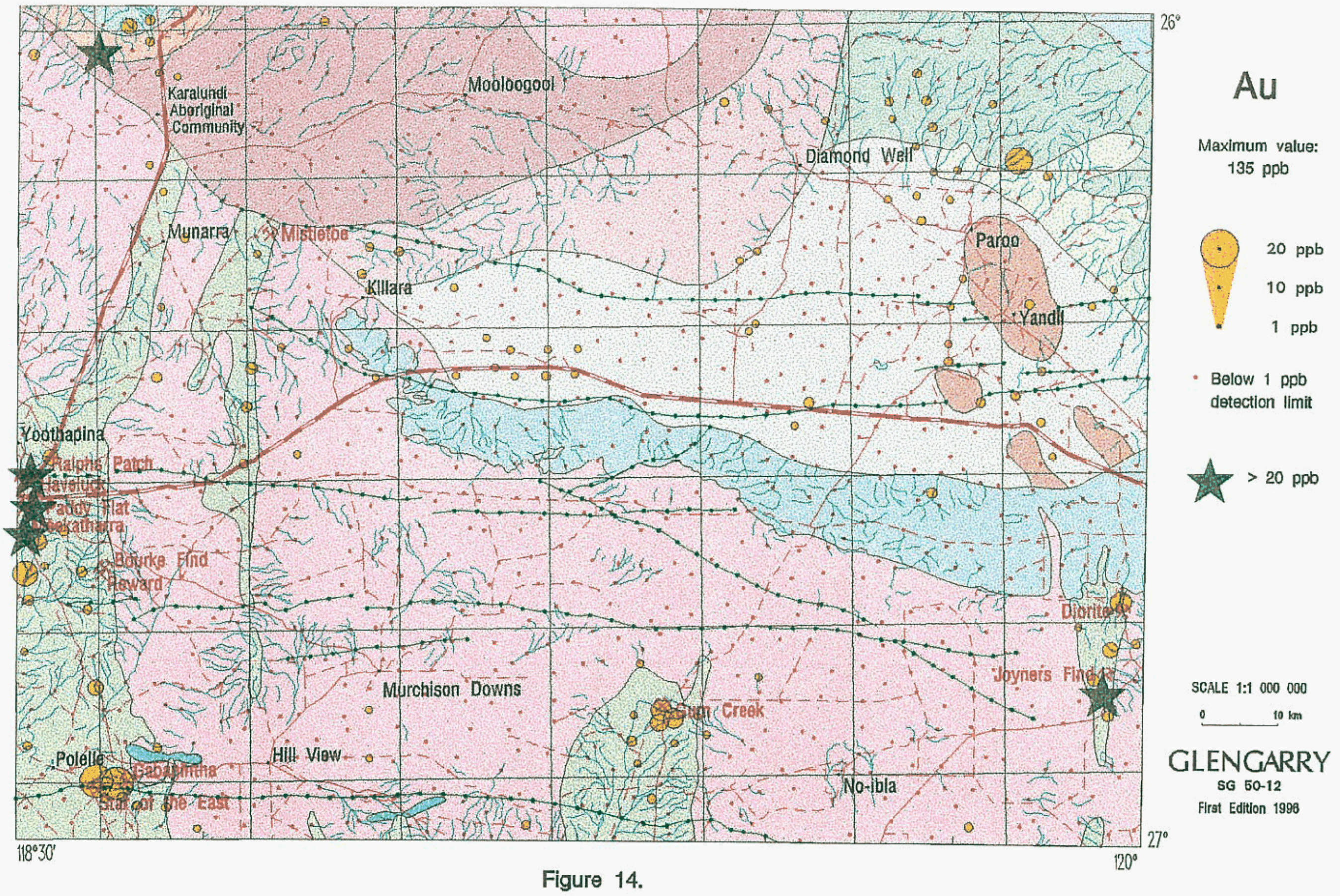


Figure 14.

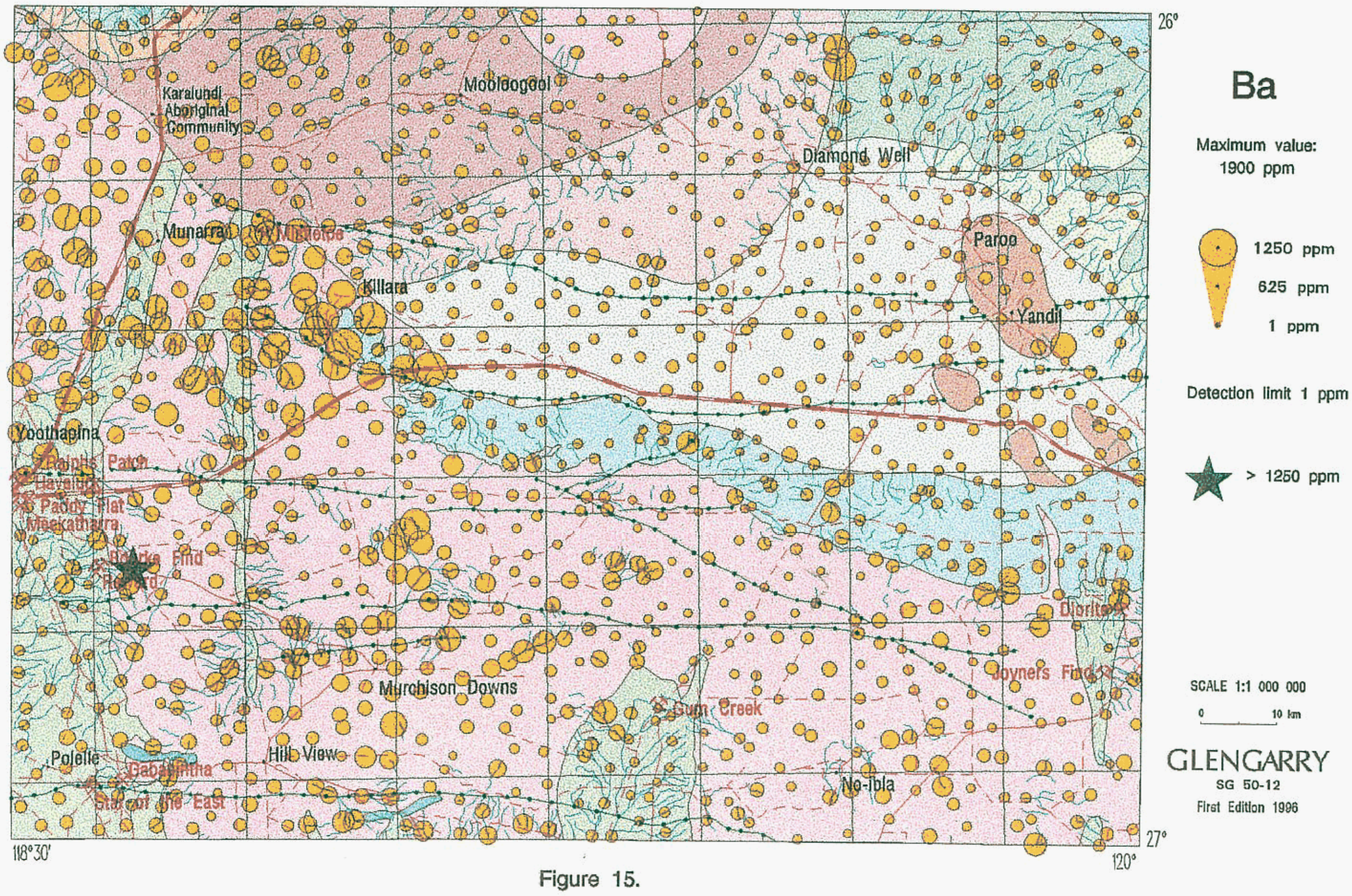


Figure 15.

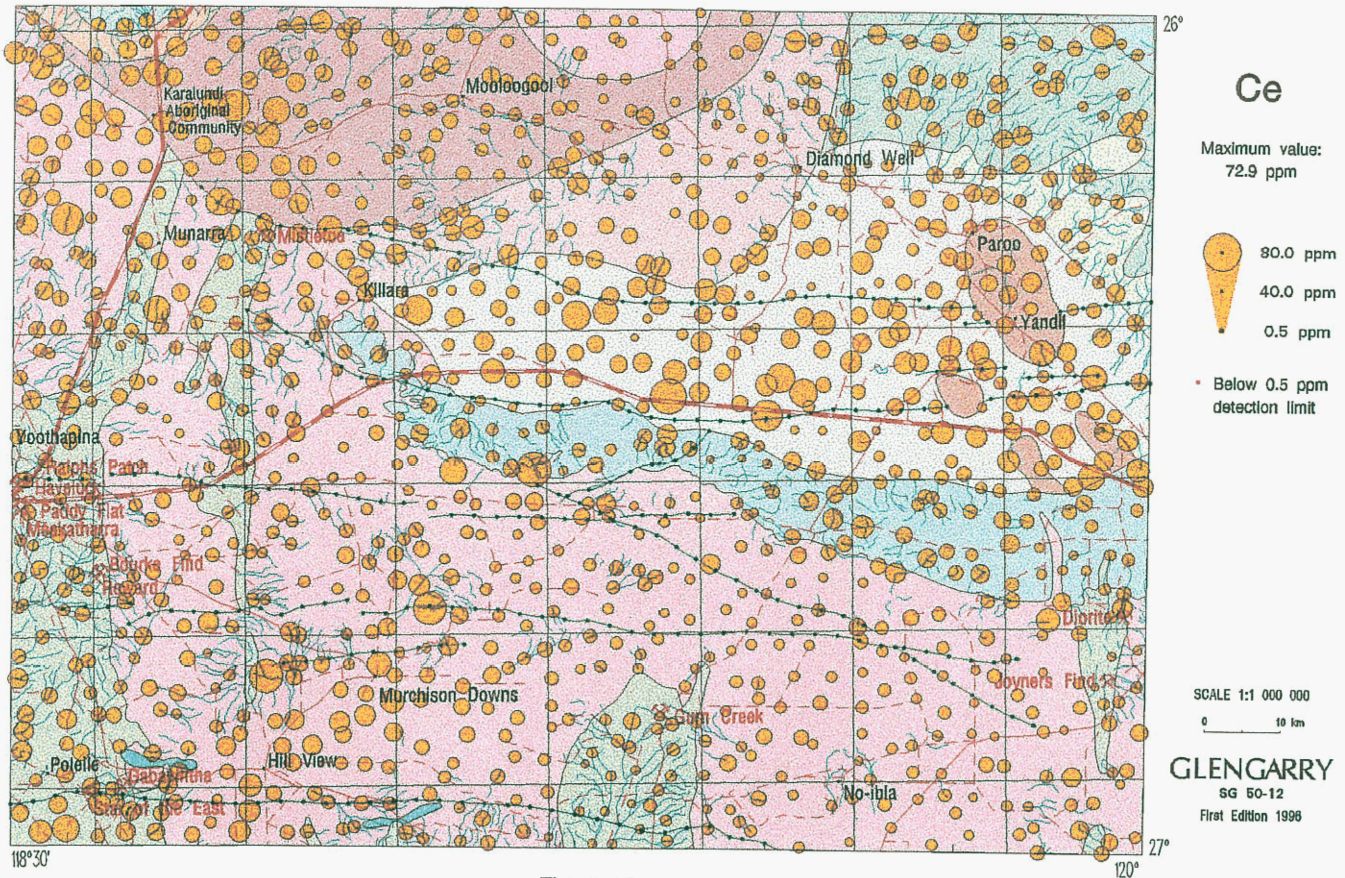


Figure 16.

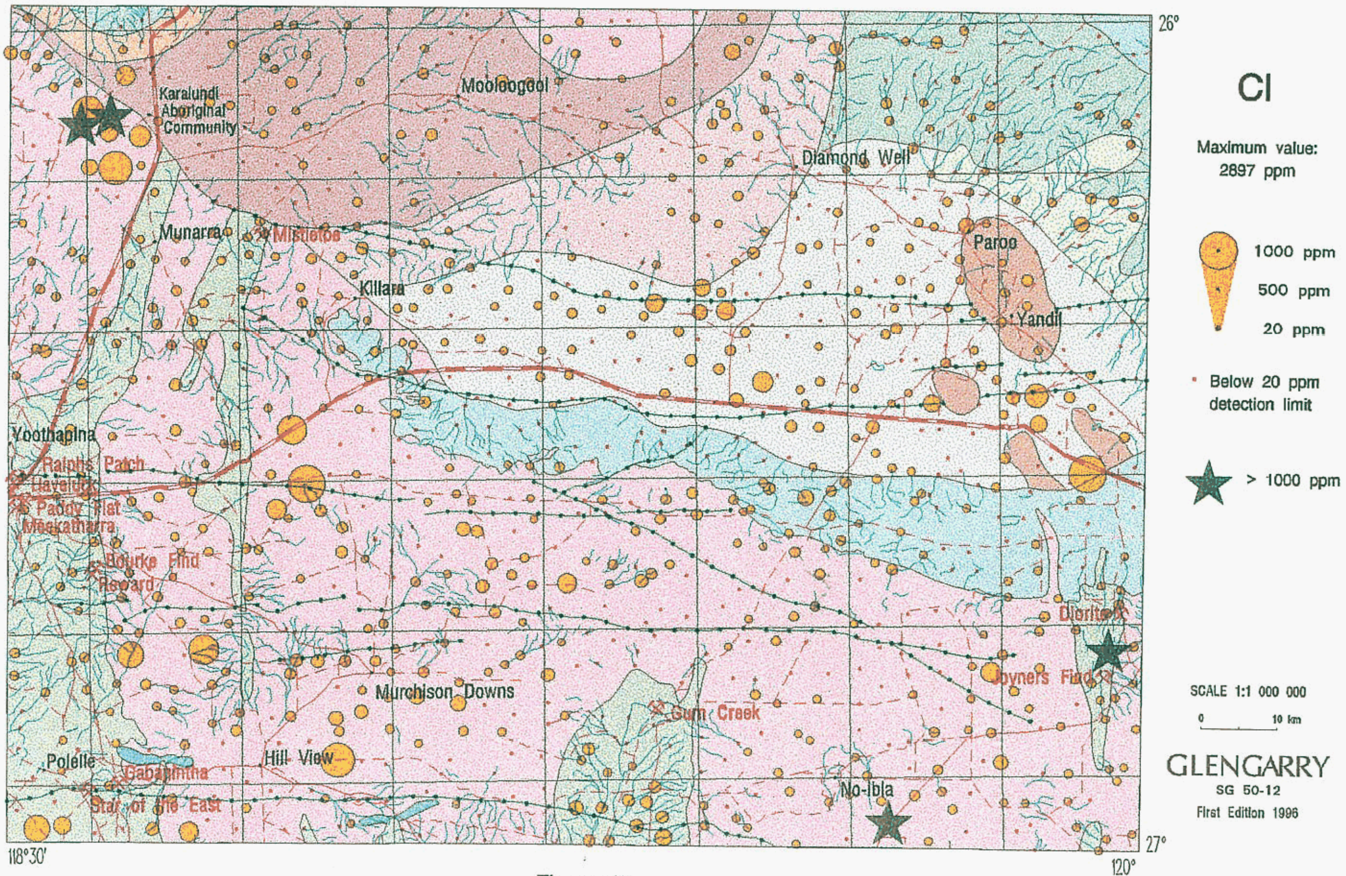


Figure 17.

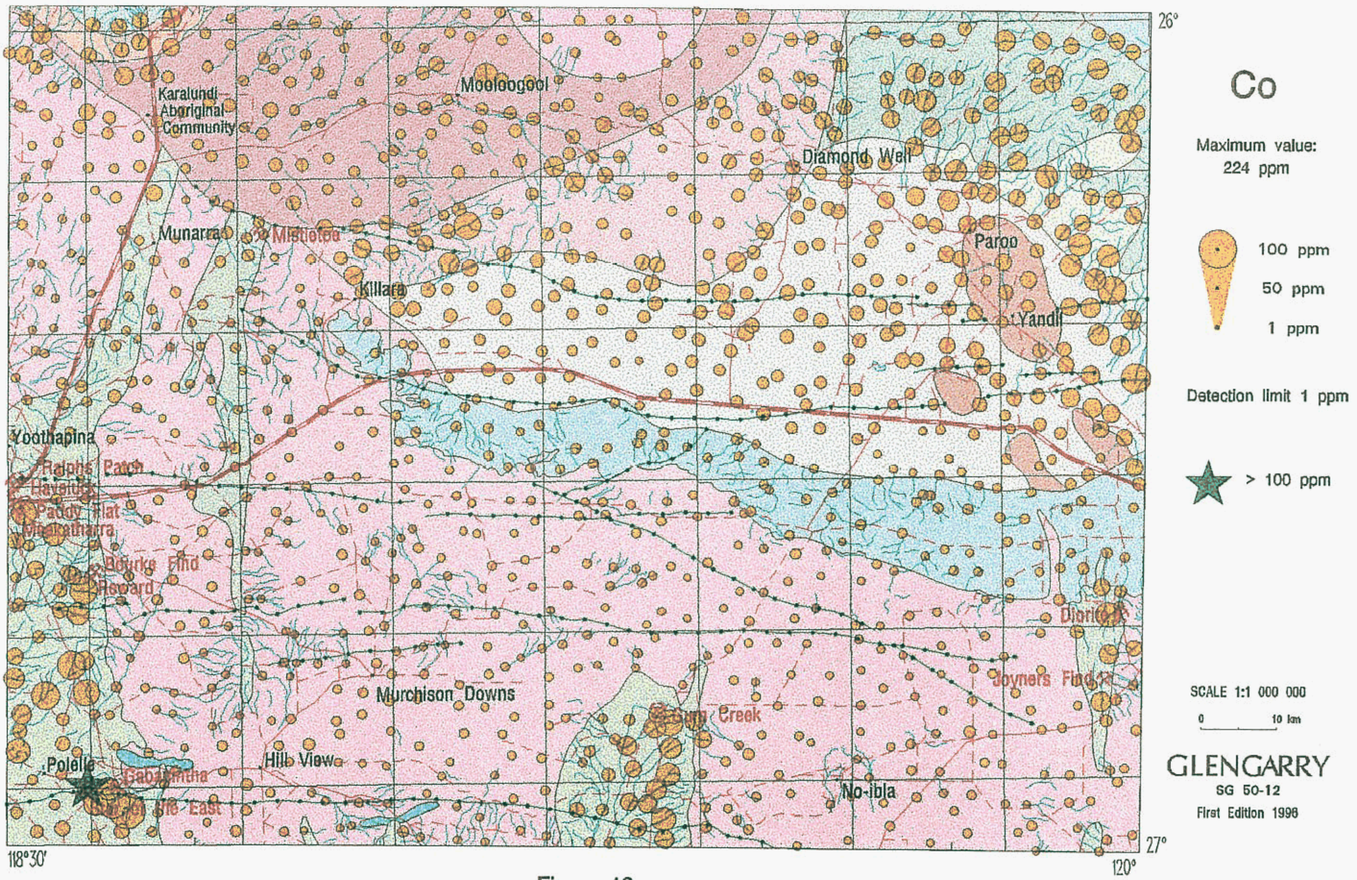


Figure 18.

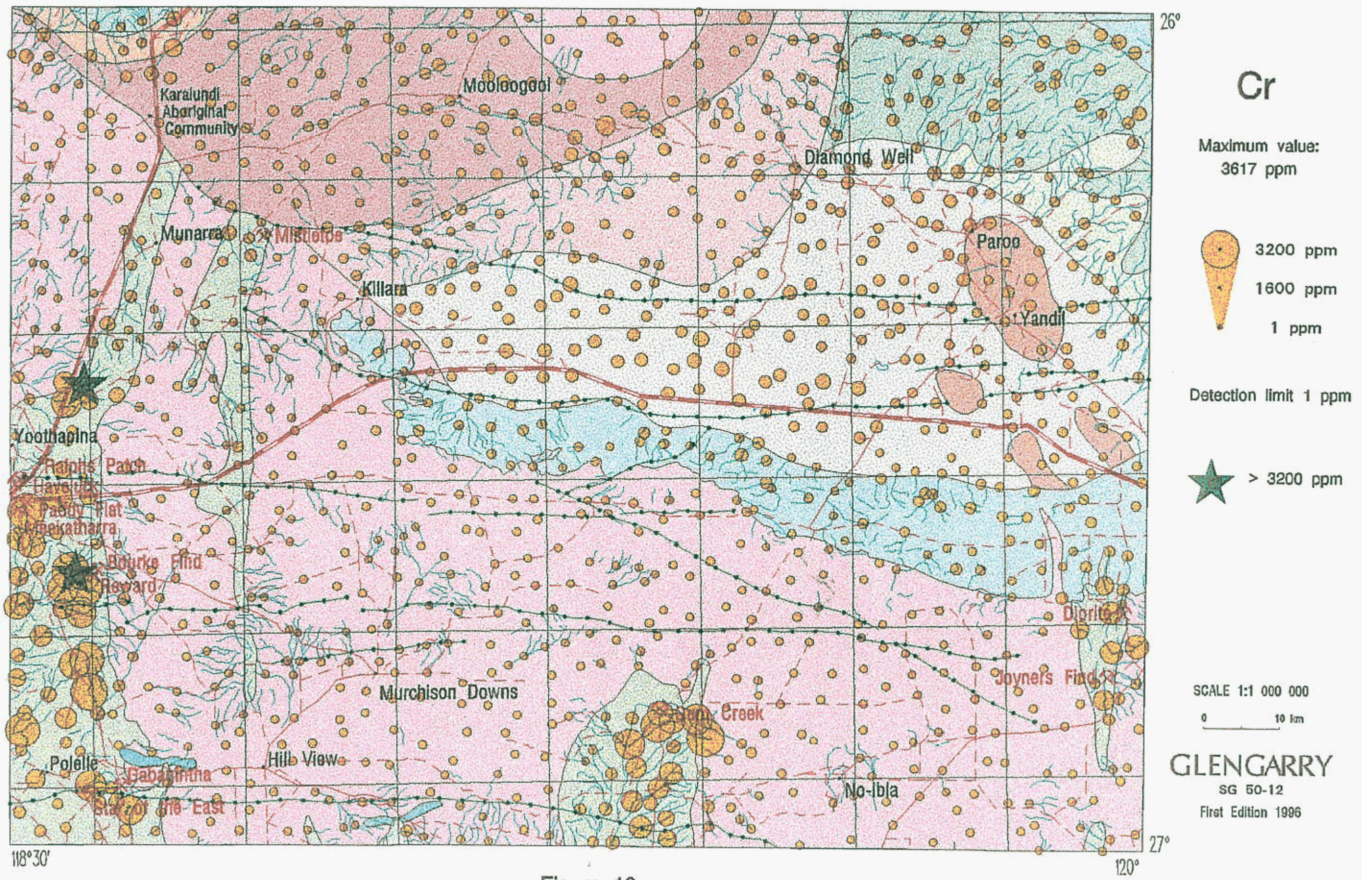


Figure 19.

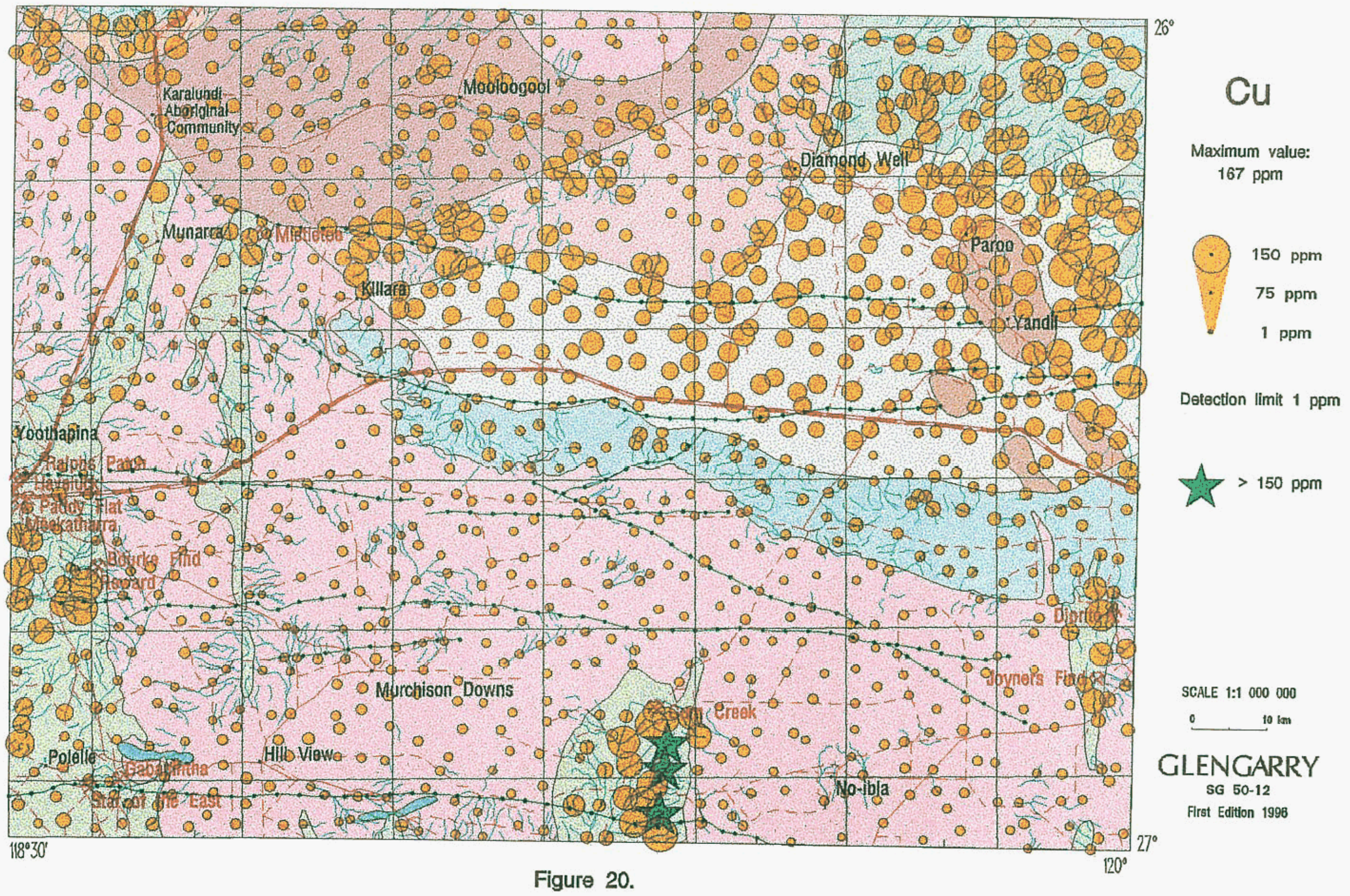


Figure 20.

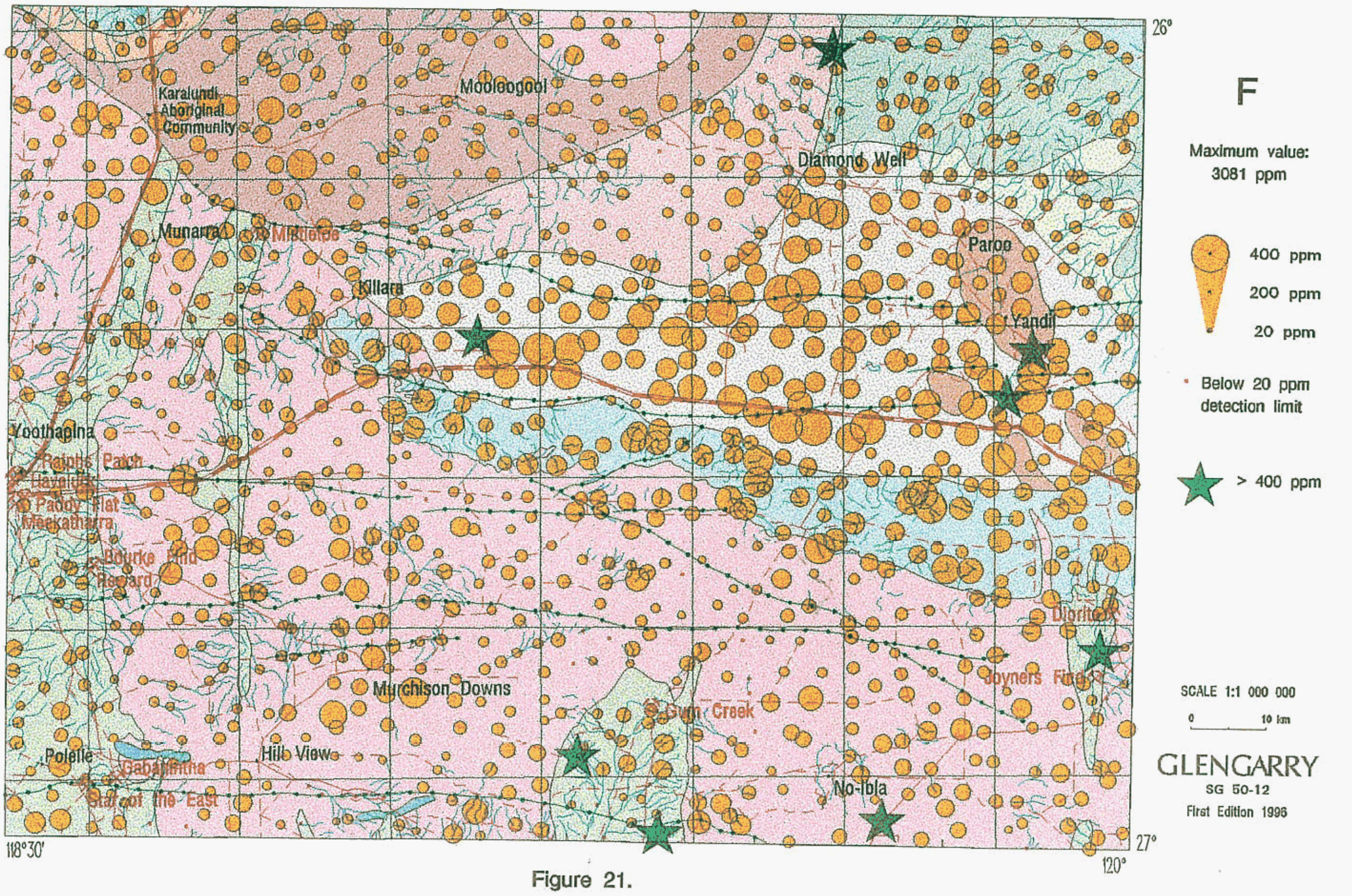


Figure 21.

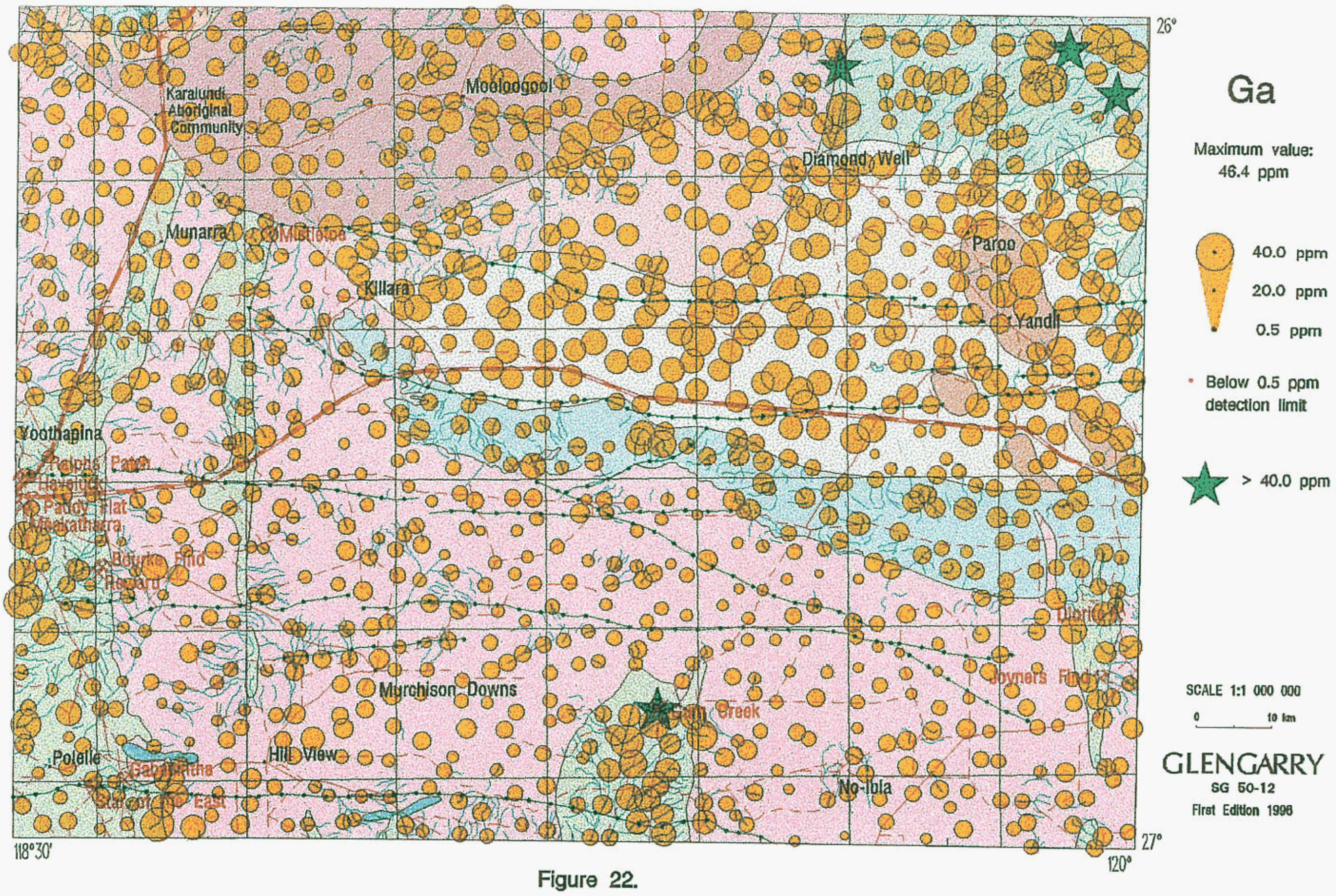


Figure 22.

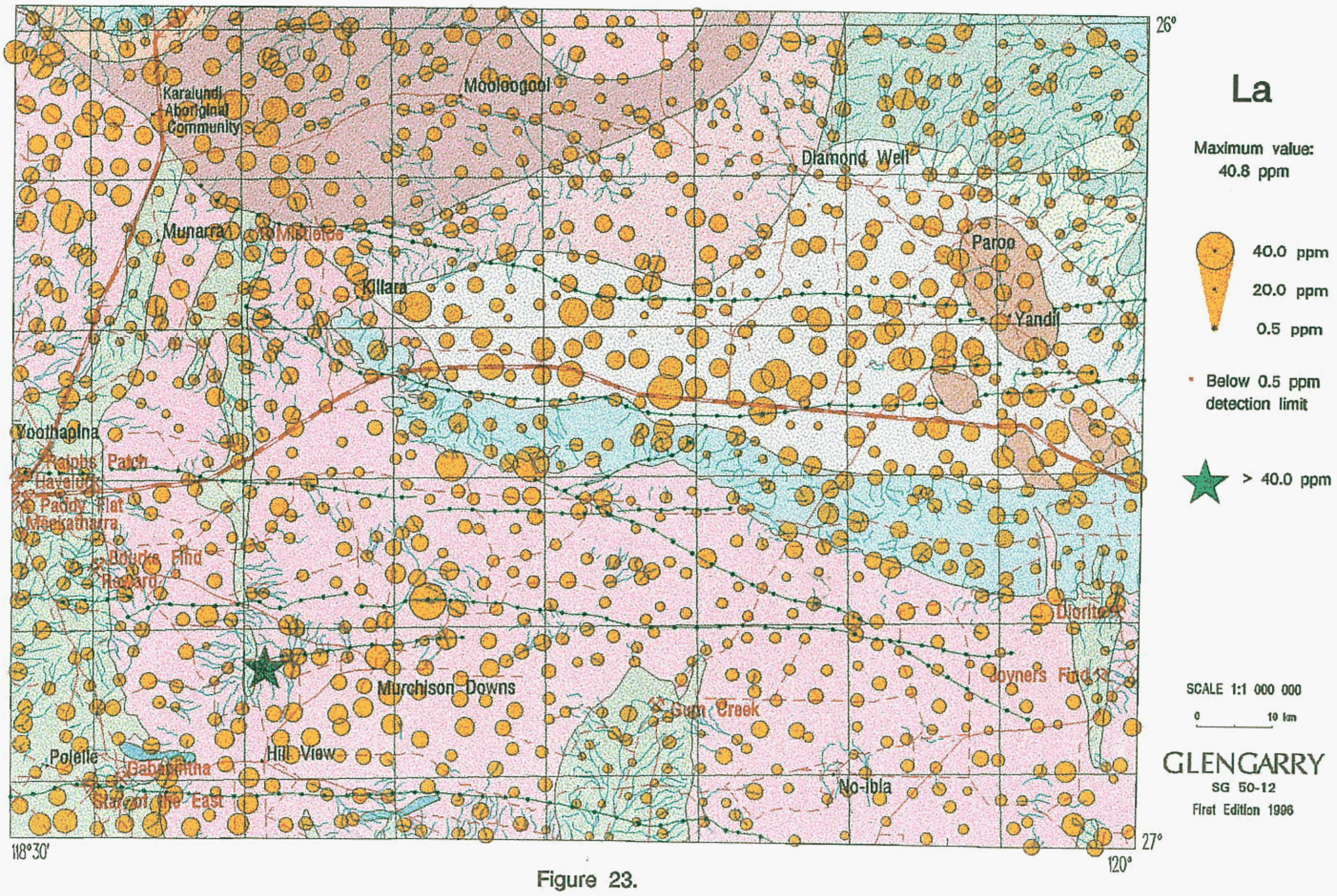


Figure 23.

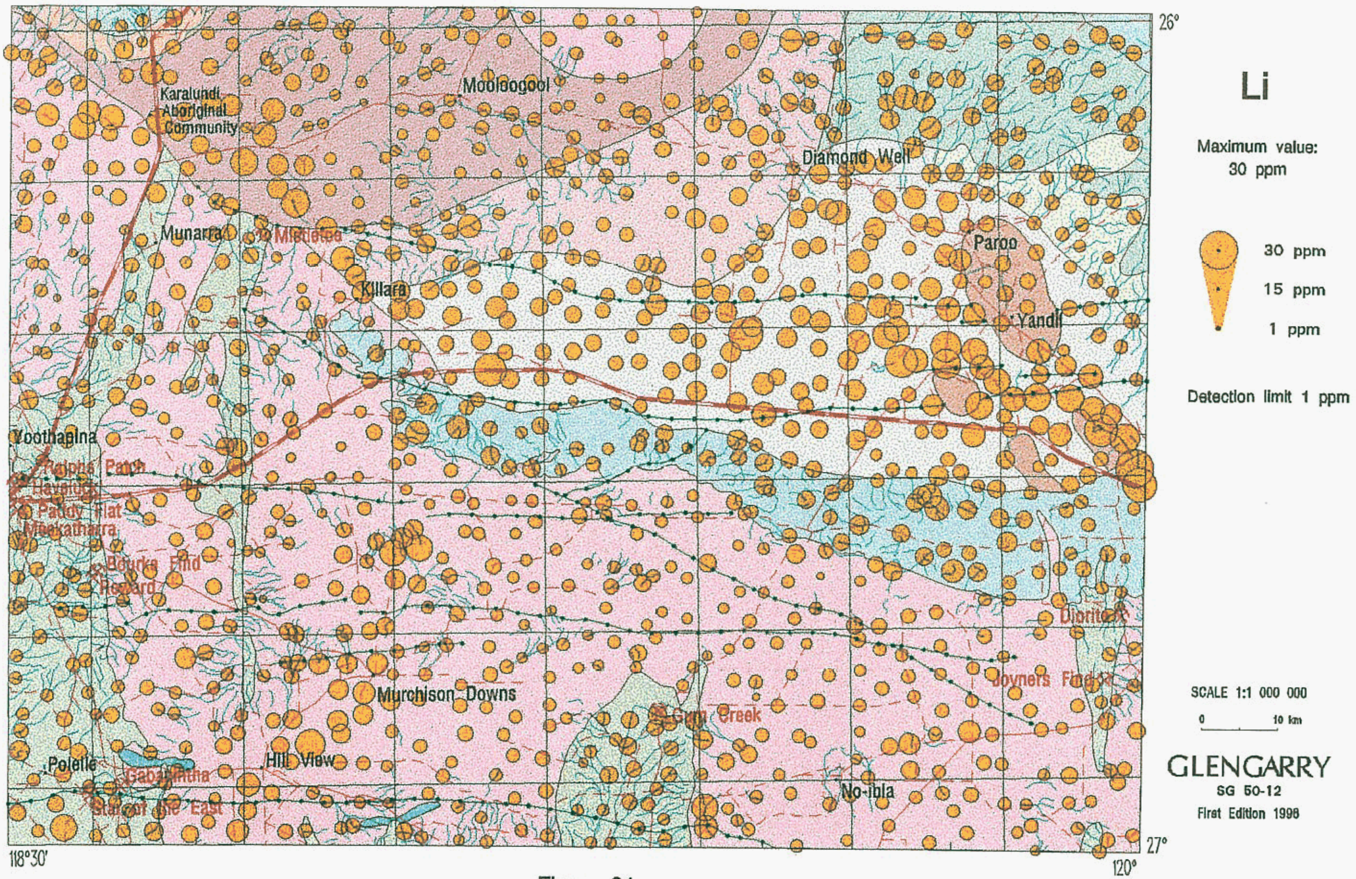


Figure 24.

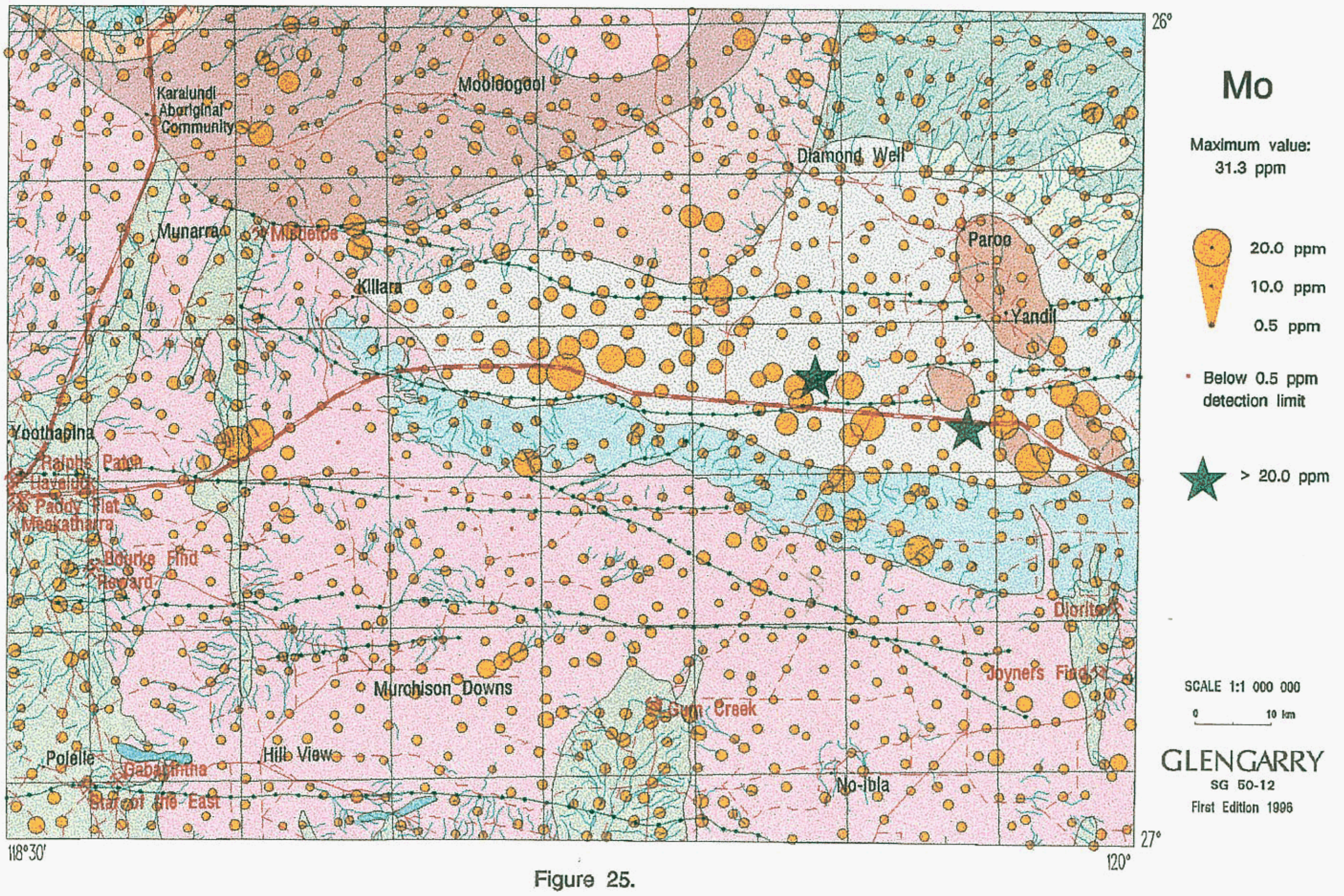


Figure 25.

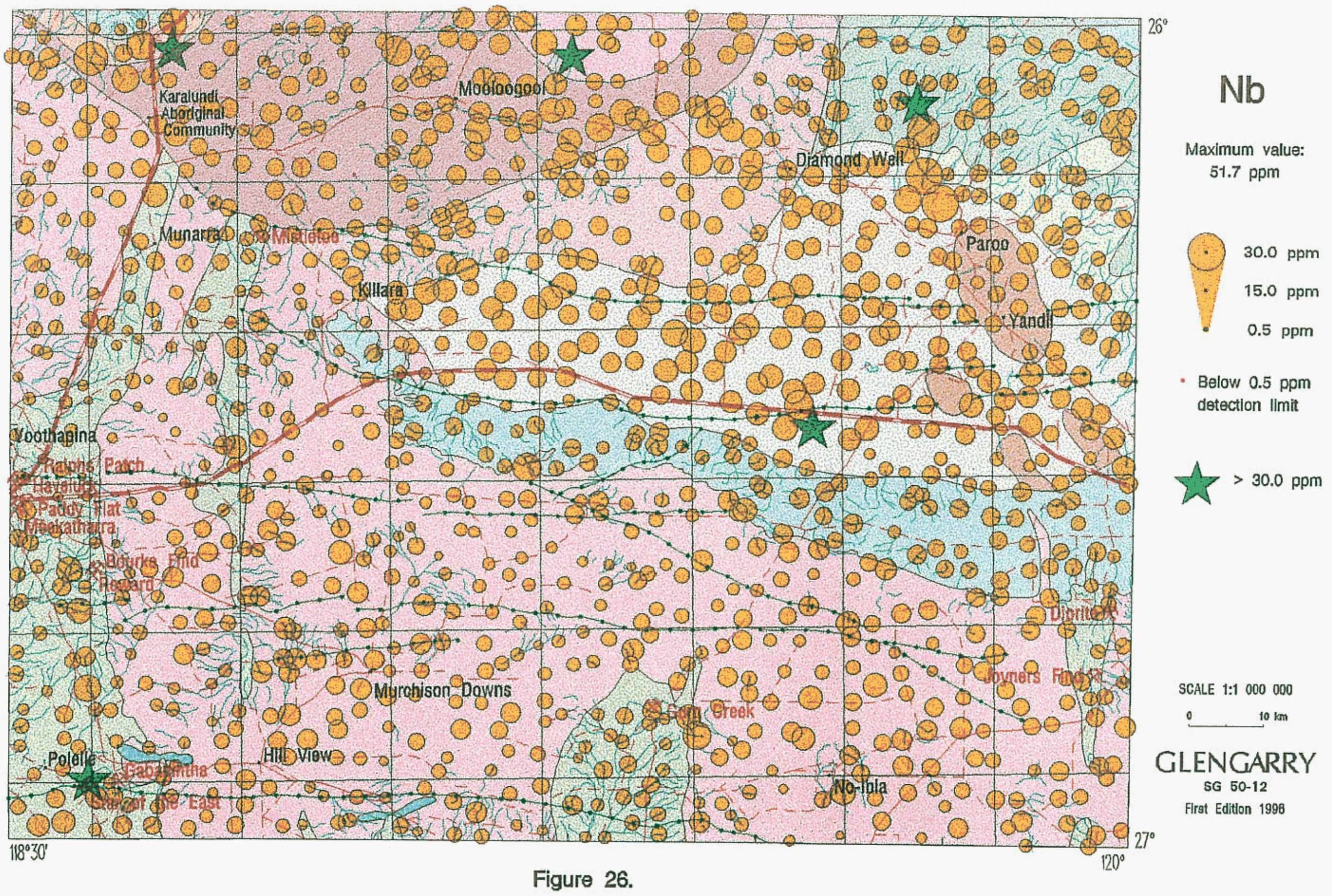


Figure 26.

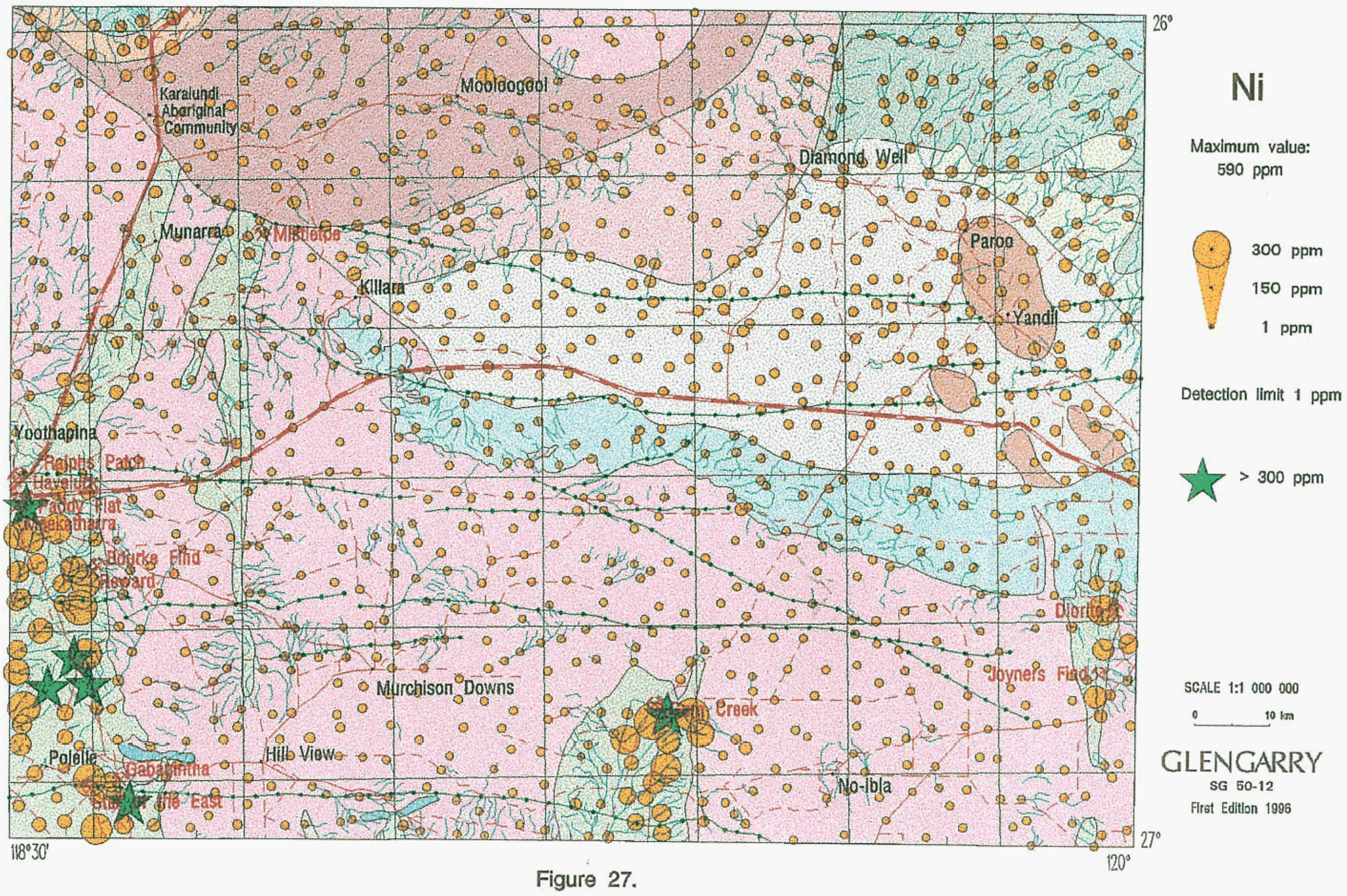


Figure 27.

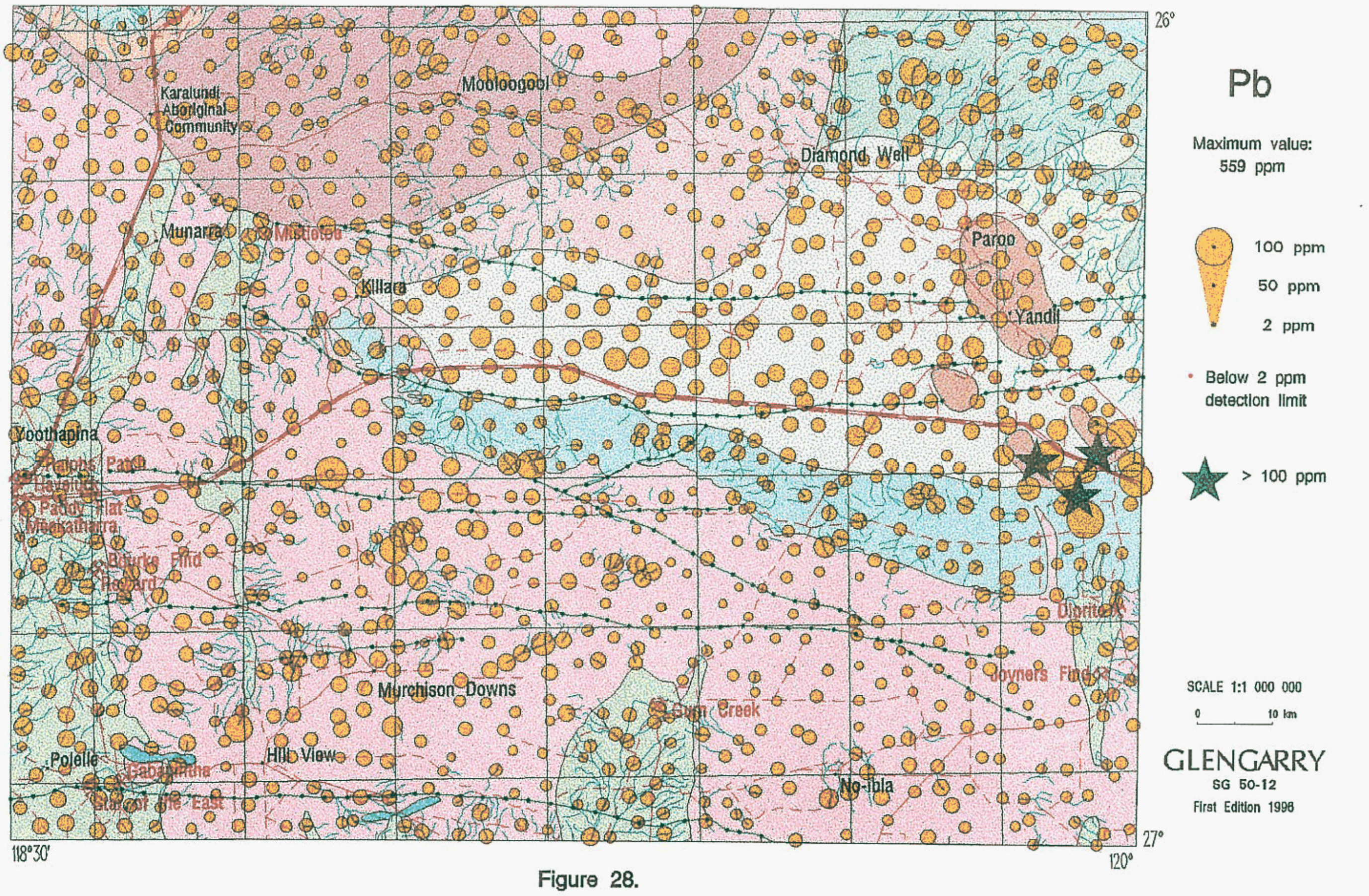


Figure 28.

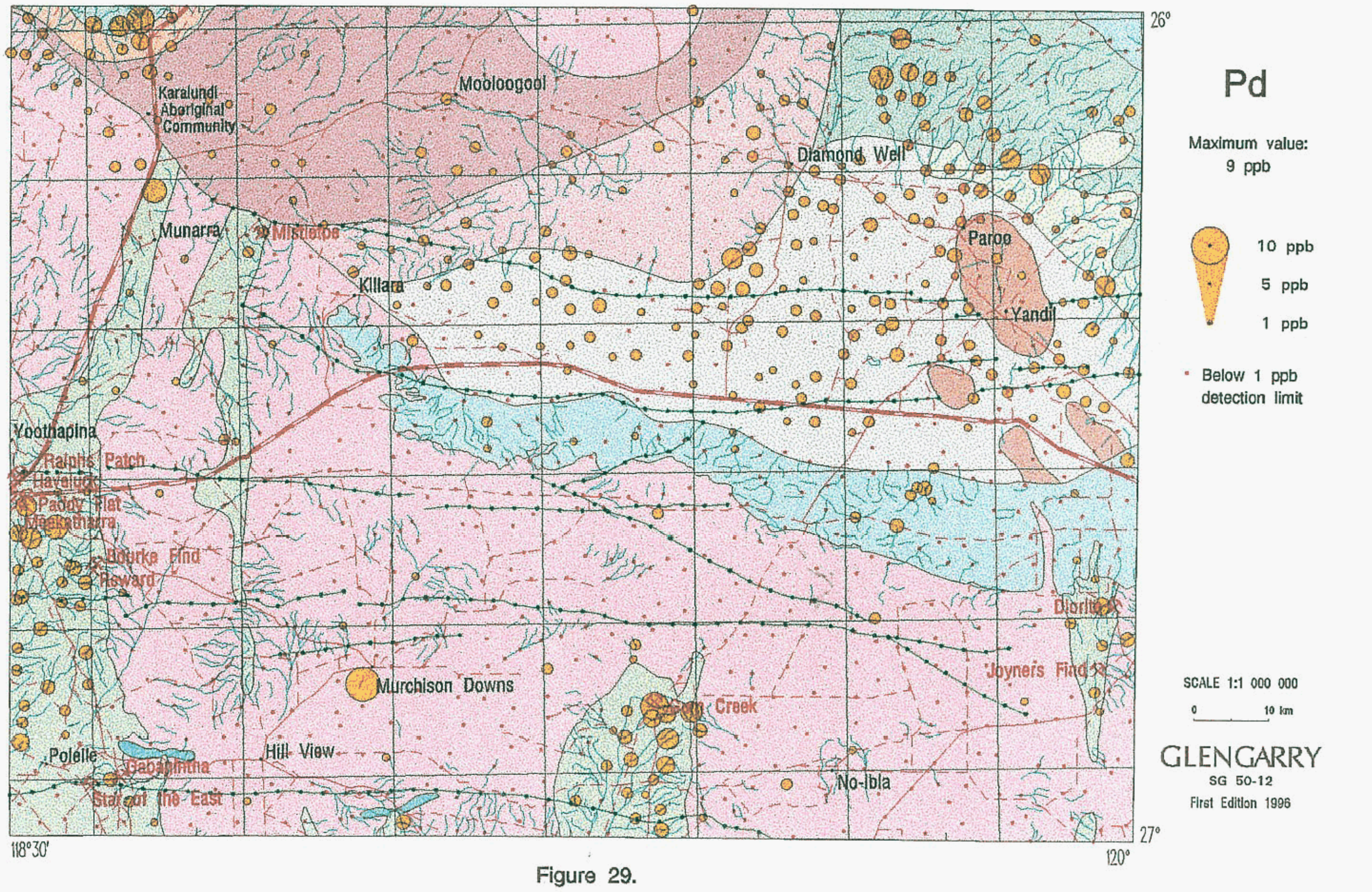


Figure 29.

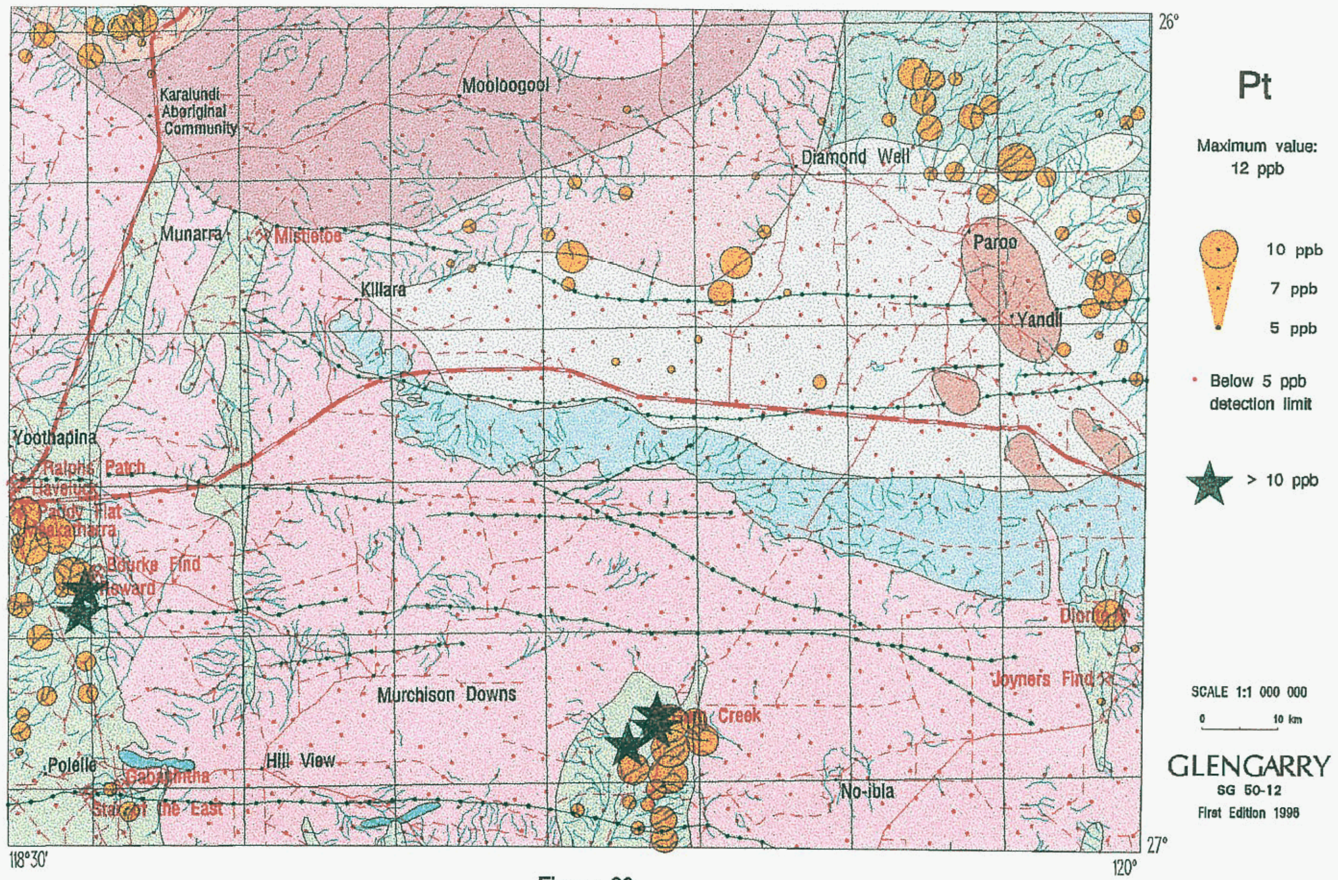


Figure 30.

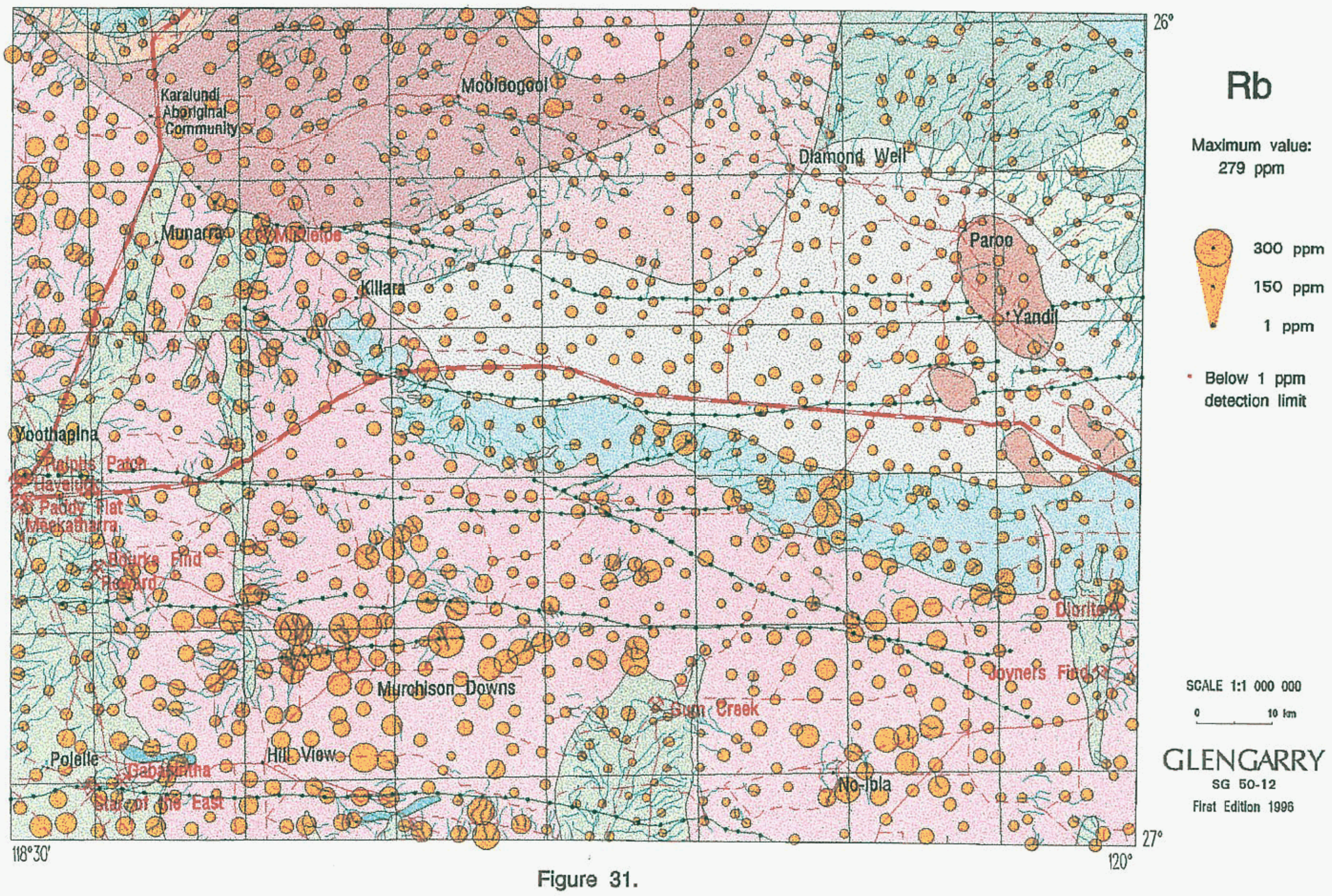


Figure 31.

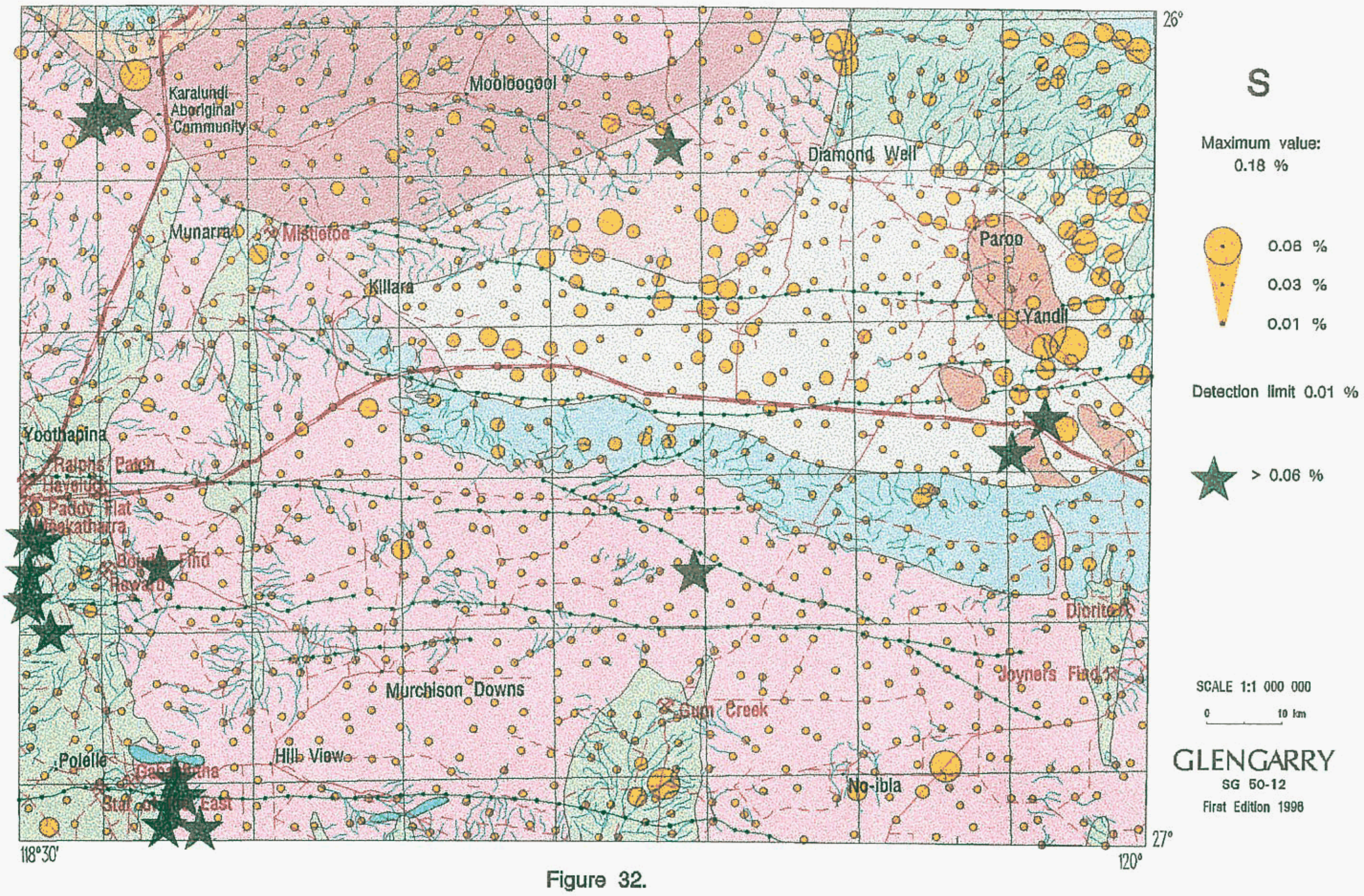


Figure 32.

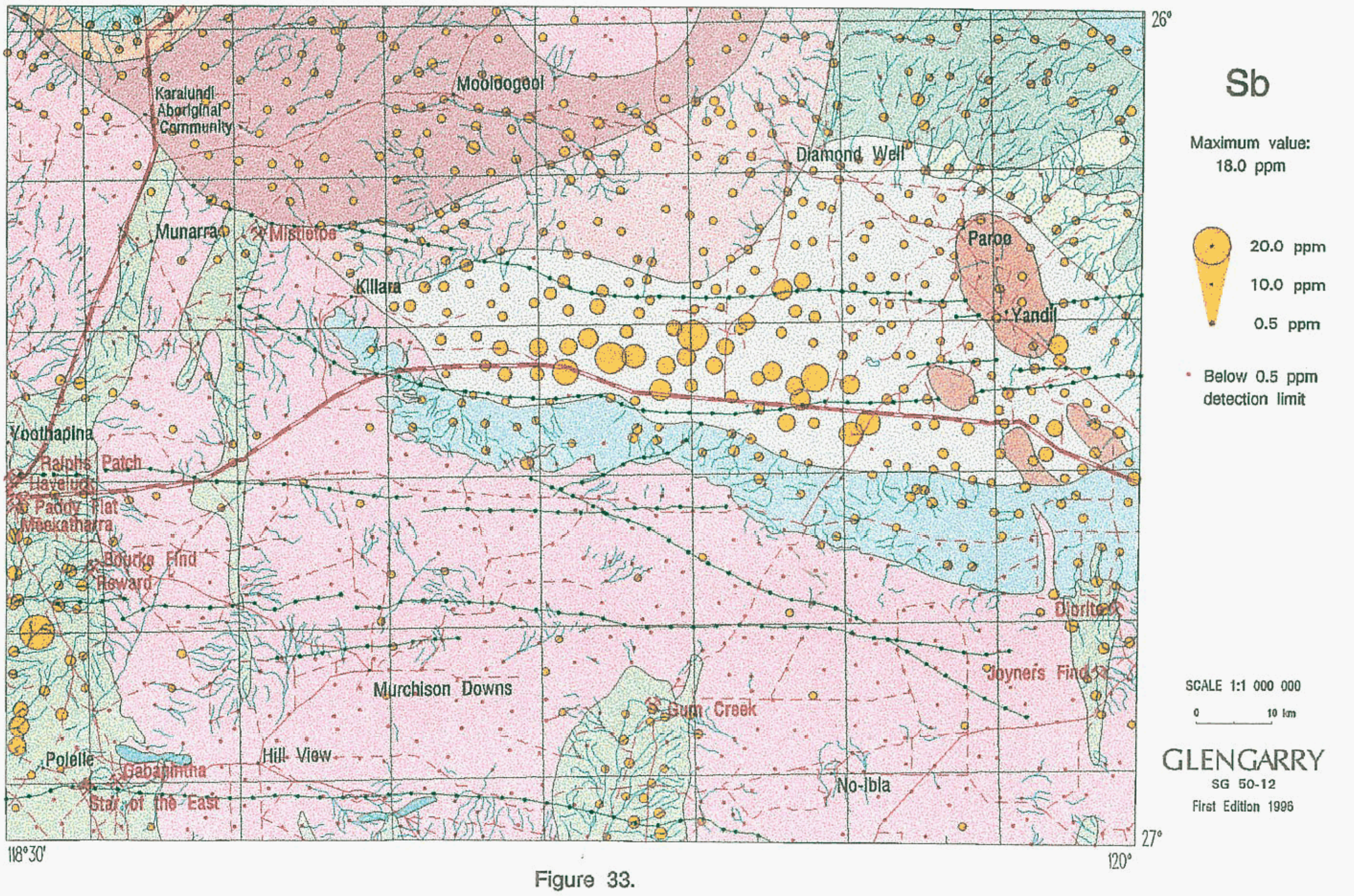


Figure 33.

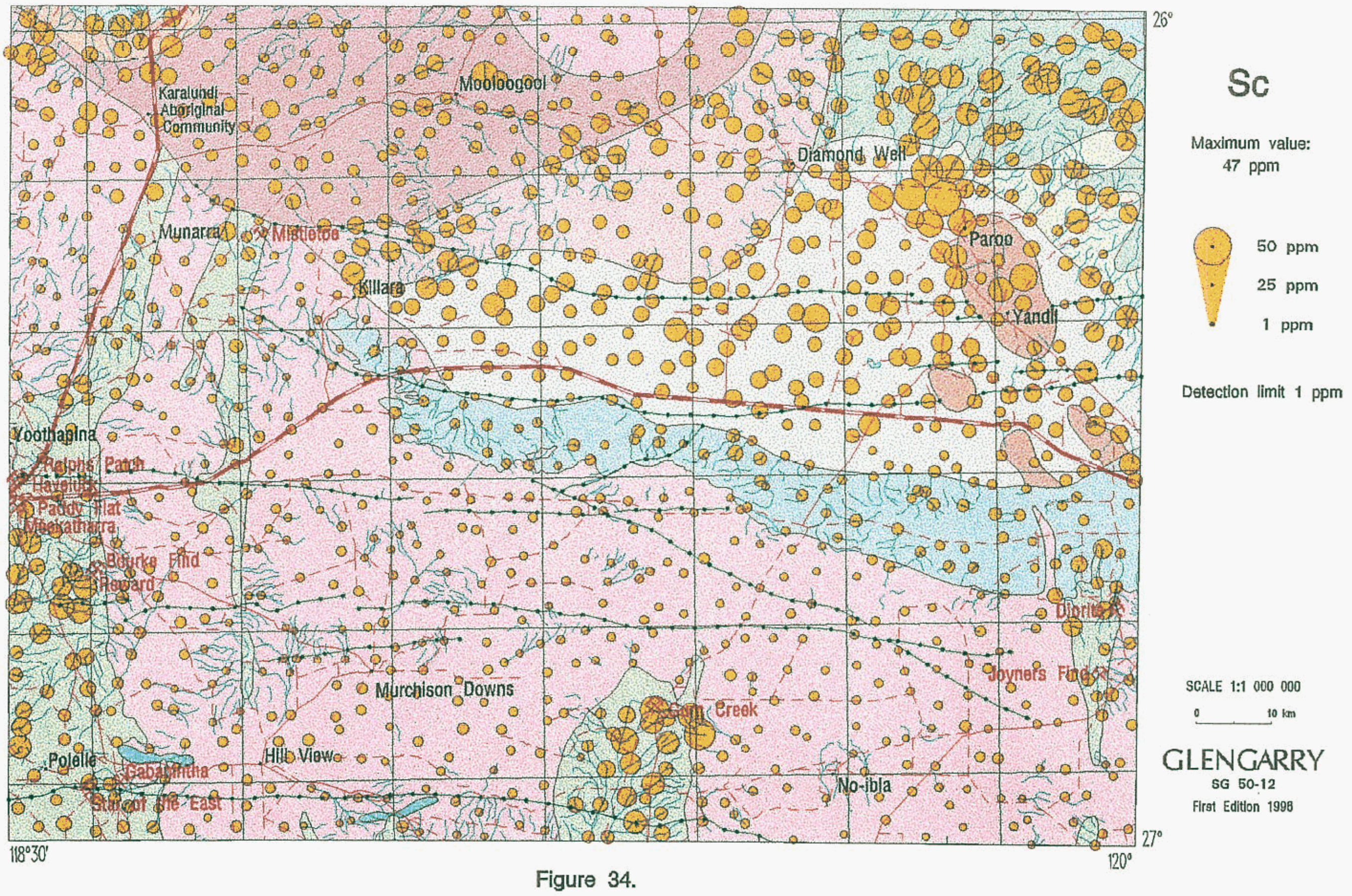


Figure 34.

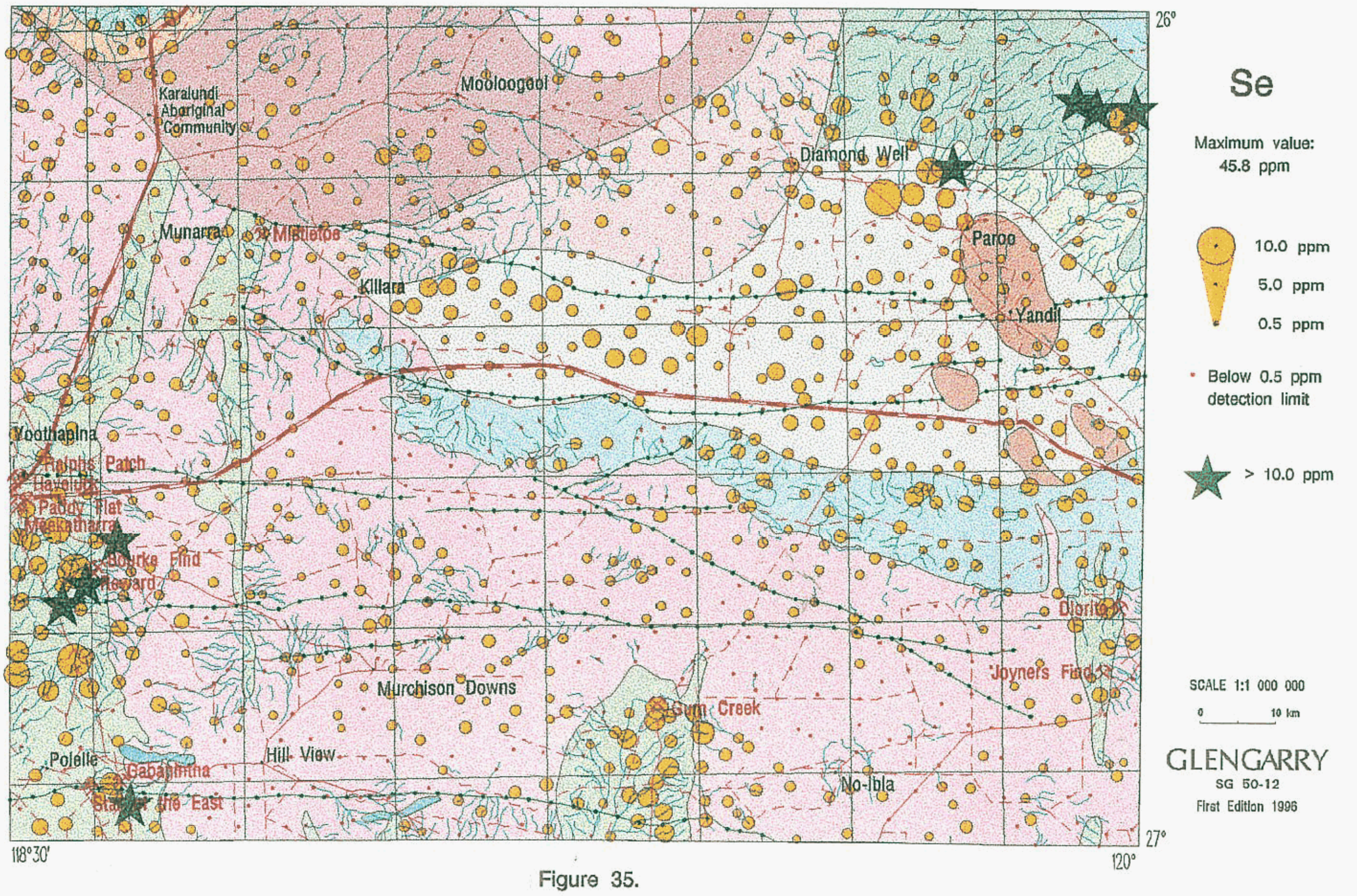


Figure 35.

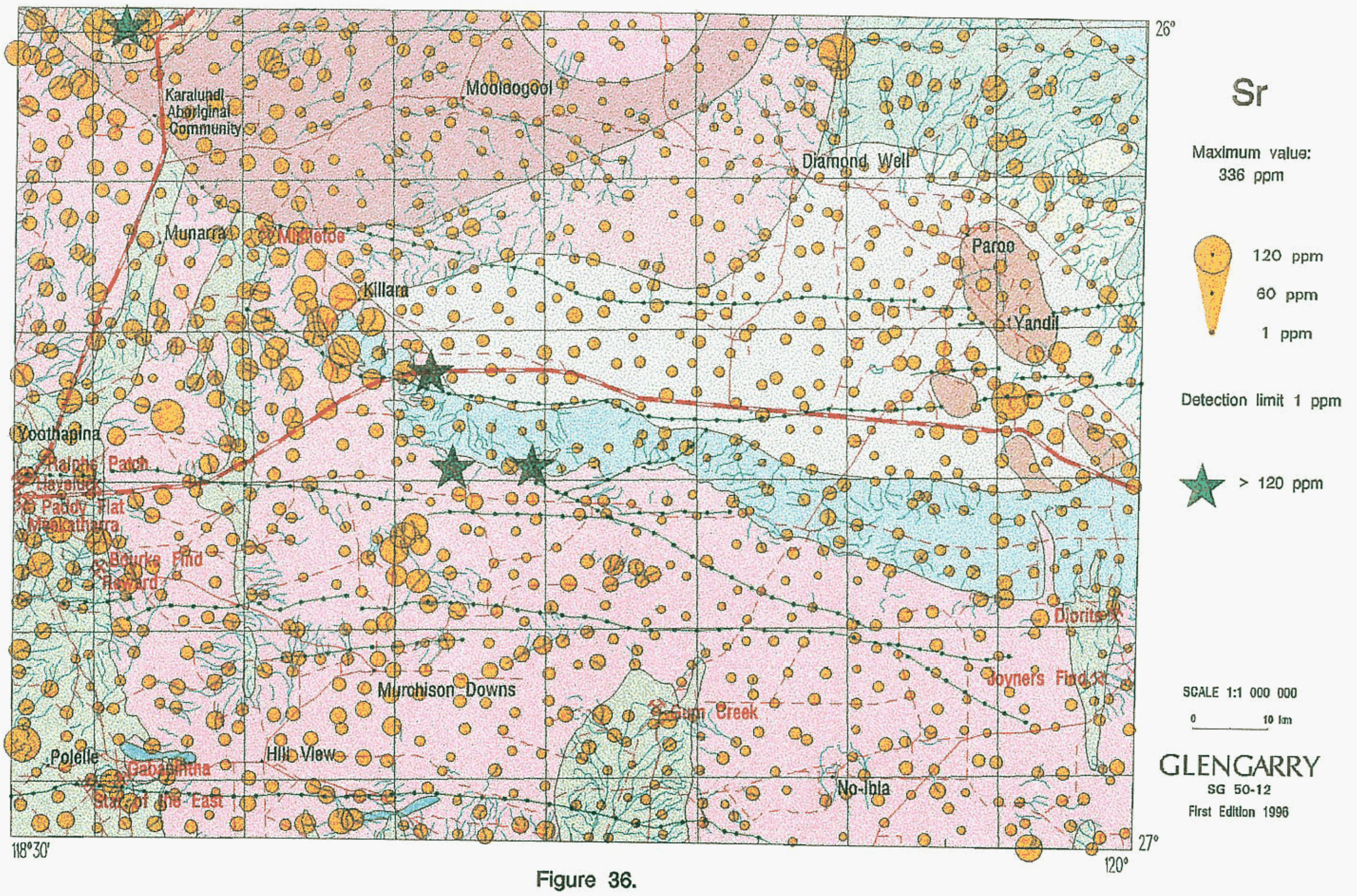


Figure 36.

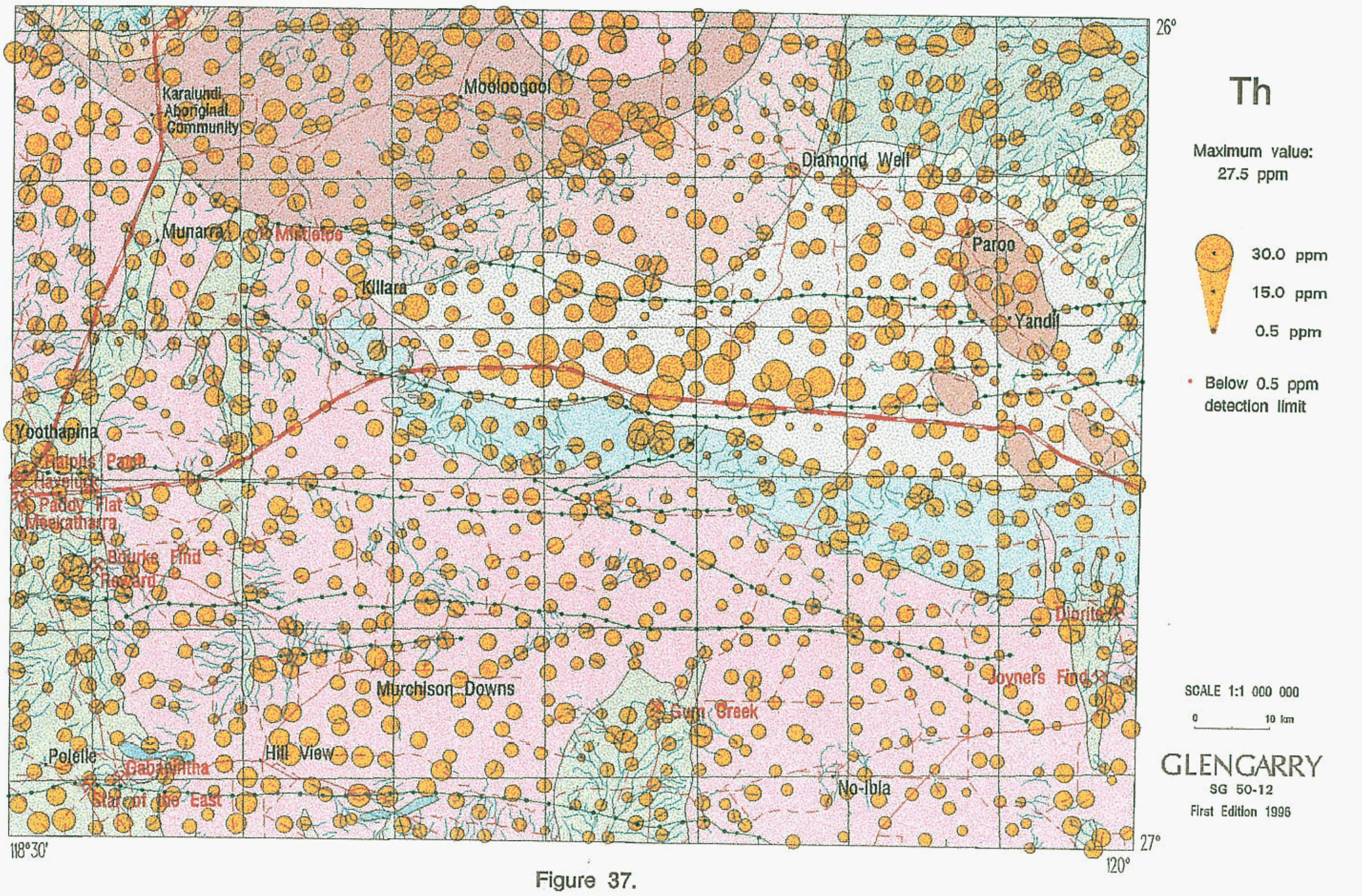


Figure 37.

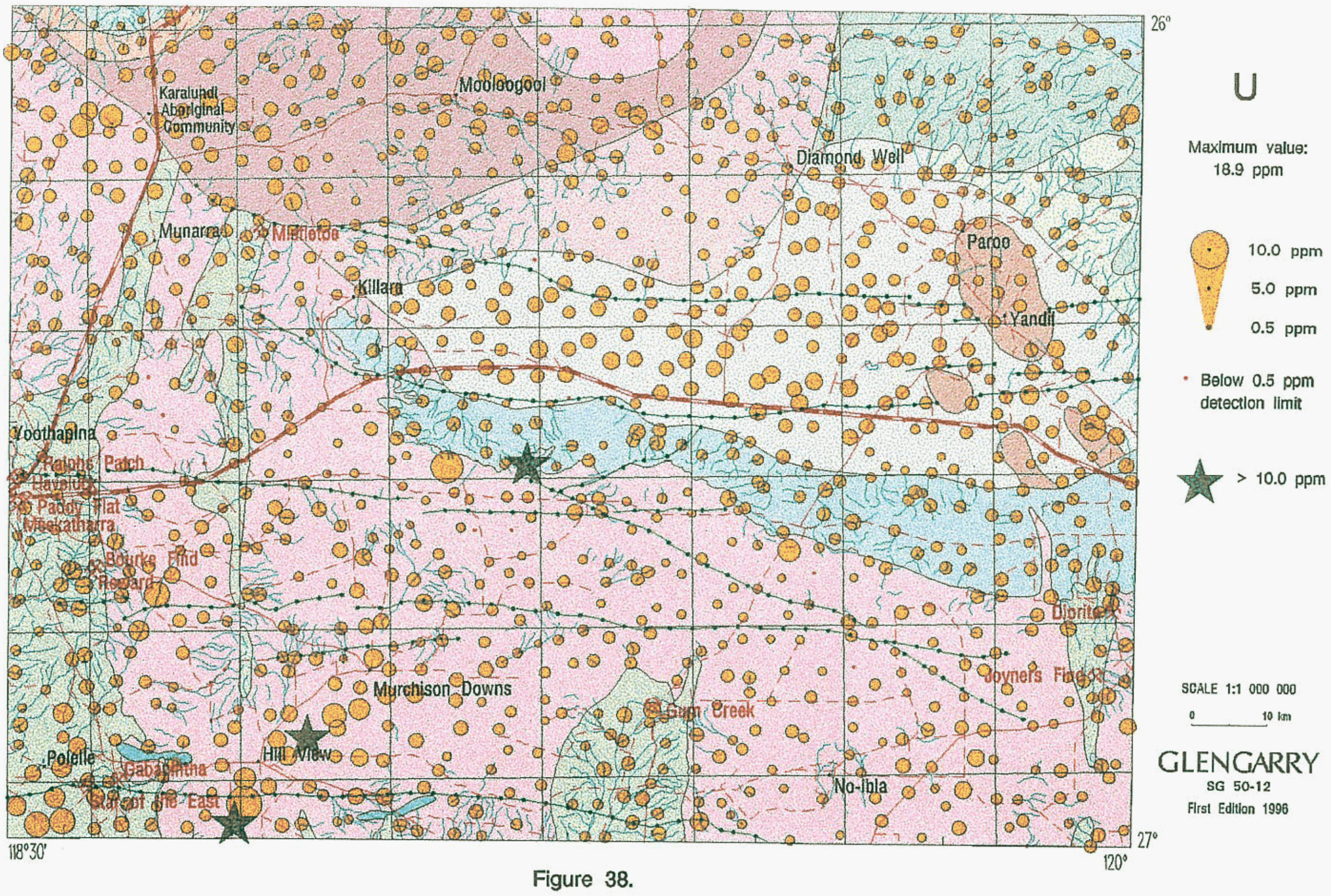


Figure 38.

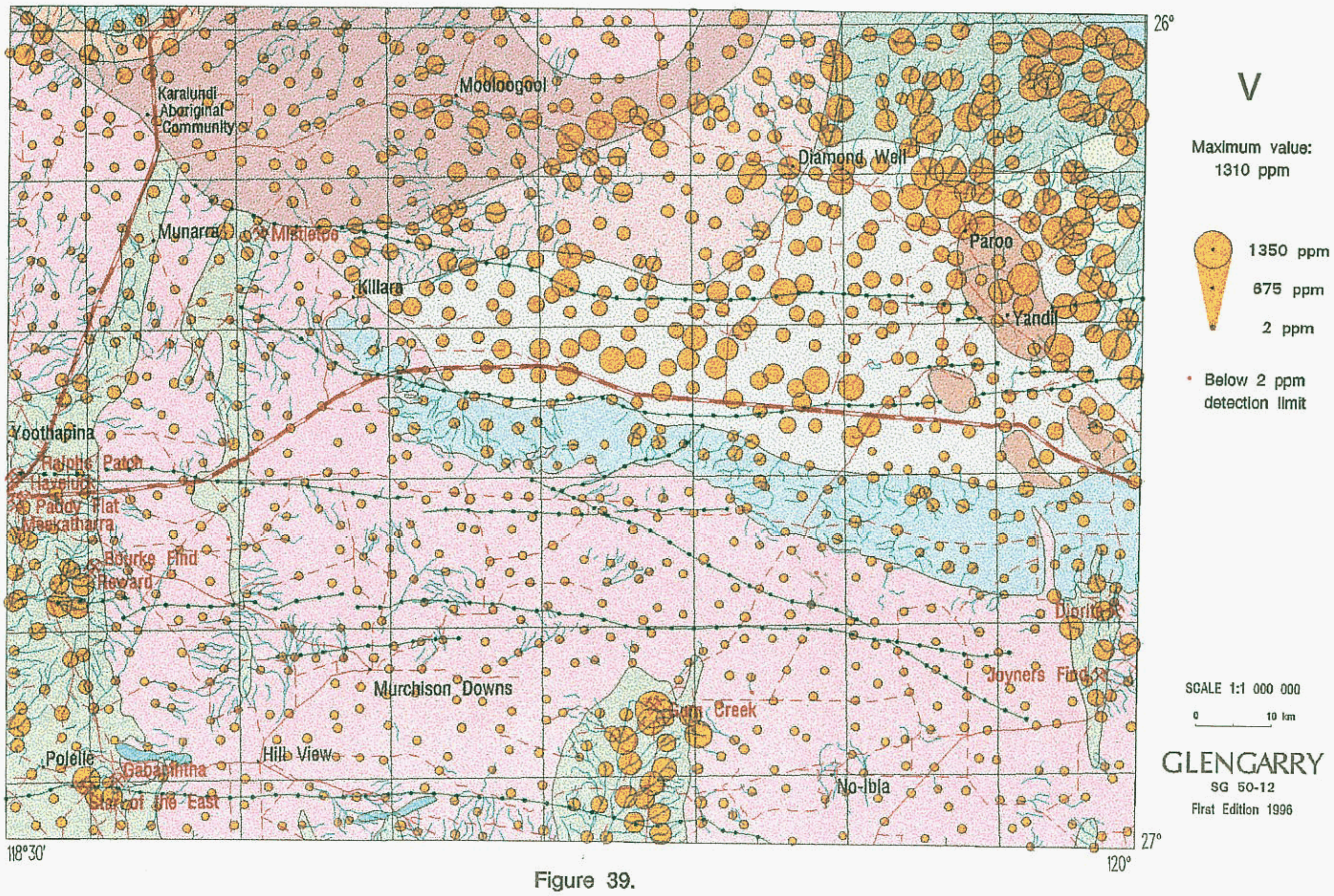


Figure 39.

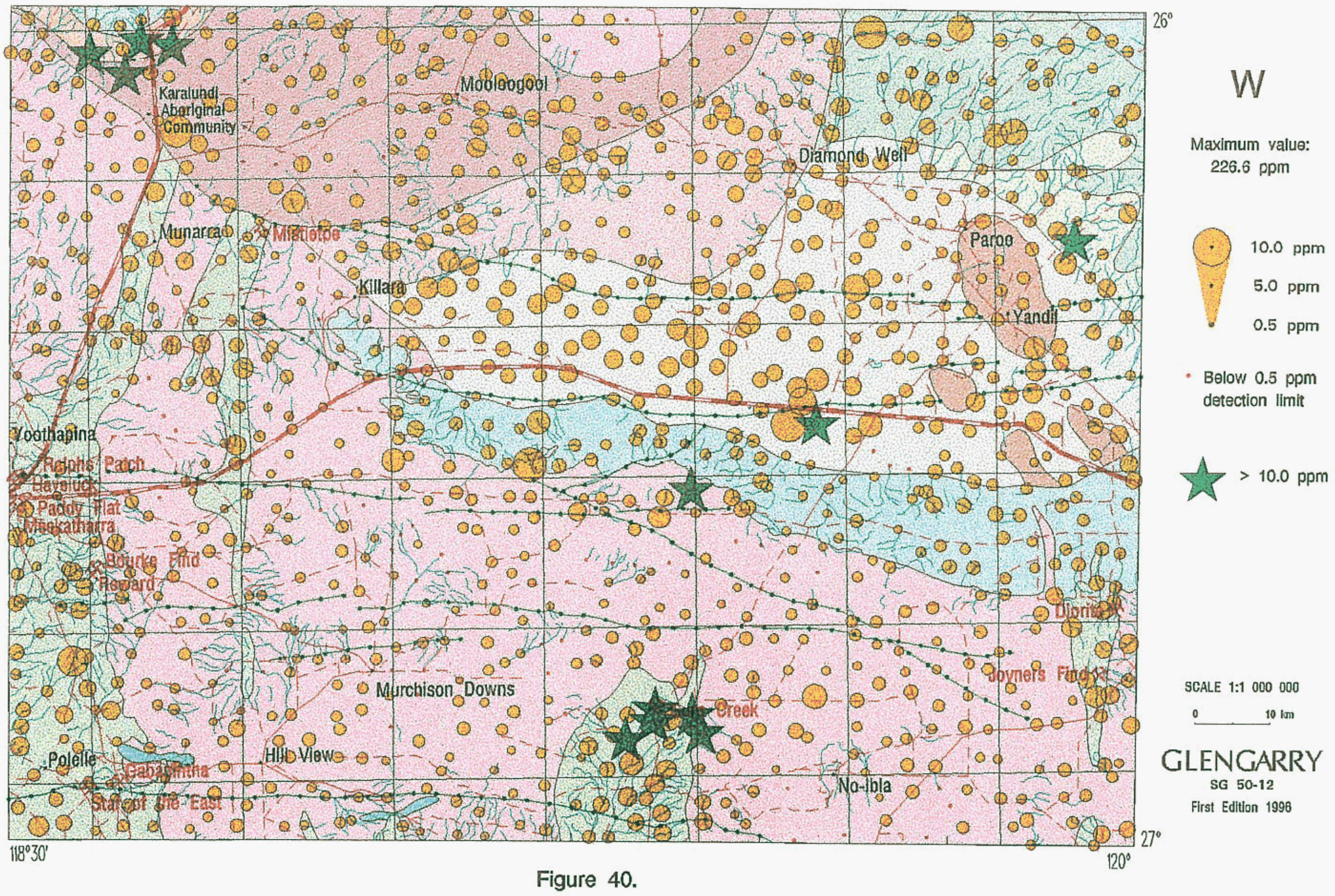


Figure 40.

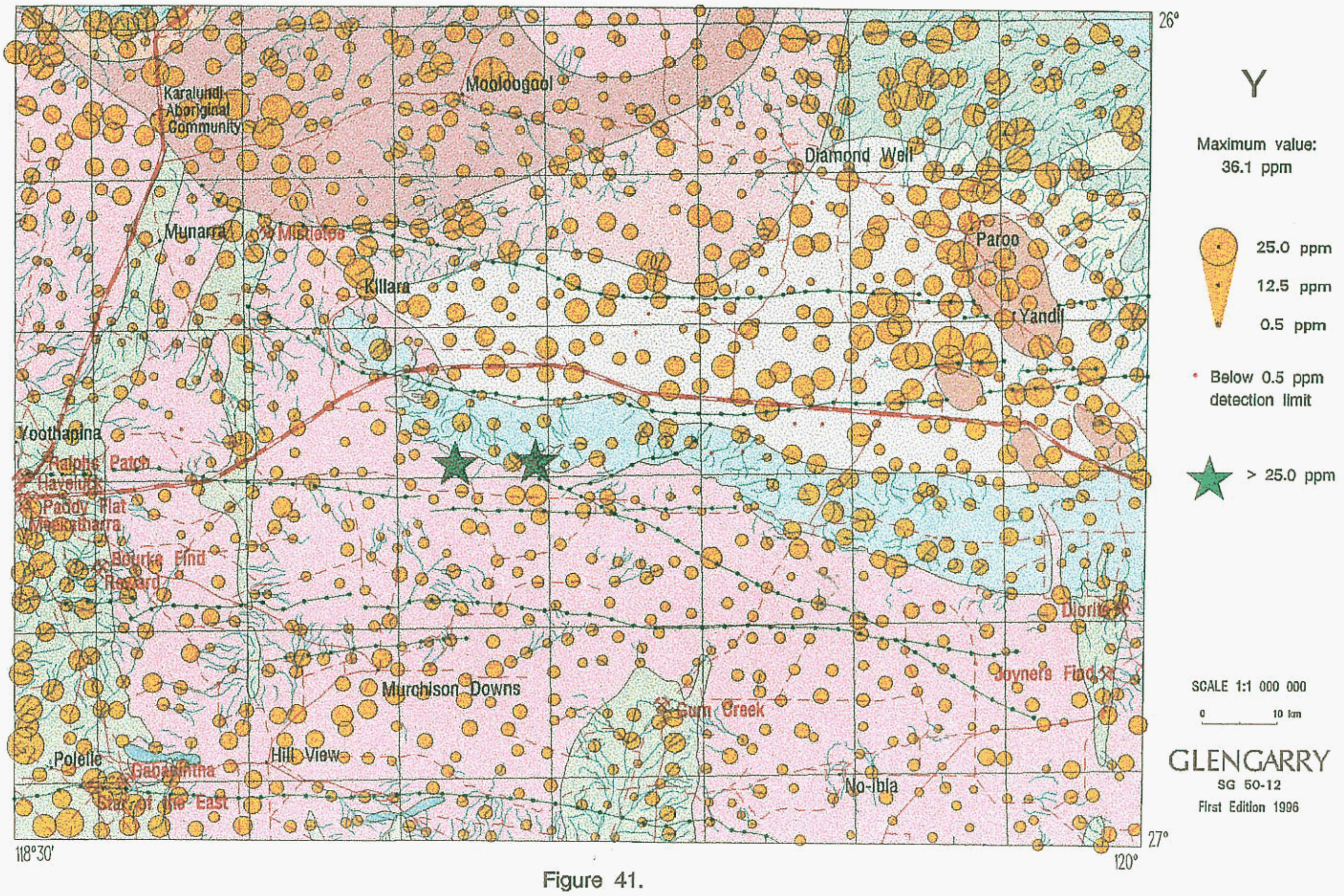


Figure 41.

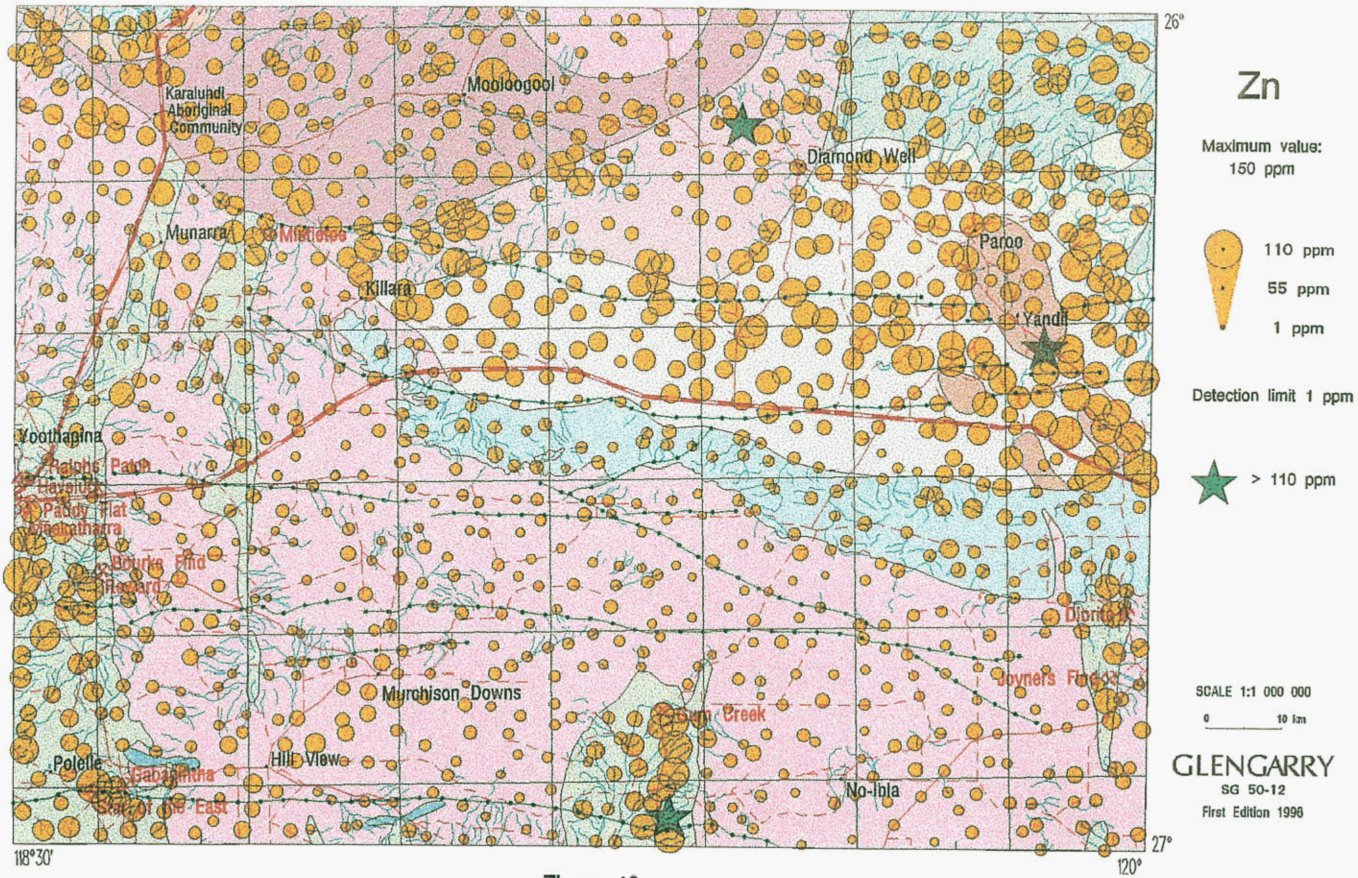


Figure 42.

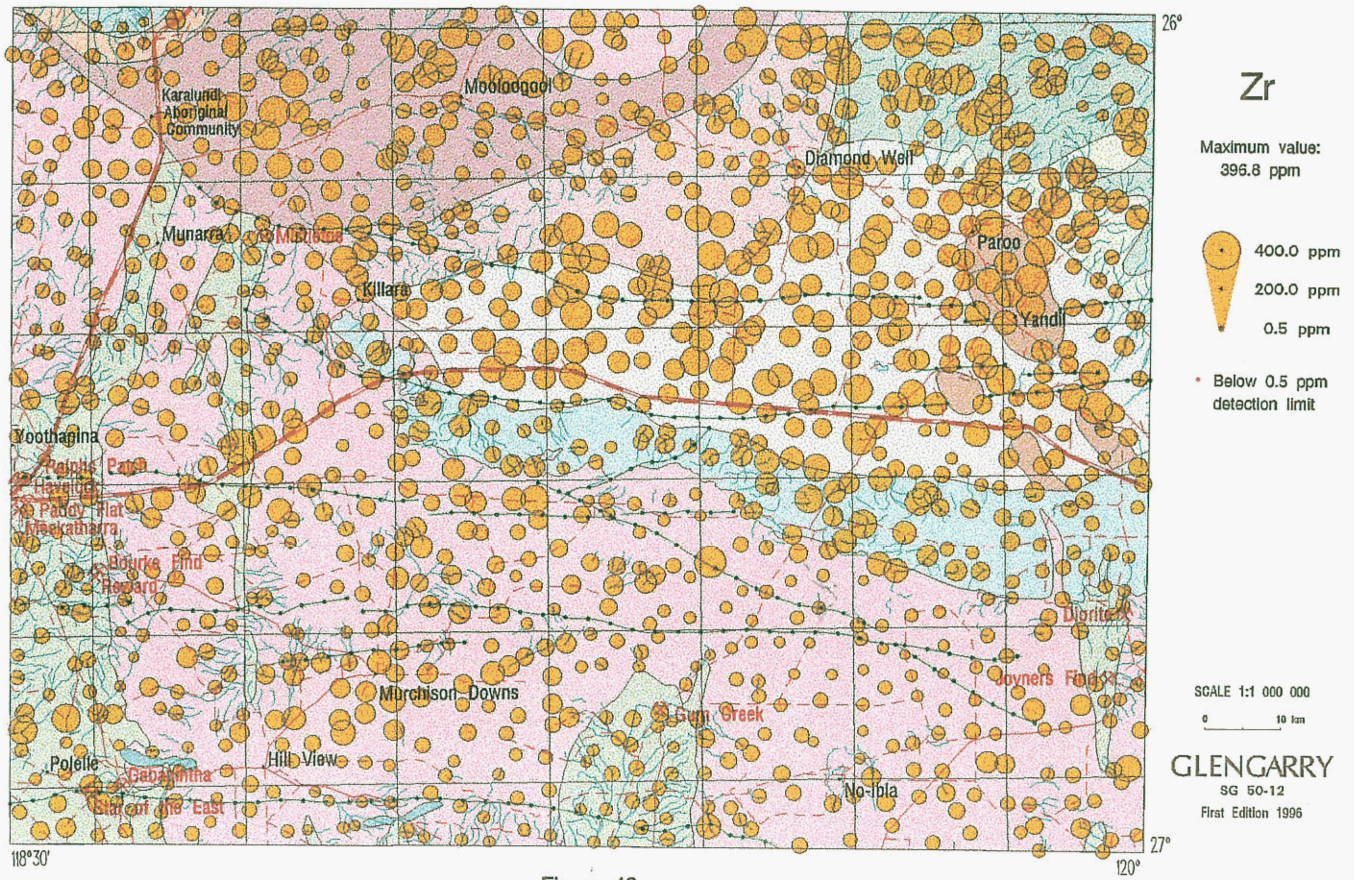


Figure 43.

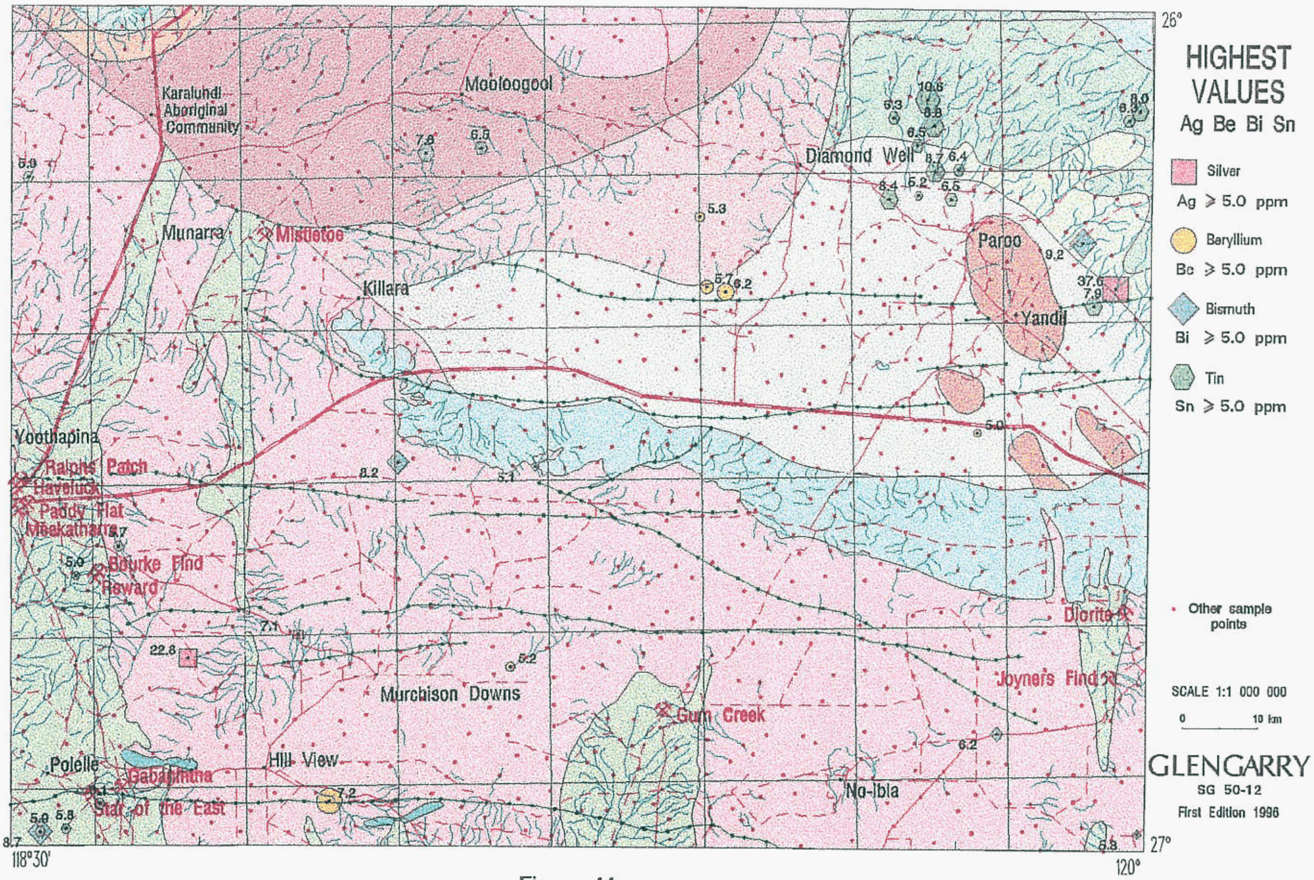

HIGHEST
VALUES
Ag Be Bi Sn
Silver
Ag ≥ 5.0 ppm
Beryllium
Be ≥ 5.0 ppm
Bismuth
Bi ≥ 5.0 ppm
Tin
Sn ≥ 5.0 ppm
Other sample points
SCALE 1:1 000 000
0
10 km
GLENGARRY
SG 50-12
First Edition 1996
26°
27°
118°30'
120°
Karalundi Aboriginal Community
Mooloogool
Diamond Well
Munarra
Mistletoe
Killara
Paroo
Yandil
Yoothapina
Ralphs Patch
Havelock
Paddy Flat
Meekatharra
Bourke Find
Reward
Diorite
Joyners Find
Murchison Downs
Gum Creek
Polelle
Gabanintha
Star of the East
Hill View
No-Ibla

Figure 44.

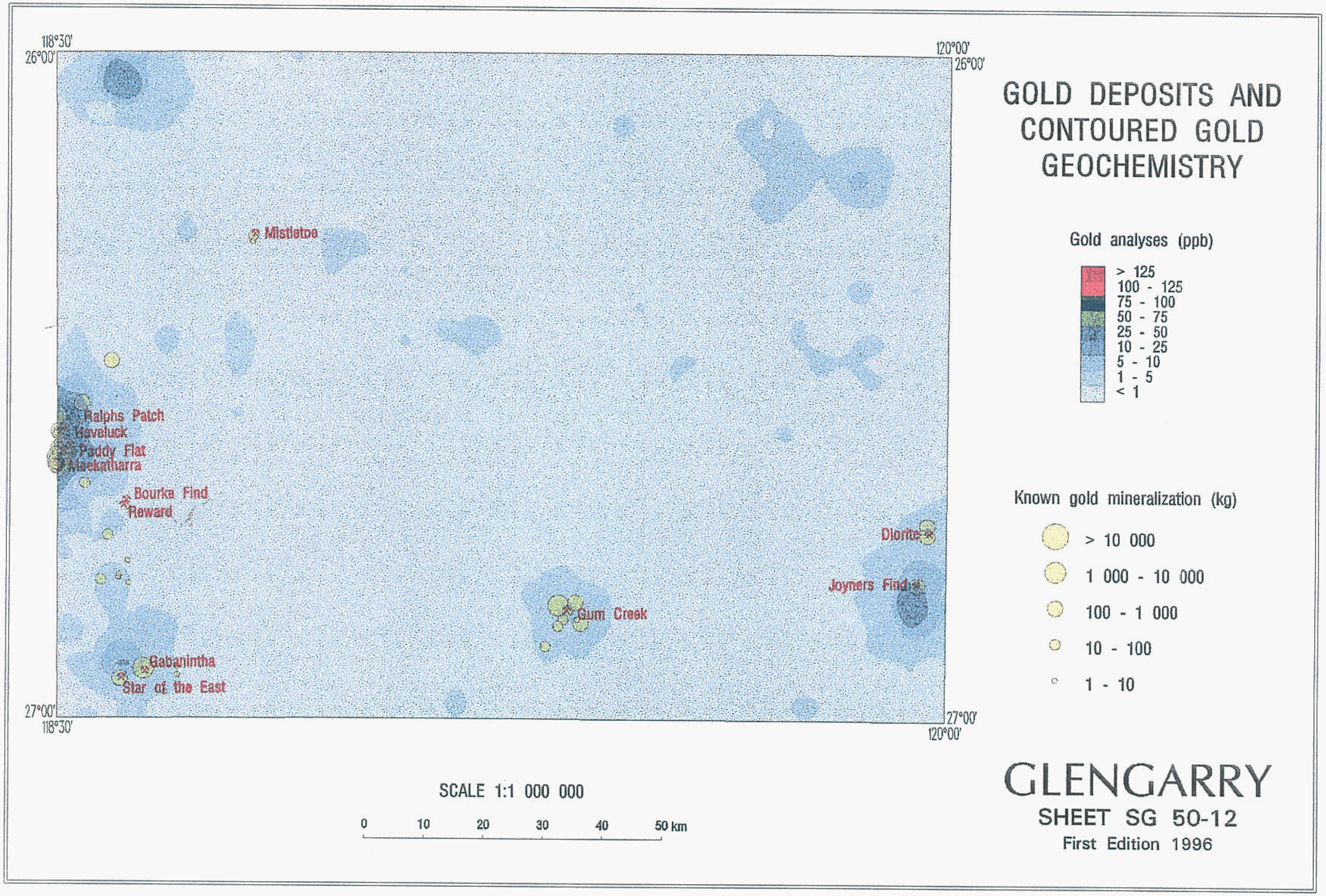

GOLD DEPOSITS AND CONTOURED GOLD GEOCHEMISTRY
Gold analyses (ppb)
> 125
100 - 125
75 - 100
50 - 75
25 - 50
10 - 25
5 - 10
1 - 5
< 1
Known gold mineralization (kg)
> 10 000
1 000 - 10 000
100 - 1 000
10 - 100
1 - 10
118°30'
26°00'
120°00'
27°00'
Mistletoe
Ralphs Patch
Haveluck
Paddy Flat
Meekatharra
Bourke Find
Reward
Gabanintha
Star of the East
Gum Creek
Diorite
Joyners Find
SCALE 1:1 000 000
0 10 20 30 40 50 km
GLENGARRY
SHEET SG 50-12
First Edition 1996

Figure 45.

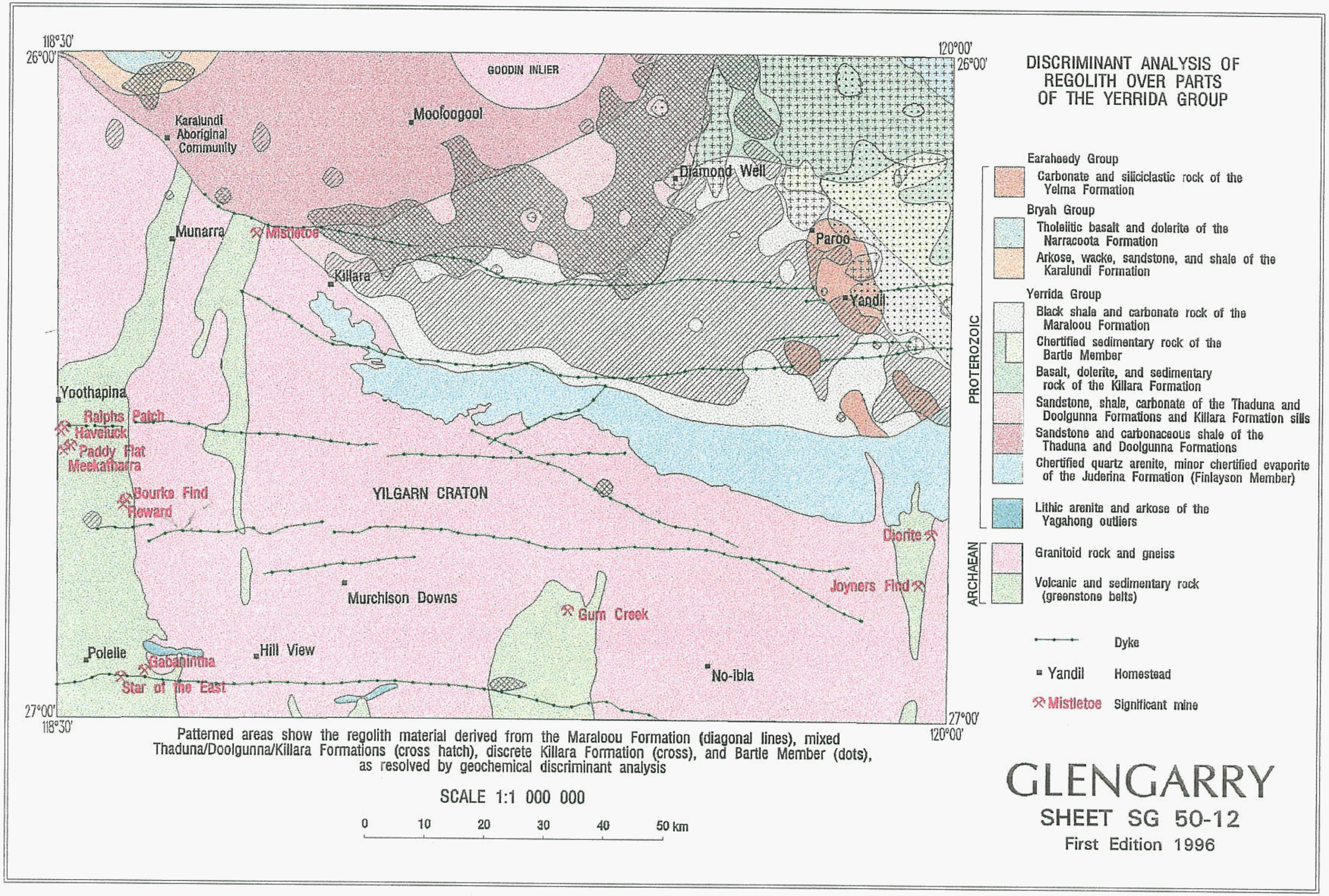

DISCRIMINANT ANALYSIS OF REGOLITH OVER PARTS OF THE YERRIDA GROUP
118°30'
26°00'
120°00'
26°00'
27°00'
118°30'
27°00'
120°00'
GOODIN INLIER
Karalundi Aboriginal Community
Mooloogool
Diamond Well
Munarra
Mistletoe
Killara
Paroo
Yandil
Yoothapina
Ralphs Patch
Haveluck
Paddy Flat
Meekatharra
Bourke Find
Reward
YILGARN CRATON
Diorite
Joyners Find
Murchison Downs
Gum Creek
Polelle
Gabanintha
Hill View
Star of the East
No-ibla
Earaheedy Group
Carbonate and siliciclastic rock of the Yelma Formation
Bryah Group
Tholeiitic basalt and dolerite of the Narracoota Formation
Arkose, wacke, sandstone, and shale of the Karalundi Formation
Yerrida Group
Black shale and carbonate rock of the Maraloou Formation
Chertified sedimentary rock of the Bartle Member
Basalt, dolerite, and sedimentary rock of the Killara Formation
Sandstone, shale, carbonate of the Thaduna and Doolgunna Formations and Killara Formation sills
Sandstone and carbonaceous shale of the Thaduna and Doolgunna Formations
Chertified quartz arenite, minor chertified evaporite of the Juderina Formation (Finlayson Member)
Lithic arenite and arkose of the Yagahong outliers
PROTEROZOIC
Granitoid rock and gneiss
Volcanic and sedimentary rock (greenstone belts)
ARCHAEAN
Dyke
Yandil
Homestead
Mistletoe
Significant mine
Patterned areas show the regolith material derived from the Maraloou Formation (diagonal lines), mixed Thaduna/Doolgunna/Killara Formations (cross hatch), discrete Killara Formation (cross), and Bartle Member (dots), as resolved by geochemical discriminant analysis
SCALE 1:1 000 000
0 10 20 30 40 50 km
GLENGARRY
SHEET SG 50-12
First Edition 1996

Figure 46.

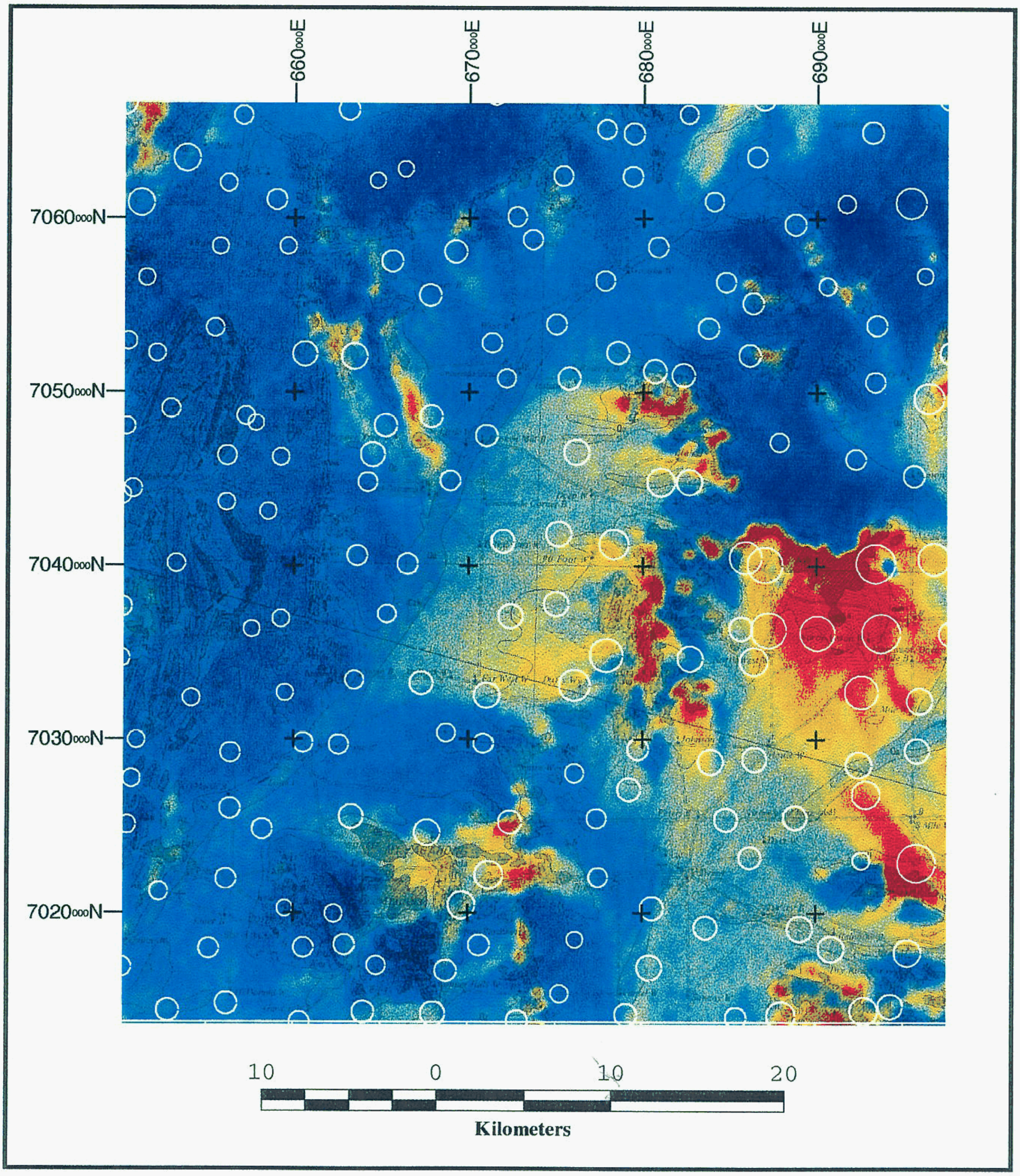


Figure 47. Comparison of airborne radiometrics (K) with regolith K2O, Gabanintha sheet.

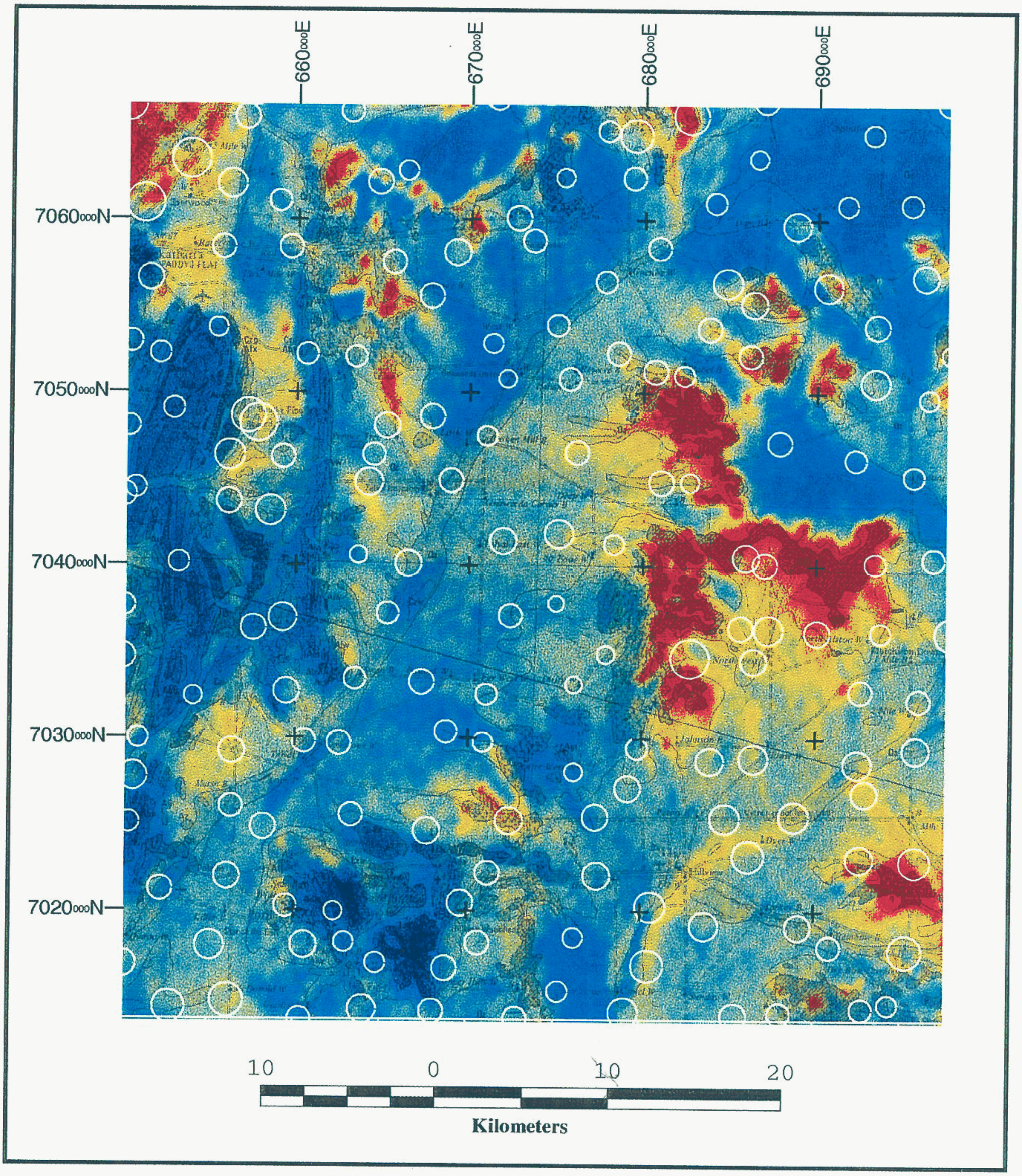


Figure 48. Comparison of airborne radiometrics (Th) with regolith Th, Gabanintha sheet.

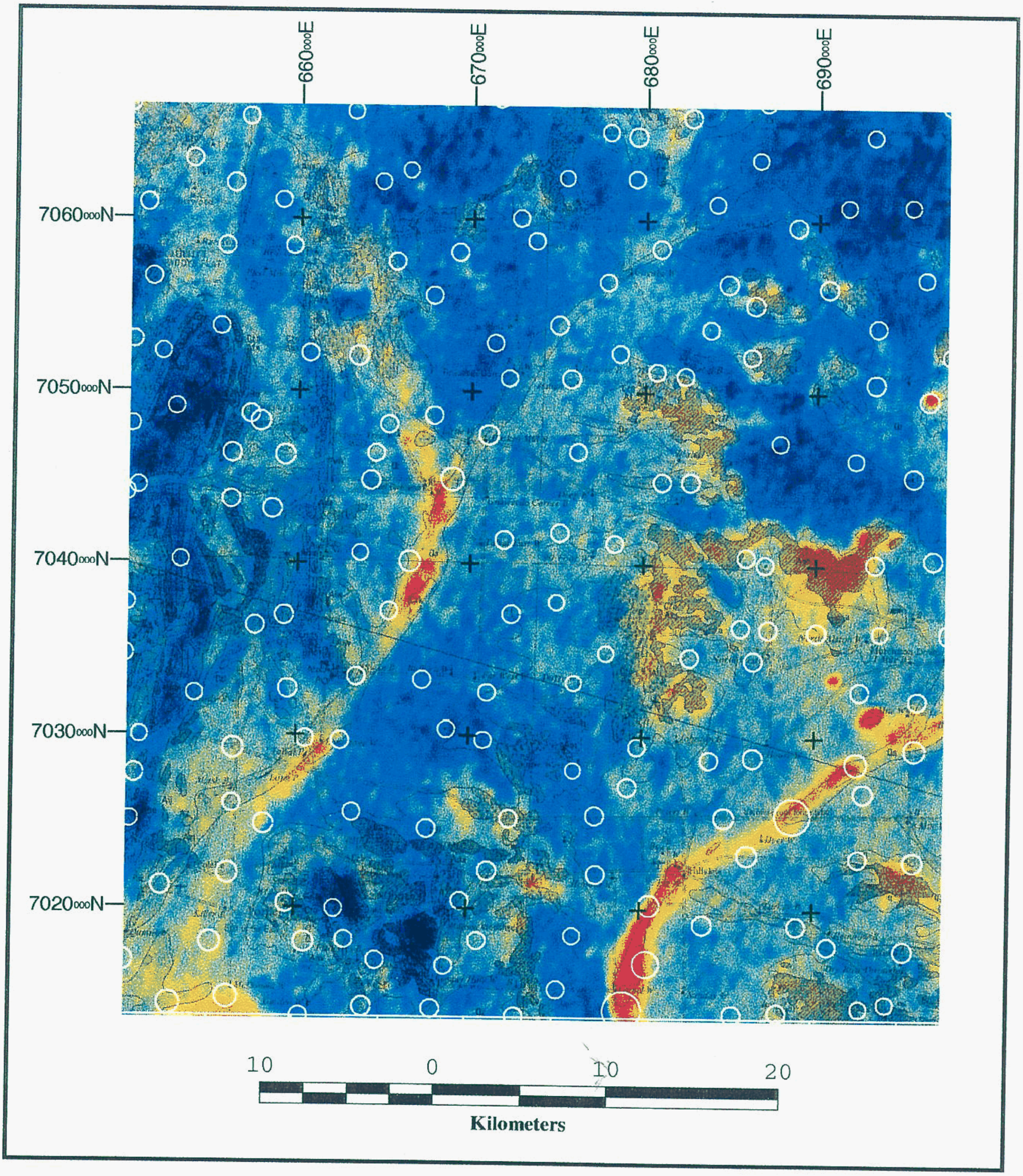


Figure 49. Comparison of airborne radiometrics (U) with regolith U, Gabanintha sheet.

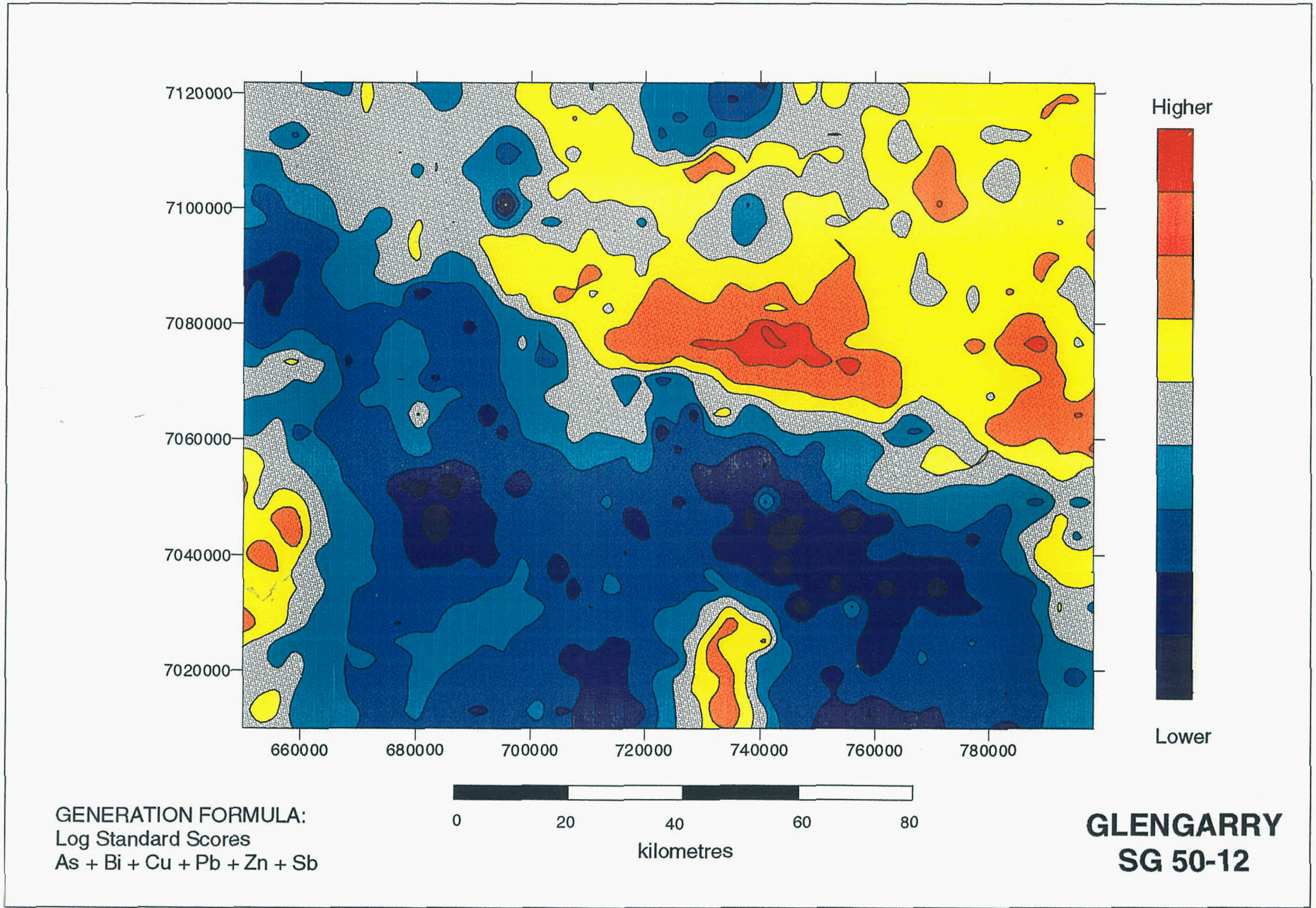


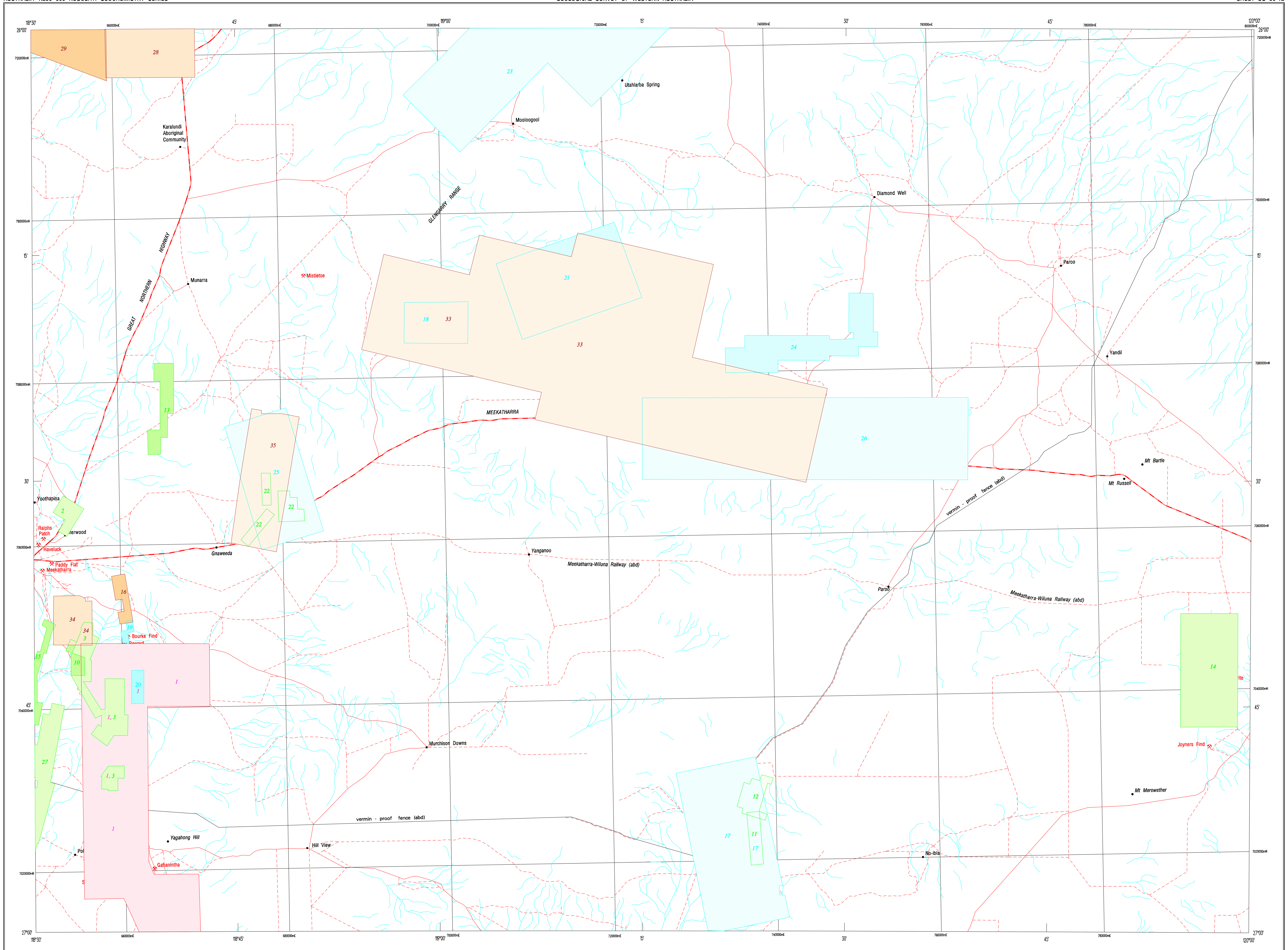
FIGURE 50. Plot of 'base metals index'

GLENGARRY

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SG 50-12



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

PROJECTS REPORTED BETWEEN 1966 AND 1985

Period Project Reported Within

(Various colour shades used for ease of project indentification)

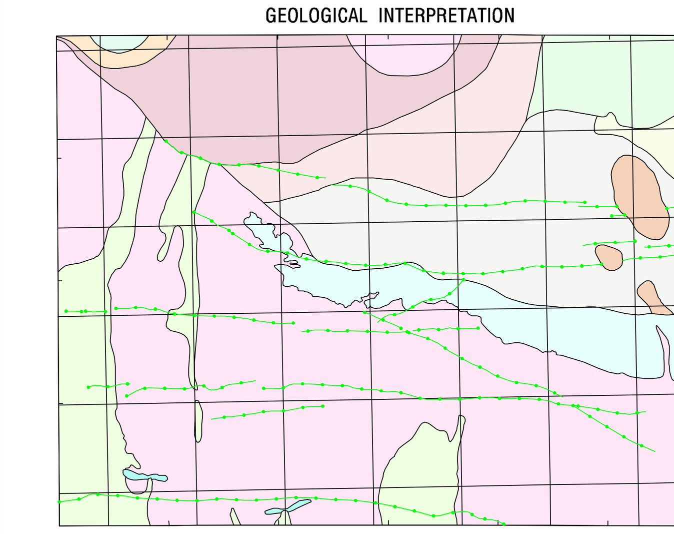
- 1966 - 1970
- 1971 - 1975
- 1976 - 1980
- 1981 - 1985
- 1986 - 1990
- 1991 - 1994

See PLATE 2 (1986 - 1990, 1991 - 1994)

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

- Principal road
- Minor road
- Track
- Watercourse and lake boundaries
- Yandil — Homestead
- Gnaweeda — Locality
- Gabanintha — Significant mine

GEOLOGICAL INTERPRETATION



Geological interpretation after Elias, Bunting and Wharton (1982); Gee (1985); Dawes and Le Blanc Smith (1995); Pirajno (1995, pers. comm.).

PROTEROZOIC

Earaheedy Group
- Carbonate and siliciclastic rock of the Yelma Formation

Bryah Group
- Tholeiitic basalt and dolerite of the Narracoota Formation
- Arkose, wacke, sandstone, and shale of the Karalundi Formation

Yerrida Group
- Black shale and carbonate rock of the Maraloou Formation
- Chertified sedimentary rock of the Bartle Member
- Basalt, dolerite, and sedimentary rock of the Killara Formation
- Sandstone, shale, carbonate of the Thaduna and Doolgunna Formations and Killara Formation sills
- Sandstone and carbonaceous shale of the Thaduna and Doolgunna Formations
- Chertified quartz arenite, minor chertified evaporite of the Juderina Formation (Finlayson Member)

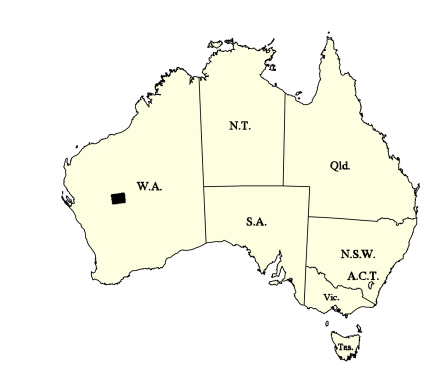
- Lithic arenite and arkose of the Yagahong outliers

ARCHAEAN
- Granitoid rock and gneiss
- Volcanic and sedimentary rock (greenstone belts)

- Dolerite Dyke

SHEET INDEX

ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5
BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9
CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13



INDEX TO 1:100 000 MAP SHEETS WITHIN GLENGARRY 1:250 000

GLENGARRY 2645	MOOLOOGOOL 2745	MT BARTLE 2845
GABANINTHA 2644	YANGANOO 2744	MEREWETHER 2844

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

PROJECTS REPORTED BETWEEN 1966 AND 1985

REGOLITH GEOCHEMISTRY SERIES

GLENGARRY

SHEET SG 50-12

FIRST EDITION 1996

Edited by C. Strong and G. Loan

Cartography by G. Jose, K. Smith and S. Collopy

Topography from Australian Surveying and Land Information Group Sheet SG 50-12 and roads modified from geological field survey (1994)

This map was compiled digitally from the geochemical database held by Geological Survey Western Australia and stored in the ORACLE database management system; compiled and produced using a Geographic Information System, Arc/Info

This map is also available in digital form

Copies of this map, or extracts from the database, are available from the Department of Minerals and Energy, 100 Plain Street, East Perth, W.A., 6004

DEPARTMENT OF MINERALS AND ENERGY
HON. GEORGE CASH J.P., M.L.C. MINISTER FOR MINES
K.R. PERRY, DIRECTOR GENERAL

SCALE 1:250 000

5000 METRES 0 5 10 15 20 25 30 KILOMETRES

TRANSVERSE MERCATOR PROJECTION

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

PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Compiled by: J.A. Faulkner, 1995

Compiled from open file company reports held by Geological Survey of Western Australia

The recommended reference for this map is: FAULKNER, J.A., 1996, Glengarry, W.A. Sheet SG 50-12 -- Company projects with surface geochemistry data in open file reports (at February 1995), projects commenced between 1966 and 1985: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series

Some tenement boundaries have been generalized for the purpose of this map. Refer to specific project reports for precise boundary descriptions

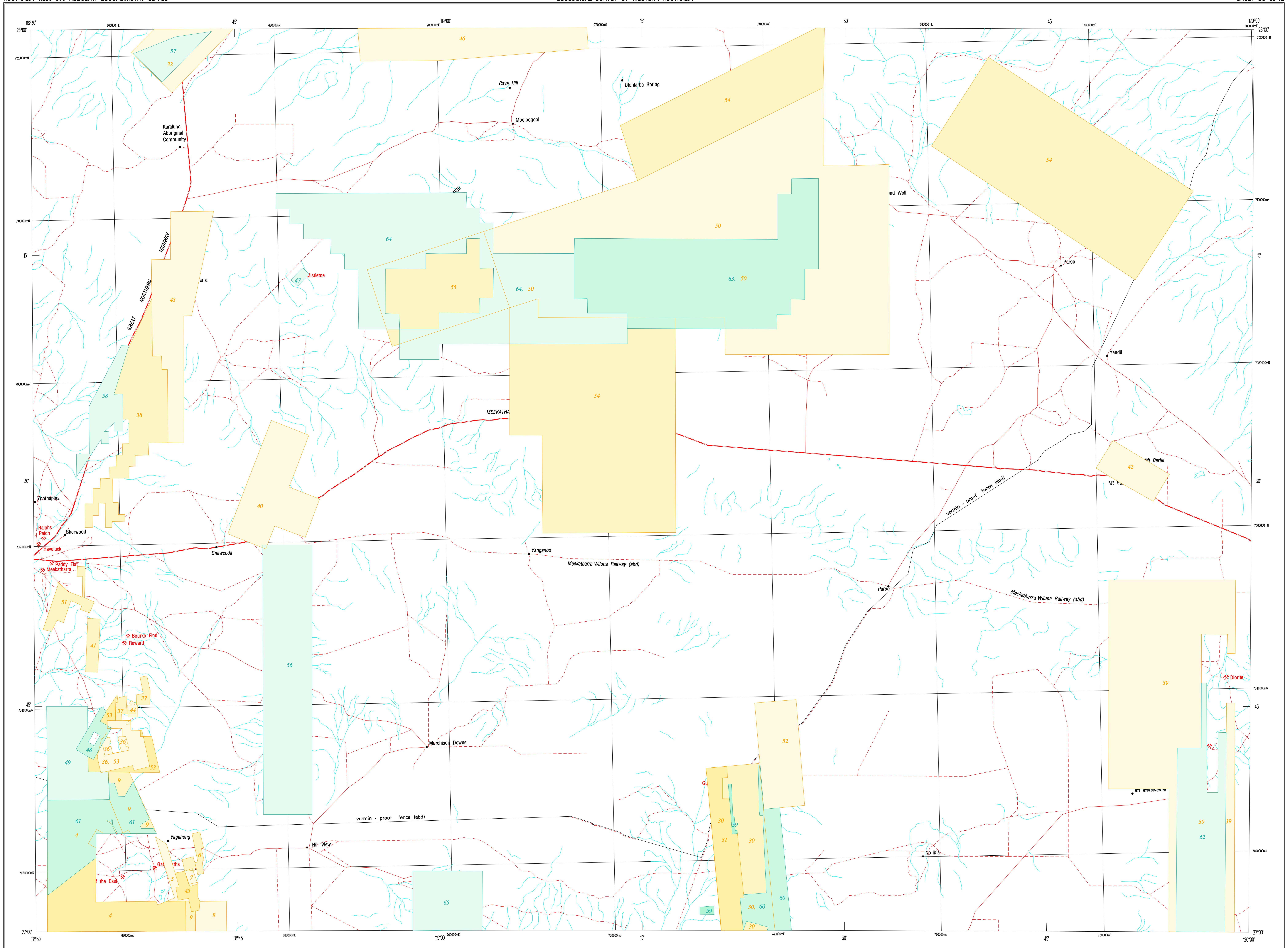
WARNING: Inks are water soluble and will fade with prolonged exposure to light

GLENGARRY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

SHEET SG 50-12



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

PROJECTS REPORTED BETWEEN 1986 AND 1994

Period Project Reported Within

(Various colour shades used for ease of project indentification)

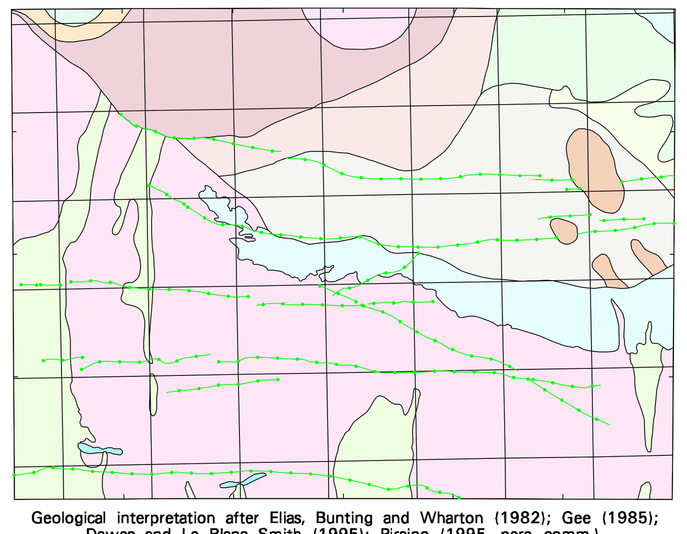
- 1966 - 1970
- 1971 - 1975
- 1976 - 1980
- 1981 - 1985
- 1986 - 1990
- 1991 - 1994

See PLATE 1 (1966 - 1985)

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

- Principal road
- Minor road
- Track
- Watercourse and lake boundaries
- Yandil — Homestead
- Gnaweeda — Locality
- Gabanintha — Significant mine

GEOLOGICAL INTERPRETATION



Geological interpretation after Elias, Bunting and Wharton (1982); Gee (1985); Dawes and Le Blanc Smith (1995); Pirajno (1995, pers. comm.).

PROTEROZOIC

Earaheedy Group
- Carbonate and siliciclastic rock of the Yelma Formation

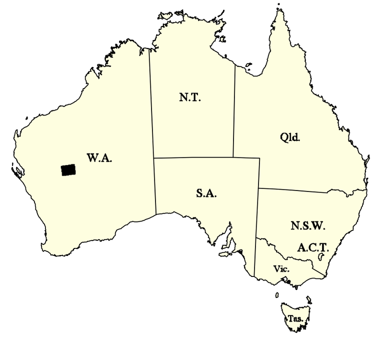
Bryah Group
- Tholeiitic basalt and dolerite of the Narracoota Formation
- Arkose, wacke, sandstone, and shale of the Karalundi Formation

Yerrida Group
- Black shale and carbonate rock of the Maraloou Formation
- Chertified sedimentary rock of the Bartle Member
- Basalt, dolerite, and sedimentary rock of the Killara Formation
- Sandstone, shale, carbonate of the Thaduna and Doolgunna Formations and Killara Formation sills
- Sandstone and carbonaceous shale of the Thaduna and Doolgunna Formations
- Chertified quartz arenite, minor chertified evaporite of the Juderina Formation (Finlayson Member)

- Lithic arenite and arkose of the Yagahong outliers

ARCHAEAN
- Granitoid rock and gneiss
- Volcanic and sedimentary rock (greenstone belts)

Dolerite Dyke



SHEET INDEX

ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5
BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9
CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13

INDEX TO 1:100 000 MAP SHEETS WITHIN GLENGARRY 1:250 000

GLENGARRY 2645	MOOLOOGOOL 2745	MT BARTLE 2845
GABANINTHA 2644	YANGANOO 2744	MEREWETHER 2844

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

PROJECTS REPORTED BETWEEN 1986 AND 1994

REGOLITH GEOCHEMISTRY SERIES

GLENGARRY

SHEET SG 50-12

FIRST EDITION 1996

Edited by C. Strong and G. Loan

Cartography by G. Jose, K. Smith and S. Collopy

Topography from Australian Surveying and Land Information Group Sheet SG 50-12 and roads modified from geological field survey (1994)

This map was compiled digitally from the geochemical database held by Geological Survey Western Australia and stored in the ORACLE database management system; compiled and produced using a Geographic Information System, Arc/Info

This map is also available in digital form

Copies of this map, or extracts from the database, are available from the Department of Minerals and Energy, 100 Plain Street, East Perth, W.A., 6004

DEPARTMENT OF MINERALS AND ENERGY

HON. GEORGE CASH J.P., M.L.C.
MINISTER FOR MINES

K.R. PERRY, DIRECTOR GENERAL

SCALE 1:250 000

5000 METRES 0 5 10 15 20 25 30 KILOMETRES

TRANSVERSE MERCATOR PROJECTION

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

PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Compiled by: J.A. Faulkner, 1995

Compiled from open file company reports held by Geological Survey of Western Australia

The recommended reference for this map is: FAULKNER, J.A., 1996, Glengarry, W.A. Sheet SG 50-12 -- Company projects with surface geochemistry data in open file reports (at February 1995), projects commenced between 1986 and 1994: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series

Some tenement boundaries have been generalized for the purpose of this map. Refer to specific project reports for precise boundary descriptions

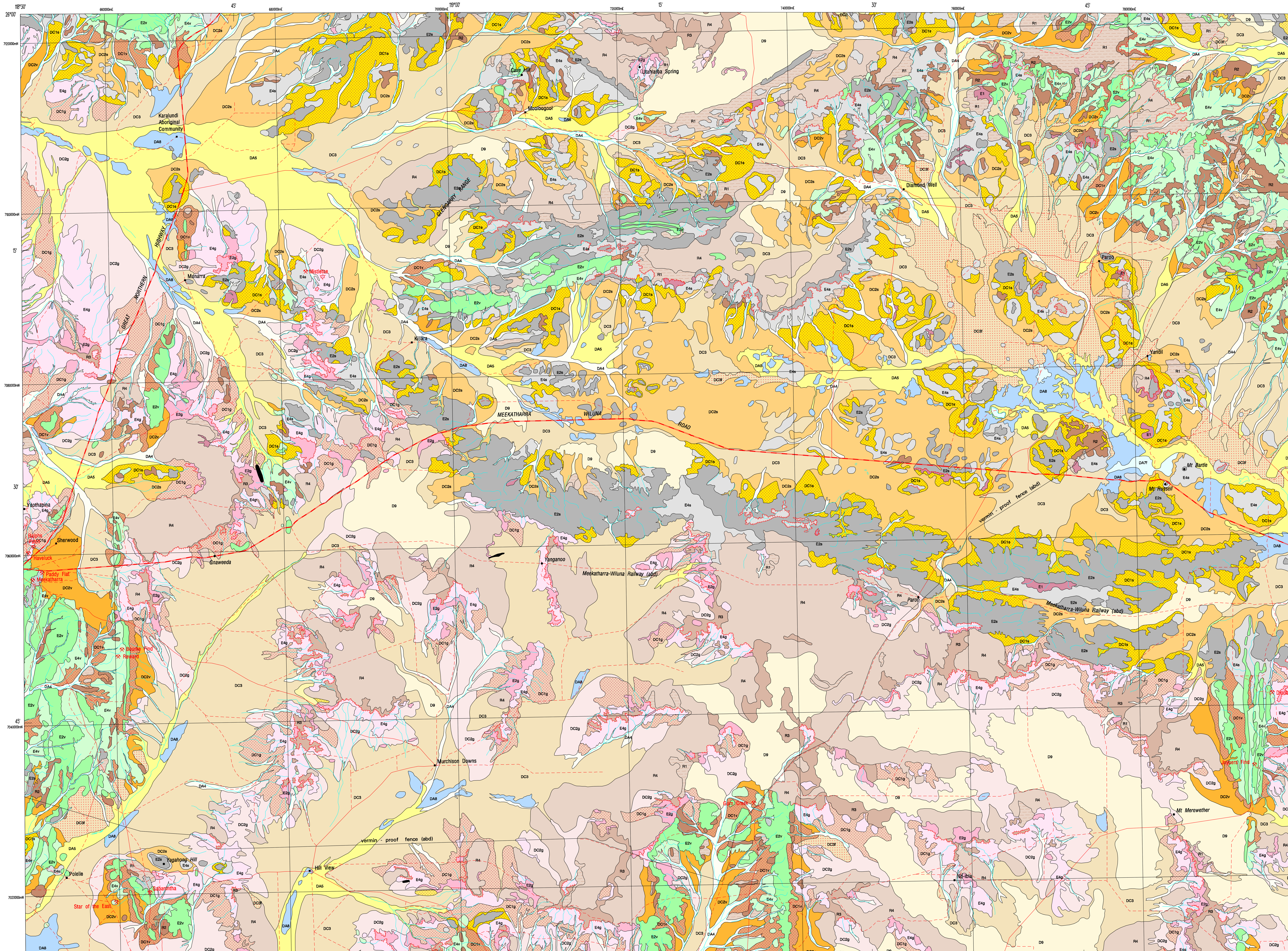
WARNING: Inks are water soluble and will fade with prolonged exposure to light

GLENGARRY

1:250 000 REGOLITH MATERIALS SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SG 50-12



REFERENCE

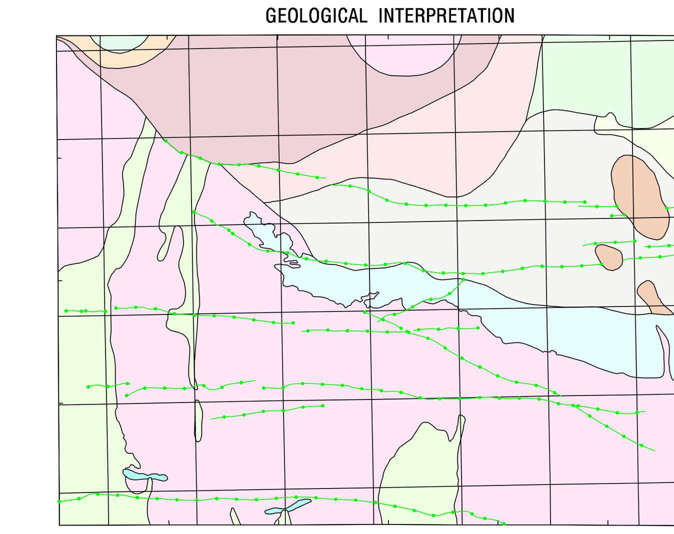
		CSIRO (1)	CSIRO (2)	AGSO
RELICT REGIME				
R1	Ferruginous pisolites and nodules	LT1	R2	NO40
R2	Iron-rich duricrust forming remnant land surfaces	LT2 LT3	R1	DS41 DS42
R3	Silcrete (often weakly ferruginized): mainly overlies granitoid and sedimentary rocks	BR2	--	DS60
R4	Quartz-rich sands and silts overlying presumed or known R1-R3 material	ET1, LS3 LS4, LS5	D9	WR22
EROSIONAL REGIME				
E1	Mottled zone and saprolite; generally poorly exposed	SP1-5	E3 E4	WR11-14
E2g	Outcrop of saprock and bedrock; subcrop areas have locally derived sands and sandy clays; coarse (bouldery) lag locally bounds prominent ranges; derived from granitoid rocks	BR3, SR2 SS1, SS6	E1 E6-E9	WR12, WR21 WR24
E2s	As E2g but derived from sedimentary rocks			
E2v	As E2g but derived from volcano-sedimentary greenstone and mafic rocks			
E4g	Lag of locally derived ferruginous and/or lithic fragments, and/or feldspar in a sandy clay to sand-rich matrix associated with actively eroding outcrop/subcrop; derived from granitoid rocks	NL3, NL4 SS1, SS5-6	E6-E9	WR12, WR21 WR24
E4s	As E4g but derived from sedimentary rocks			
E4v	As E4g but derived from volcano-sedimentary greenstone and mafic rocks			
q	Quartz vein	--	--	--
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	CS3, CS4 NL3	D1 D4	SC01, SC04 SC05
DC1g	DC1 derived mainly from granitoid rocks			
DC1s	DC1 derived mainly from sedimentary rocks			
DC1v	DC1 derived mainly from volcano-sedimentary greenstone and mafic rocks			
DC2	Fine- to medium-grained detritus (most clasts 4-25 mm) mainly of ferruginized lithic origin, or quartz in a sandy clay matrix	CS1, CS3-4 NL2-3	D3 D4	SC05
DC2g	DC2 derived mainly from granitoid rocks			
DC2s	DC2 derived mainly from sedimentary rocks			
DC2v	DC2 derived mainly from volcano-sedimentary greenstone and mafic rocks			
DC3	Variably feldspathic sand- and clay-rich colluvium or sheetwash; merges into alluvial plains (DA5)	CS1-4 Mi1-3	D3 D4	SC05 SC06
DC3f	Detritus, mainly non-lithic ferruginous (most clasts <10 mm) possibly magnetic in red sandy clay; includes buckshot gravel	CS1, Mi1-3 NL5	D3 D4	SC05 SC06
DOMINANTLY ALLUVIAL				
DA4	Gravelly sands and sandy clays of active alluvial channels with mixtures of ferruginous and variably altered lithic fragments	AS1 AS2	D1	SA00 SA10
DA5	Sand- or clay-rich alluvium and colluvium on broad drainage floors, including overbank alluvial deposits and terraces; includes non-saline claypans; calcrete fragments	AS1 AS2	D5	SA00 SA20
DA7f	Sediments of former freshwater claypans	AS1, AS2 AS5	D5	SL00
DA8	Valley calcrete; in places silicified	AS2, CS2	D3?	DS20
DOMINANTLY EOLIAN				
D9	Sandplain, eolian in origin; may form dunes or thin sheets; overlies sheetwash, soil, or 'bedrock'	ES1, ES2 ET7	D9	SE01, US00 WR22

CSIRO (1) regolith codes: R.R. Anand et al., 1993
CSIRO (2) regolith codes: M.A. Craig and R.R. Anand, 1993
AGSO regolith codes: C. Pain et al., 1991

SYMBOLS

- Regolith boundary
- Principal road
- Minor road
- Track
- Breakaway
- Watercourse, ephemeral
- Homestead — Yandil
- Locality — *Gnaweeda*
- Significant mine — Gabanintha
- Mining area, made ground

GEOLOGICAL INTERPRETATION



Geological interpretation after Elias, Bunting and Wharton (1982); Gee (1985); Dawes and Le Blanc Smith (1995); Pirajno (1995, pers. comm.).

PROTEROZOIC
- Earaheedy Group
  - Carbonate and siliciclastic rock of the Yelma Formation
- Bryah Group
  - Tholeiitic basalt and dolerite of the Narracoota Formation
  - Arkose, wacke, sandstone, and shale of the Karalundi Formation
- Yerrida Group
  - Black shale and carbonate rock of the Maraloou Formation
  - Chertified sedimentary rock of the Bartle Member
  - Basalt, dolerite, and sedimentary rock of the Killara Formation
  - Sandstone, shale, carbonate of the Thaduna and Doolgunna Formations and Killara Formation sills
  - Sandstone and carbonaceous shale of the Thaduna and Doolgunna Formations
  - Chertified quartz arenite, minor chertified evaporite of the Juderina Formation (Finlayson Member)
- Lithic arenite and arkose of the Yagahong outliers

ARCHAEAN
- Granitoid rock and gneiss
- Volcanic and sedimentary rock (greenstone belts)

Dolerite Dyke

SHEET INDEX

ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5
BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9
CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13

Edited by C. Strong and G. Loan

Cartography by G. Jose, K. Smith, and C. Bartlett

Topography from Australian Surveying and Land Information Group Sheet SG 50-12 and roads modified from geological field survey (1994)

This map is also available in digital form

Published by, and available from, the Geological Survey of Western Australia, Department of Minerals and Energy, 100 Plain Street, East Perth, W.A., 6004

DEPARTMENT OF MINERALS AND ENERGY
HON. GEORGE CASH J.P., M.L.C.
MINISTER FOR MINES
K.R. PERRY, DIRECTOR GENERAL

SCALE 1:250 000

5000 METRES 0 5 10 15 20 25 30 KILOMETRES

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

PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Compiled by: R.A. Crawford, J.R. Gozzard, and A.J. Sanders, 1995

Field observations by: R. Crawford, J.R. Gozzard (GSWA), L. Fitzgerald, G. Tolland, and G. Lawrence (Geochemex Australia), 1994

The recommended reference for this map is: CRAWFORD, R.A., GOZZARD, J.R., and SANDERS, A.J., 1996, Glengarry, W.A. Sheet SG 50-12: Western Australia Geological Survey, 1:250 000 Regolith Materials Series

REGOLITH MATERIALS SERIES

GLENGARRY

SHEET SG 50-12

FIRST EDITION 1996

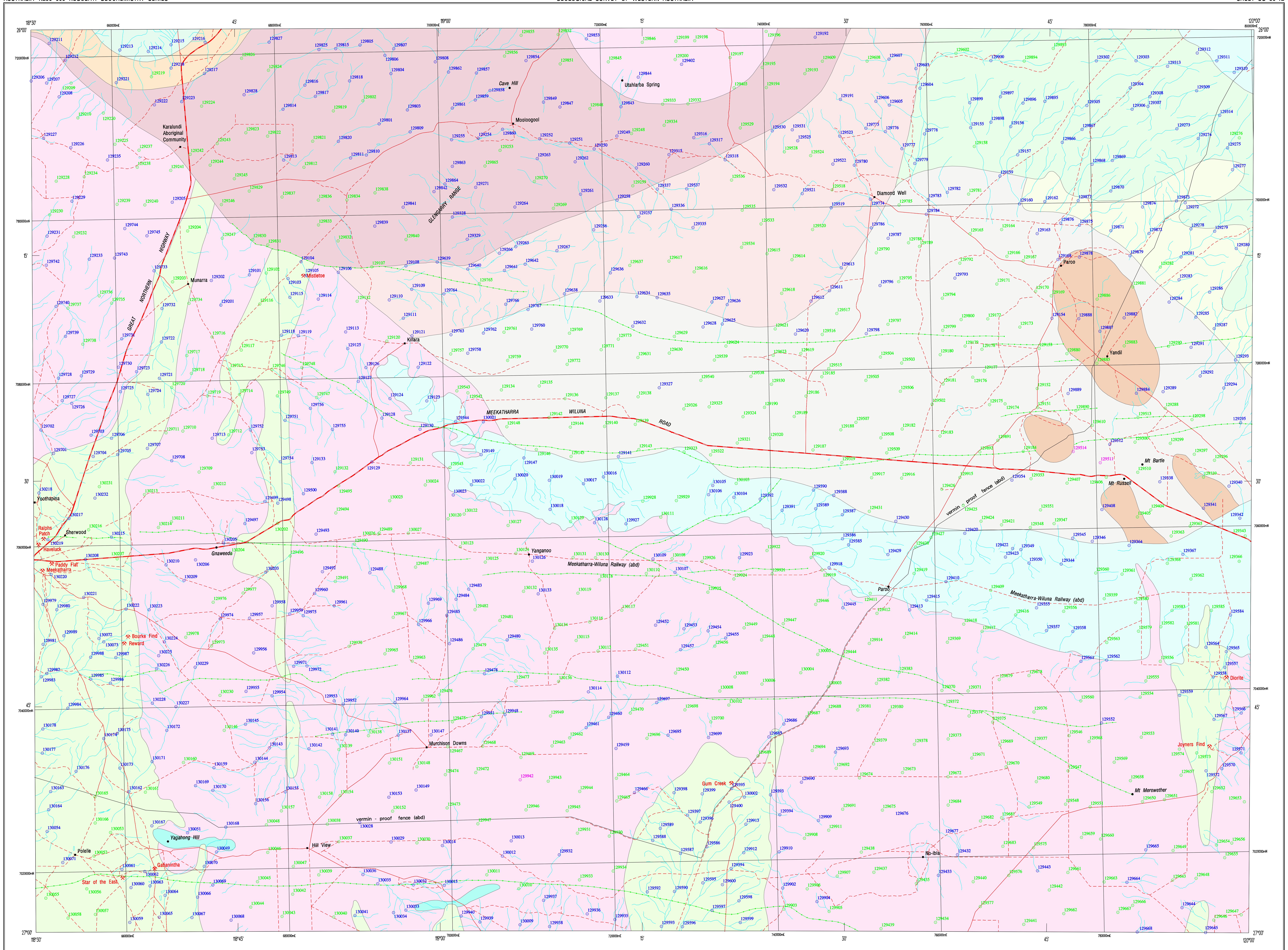
WARNING: Inks are water soluble and will fade with prolonged exposure to light

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

GLENGARRY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SG 50-12



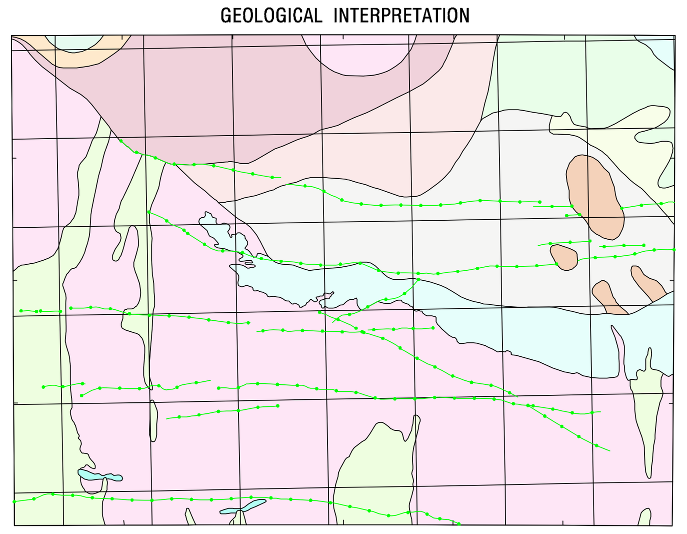
SAMPLE LOCATIONS

Sample point references

- 122123 Lake sample
- 122123 Stream sample
- 122123 Soil sample

- Principal road
- Minor road
- Track
- Watercourse and lake boundaries
- Yandil — Homestead
- Gnaweeda — Locality
- Gabanintha — Significant mine

GEOLOGICAL INTERPRETATION



PROTEROZOIC

Earaheedy Group
- Carbonate and siliciclastic rock of the Yelma Formation

Bryah Group
- Tholeiitic basalt and dolerite of the Narracoota Formation
- Arkose, wacke, sandstone, and shale of the Karalundi Formation

Yerrida Group
- Black shale and carbonate rock of the Maraloou Formation
- Chertified sedimentary rock of the Bartle Member
- Basalt, dolerite, and sedimentary rock of the Killara Formation
- Sandstone, shale, carbonate of the Thaduna and Doolgunna Formations and Killara Formation sills
- Sandstone and carbonaceous shale of the Thaduna and Doolgunna Formations
- Chertified quartz arenite, minor chertified evaporite of the Juderina Formation (Finlayson Member)

- Lithic arenite and arkose of the Yagahong outliers

ARCHAEAN
- Granitoid rock and gneiss
- Volcanic and sedimentary rock (greenstone belts)

- Dolerite Dyke

Geological interpretation after Elias, Bunting and Wharton (1982); Gee (1985); Dawes and Le Blanc Smith (1995); Pirajno (1995, pers. comm.).

SHEET INDEX

ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5
BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9
CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13

SAMPLE LOCATIONS

REGOLITH GEOCHEMISTRY SERIES

GLENGARRY

SHEET SG 50-12

FIRST EDITION 1996

Edited by C. Strong and G. Loan

Cartography by G. Jose and K. Smith

Topography from Australian Surveying and Land Information Group Sheet SG 50-12 and roads modified from geological field survey (1994)

This map was compiled digitally from the geochemical database held by Geological Survey Western Australia and stored in the ORACLE database management system; compiled and produced using a Geographic Information System, Arc/Info

This map is also available in digital form

Copies of this map, or extracts from the database, are available from the Department of Minerals and Energy, 100 Plain Street, East Perth, W.A., 6004

DEPARTMENT OF MINERALS AND ENERGY

HON. GEORGE CASH J.P., M.L.C.
MINISTER FOR MINES

K.R. PERRY, DIRECTOR GENERAL

SCALE 1:250 000

5000 METRES 0 5 10 15 20 25 30 KILOMETRES

TRANSVERSE MERCATOR PROJECTION

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

PIETRO GUJ

DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

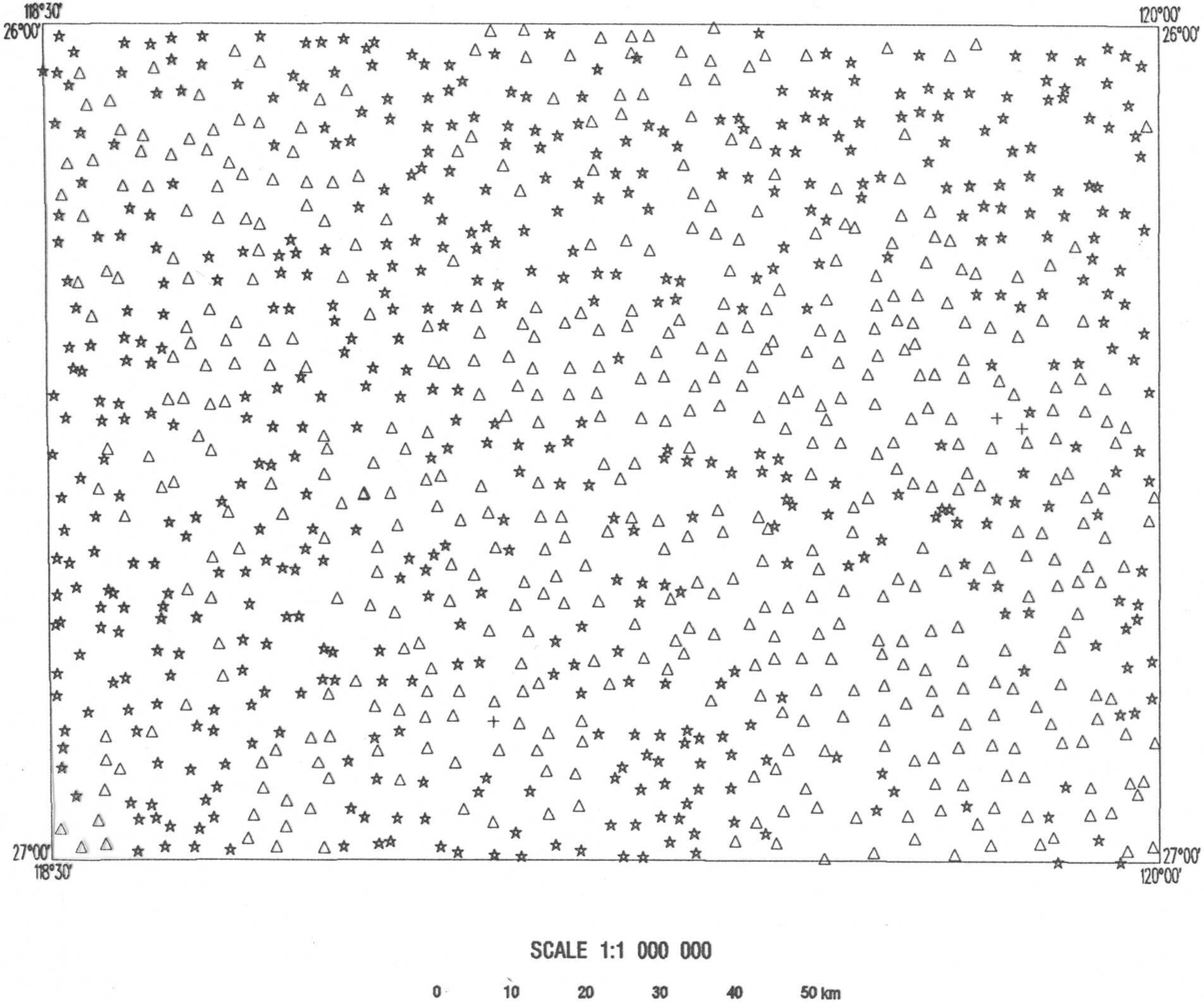
Sampling by: R.A. Crawford (GSWA), L. Fitzgerald, G. Lawrence, and G. Tolland (Geochemex Australia), 1994

Total sample sites: 1035; 528 stream sediment, 3 lake sediment, and 504 soil

Analyst: Chemistry Centre, Western Australia. Minimum sample size: 1.5 kg. Fraction of soil, stream sediment and lake sediment samples analysed: -2mm+0.45mm

The recommended reference for this map: CRAWFORD, R.A., FAULKNER, J.A., and SANDERS, A.J., 1996, Glengarry, W.A. Sheet SG 50-12 -- Sample locations: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series

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



SAMPLE LOCATIONS

SAMPLE TYPE

△ Soil

+ Lake

☆ Stream

GLENGARRY

SHEET SG 50-12

First Edition 1996

PLATE 5