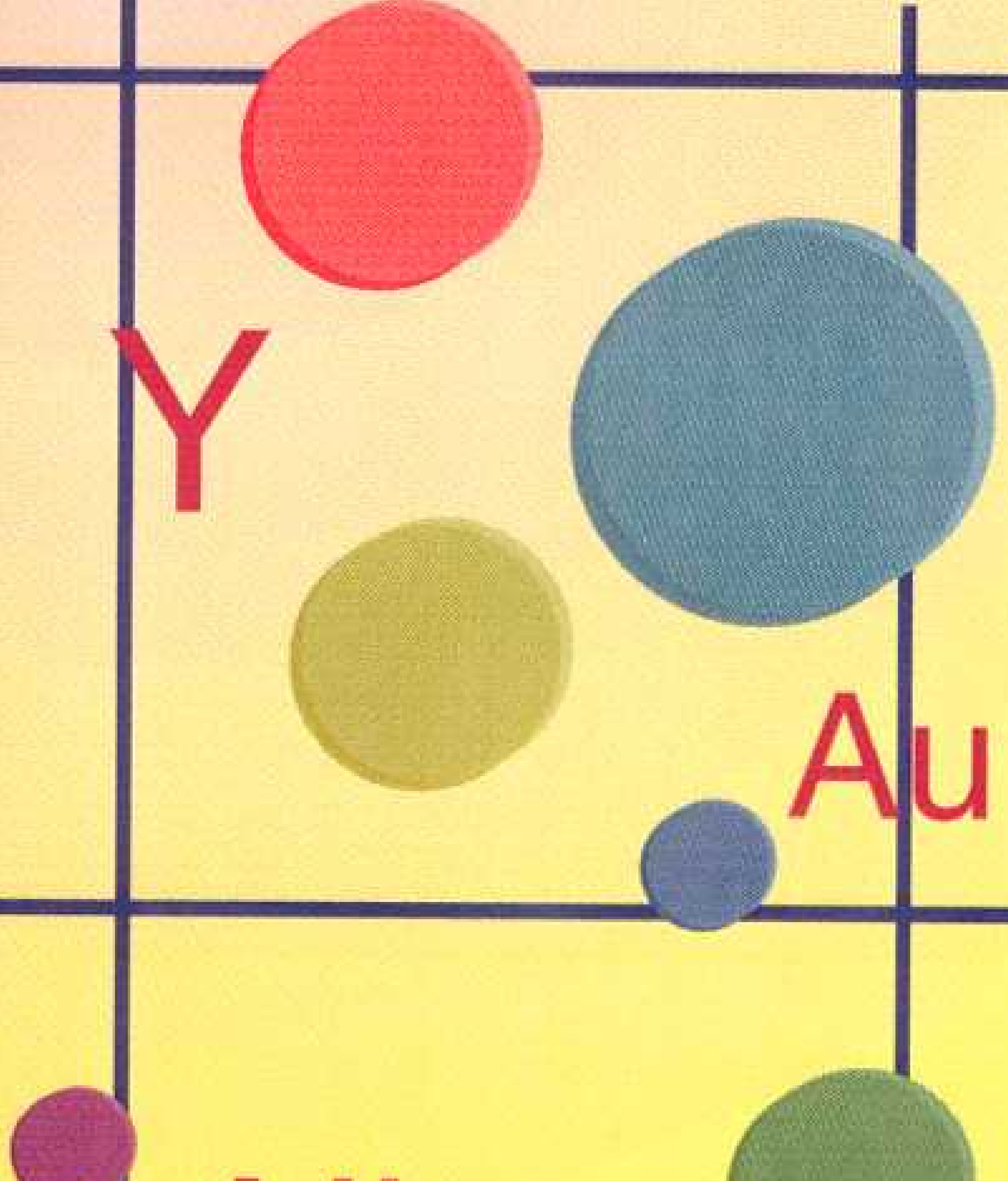
EXPLANATORY NOTES

# GEOCHEMICAL MAPPING OF THE LEONORA 1:250 000 SHEET

by J.J. BRADLEY, A.J. SANDERS, Z.S. VARGA, and J.M. STOREY




GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

DEPARTMENT OF MINERALS AND ENERGY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

# GEOCHEMICAL MAPPING OF THE LEONORA 1:250 000 SHEET

by
J. J. Bradley, A. J. Sanders, Z. S. Varga, and J. M. Storey

Perth 1995

**MINISTER FOR MINES**
**The Hon. George Cash, JP, MLC**

**DIRECTOR GENERAL**
**K. R. Perry**

**DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA**
**Pietro Guj**

**National Library of Australia Card Number and ISBN 0 7309 4422 0**

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

# Contents

Page

Abstract ........ 1
Introduction ........ 2
Setting ........ 2
  Access ........ 2
  Climate and vegetation ........ 3
  Topography and drainage ........ 3
  Landforms and regolith development ........ 3
Data acquisition and previous geoscientific investigations ........ 4
  Geological mapping ........ 4
  Regolith mapping ........ 4
  Hydrogeological investigations ........ 4
  Mineral resource and occurrence datasets ........ 5
  Topographic and remote sensing datasets ........ 5
Geology ........ 5
Mineralization ........ 7
  Gold ........ 7
  Other minerals ........ 9
Regolith-materials mapping ........ 9
  Regolith-materials map units ........ 9
    Relict regime ........ 9
    Erosional regime ........ 11
    Depositional regime ........ 11
Geochemical mapping ........ 12
  Sampling density ........ 12
  Site selection ........ 12
  Sample-site form ........ 12
  Sampling ........ 13
Analytical methods ........ 13
  Quality control ........ 14
  Sample-site checks ........ 14
  Submission of GSWA geochemical standards ........ 14
  Submission of replicate samples ........ 14
  Inclusion of in-house standards and duplicates ........ 15
  Repeat analyses ........ 15
  Check analyses at Chemistry Centre (W.A.) ........ 15
  Mineralogical examination ........ 15
Data presentation ........ 15
  Geochemical mapping — maps and plans ........ 15
  Mines and prospects — map and table ........ 16
  Company surface geochemistry projects — map and table ........ 16
  Geochemical surveys on open-file company reports ........ 16
Results and discussion ........ 17
  Mineralogy of sediments ........ 17
  Comparison of regolith units ........ 18
    Regolith units sourced from greenstones ........ 18
      Relict regime ........ 18
      Erosional regime ........ 18
      Colluvial regime ........ 19
    Regolith units sourced from granitoids ........ 19
      Relict regime ........ 19
      Erosional regime ........ 19
      Colluvial regime ........ 20
    Regolith units in drainages: alluvium, salt lakes, and precipitates ........ 20
  Regional considerations ........ 21
    Differences between greenstone belts ........ 22
    Identification of specific granitoid bodies ........ 22
  Economic geology ........ 23
    Gold contours and known mineralization ........ 23
    Other mineralization and potential for mineralization ........ 23
    Chalcophile indices ........ 24
Summary and conclusions ........ 24
References ........ 25

Page

## Appendices


1. Details of gold mines and deposits .......... 29
2. Mineral production (other than gold) for LEONORA .......... 31
3. Sample-site form .......... 33
4. Open-file geochemistry surveys .......... 35


## **Plates** (in pocket)


1. Regolith-materials map (1:250 000)
2. Sample locations (1:250 000)
3. Company surface geochemistry projects (1:250 000) 1966–75
4. Company surface geochemistry projects (1:250 000) 1976–85
5. Company surface geochemistry projects (1:250 000) 1986–94
6. Sample locations overlay (1:1 000 000)
7. General geology overlay (1:1 000 000)


## **Figures** (from p. 61)


1. Locality plan
2. Geological interpretation with mining localities and prospects
3. Generalized regolith map

Element-distribution maps (4–40)

4. Titanium oxide
5. Aluminium oxide
6. Iron oxide
7. Magnesium oxide
8. Calcium oxide (high)
9. Calcium oxide (low)
10. Sodium oxide
11. Potassium oxide
12. Phosphorus oxide
13. Manganese oxide
14. Arsenic
15. Gold
16. Barium
17. Cerium
18. Cobalt
19. Chromium
20. Copper
21. Fluorine
22. Gallium
23. Lanthanum
24. Nickel
25. Lead
26. Palladium
27. Platinum
28. Rubidium
29. Sulfur
30. Antimony
31. Scandium
32. Strontium
33. Thorium
34. Uranium
35. Vanadium
36. Yttrium
37. Zinc
38. Zirconium
39. Beryllium, lithium, molybdenum, niobium, tin
40. Silver, bismuth, cadmium, indium, selenium, tungsten
41. Gold deposits and contoured gold geochemistry
42. Map of first and second principal components
43. Map of the data using the CHI-6*X chalcophile index
44. Map of the data using a pegmatite chalcophile index (based on PEG-4)

# Tables

Page

1. Description and relationships of the greenstone belts on LEONORA (Griffin, 1990) .............................. 6
2. Historical gold production for the LEONORA map sheet .............................. 8
3. Regolith codes and descriptions .............................. 10
4. Detection limits and number of samples below detection .............................. 14
5. XRD analysis of selected samples (CSIRO) .............................. 18
6. Geometric means of analytical results for regolith units derived from greenstone belts .............................. 19
7. Geometric means of analytical results for regolith units derived from granitoids .............................. 20
8. Geometric means of analytical results for regolith units from alluvial and lake areas .............................. 21

# Digital data set

Leonora regional-geochemistry data (LEONCHEM.CSV)

# Geochemical mapping of the Leonora 1:250 000 sheet

by

J. J. Bradley, A. J. Sanders, Z. S. Varga, and J. M. Storey

# Abstract

A regolith-materials map, sample-location plan and 37 element-concentration maps have been prepared for the LEONORA 1:250 000 map sheet area. These are supported by a map showing the positions of previous mineral-exploration projects which have used surface exploration geochemistry.

Regolith samples (-2 mm to +0.45 mm), collected at a nominal density of 1 per 16 $km^2$, were chemically analysed for 47 components. Results are presented in a digital data file with these notes and as element-distribution maps which display 45 components at the 1:1 000 000 scale, with 11 trace elements represented as plots of higher values only. Copies of all element-distribution maps are available on demand at the 1:250 000 scale.

The sampling program yielded 1042 samples including 453 stream-sediment, 546 soil, and 43 lake samples. The results suggest that, for soil and stream sediment, underlying rock type and the degree of weathering are the main differentiating features rather than the sample medium.

Regolith materials have been divided into 17 regolith units; three corresponding to a relict regime, five to an erosional regime, and nine to a depositional regime.

The chemical analyses differentiate the greenstone belts from granitic terrain. General positions of the mafic, ultramafic, and felsic rocks within the six major greenstone belts are suggested by differing element associations. There is a wide variation in sediment composition over granitoids west and east of the main greenstone belt. More-intense mechanical erosion to the west has exposed less-altered granitic bedrock, whereas dominant chemical weathering to the east has resulted in sediments composed of fewer primary minerals and revealing less evidence of the underlying bedrock. Principal-component analysis has identified three centres of potassic granitoids in the west of the map sheet. A fractionated, potassic granitoid enriched in Ce, Pb, La, and Th is also identified in the south.

Over both granitoids and greenstones, the variation in regolith sediments from erosional to depositional regimes is not systematic and may reflect poorly exposed subcrop. Most lake sediment samples are saline; many contain gypsum and calcrete. In general, lake samples are also characterized by an accumulation of MgO, Li, Sr, and U.

Gold mineralization on LEONORA is associated with granite–greenstone contacts and shear zones. Both granitoids and greenstones are known to host mineralization, and association with As and sulfides is common. The contouring of the gold values shows that the 2 ppb contour highlights the known gold deposits, except the Bannockburn deposit.

The Cu, Zn, and Ag deposit at Teutonic Bore is represented by relatively high Cu and Zn values south of the deposit. There are high Ni values in the vicinity of the Mount Clifford nickel deposits; however, there is little surface expression of Weebo Bore (Ni), Wilsons Patch (Pb), or Dodgers Hill (Mo) deposits. The highest uranium values are found in Lake Raeside.

**Keywords:** Leonora, Yilgarn Craton, regolith materials, regional sampling program, multi-element analysis, geochemical maps.

# Introduction

In 1994, the Geological Survey of Western Australia (GSWA) initiated a program of regional geochemical mapping to aid in mineral exploration and to assist monitoring of the environment. The first area studied was the MENZIES* 1:250 000 map sheet (Kojan and Faulkner, 1994). The LEONORA Geochemical Mapping Project, reported here, is the second in the series. LEONORA is contiguous with MENZIES and the intention is to build a database covering a north–south portion of the northeast Yilgarn Craton between Menzies and Wiluna.

The general aims of the program are to

- provide regional baseline geochemical data to assist in the interpretation of other geochemical exploration results;
- assist in the identification of metallogenic provinces and specific areas with potential for undiscovered mineralization;
- assist in the identification of rock types and assemblages present, and provide comparison with prior geological mapping;
- 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 (regolith), and the sampling and analysis of such materials, at regular intervals, over large areas (Kojan and Faulkner, 1994). Regolith is a general term used to cover the blanket of clastic or chemical material, either cemented 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/or erosion. Chemical deposits such as 'hardpans' and calcrete, and eolian sediments, may be intermixed with these materials. Regolith thus includes both residual and transported sediments of various types (Trendall, 1990; Anand et al., 1993a).

Extensive and prolonged weathering of the landsurface through Tertiary and Quaternary time has produced a variably thick regolith cover, which conceals fresh bedrock and hinders mineral exploration in the Yilgarn Craton. 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 relationships, and the nature, origins and weathering history of components of the regolith are extremely important for geochemical exploration/mapping (Anand and Smith, 1994).

Summaries of the state of progress in regional geochemical mapping around the world are given in Darnley (1990) and Davenport (1993). Multi-element geochemical programs have been implemented in the UK, Greenland, the former East Germany, Hungary, Finland, Canada, and China. The Geological Survey of Canada has had a regular program of regional geochemical mapping for the past twenty years. Although the initial objective was to assist mineral exploration, the contribution of this program to understanding the geochemical environment of Canada has become increasingly apparent (Painter et al., 1994).

There are few recent published works in the field of geochemical mapping in Australia. Exceptions include a stream-sediment study on the 1:250 000 EBAGOOLA map sheet in north Queensland (Cruikshank, 1994) and the GSWA geochemical mapping of the MENZIES 1:250 000 map sheet in Western Australia (Kojan and Faulkner, 1994). There is a complementary regolith–landform study of EBAGOOLA (Pain et al., 1994).

Regolith sampling and mapping for the LEONORA map sheet commenced in June 1994 with assistance from sampling teams provided by Geochemex Australia Pty Ltd. The chemical analysis was contracted out to Amdel Laboratories. The contribution of these organizations to this study is acknowledged. Dr Richard Davy assisted in the planning of the project and editing of these notes.

# Setting

The LEONORA 1:250 000 map sheet (SH/51-1) is bounded by latitudes 28°00' and 29°00'S, and longitudes 120°00' and 121°30'E, and is located within the Eastern Goldfields Province. The sheet straddles the boundaries of three defined goldfields — the East Murchison, North Coolgardie, and the Mount Margaret Goldfields.

The map sheet takes its name from the town of Leonora in the southeastern corner of this map, 235 km north of Kalgoorlie. The regional population, which is strongly tied to the gold-mining industry, peaked early in the century during a major gold-mining boom and then steadily declined as mining operations shut down. Towns such as Lawlers and Kurrajong disappeared and, with the closure of the Sons of Gwalia mine in 1963, Gwalia also became deserted. Leonora has remained as a service centre for the region and, with the start of opencut operations at Sons of Gwalia in 1982 and development and operation of numerous other mines, the population of the shire in the 1991 census increased again to 2903. The only other permanent habitation is related to the pastoral stations, but there is an additional, largely transient population involved mainly in mining and exploration.

## Access

The sheet area is traversed from south to north by a sealed road which runs from Kalgoorlie to Leinster, and by a graded road between Leonora and Agnew. A second sealed road links Leonora with Laverton to the east. South of Leonora, a sealed road leads to the Gwalia townsite and the Sons of Gwalia mine. From Leonora, the Kalgoorlie–Leinster road runs in a northerly direction past a number of minesites, past and present, including Harbour Lights, Casino, Trump, Forrest, and Teutonic Bore. The Leonora–Agnew road has a more northwesterly direction and

* Capitalized names in these notes refer to standard map sheets

provides access to the Bannockburn mine and the mining centres of Lawlers and Agnew, and to the west of the map sheet. Major locations are identified on Figure 1 and Plate 1.

Graded roads link these major roads to pastoral station homesteads. The Leonora–Nambi road provides access to the east of the LEONORA 1:100 000 sheet, to the Gambier Lass mine, and the Pig Well Mining Centre. The Leonora–Mount Ida road and the Ida Valley Road provide access to the WILBAH 1:100 000 sheet area and part of the MOUNT ALEXANDER 1:100 000 sheet. Roads to the Pinnacles and Munjeroo stations allow access to the MUNJEROO 1:100 000 sheet, and the Wildara–Weebo road runs through the north east of the WILDARA 1:100 000 sheet and the northwest corner of the WEEBO 1:100 000 sheet.

In off-road areas, access is highly variable. Tracks made for mineral exploration allow reasonable access to the greenstone belts. Access in other areas is subject to the availability of well-maintained fence lines and the density of the vegetation.

## Climate and vegetation

Climate in the LEONORA 1:250 000 map sheet area is semi-arid to arid, with a highly variable annual rainfall of 200 mm nominal average. Summers are hot and dry with occasional heavy rainfall from thunderstorms or cyclonic activity. Winters are cool to mild with most rain falling in the first half of the year. The rainfall may vary widely between different years, and droughts and floods are common features of the climate.

The vegetation of this area is part of the Eremaean botanical province (Beard, 1981). In his 1:3 000 000 vegetation study of Western Australia, Beard recognizes five major vegetation classes for the map sheet: mulga woodlands, acacia and teatree scrub, hummock grassland with scattered trees, samphire *Halosarcia* communities, and bare salt lakes. Variations in vegetation can usually be attributed to variations in regolith, bedrock, and rainfall.

Greenstone ridges are densely vegetated with acacia and teatree scrub with scattered mulga and sheoak. Granite upland areas and eolian sandplains are typically covered by hummock grassland with spinifex and scattered acacias, whereas on the plains the main vegetation types are mulga woodlands with scattered eucalypts. The best growth on the plains is associated with red loamy soils (Chan et al., 1992). The major drainage floors are palaeodrainages with no flowing rivers; salt lakes (salinas) are numerous. The major vegetation types present in these saline drainages are samphire *Halosarcia*, saltbush, and blue bush.

## Topography and drainage

Most topographic relief on LEONORA is related to fresh and weathered outcrops of both granite and greenstone. A large mass of greenstone forms a range of hills trending north-northwest from Leonora to Agnew. Some hills are composed of metamorphosed basalt (Mount Ross, Mount Stirling), whereas others owe their prominence to a resistant chert band within the felsic–clastic sequence (Mount George, Mount Davis, Mount Leonora). Fresh granite may take the form of rounded hills (Mount Adamson) or tors, as at Munjeroo, but typically occurs as flat sheets or bouldery outcrops. Deep-weathered granite, commonly capped with silcrete, gives rise to the prominent, south-facing breakaways such as The Terraces (northeast of Leonora), and to mesas such as Table Hill, east of Lawlers (Thom and Barnes, 1977).

Agnew Bluff, formed of mafic/ultramafic rock is, at 557 m above sea level, the highest point in the area (Thom and Barnes, 1977). The lowest areas are part of a major saline drainage known as the Lake Raeside palaeodrainage (Fig. 1). The lowest point is near the southeastern corner of the map sheet and the flow direction of the southern drainage, which includes Lake Raeside itself, is from west to east. This dominant drainage is joined by a large tributary, flowing in an arcuate path from the northwest of the sheet to a confluence southwest of the Sturt Meadows homestead.

The best-defined, active drainages are in the areas of greatest relief — in the greenstone belts, granite interfluves and on the margins of former plateaus. These active drainages commonly cut back into the resistant uplands. At the base of the hills, many of the channels broaden and become poorly defined sheetwash areas, where most sediment is transported by mass flow following heavy rain. However, this is not always the case and, in some parts of the sheet, large creeks have deep, well-defined channels (e.g. Sullivan Creek in the Tarmoola–King of the Hills area).

## Landforms and regolith development

The major landforms recognized on LEONORA are similar to those found over much of the Eastern Goldfields, namely

- breakaways with sand-covered backslopes and granitic bedrock;
- hills and ridges of greenstone;
- dissected plateau areas with duricrust remnants and abundant lag;
- low hills and rises of fresh to deeply weathered granitoid outcrop;
- sediment plains in upland areas interrupted by areas of outcrop;
- major alluvial plains and sheetwash fans; and
- major drainage floors containing salt lakes.

The major classification scheme of this project divides landforms into three major regimes; *relict*, *erosional*, and *depositional*. These regimes are similar to those of Anand et al. (1993b) except that their term '*residual*' is replaced by *relict*, a term which has fewer genetic connotations.

Relict regimes are characterized by widespread preservation of an apparently lateritic profile, including a hardened ferruginous duricrust (or ferricrete). Recent studies of the duricrusts of the Leonora area have found that seven of the eight duricrusts examined are of transported, rather than residual, origin (Davy and Gozzard, 1995); some duricrusts are ferruginous saprolite. The relict areas defined in this project include not only ferruginous duricrust but also siliceous duricrust (silcrete). The former is best preserved over weathered greenstone, the latter over granitoids. Both types of duricrust cap breakaways. Upland sandplains above granitoid breakaways are assumed to overlie a complete weathering profile and are also included in the relict regime.

Erosional regimes prevail in those areas where there is continuing downcutting by high energy channels and a net removal of materials. Greenstone hills, and dissected plateaus of either granitoid or greenstone, fall in this regime. Elsewhere, a ferruginous profile or breakaway capped by duricrust, has been eroded to expose mottled zone, saprolite, or fresh bedrock. Lower slopes of erosional regimes include pediments where rock is either exposed, or concealed as subcrop beneath shallow skeletal soils or beneath thin, locally derived transported sediments.

There are many examples on LEONORA of streams cutting through a hardpan of cemented colluvium and reworked sediments. These hardpans have been assigned to a depositional regime although their present status is erosional. The large mass of these materials formed in depositional conditions although 'recent' uplift has allowed further erosion to proceed.

Depositional regimes have a net gain of detritus and are characterized by widespread sediments, deposited in lower energy environments, which may be many metres thick. These regimes include sediments transported in alluvial channels, sediments transported and accumulating on slopes by creep under the influence of gravity, and areas of water-transported sheetwash with poorly defined channels. Eolian sediments deposited as sandplains or dunes are also part of the depositional regime.

# Data acquisition and previous geoscientific investigations

## Geological mapping

Numerous reports on the geology of the Leonora area are cited by Hallberg (1976) in his unpublished CSIRO report on the history of geological studies in the Leonora–Laverton area from 1904 to 1976. The first regional geology report, describing the eastern half of the sheet area, was written by Clarke (1925).

The first geological map and explanatory notes for the whole LEONORA map sheet was presented by Thom and Barnes (1977). Since then there have been numerous studies of the geology of parts of LEONORA. Hallberg (1985), Skwarnecki (1988), Williams et al. (1989), Williams and Currie (1993), and Passchier (1990, 1994) have mostly studied the economically important southeastern corner of the map sheet. Williams et al. (1989), Van der Hor and Witt (1992), Williams and Whitaker (1993) and Passchier (1994) provide a history of the deformation events, mainly with regard to the greenstone belts between Leonora and Agnew. The geology and explanatory notes for LEONORA are being revised (Australian Geological Survey Organisation, in press). In addition, Hickman (in prep.) has produced a map for the Leonora–Wiluna region which covers most of the area. In the preparation of this map he has utilized aeromagnetic surveys, aerial photography, LANDSAT imagery, radiometric data, and past reports and geology maps.

## Regolith mapping

The Australian Geological Survey Organisation (AGSO) is producing a 1:250 000 scale LEONORA regolith–landform map (Churchward and Craig, in press) to complement the regolith-materials map, which forms part of these notes (Plate 1). A preliminary copy of this map has been made available to the GSWA.

Other regolith mapping, particularly in the Lawlers–Agnew area, is being carried out by CSIRO and associated organizations as part of various AMIRA and CRC projects. Much of this work is currently unpublished.

## Hydrogeological investigations

An early study by Sanders (1969) investigated calcrete aquifers and their potential use for irrigation and mine water supplies. Thom and Barnes (1977) also included a section on water availability and a contour map displaying regional variation in salinity.

A recent review by Allen (1995) of the hydrogeology of the northern Eastern Goldfields area provides information on groundwater resources and an extensive literature review. Allen has found that there is abundant, but brackish to ultrasaline, water in the area. Groundwater is found in fractured rocks and their weathering profiles, and in the surficial aquifers of the main drainages. Recharge is either by direct infiltration or via stream flow as a consequence of localized, or widespread, downpours (thunderstorms or cyclones). Recharge occurs mainly on or adjacent to catchment divides with the groundwater moving downhill under gravity and, in general, becoming progressively more saline. In salt lakes, evaporation of ponded groundwater results in the residual water becoming ultrasaline brine. Salinity ranges from about 1000 mg/L TDS (along the catchment divides and in some major fractures) to about 300 000 mg/L TDS in the playas.

With an emphasis on the need for groundwater extraction for townships and mines, Bestow (1992) assessed recharge and stored groundwater resources for each 1:250 000 sheet area (including LEONORA) in the Eastern Goldfields. The Leonora town water supply is obtained from a small wellfield on Station Creek, north of the town, and from some scattered bores (Allen, 1995). Groundwater is taken from alluvium, calcrete, weathered basement, and shear zones in greenstones. The extracted water has a high nitrate concentration and a salinity ranging from 600 to 1800 mg/L TDS.

## Mineral resource and occurrence datasets

Data on historic gold production are derived from two sources: a 1954 Department of Mines publication of cancelled gold mining leases for mines that have produced gold, and more up-to-date production records kept by the Royalties Division of the Department of Minerals and Energy (DME).

The DME MINEDEX database supplied records of published company-reported in-ground resources. The locations of the major gold producers were provided by the Bureau of Resource Services MINLOC database. Data presented in this report include those to November 1994.

## Topographic and remote sensing datasets

The topographic information used in the maps for this report was supplied by the Australian Land Information Group (AUSLIG).

Landsat Thematic Mapper scenes were widely used in the interpretation of the regolith boundaries for the resultant regolith-materials map (Plate 1). Six 1:100 000-scale scenes displaying bands 2, 4, and 7 and smaller scale stereo-pair sets were obtained from the Department of Land Administration (DOLA). The stereo pairs, which were computer-derived using a vertically exaggerated elevation model obtained from contouring of known spot heights, allowed three-dimensional viewing.

Other remote-sensing datasets, used in planning the position of sample sites and in the interpretation of results, included all available total-magnetic-intensity and gamma-ray spectrometry data.

# Geology

The LEONORA map sheet lies within the Eastern Goldfields Province, in the Archaean Yilgarn Block. In this province, large areas of granitoids and granitic gneiss are separated by elongate greenstone belts. The greenstone belts generally trend either north-northwest or north, and the rocks consist mainly of mafic and felsic metavolcanics, with minor amphibolite, metagabbro, quartzite, BIF, ultramafic rocks, and intrusions of porphyry and dolerite. Rocks of the greenstone belts have been metamorphosed within the prehnite–pumpellyite, greenschist or amphibolite facies (Binns et al., 1976; Hallberg, 1985; Ahmat, 1986). In the Leonora district, shear zones are common in all lithological units, and are well developed along the contact of the granitoid plutons and the greenstone belts (Passchier, 1990). Basement in the region gained its present, general configuration about 2700 Ma, with the greenstone belts ranging from 2900 Ma to approximately 2660 Ma (Barley and Groves, 1988).

A simplified geology map (Fig. 2) has been compiled from Thom and Barnes (1977), Hickman (in prep.), AGSO (1993), and W. Witt and T. Griffin (pers. comm., 1994). Bedrock present is represented either as granitoid, gneiss, or greenstone. The map shows the major faults, shear zones and the Keith–Kilkenny tectonic zone. The naming of certain features are taken from Thom and Barnes (1977), Griffin (1990b), AGSO (1993), and Passchier (1994). The position of the Mount Ida Fault is not well defined, even by aeromagnetics, and its position is an approximation suggested by W. Witt and T. Griffin (pers. comm., 1994). The post-granitic, mafic dykes have not been included on the simplified map, but an interpretation is included in Thom and Barnes (1977). These authors used a combination of outcrop information and aeromagnetic interpretation to identify a number of easterly trending dykes. Most of the dykes are only a few metres wide at outcrop but, although they are not consistently exposed along strike, aeromagnetic information suggests that some of the dykes are regionally continuous. Much of the LEONORA area has poor outcrop, and bedrock relationships are difficult to interpret, especially within areas of deeply weathered granitoid and in those of alluvial, colluvial, and eolian deposition.

The granitoids have been broadly divided in terms of the Eastern Goldfields and Southern Cross Provinces. The Mount Ida Fault is the accepted boundary between the two provinces, with the Southern Cross Province continuing to the west into the adjacent YOUANMI map sheet. Rocks of the western province consist predominantly of undeformed, porphyritic monzogranite (Thom and Barnes, 1977; Griffin, 1990a).

Similarly, the granitoids of the Eastern Goldfields Province are mainly monzogranite or granodiorite, with lesser amounts of syenogranite. These granitoids are of various Archaean ages. Small, discrete, younger plutons intrude gneiss, older granitoid and greenstone, and can usually be separated from large batholithic areas of unfoliated and foliated granitoid (Griffin, 1990b). Gneiss is a minor component of the foliated granitoid–gneiss areas delineated on Figure 2. The largest area of granitoid–gneiss is situated at the western boundary of the Eastern Goldfields Province on the eastern side of the Mount Ida and Zuleika Faults.

A brief description of the six major greenstone belts named in Figure 2, and their relationships, are provided in Table 1 which is modified from Griffin (1990b, table 2-8). Five of these belts form an almost continous belt of volcano-sedimentary rocks between Leonora and Agnew. Some belts are mapped as compositionally similar, the Malcolm and Murrin belts for example, and their correlation is noted in the table. References to more detailed information are also provided in the table.

The Keith–Kilkenny Tectonic Zone is a major feature separating the Mount Clifford and Malcolm Belts in the west, from the Yandal and Murrin Belts in the east. Most

**Table 1. Description and relationships of the greenstone belts on LEONORA (Griffin, 1990)**

| *Belt name* | *1:250 000 sheet* | *Rock types* | *Metamorphic grade* | *Structure* | *Correlation* | *References* |
|---|---|---|---|---|---|---|
| **Agnew** | SIR SAMUEL<br>LEONORA | Komatiite, high-Mg basalt, tholeiite, dolerite, gabbro, pelitic schist, arkose, conglomerate | Greenschist, plus some lower amphibolite | Two phases of isoclinal folding recognized | Correlates with lower part of Mt Keith–Perserverance Belt | Thom and Barnes (1977) |
| **Mount Clifford** | LEONORA | Komatiite, basalt, dolerite, gabbro, ultramafic intrusives, sedimentary rocks, and chert | Greenschist | North-northwest trending anticlines and synclines | Extends to the north into the Mount Keith–Perserverance Belt | Thom and Barnes (1977) |
| **Yandal (South)** | SIR SAMUEL<br>LEONORA | Felsic volcanic rocks, chert, shale, arkose and pelite; basalt and basic sills; komatiite in places | Greenschist. | Tight fold closures indicate intense deformation; strike faults common | S extension of Lake Violet Belt; extends into the Malcolm Belt to the south | Bunting and Williams (1979) |
| **Murrin** | LAVERTON<br>LEONORA<br>EDJUDINA | Basalt, dolerite, gabbro, pyroxenite, chert, sedimentary rocks, andesite, and BIF | Prehnite–pumpellyite, greenschist | Tight folding; outcrop patterns indicative of interference folding | Some similarity with adjacent greenstone belts | Thom and Barnes (1977)<br>Hallberg (1985) |
| **Malcolm** | LAVERTON<br>LEONORA<br>MENZIES<br>EDJUDINA | Basalt, felsic volcanic rocks, dolerite, gabbro, sedimentary rocks (including conglomerate), chert; includes large masses of deformed intrusive porphyry | Ranges from prehnite–pumpellyite to amphibolite; mostly greenschist | Intense deformation; outcrop indicates refolded folds | Possible southern extension of the Yandal Belt; lithologies and structure similar to Murrin | Thom and Barnes (1977)<br>Hallberg (1985) |
| **Mount Ida** | MENZIES<br>LEONORA<br>KALGOORLIE | Basalt, shale, dolerite, gabbro, pyroxenite, komatiite, and BIF | Greenschist | Some evidence of tight folding in mafic rocks | Possibly extends north to Agnew Belt through isolated outcrops in granitoid | Thom and Barnes (1977) |

of the Mount Ida greenstone belt, which is spatially separated from the main line of the greenstones, lies on MENZIES; only the northern part of the belt extends onto the southwestern portion of the sheet. The boundary between the Yandal (South) and Murrin greenstone belts lies in the vicinity of Mount Davis; both belts terminate against the Keith–Kilkenny Tectonic Zone. The boundary between the Mount Clifford and the Malcolm belts is less well defined, but is taken here as the northerly trending Sullivan Creek, 2 km west of the King of the Hills gold mine and about 30 km northwest of Leonora. The Agnew greenstone belt is separated from the Mount Clifford belt by a granitoid intrusion west of the Wildara outstation.

The major structural features marked on Figure 2 are important for exploration. As previously mentioned, the Keith–Kilkenny tectonic zone and the Mount Ida fault are significant lithological boundaries. The southern part of the Keith–Kilkenny tectonic zone contains abundant rhyolitic volcanic rocks characterized by Zr, Nb, and Y enrichment (Hallberg, 1985).

The Sons of Gwalia shear zone is an important belt hosting rich gold mineralization. The zone consists of a belt of deformed (mainly schistose) rocks that can be traced from the southern part of the map northward through the Sons of Gwalia mine and the Harbour Lights area to the Jasper Hills mine. Rocks within the shear zone are mainly chlorite schist and talc–chlorite schist, with several lenses of undeformed high-Mg tholeiitic basalt, gabbro, and amphibolite (Williams et al., 1989).

The Butchers Flat shear zone, east of Mount Leonora, is composed of porphyroblastic quartz–sericite schist, and hosts (minor) gold mineralization.

The north-northwesterly trending Mount George shear zone, northwest of Leonora, is truncated by the Butchers Flat shear zone near the Leonora township. The assemblage of lithologies present includes chlorite schist, graphite phyllite, quartz–sericite phyllite, minor quartzite, and quartz mylonite (Williams et al., 1989).

# Mineralization

Mineralization in LEONORA includes numerous major gold deposits (>30 kg total production), and a major copper–zinc deposit at Teutonic Bore. Most of the gold mineralization on LEONORA has been classified as epigenetic in origin and was probably derived from mafic and ultramafic rocks as a result of regional or contact metamorphism (Hickman and Keats, 1990). The deposits are located either in greenstones, or in granitoids near their contact with greenstone. Copper mineralization at Teutonic Bore occurred within highly deformed greenstone (Marston 1979; Greig 1984).

## Gold

The map sheet straddles those parts of the Mount Margaret, East Murchison and North Coolgardie Goldfields which are further subdivided into the mining districts of Mount Malcolm, Lawlers, and Menzies respectively. To date, there has been no known production within the sheet area for the Menzies district — that is, from the northern part of the Mount Ida greenstone belt. The Leonora Mining Centre in the Mount Malcolm District is the largest producer, the major sources being the Sons of Gwalia and three other significant mines. A summary table of historical production figures, including ground resources, has been extracted from the mineral resource and occurrence datasets MINEDEX and MINLOC (Table 2; Appendix 1). The Lawlers district continues northwards into the SIR SAMUEL sheet and only the mines on LEONORA are included in the total. However, 'sundry claims' for the Lawlers district could not be similarly divided and are all included.

The largest deposits, in decreasing order (with their officially named mining centres) are, or have been: Sons of Gwalia (Leonora), Emu (Lawlers), Tarmoola – King of the Hills (Diorite), Bannockburn (Mount Clifford), Harbour Lights, Forrest and Tower Hill (all Leonora), McCafferys (Lawlers) and Wilsons Patch (Wilsons Patch). Each of these mines has produced at least one tonne of gold. Thom and Barnes (1977), Hallberg (1985), Groves and Barley (1988), Skwarnecki (1988), Makar (1988), Kalnejais (1988, 1990), Williams et al. (1989), Aoukar and Whelan (1990), Dudley et al. (1990), Hickman and Keats (1990), Schiller and Hanna (1990), and Stokes et al. (1990) provide descriptions of the geology related to most of these deposits.

Skwarnecki (1988) has identified three main styles of gold mineralization near granite–greenstone contacts for the Leonora District.

1. Shear zones with wide alteration haloes (Harbour Lights, Sons of Gwalia, Trump),
2. Laminated quartz veins in shear zones with irregular, poorly developed alteration haloes (Tower Hill, and Forrest),
3. Deposits along late east–west faults with very narrow alteration haloes (Leonora Gold Blocks).

The host rocks include granitoids, komatiites, and high-Mg tholeiitic basalts. Minor mineralization is also hosted by sediments (Savannah) and altered porphyry (Grey Lode). Numerous mines east of Leonora, and at Mount Malcolm, are hosted by felsic volcanic and pyroclastic rocks (Harriston, Pig Well).

The Sons of Gwalia mine, with an historic production of 99 939 kg and an in-ground resource of over 50 tonnes (t) of gold (1994), is the richest mine in the Eastern Goldfields outside the Golden Mile at Kalgoorlie. It is situated in the Sons of Gwalia shear zone. The dominant rocks are chlorite schist and talc–chlorite schist with several lenses of undeformed high-Mg tholeiitic basalt, gabbro and amphibolite. Carbonate alteration is common and numerous concordant lenses of granitoid and porphyry are present (Williams et al., 1989). Mineralization at Sons of Gwalia occurs in highly foliated chlorite–sericite–quartz schists in a zone up to 150 m wide and extending 400–500 m along strike (Williams et al., 1989).

**Table 2. Historical gold production for the LEONORA map sheet**

| *Goldfield* | *District* | *Centre* | *Ore treated (tonnes)* | *Contained gold (gm)* | *Alluvial/ dollied (gm)* | *Total gold recovered (gm)* |
|---|---|---|---|---|---|---|
| **MOUNT MARGARET** | MOUNT MALCOLM | Diorite | 3 267 035 | 9 868 638 | 52 437 | 9 921 075 |
| | | Dodgers Well | 2 852 | 82 348 | 2 532 | 84 880 |
| | | Goanna Patch | 531 770 | 932 150 | 14 410 | 946 560 |
| | | Leonora | 19 412 595 | 118 952 611 | 171 836 | 119 124 447 |
| | | Malcolm | 34 797 | 766 759 | 1 885 | 768 644 |
| | | Mount Clifford | 1 657 236 | 4 375 869 | 116 420 | 4 492 289 |
| | | Pig Well | 16 799 | 449 443 | 2 061 | 451 504 |
| | | Wilsons Creek | 658 | 12 834 | 154 | 12 988 |
| | | Wilsons Patch | 30 915 | 419 418 | 5 518 | 424 936 |
| | | **TOTAL** | **24 954 657** | **135 860 070** | **367 253** | **136 227 323** |
| **EAST MURCHISON** | LAWLERS | Part of Lawlers | 12 306 016 | 48 629 182 | 71 706 | 48 700 889 |
| | | **TOTAL** | **12 306 016** | **48 629 182** | **71 706** | **48 700 889** |

The Harbour Lights deposit (6700 kg historical production, and 4.3 tonnes in ground in 1994) is contained in a sequence of highly deformed komatiitic basalts, high Mg-tholeiitic basalts and minor sedimentary rocks. The sequence is intruded by dolerite and porphyry dykes (Dudley et al., 1990). Gold mineralization is associated with sulfides (mainly arsenopyrite) and iron oxide, and is mined from numerous lenses within the alteration zone (Dudley et al., 1990; Williams et al., 1989; Skwarnecki, 1988; Hickman and Keats, 1990).

The Tower Hill mine is positioned between Harbour Lights and Sons of Gwalia mines in the Sons of Gwalia shear zone. Gold inhabits quartz veins and no mineralization is known in the host ultramafic schist. The quartz lodes lie at the base of the ultramafic sequence within 100 m of the granitoid contact (Schiller and Hanna, 1990; Skwarnecki, 1988; Hickman and Keats, 1990).

The Forrest deposit, also found in the Sons of Gwalia shear zone at the granite–greenstone contact, lies within altered and sheared ultramafic rocks, amphibolites and granitoid. Gold is found in laminated quartz veins (Skwarnecki, 1988).

As mentioned earlier, granitoids also host mineralization. The Trump mine is situated in the Sons of Gwalia shear zone, in altered and sheared granitoids. The gold is found in quartz veins, or associated with sulfides (Skwarnecki, 1988).

In the Diorite Mining Area, near Tarmoola northwest of Leonora, a ferruginous caprock overlies a series of totally metamorphosed mafic and ultramafic rocks. The latter, now partly silicified schists, are cut by quartz veins and intruded by granitoid. Most of the gold is associated with quartz veins (Wilkinson, 1993). At the King of the Hills mine, a large part of the mineralization is associated with a chert horizon, and also with several northerly trending siliceous cherty bands (Wilkinson, 1994, p. 130).

The Bannockburn deposit, 65 km northwest of Leonora, has not been described in detail. Mineralization is reported to be present in three subparallel zones of sheared and altered mafic schists and is closely associated with quartz–feldspar porphyry intrusions (Wilkinson, 1994, p. 61).

Gold mineralization in the Lawlers District in the north-northwest of the map sheet is similarly associated with granite–greenstone contacts and shear zones. The Agnew greenstone belt is the only greenstone belt present in this district. The principal deposits are Emu–Waroonga, Great Eastern, and McCafferys.

The Emu–Waroonga deposit is controlled by quartz veins and located in an actinolitic zone at the contact between granitoid and mafic/ultramafic rocks. The Great Eastern mineralization is also controlled by quartz veins along shears, with the host rocks mafic enclaves within a granitoid. The McCafferys deposit is hosted in chlorite and talc–chlorite schist, in association with minor dolerite, pyroxenite, and carbonaceous shale. A shear zone controls the location of mineralization (Hickman and Keats, 1990).

The richest mineralization of LEONORA corresponds to the granite–greenstone contact and shear zones within the Agnew, Malcolm, and Mount Clifford greenstone belts. There are minor deposits associated with the Yandal and Murrin belts; as yet no mineralization has been found in the Mount Ida greenstone belt.

## Other minerals

The historical production of metals other than gold is provided in Appendix 2. The major producer of copper, silver and zinc has been Teutonic Bore. Silver is produced as a by-product of gold mining; prior to 1994, the Mount Margaret Goldfield had produced approximately 15.45 t. There are deposits of nickel, uranium, and molybdenum present in this area, although not in production.

Teutonic Bore is located on the eastern margin of the Keith–Kilkenny tectonic zone. The deposit consists of massive sulfide within a succession of felsic metavolcanic rocks interleaved with, and overlain by, basalt. The primary sulfides are pyrite, sphalerite, chalcopyrite, and galena. Prior to 1987, the mine had produced 195 324 t of copper, 149 307 kg of silver and 132 251 t of zinc. In 1984, the resource was estimated to consist of a single, steeply dipping lens containing 1.4 million tonnes of massive sulfides, averaging 4.2% copper, 16.4% zinc, and 1.2% lead, plus 203 g/t silver (Greig, 1984). In addition, cross-cutting 'stringer' mineralization in the footwall was estimated to contain a further 0.75 million tonnes averaging 2.4 % copper, 1.9% zinc, and 52 g/t of silver (Greig, 1984). Hallberg (1985) reported sulfide mineralization within basalt 100 m above its contact with underlying rhyolite.

Three small copper deposits have also been discovered in the Agnew–Lawlers area (Marston, 1979). Intermittent copper production from the Agnew–Lawlers group between 1915 and 1958 has yielded 198.75 t of copper. The Bungarra deposit, some 6 km north of the Lawlers townsite, contains copper carbonates, oxides, and quartz in a short, east-trending vein. The Lawlers West mine, 500 m west-northwest of the Bounty gold mine, has produced 118 t of copper and concentrates. The country rocks are lineated, fine- to medium-grained amphibolites, chloritized adjacent to mineralized quartz–limonite veins. Approximately 2.4 km southwest of the Lawlers townsite 35.5 t of cupreous ore were mined in 1952 from a quartz vein in foliated to schistose, northeast-striking, amphibolites.

Significant nickel mineralization at Weebo Bore (Legge, 1975) and Mount Clifford (Travis, 1975) is found in dunite and peridotite respectively. Weebo Bore is the larger of the two deposits with 84 kt of contained metal (Marston, 1984). The deposits are still to be exploited. Marston (1984) also reported on several minor nickel deposits: Schmidt Well (north and south), Marriott, 107 prospect, and Allstate.

Accumulation of uranium is associated with calcrete and the largest deposits are found in Lake Raeside. The largest three deposits total 1.852 kt of uranium metal in the form of $U_3O_8$ (Sharp, 1978, Semple 1979 a,b). Six other prospects are reported elsewhere within the Raeside drainage (Butt et al., 1977).

An uneconomic molybdenum prospect has been identified in quartz veins and pegmatite within granitoids southeast of Dodgers Hill. A small lead prospect has been reported south of Wilsons Patch (Fig. 2).

# Regolith-materials mapping

A regolith-materials map of LEONORA has been prepared using interpretation of 2D and 3D Landsat Thematic Mapper imagery, with field observations noted at each sample site. Additional outcrop information was supplied by the 1:250 000 geology map (Thom and Barnes, 1977). The regolith-materials map (Plate 1) is found in the back pocket of these notes and is intended to aid in the interpretation of the geochemical data. The map is intended to complement a LEONORA regolith–landform map in preparation at AGSO; the preliminary edition of this map (Churchward and Craig, in press) was supplied by AGSO to assist in the choice of regolith units and sample points, but was not used in the construction of Plate 1. The restricted number of units on Plate 1 conforms generally to the Kalgoorlie–Kurnalpi regolith–landform map of Craig and Anand (1993). A simplified version of Plate 1 appears as Figure 3.

## Regolith-materials map units

Anand et al. (1993a, section 2.1) define a regolith–landform map unit as 'an area delineated on a map, within which occurs a particular association of regolith materials, bedrock geology and landforms'. Boundaries are drawn to indicate an area in which similar characteristics could be expected to be identified. The scale of the imagery used determines the choice and definition of the mapping units because of the practicalities of representing heterogeneous assemblages at different scales (Anand et al., 1993a). This project recognizes the close relationships of landform and materials, but Plate 1 concentrates on materials (the chemically analysed components) since the same landform can be composed of different materials. For example, a breakaway may be made of one or more of lateritic duricrust, silcrete or rock. Similarly, the same material can constitute different landforms, for example eolian sand as a sheet or a dune.

The map units of this project follow the same general format as Kojan and Faulkner (1994), with the exception that unit E3 of Kojan and Faulkner has been incorporated into E2g or E2vs. They are shown in Plate 1 and in Table 3. The units are grouped into *relict*, *erosional* and *depositional* regimes.

### Relict regime

Three major relict units are described in the landscape: R2, R3, and R4. The R1 unit consisting of lateritic pisolites and nodules, though it exists, was not identified in sufficient abundance on the map sheet for portrayal at the 1:250 000 scale. The R2 and R3 units relate to cemented ferruginous or siliceous materials respectively, capping a weathered profile and preserving it from further erosion. The R2 unit forms isolated mesas and plateau remnants within the greenstone belts; it includes the duricrusts derived from transported materials as well as hardened ferruginous saprolite. Little R2 has been identified on the map sheet. Unit R3 corresponds to *Czb* and some *Czj* in Thom and Barnes' (1977) classification. The unit occurs

**Table 3. Regolith codes and descriptions**

| *Regolith code* | *Description* |
|---|---|
| RELICT REGIME | |
| R2 | Iron-rich duricrust/hardpan forming remnant landsurfaces |
| R3 | Silcrete and silicified rock |
| R4 | Sand overlying presumed or known lateritic material |
| EROSIONAL REGIME | |
| E1 | Exposed mottled zone and saprolite |
| E2g | Granitoid and granitoid–gneiss saprock, bedrock and ferruginous bedrock |
| E2vs | Volcano-sedimentary greenstone saprock, bedrock and ferruginous bedrock |
| E4g | Lag of lithic detritus and/or feldspar in a sand-rich matrix associated with actively eroding outcrop/subcròp; mainly confined to granitoid terrains |
| E4vs | Lag of locally derived ferruginous and lithic detritus in a sand-rich matrix associated with actively eroding outcrop/subcrop; mainly confined to greenstone terrains |
| DEPOSITIONAL REGIME | |
| | **Dominantly colluvial** |
| DC1 | Medium to coarse detritus mainly of lithic or ferruginized lithic clasts (most >25mm), in colluvium with a sand or sandy clay matrix |
| DC2 | Fine to medium detritus (clasts 4–25 mm) of two types; mainly of lithic or ferruginized lithic origin, in a red sandy clay colluvial matrix (mainly greenstone terrains) or mainly quartz sand deposits(± feldspar) in plains and upland areas (mainly granitic terrains) |
| DC3 | Sand/clay dominated colluvium or sheetwash (± feldspar); merges into alluvial plains (DA5) |
| DC3f | Predominantly non-lithic ferruginous detritus (most clasts <10mm) some magnetic, in a red sandy clay matrix in sheetwash areas. Includes, but is not exclusive to, buckshot gravels |
| | **Dominantly alluvial** |
| DA4 | Gravelly sands and sandy clays of active alluvial channels with mixtures of lateritic, non-lateritic, and variably altered lithic clasts |
| DA5 | Sand or clay-rich alluvium on or adjacent to broad drainage floors with negligable detritus; calcrete nodules common |
| DA6 | Gypsiferous alluvial and eolian sediments adjacent to playa lakes; usually vegetated |
| DA7 | Saline clays and sandy clays of playa lakes; usually lacking vegetation |
| DA8 | Extensive and continuous calcrete outrop in broad drainage floors (valley calcrete) |

only on breakaways and former plateau areas; though mainly overlying granite, silcrete also caps some greenstone. The R4 unit is found most often on backslopes from granitic or greenstone breakaways and describes an upland sandplain with few or no lateritic pisolites. The major assumption for this unit is that it is the surface expression of a complete, buried lateritic weathering profile. The unit mainly corresponds to the eolian *Qps* unit as mapped by Thom and Barnes (1977) and the Old Landsurface unit of Churchward and Craig (in press).

## Erosional regime

The regime is divided into 5 units, mainly organized to highlight the parent material being eroded (E1, E2g, E4g, E2vs, and E4vs). The E3 unit used on MENZIES has been incorporated into E2g and E2vs.

Unit E1 (mottled zone, saprolite) occurs below breakaways and in dissected uplands in both the granitic and the greenstone landscape and, owing to map scale, is commonly underestimated on Plate 1. Lag-covered pediment below E1, downslope from these breakaways, is included in Unit E4g.

Unit E2g (granitoid and gneiss bedrock) exists predominantly as flat sheets or bouldery outcrops, more rarely as rounded hills and tors. The sediment overlying these outcrops is usually sandy and contains relict K-feldspar. Coarse detritus is rare.

The E2vs unit represents greenstone outcrop with surficial rather coarse ferruginized or partially ferruginized rock lag. It is most prominent on the more-resistant greenstone belts, which provide the highest topographic surfaces on LEONORA.

The E4vs unit (dominated by a lag of ferruginized lithic fragments) is present in erosional areas of moderate relief downslope from greenstone outcrop. It typically overlies greenstones but can be found on granitic bedrock adjacent to greenstones. Compared with unit E2vs, the lag is generally more completely ferruginized and the rock fragments are smaller. Outcrop is scarcer and is more generally altered, and the unit is most commonly identified on the more-distal, shallower slopes (including pediments) relative to the main source rocks. Lag derived from felsic volcanic rock is included in the E4vs unit and was, as expected, geochemically distinct from the Fe-rich materials derived from mafic parents.

Unit E4g describes lag of immature granitic sediments that lies close to outcrop, and also overlies subcrop and granitic pediments. It typically occurs in areas of low to moderate relief, and is the dominant erosional unit away from the main areas of granitic outcrop.

## Depositional regime

The regime is divided into eight units — DC1–3 and DA4–8. The units DC1, DC2, and DC3 are composed predominantly of colluvial materials. Units DA4 and DA5 have a predominantly alluvial origin, whereas units DA6, DA7, and DA8 include chemically precipitated deposits. The DA6 (playa margin) unit includes a significant eolian sand component. Other depositional units may also include a variable proportion of eolian material, mainly sand.

Units DC1–3 are not classified by source material on Plate 1. However, for subsequent discussion, they have been grouped on the basis of greenstone ('vs') or granitoid ('g') sources, using their chemical composition coupled with mapped geology in related uplands.

Unit DC1 consists of coarser colluvium that has been deposited close to its source. It is commonly sited adjacent to upland areas and is the first area with net material accumulation when the overall landform processes change from erosion to deposition. Most of the sediment present is still relatively immature and closely reflects the source material. The unit is therefore associated with the E4 'vs' and 'g' units. Greenstone-derived DC1 material is highly ferruginous and granitoid-derived DC1 is feldspathic. The DC1 unit varies slightly between lithological groups; because of their typically more resistant nature, many of the coarser clasts of greenstone are transported farther from their source than is the case with granites. In fact, clast breakdown in the vicinity of granitoids is so rapid that granitic source areas give rise to little DC1.

The DC2 unit (fine to medium colluvium) occurs as sheetwash-derived sediment plains in upland granitic terrains, and as marginal colluvial plains with lower relief in both greenstone and granitic areas. The DC2 unit is typically slightly lower in the topographic profile than DC1 where that unit occurs; however, it has slightly greater topographic relief than adjoining areas of DC3.

The DC3 unit is widespread on LEONORA, lying mainly in the lower parts of sheetwash fans that commonly have wide, but poorly defined, normally inactive drainage channels. The old channels are sometimes defined by a line of increased vegetation. The sheetwash fans are usually broad features that terminate, with interfingering, at the edge of main alluvial floodplains (DA5) and drainage floors (DA6, DA7). A subunit of DC3, DC3f, contains abundant ferruginous, but not obviously lithic, detritus. This subunit includes buckshot gravels and detritus derived from chemically precipitated iron oxides.

Although there is some channel flow in the three colluvial units after cyclonic rain or thunderstorms, most sediment has been transported under the influence of gravity in conjunction with overland water flow and is therefore sheetwash. Most of the boundaries between the units, although represented by distinct lines on the regolith-materials map, are, in practice, gradational.

Active alluvial channels (DA4) are usually limited to areas of significant relief. Flowing from the hills, most stream courses ultimately devolve into sheetwash areas with poorly defined channels.

Hardpan, including the 'Wiluna Hardpan' of Bettenay and Churchward (1974), is often exposed on the margins of alluvial channels and occurs extensively at shallow depths within many depositional units. Hardpan has the fabric of cemented colluvium and, strictly, belongs to a previous depositional regime. Though the exposed margins of these hardpans are now being eroded and reworked into the active alluvium, for the purposes of this project the overall environment is treated as depositional.

Most deposits of unit DA5 are relatively free of clasts; they are situated on, or adjacent to, broad drainage floors (alluvial plains). Sediments present are a mixture of fine-grained overbank materials (flood deposits), materials transported downslope — especially material derived from DC3 — and eolian sediments. Calcrete nodules may also be present.

Unit DA6 (playa lake margin) includes gypsiferous sediments and eolian sand sheets and dunes. Sediments of DA6 are variably saline, but not to the exclusion of halophyllic vegetation.

Sediments of unit DA7 (playa lake) consist of saline silts and clays which, when dry, are covered with a white salt crust. Sediments of this unit contain abundant halite or gypsum (both minerals are usually present), to the extent that there is little or no vegetation cover.

Unit DA8 (calcrete) commonly consists of a thin layer of alluvial and eolian sediment overlying a karst-capped calcrete platform. Calcrete nodules may be abundant at the surface. Areas mapped as calcrete typically correspond to those mapped by Churchward and Craig (in press), with additional areas added from field observation and interpretation of satellite imagery.

# Geochemical mapping

Field mapping and sampling commenced in June 1994 and was conducted by J. Storey (GSWA) with assistance from J. Bradley (GSWA), D. Ellis, G. Mehri, and G. Kjellgren (Geochemex Australia). Four ground crews were involved, each crew comprising a geologist and a field assistant.

## Sampling density

A nominal sampling density of 1 sample per 16 km$^2$ was used. This density translated to just over 1000 samples for the sheet. The rationale for this density is given in Kojan and Faulkner (1994).

## Site selection

Sample sites were selected using a basic 4 x 4 km grid overlay on 1:100 000 scale topographic maps. Sites were chosen in each square after taking into account the known geology, Landsat imagery, topographic and a ccess information, and aeromagnetic and radiometric data where available. The whole map sheet was sampled, with a slight bias towards greenstone belts and some areas with reported anomalies. Areas near minesites may be subject to contamination and deliberately were not sampled.

The selected points were digitized and assigned a reference number, and identified with AMG coordinates for field location. The field crews were equipped with dashboard-mounted GARMIN 75 GPS (Global Positioning System) units set to the Ausgeo84 datum. The GPS is accurate to within 40 m. The sampling geologist was allowed some scope to move the sample sites to an improved position.

Active stream sediments were the preferred medium for sampling. However, most well-defined streams are confined to upland areas in both greenstone and granitoid terrain. Many streams are poorly defined, forming broad, vegetated or partially vegetated depressions on sheetwash fans. In such cases, where possible, samples were taken from stream courses within the fans.

In the many areas with no well-defined drainage, sheetwash or soil samples were taken. Sheetwash samples were commonly collected from lower pediment slopes and from some colluvial fans; soils from areas with no clear slope and/or no clear drainage.

Some samples of 'soil' were taken along lake margins, with samples of 'lake sediment' taken from the surface of playa and other lakes. The lake sediments were classed as a discrete group.

Samples, and the sample type, are identified on Plate 2.

## Sample-site form

A site form was completed at each sample location in order to assist subsequent interpretation. An example of the form used for LEONORA is provided in Appendix 3. This form, slightly modified from that used by Kojan and Faulkner (1994) for MENZIES, includes a number of options that are selected by marking the appropriate box, with provision for extra information to be entered in a remarks section. Though in many cases the samples collected were of active stream sediment (alluvium), the form has provision for description and regolith classification of the environs of the site.

Data collected about the sample included type, colour, size-fraction distribution, clasts contained (including nature and relative abundance), the nature of the matrix and the depth of collection.

Data collected about the site included actual position measured using the GPS at the collecting point, the local area characteristics of the regolith, the position in the landform regime, the nature and location of visible outcrop, the nature and distribution of secondary materials such as hardpan or calcrete and other relevant information.

A separate GSWA number was allocated to each sample, including quality-control replicates. A site-location number (coded according to the 1:100 000 map sheet on which the site was located) served as a reference number for subsequent database storage of the site information.

## Sampling

Two samples were collected at each site: one for geochemical analysis and the other as an archive sample, available for later research. The geochemistry samples comprised approximately 1.5 kg of -2 mm to +0.45 mm material. This size fraction was chosen to avoid the heterogeneity of larger sized material, and to remove the majority of eolian sediment present in large quantities in the 0.1–0.2 mm fraction (Kojan and Faulkner, 1994). The archive sample comprised approximately 3 to 4 kg of the complete -2 mm fraction. An estimate of the amounts of under- and oversize materials was recorded on the sample-site form as an indication of the proportion of the fraction collected and the degree of sorting of the sediment.

At each sampling point the vegetation debris and loose wind-blown sand were removed from the surface, and material was collected from a pit or trench excavated between 10 cm and 40 cm deep. Well-defined streams were sampled by trenching across the channel, including both active sediment and some bank material. All main channels of a braided drainage were sampled and composited. Soil and lake sediment samples were collected by compositing from three points 30–50 m apart set in a triangle. In those sheetwash areas with some discernable slope, the three subsamples were collected in a line normal to the slope direction.

The three subsamples were combined and dry samples were sieved on site. Wet samples were dried and sieved in Perth. Some lake samples had high clay contents and could not be sieved without light crushing. Both geochemistry and archive samples were labelled externally with the GSWA number. Numbered paper tags were placed in geochemistry samples and numbered aluminium tags were included with archive samples. The general area of the sample site can be easily revisited using the GPS. For follow-up purposes, including quality control, numbered aluminium tags were riveted to steel stakes and driven into the ground at the site. Flagging tape was also used on the stakes and nearby trees to facilitate relocation.

A second complete geochemistry sample (a replicate) was collected for quality-control analysis with every fiftieth sample; the method of sampling being identical to that for the first.

A total of 1042 samples were collected and analysed, comprising 453 stream-sediment, 546 soil, and 43 lake samples, together with 20 replicate samples.

## Analytical methods

Samples were analysed by Amdel Laboratories Ltd, Wangara, Perth. The sample preparation involved crushing to an average size of 75 microns using a Labtechnics 'chromium-free' diskmill pulverizer. The manufacturer, in information supplied with the equipment, states that such pulverizers contain, on average, 0.14% C, 0.20% Si, 1.10% Mn, 0.02% P, and 0.025% Al and that minor contamination of approximately 50 ppm Mn and 5000 ppm Fe could be expected.

Forty-seven constituents were determined.

- Ten major elements, presented as oxides: $Al_2O_3$, CaO, $Fe_2O_3$, $K_2O$, MnO, MgO, $Na_2O$, $P_2O_5$, $SiO_2$, and $TiO_2$;
- Two anions: 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;
- Loss on Ignition (LOI), which was included with the analysis of the major oxides.

Seven different methods were used for the element determinations as follows.

- *Inductively coupled plasma mass spectroscopy (ICP-MS) using a combined hydrofluoric/multi-acid digestion (AMDEL code IC3M).* The pulverized sample was digested in a hydrofluoric/perchloric/nitric/hydrochloric acid mixture for a period of over 24 hours, evaporated to fume dryness and dissolved in dilute hydrochloric acid. The solution was then read using an ICP-mass spectrometer. Elements analysed by this method were Ag, As, Bi, Cd, Ce, Ga, In, La, Li, Mo, Nb, Pb, Rb, Sb, Sc, Se, Sn, Sr, Th, U, and W.
- *Inductively coupled plasma mass spectroscopy (ICP-MS) using an alkaline (lithium metaborate) fusion and dilute hydrochloric acid digestion (AMDEL code IC4M).* Elements analysed by this method were Ba and Be.
- *Inductively coupled plasma optical emission spectroscopy (ICP-OES) using a combined hydrofluoric/multi-acid digestion (AMDEL code IC3E).* The pulverized sample was digested in a hydrofluoric/perchloric/nitric/hydrochloric acid mixture for a period of over 24 hours, evaporated to fume dryness and dissolved in dilute hydrochloric acid. The solution was then read using an ICP-optical emission spectrometer. Elements analysed by this method were Co, Cr, Cu, Ni, V, Y, Zn, and Zr.
- *Inductively coupled plasma optical emission spectroscopy (ICP-OES) using an alkaline (lithium metaborate) fusion and dilute hydrochloric acid digestion (AMDEL code IC4).* Elements analysed by this method were Al, Ca, Fe, Mg, Mn, P, K, Si, Na, Ti, and LOI.
- *Fire assay extraction and atomic absorption spectroscopy measurement using graphite furnace atomization (AMDEL code FA3).* Elements analysed by this method were Au, Pt, and Pd.
- *Sulfur (AMDEL code VOL2)* was determined by roasting the sample in a Leco furnace, absorbing the resultant gases in acidified potassium iodide solution followed by back titration using potassium iodate solution.
- *Fluorine (AMDEL code SIE2)* was determined using a sodium peroxide fusion, dissolution in water and a selective ion electrode.

**Table 4. Detection limits and number of samples below detection**

| *Element* | *Detection limit* | *Number of values below detection limit* |
|---|---|---|
| | **Percentage** | |
| $SiO_2$ | 0.01 | 0 |
| $TiO_2$ | 0.01 | 0 |
| $Al_2O_3$ | 0.01 | 0 |
| $Fe_2O_3$ | 0.01 | 0 |
| MnO | 0.01 | 345 |
| MgO | 0.01 | 83 |
| CaO | 0.01 | 211 |
| $Na_2O$ | 0.01 | 118 |
| $K_2O$ | 0.01 | 3 |
| $P_2O_5$ | 0.01 | 53 |
| LOI | 0.01 | 0 |
| S | 0.05 | 997 |
| F | 0.01 | 965 |
| | **Parts per million** | |
| Ag | 0.05 | 629 |
| As | 0.5 | 82 |
| Au | 0.001 | 902 |
| Ba | 10 | 0 |
| Be | 0.5 | 730 |
| Bi | 0.1 | 400 |
| Cd | 0.1 | 427 |
| Ce | 0.05 | 0 |
| Co | 2 | 443 |
| Cr | 2 | 45 |
| Cu | 2 | 67 |
| Ga | 0.05 | 0 |
| In | 0.05 | 625 |
| La | 0.1 | 0 |
| Li | 0.5 | 23 |
| Mo | 0.2 | 35 |
| Nb | 0.5 | 5 |
| Ni | 2. | 161 |
| Pb | 0.2 | 0 |
| Pd | 0.001 | 946 |
| Pt | 0.001 | 976 |
| Rb | 0.02 | 0 |
| Sb | 0.5 | 804 |
| Sc | 0.5 | 9 |
| Se | 0.5 | 365 |
| Sn | 0.5 | 131 |
| Sr | 0.1 | 0 |
| Th | 0.02 | 0 |
| U | 0.02 | 12 |
| V | 2 | 2 |
| W | 0.1 | 47 |
| Y | 2 | 282 |
| Zn | 2 | 12 |
| Zr | 5 | 3 |

Detection limits (and the number of samples with values below detection) are given in Table 4.

## Quality control

Quality-control procedures are designed to monitor the variability associated with sampling and analytical methods, to ensure that sample results reflect true geochemical variation and are not artefacts of the processes involved. Replicate samples taken from the same field location should yield consistent analytical results; similarly laboratory duplicate and standard analytical determinations should be reproducible within set boundaries, except that precision will inevitably decrease towards the detection limit.

Six main quality-control procedures were employed for the geochemical mapping program:

- sample-site checks;
- submission of GSWA geochemical standards for analysis;
- submission of replicate samples from the same site;
- inclusion of in-house standards and duplicates on a regular basis;
- repeat analyses for gold and anomalous values;
- check samples analysed by the Chemistry Centre.

## Sample-site checks

On completion of the field program, approximately 50 field sites were revisited by an independent geologist and a second sample form filled in for comparison with the data recorded by the sampling geologist, including sampling methodology, location and regolith details. The site suitability was also assessed, both for sampling and for potential contamination which could affect the geochemical analysis.

## Submission of GSWA geochemical standards

The GSWA submitted a number of external standards to monitor sample accuracy within and between analytical laboratories. Standard duplicates were sent to Amdel, randomly distributed throughout the sample batches with further check analyses being undertaken by the Chemistry Centre (W.A.). The results within and between the two laboratories were consistent, with the only major discrepancy being a low uranium value reported by Amdel for one of the duplicates.

## Submission of replicate samples

Replicate geochemical samples were collected at 20 sites throughout the study area to gain a measure of the overall reproducibility of the sampling and analytical process. Each replicate was assigned a unique GSWA number and submitted independently for analysis. 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 replicate sample results. Critical values for the 5% and 10% confidence levels with 19 degrees of freedom were compared with the t-statistic generated by EXCEL for each of the replicate pairs.

Owing to the high number of values close to the detection limit, the t-values were not significant for Au, Be, Bi, Cd, Cl, F, Li, Pd, Pt, Sb, and Y. Minor variation in the accuracy of the analytical process is evident for $P_2O_5$, Cu, Zn, and Zr. In each case the second analyses yielded marginally higher values. Determinations of Cr also showed some inconsistencies, probably due to incomplete sample dissolution.

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

## Inclusion of in-house standards and duplicates

Amdel included several in-house standards in each batch of samples analysed. Several different standards were used, containing both low and high levels of concentration of most of the elements analysed. For each standard the element concentration, means, standard deviations and relative standard deviations (RSDs) were reported. Each standard was submitted at least three times and up to six times in each batch sent to the laboratory.

Consistent results were achieved for most of the major elements with low RSDs at all levels of concentration. Results for $K_2O$ and $P_2O_5$ yielded higher though satisfactory variability at low levels of concentration.

Results for the trace elements were mixed. Consistency across all standards was good for Co, Cr, Cu, Li, Ni, and V with RSDs less than 8.0, and generally satisfactory for As, Au, Cd, Sc, Zn and Zr with RSDs less than 25. Consistency for the remaining elements varied, depending on the range of concentration and improving with higher concentrations.

Amdel repeated analyses for 35 and 68 samples for the major and trace elements respectively, taking a separate split of the same powder used for initial analysis. The duplicate values were compared using the previously described 'paired t-test'. No significant differences were shown between pairs in the major elements supporting the reproducibility of the analytical technique.

The trace-element duplicates compared well with the originals with the exception of one pair which suggested a sample mismatch. Output from the 'paired t-test' showed that most elements had no significant variation, with minor exceptions being As, Ni, W, and Zr, each affected by a small number of inconsistent pairs. Since many values of Ag, Au, Cd, Co, Pd, Pt, and Sb were below detection, results for these elements were not meaningful.

## Repeat analyses

Amdel carried out repeat analyses for gold on 62 samples. Repeats were undertaken at regular intervals throughout the batch and for most samples containing >5 ppb Au. Although there were minor variations, there were no major discrepancies.

Samples that showed anomalous values for other elements in the initial analyses were also repeated; most showed little change, although a few initial high values for Ag, Cr, Cu, V, W, and Zn could not be repeated.

## Check analyses at Chemistry Centre (W.A.)

Duplicates of twenty-eight samples were submitted to the Chemistry Centre of Western Australia (CCWA) for analysis of the same forty-eight components. Results from this laboratory and those from AMDEL were compared using the 'paired t-test'. Owing to the high number of values close to the detection limit, results are not meaningful for In, MnO, Pd, Pt, and Se. The CCWA *consistently* yielded marginally higher values for $Na_2O$, Cr, Cu, La, Mo, Ni, Sc, W, V, Zr and lower values for $Fe_2O_3$ and $P_2O_5$. The consistent nature of these paired values suggests that although there are some small absolute differences the precision of each laboratory is acceptable.

## Mineralogical examination

The mineralogy of fifteen samples from various regolith types was determined by powder X-ray diffraction methods (XRD) at CSIRO, Floreat Park, WA. A further number of samples was examined using a binocular microscope.

# Data presentation

The main products from the regional geochemical mapping program for LEONORA include the maps, tables and digital datafile that accompany these notes, and the maps which can be inspected and purchased at Mineral House. Quality-control data are available for inspection in the Geochemistry Section of the GSWA.

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 Plate 1 and the sample sites. The availability and pricing of such products are indicated in the 'Digital data information index' which is produced and maintained by the Department of Minerals and Energy.

## Geochemical mapping — maps and plans

Products include a regolith-materials map (Plate 1) and sample-locations plan (Plate 2) at 1:250 000 scale, and element-distribution maps (Figs 4–40) and contoured gold geochemistry plan (Fig. 41) at 1:1 000 000 scale. The regolith-materials map has been described earlier. The sample-location plan shows the location and GSWA sample number of each sample site and also the sample type (soil, stream sediment, etc). Details of sampling, regolith materials, landforms, and geology for each site are stored separately. The element-distribution maps show the distribution in element concentration for LEONORA for a total of thirty-four different elements or oxides: $TiO_2$, $Al_2O_3$, $Fe_2O_3$, MgO, CaO, $Na_2O$, $K_2O$, $P_2O_5$, MnO, As, Au, Ba, Ce, Co, Cr, Cu, F, Ga, La, Ni, Pb, Pd, Pt, Rb, S, Sb, Sc, Sr, Th, U, V, Y, Zn, and Zr, from a total of 1042 samples. Figures 8 and 9 show high and low values for CaO. Figures 39 and 40 show high values only for Be, Li, Mo, Nb and Sn, and Ag, Bi, Cd, In, Se and W respectively. The relationship of element distribution to sample type and geology can be examined by using the sample location plan and geological interpretation overlays (Plates 6 and 7).

The element-distribution maps generally show the complete range of concentrations, from the detection limit to the highest value. These values are represented by circles, with their diameter proportional to the concentration. However, on some maps where an element has a strong positive skew, the highest values are represented by 'stars'. This is to allow easier comparison of lower values, which might otherwise appear as very small circles or dots. Precise values for a specific element at a particular location can be obtained from the GSWA number on the sample-location plan and then referring to the digital-data file (LEONCHEM.CSV) included with these notes. This file contains all the key data obtained from the LEONORA geochemical mapping project for all 1042 samples. Apart from the analytical data, the file contains sample type, geology (granitoid, greenstone, mixed or lake) regolith code (as per regolith map) and AMG coordinates for each sample.

Reference sets of element-distribution maps for LEONORA at 1:250 000 scale, for most components analysed, are available for inspection and purchase at the first floor public counter of the Department of Minerals and Energy, Mineral House. These maps have the 'stars' annotated with the approximate value. Complete sets or individual copies of the distribution maps can also be purchased at this address.

## Mines and prospects — map and table

A plan at 1:1 000 000 scale (Fig. 41) shows the location of gold mines and prospects for LEONORA superimposed on a contoured plot of the gold distribution. The size of the circle symbol reflects the total contained gold. Appendix 1 shows location, past production, resources and total contained gold for fifty-two major mines and prospects.

## Company surface geochemistry projects — map and table

Three maps at 1:250 000 scale (Plates 3, 4, and 5), showing the location of all company surface-geochemistry projects for LEONORA, accompany these notes. A table (Appendix 4) provides some details for individual projects.

## Geochemical surveys on open-file company reports

In accordance with the provisions of Regulation 96 of the Regulations under the Mining Act 1978 (as amended), tenement holders (exploration companies) are required to lodge annual reports with the GSWA. These reports detail any mineral exploration activities undertaken within the tenement(s) in the previous year. Once a tenement or tenements are surrendered, or parts thereof relinquished, information relating to these areas is then made available to the public, on 'open-file', and listed on the GSWA database WAMEX.

Information concerning geochemical exploration was extracted from the open-file company reports covering the whole of the LEONORA sheet, and summarized in a table (Appendix 4). The table includes information about exploration undertaken between the surface and four metres depth. Only those projects were included where at least thirty samples were analysed over the project area.

Plates 3, 4, and 5 provides an overview of surface exploration coverage for LEONORA. Each project has been assigned an identification number for cross-referencing to Appendix 4. Individual project boundaries are shown on Plates 3, 4, and 5 together with the corresponding identification numbers. The boundaries shown in the plate represent the perimeter of a tenement or group of tenements. Spatial accuracy after the compilation of boundaries from DME public plans is within 500 m. Most projects are applicable to a single area, although in a few cases two or more blocks of ground may be involved. On the other hand, the same tenement(s) may be the subject of successive phases of geochemical exploration by different companies, so that the same block of ground may be assigned more than one identification number.

Appendix 4 contains the identification number, the sheet number of the relevant 1:50 000 Public Plan, the GSWA Item Number, and the Accession Number. The Item Number refers to a catalogue in the Geological Survey library. The Accession Number is sequentially allocated to the report at the time it is received in the Department. These numbers are included to facilitate rapid retrieval of individual reports from the library through the medium of microfiche film or hardcopy. The Appendix also includes year of reporting, sample medium, number of samples taken, elements analysed, method of analysis and the analyst (when given).

Appendix 4 displays summary data principally on surface geochemical exploration, but includes costean and shallow-drilling information when analyses were produced from material sampled at depths between zero and four metres. Surface samples that were reported to have been taken from mullock dumps or old workings were excluded.

In total, 152 projects are tabulated in chronological order covering the period 1966 to the end of 1994. Exceptions to this order are due to the late arrival of some reports at the GSWA.

An area of the map with no shading does not necessarily indicate that there has been no geochemical exploration. Reports for the region may still be confidential and on closed file, available geochemical information may be related to *deep* drilling only, or the results of analysis may not have been reported to the GSWA.

To digitize this map, slight adjustments have been made to the positions of tenement polygons in order to simplify polygon–polygon boundaries. For more detail and accurate representation of tenement boundaries, the reader is referred to the appropriate report(s).

# Results and discussion

The general philosophy for this project is that which was used for MENZIES (Kojan and Faulkner, 1994). However, there are three main differences: (a) samples of 'laterite' were not collected, (b) samples from lake margins were not counted as lake sediments, and (c) analyses for chlorine were unreliable and unable to be used. No stream sediments were collected near lateritic outcrop, and no sample contained abundant lateritic material, though ferruginous nodules and granules in some samples may indeed have had a lateritic origin. Marginal lake sediments (of unit DA6) were counted as soils; only four of twelve samples contained significant gypsum, and of these, one contained only 1.5% S. However, strictly, they are intermediate between conventional soils and lake sediments. As in the MENZIES project, there appear to be no significant compositional differences between sheetwash and soil samples in any given area, and samples of these materials have been collectively grouped under 'soil'. Soils are in general skeletal, with no well-defined humic or other layer; most appear to be weakly consolidated sheetwash.

Many streams, identified by blue lines on Plate 1, are inactive and, as on MENZIES, active stream drainages only cover about 40% of the sheet. As saline lakes and the main palaeodrainages between them occupy almost 10% of the sheet, about half the sheet has no active drainage. Comparison between stream sediments and soils remains a problem. However, as for MENZIES, the element plots suggest that underlying rock or the degree of weathering are the main differentiating factors rather than the sample medium. An overlay (Plate 6) is provided to aid interpretation of the analytical data of Figures 4–40 in terms of the differences between sample types. Soils and stream sediments from greenstone areas seem to show 'greenstone' values; from granitic areas they show 'granitic' values. The simplified geological map overlay, Plate 7, is provided to assist visual interpretation of differences between the compositions of sediments from the two main types of source rock. Table 5 reports the X-ray diffraction mineralogy of a selected number of samples.

Data for $SiO_2$ and loss on ignition (LOI) are not included in Figures 4–40 although results are included in the accompanying digital dataset (LEONORA.CSV). Figures 39 and 40 show the highest reported values for 11 elements; some of these elements have poor reproducibility at low concentrations, others (such as Li) are generally featureless and the highest values are not considered unusual. A map of Mo distribution at the 1:250 000 scale is included in the reference set of maps on display at Mineral House. Plots for elements are available, on request, for purchase from the Department.

Tables 6–8 show geometric means for most components for samples derived from granitoids, greenstones, and the main alluvial and lake areas. Elements with a large number of values close to, or below, detection are omitted. Samples of mixed or unknown origin in erosional or colluvial areas are omitted from these tables but the raw data are included in the LEONORA.CSV dataset and are shown on the element distribution maps. As in the MENZIES Explanatory Notes (Kojan and Faulkner, 1994), geometric means are used for overall comparisons to minimize the effect of outlying very high or low values.

# Mineralogy of sediments

Table 5 lists minerals found in fifteen samples from the various regolith types, examined by X-ray diffraction (XRD). The minerals reported were compared with the chemical composition to confirm estimates of proportion.

The main minerals identified were, as expected, quartz, kaolinite, and iron oxides. The latter were only abundant (>10%) in sediments derived from greenstone belts. Most iron oxide is goethite with hematite substantially less common, the latter being recorded in only two of the samples examined by XRD. A magnetic phase, maghemite, was noted by physical testing in many samples, but did not show in the diffraction traces.

A surprisingly large amount of fresh minerals was present. Nine of the fifteen samples contain K-feldspar, and eight contain plagioclase. Chlorite and muscovite each featured in three samples, amphibole (hornblende) in one. The lake sediments contained halite and gypsum, but the latter tended, on drying, to alter to bassanite — calcium sulfate hemi-hydrate. The proportion of altered minerals typically increases with distance from source material, but feldspar can still be present in major floodplain and in lake sediments.

A general, but non-quantitative, agreement with the chemical analyses was found. As a result many samples were inferred to contain amorphous material, mainly in the form of hydrated iron oxides and hydrated aluminium silicates. The mineral containing magnesium in lake sediments, surprisingly, was not identified, but magnesium may have been co-precipitated either with iron oxides or with aluminosilicate.

Examination of grain mounts under the binocular microscope confirmed the presence of feldspars and small amounts of mica in many samples of all types, and also the presence of amphibole and chlorite in samples derived

Table 5. XRD analysis of selected samples (CSIRO)

| GSWA no. and reg. unit | Sample | Qtz | Kao | K-Fsp | Plag | Goe | Hem | Hbd | Chlr | Musc | Hlt | Bass | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125876 - DA7(?) | Lake | 20 | 27 | – | – | 3 | – | – | – | – | 7 | 29 | 86 |
| 126585 - DA7(?) | Lake | 37 | 35 | 9 | – | 8 | – | – | – | – | – | – | 89 |
| 126666 - DA7(?) | Lake | 30 | 32 | – | – | 6 | – | – | – | – | 12 | – | 80 |
| 126126 - E2G | Stream | 45 | 6 | 30 | 17 | 1 | – | – | – | – | – | – | 99 |
| 126307 - E4G | Stream | 52 | – | 29 | 12 | 1 | – | – | 2 | 4 | – | – | 100 |
| 126154 - DC1(G) | Stream | 68 | 14 | 10 | 2 | 3 | – | – | – | – | – | – | 97 |
| 126548 - DC2(G) | Soil | 82 | 12 | 1 | – | – | 3 | – | – | – | – | – | 98 |
| 126247 - DC3(G) | Soil | 53 | 22 | 14 | 6 | 4 | – | – | – | – | – | – | 99 |
| 125946 - DA5(G) | Soil | 61 | 23 | 9 | – | 5 | – | – | – | – | – | – | 98 |
| 126369 - DA6(?) | Soil | 35 | 34 | 4 | 2 | 24 | – | – | – | – | – | – | 99 |
| 126756 - E1(VS) | Stream | 47 | – | – | 10 | 12 | – | – | 23 | 6 | – | – | 98 |
| 126193 - E2VS | Stream | 7 | 15 | 1 | 7 | 36 | – | 23 | 10 | – | – | – | 99 |
| 126280 - E4VS | Stream | 7 | 30 | – | – | 30 | 30 | – | – | – | – | – | (a) 97 |
| 126768 - DC1(VS) | Stream | 55 | 18 | – | 4 | 10 | – | – | – | 10 | – | – | 97 |
| 126534 - DC2(VS) | Soil | 58 | 24 | – | – | 16 | – | – | – | – | – | – | 98 |

Notes: (a) Denotes sample with abundant amorphous materials resulting in a low diffraction pattern. The iron content was arbitrarily split into equal hematite and goethite.

Letters in brackets indicate source material : (G) = granite; (VS) = greenstone; (?) = unknown.

Qtz = quartz; Kao =kaolinite; K-fsp = K-feldspar; Plag = plagioclase; Goe = goethite; Hem = hematite; Hbd = hornblende; Chlr = chlorite; Musc = muscovite; Hlt = halite; Bass = bassanite.

from greenstones. Minor amounts of rutile and zircon were also noted.

The presence of so many remnant primary minerals shows that mechanical erosion of relatively unweathered rock has been the dominant process in the area. Consequently, for most samples, some indication of the contributary source rock (or rocks) can be determined.

# Comparison of regolith units

Stream sediments and soils have been grouped according to their surrounding regolith unit. In erosional areas division into sub-groups indicating source rock is relatively easy. Such subdivision becomes more difficult as sediment is transported farther from its source, and the colluvial units shown on Plate 1 do not show a possible derivation. However, an attempt has been made to classify the DC units in terms of their source (with a 'vs' and 'g' identifier as appropriate) based on the chemical composition and rocks known in the source area. There are also samples, apparently of mixed source, which are not included in the following tables or discussion.

## Regolith units sourced from greenstones

The characteristic of these units, compared with those derived from granitoids, is a generally higher level of $Fe_2O_3$, $TiO_2$, Cr, Cu, Ni, and V. Gold, Pd, and Pt, where detected, and most higher values of As, Mo, Sc, and Y are also largely restricted to sediments shed from greenstone. The greenstone signature appears to remain in drainages for at least 10 km from larger outcrop areas.

There is a slight variation between soil and stream sediment samples derived from greenstone. In general, soil samples have higher average $SiO_2$, whereas stream sediments have higher average $Fe_2O_3$, As, Cr, Cu, Ni, and V.

Geometric mean values, and the number of samples, for units E2vs, E4vs, and DC1–3(vs) are given in Table 6.

### *Relict regime*

The main relict units found over greenstones are R2 (ferricrete) and very minor R3 (silcrete). Neither unit was specifically sampled, as samples were collected from channels or other sites much lower in the topographic system.

### *Erosional regime*

Sample numbers are relatively small, and the geometric means may be biased by isolated high values. Samples from the erosional regime show, on average, very little variation with the exception of dramatic leaching of Ca, Mg, Na, and Mn away from the source (E2vs to E4vs), coupled with some loss of Ce, Co, Cu, Ni, Sc, Sr, Y, and Zn. The only element which shows significant downslope enrichment is Cr, though there are slight rises for As, Ga, Th, U, and Zr. There is little evidence of silicification. Comparison of geometric mean values shows overall Fe enrichment in E4vs to be minor, though the maximum value is almost 56%. Approximately nine E4vs samples (from a total of thirty-one) appear to be derived from felsic rocks. High values of MgO

**Table 6. Geometric means of analytical results for regolith units derived from greenstone belts**

| *Component* | *E2VS* | *E4VS* | *DC1(vs)* | *DC2(vs)* | *DC3(vs)* |
|---|---|---|---|---|---|
| Sample nos | N=16 | N=31 | N=82 | N=25 | N=16 |
| | | | **Percentage** | | |
| $SiO_2$ | 52.3 | 47.1 | 53.7 | 56.0 | 73.9 |
| $TiO_2$ | 0.90 | 0.70 | 0.79 | 0.72 | 0.46 |
| $Al_2O_3$ | 10.2 | 9.34 | 10.3 | 10.0 | 8.92 |
| $Fe_2O_3$ | 20.7 | 21.4 | 20.1 | 21.0 | 8.65 |
| MnO | 0.15 | 0.07 | 0.07 | 0.05 | 0.04 |
| MgO | 1.71 | 0.30 | 0.10 | 0.05 | 0.06 |
| CaO | 2.10 | 0.31 | 0.12 | 0.05 | 0.02 |
| $Na_2O$ | 0.65 | 0.17 | 0.11 | 0.06 | 0.05 |
| $K_2O$ | 0.30 | 0.28 | 0.44 | 0.38 | 0.66 |
| $P_2O_5$ | 0.06 | 0.07 | 0.08 | 0.08 | 0.06 |
| S | – | – | – | – | – |
| F | – | – | – | – | – |
| | | | **Parts per million** | | |
| As | 15.7 | 19.5 | 22.9 | 22.4 | 7.13 |
| Ba | 146 | 139 | 168 | 130 | 149 |
| Be | – | 0.87 | 0.76 | 0.63 | 0.90 |
| Bi | 0.25 | 0.24 | 0.34 | 0.39 | 0.55 |
| Cd | 0.31 | 0.21 | 0.23 | 0.21 | 0.17 |
| Ce | 26.2 | 17.7 | 21.6 | 20.2 | 19.8 |
| Co | 26.7 | 15.7 | 8.78 | 5.89 | 6.40 |
| Cr | 491 | 704 | 601 | 697 | 336 |
| Cu | 95.8 | 56.4 | 58.3 | 45.2 | 26.4 |
| Ga | 14.1 | 18.7 | 20.9 | 22.1 | 13.5 |
| In | 0.13 | 0.15 | 0.15 | 0.15 | 0.09 |
| La | 10.6 | 9.76 | 12.4 | 12.3 | 12.4 |
| Li | 7.12 | 5.07 | 7.11 | 6.32 | 7.53 |
| Mo | 1.20 | 1.95 | 2.29 | 2.33 | 1.43 |
| Nb | 5.54 | 6.37 | 7.58 | 7.40 | 6.81 |
| Ni | 140 | 119 | 71.9 | 52.8 | 36.4 |
| Pb | 11.3 | 13.9 | 15.8 | 19.0 | 15.5 |
| Rb | 15.1 | 14.8 | 26.1 | 25.0 | 32.3 |
| Sb | 1.42 | 2.24 | 1.62 | 1.60 | 0.75 |
| Sc | 25.8 | 14.9 | 16.9 | 16.4 | 9.29 |
| Se | 2.01 | 2.36 | 2.42 | 2.02 | 1.20 |
| Sn | 1.26 | 1.33 | 1.68 | 1.72 | 1.49 |
| Sr | 51.0 | 31.7 | 31.6 | 22.9 | 16.8 |
| Th | 4.31 | 6.67 | 6.99 | 8.67 | 9.34 |
| U | 0.84 | 1.23 | 2.13 | 2.09 | 2.00 |
| V | 317 | 302 | 329 | 353 | 152 |
| W | 3.19 | 1.91 | 2.57 | 2.79 | 1.50 |
| Y | 17.1 | 8.83 | 8.89 | 8.61 | 5.69 |
| Zn | 87.6 | 56.1 | 55.5 | 42.4 | 30.7 |
| Zr | 69.0 | 80.6 | 93.3 | 91.1 | 80.0 |

Note: A dash denotes too many values below the detection limit for meaningful results

(≤12%) and CaO (≤7%) indicate the general locations of ultramafic and mafic rocks; some of the higher MgO values occur southeast of Lawlers and may indicate the presence of ultramafic rocks additional to those shown by Thom and Barnes (1977). Samples of sediments derived from ultramafic rocks also contain high Cr (≤8910 ppm), Ni (≤1350 ppm) and Co (≤100 ppm). The higher Th, U, and Zr values may be related to felsic volcanics or even to sediments. Gold, Pd, and Pt are reported from about half the samples from this regime, including an Au value of 72 ppb near Mount Stirling gold mine.

### Colluvial regime

Sheetwash lies on the lower slopes of upland areas, and passes into colluvial fans and sheets farther from the source rocks. On LEONORA, no DC3f was collected. Progressive changes due to increased secondary alteration, together with dilution by eolian sand and some contribution from granitoids, are expected with distance from source. Such progressive changes are shown by $SiO_2$ and Th, which steadily increase, and by MnO, CaO, $Na_2O$, Ni, Sr, and Zn, which steadily decrease from E4vs to DC3(vs). For many components the highest values appear in the DC1(vs) or the DC2(vs) units, with a dramatic drop in DC3(vs) (e.g. $TiO_2$, $Fe_2O_3$, As, Cu, Sc, and Zr). However, many elements show no consistent changes.

Similarities between the composition of many samples of DC1 and DC2 indicate that transport on the upper slopes may remain largely mechanical with little chemical modification. Compared with MENZIES, the DC3 unit appears better defined; the compositional difference between this and other colluvial units implies further chemical changes as well as eolian dilution.

## Regolith units sourced from granitoids

Samples from units sourced by granitoids have been grouped in a manner similar to those sourced by greenstones. The geometric means for the various units (R4, E2g, E4g, DC1-3(g)) are given in Table 7.

### Relict regime

Relict surfaces over granitic terrain are principally caprock silcrete (R3) or upland sand plains above breakaways (R4). The R3 unit shown on Plate 1 has been delineated from satellite imagery and has not been sampled for this project. Samples have been taken from soils and sheetwash on the lower slopes of R4. This unit is rich in $SiO_2$, with a range of 75% to 92%, as quartz sands. The chemical composition implies the presence of a small proportion of minerals other than quartz, and iron oxides and kaolinite are present in most samples. Iron-rich nodules are not abundant, and the iron content is low ($Fe_2O_3$ ≤5%). Values of $TiO_2$ (≤0.5%) and Zr (≤110 ppm) imply the presence of resistate minerals, although Cr (≤208 ppm) and V (≤78 ppm), together with some of the Ti, are probably trapped in iron oxides. One sample with a $K_2O$ value of 1% suggests a contribution from an eroding granitoid.

### Erosional regime

The regolith units E2g and E4g are in close proximity to each other; the unit E2g is not found far from the source materials. Compared with that characterized by E2vs, much of the topography is rather subdued.

The $SiO_2$ content is higher than that expected in the source granitoids. The units are compositionally very similar, but chemical weathering in general increases away from the main outcrops. E4g is, however, marginally depleted in $SiO_2$ relative to E2g and slightly enriched in $Fe_2O_3$, $TiO_2$, $Al_2O_3$, Ba, Ce, Cr, Rb, Sr, Th, U, V, and Zn

**Table 7. Geometric means of analytical results for regolith units derived from granitoids**

| Component | R4 | E2G | E4G | DC1(g) | DC2(g) | DC3(g) |
|---|---|---|---|---|---|---|
| Sample nos | N=25 | N=20 | N=71 | N=203 | N=70 | N=186 |
| | | | **Percentage** | | | |
| $SiO_2$ | 86.2 | 85.1 | 82.4 | 82.1 | 87.3 | 84.1 |
| $TiO_2$ | 0.22 | 0.13 | 0.18 | 0.20 | 0.19 | 0.24 |
| $Al_2O_3$ | 5.70 | 6.56 | 7.77 | 8.05 | 5.22 | 7.15 |
| $Fe_2O_3$ | 3.09 | 1.93 | 2.27 | 2.34 | 2.51 | 2.59 |
| MnO | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 |
| MgO | 0.11 | 0.09 | 0.06 | 0.06 | 0.09 | 0.06 |
| CaO | 0.04 | 0.10 | 0.14 | 0.07 | 0.03 | 0.02 |
| $Na_2O$ | 0.03 | 0.59 | 0.55 | 0.35 | 0.04 | 0.08 |
| $K_2O$ | 0.18 | 1.14 | 1.30 | 1.54 | 0.63 | 1.23 |
| $P_2O_5$ | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 |
| S | – | – | – | – | – | – |
| F | – | – | – | – | – | – |
| | | | **Parts per million** | | | |
| As | 3.00 | 1.54 | 1.75 | 1.99 | 2.42 | 2.45 |
| Ba | 59.5 | 338 | 398 | 396 | 141 | 316 |
| Be | – | – | – | – | – | – |
| Bi | – | – | 0.21 | 0.21 | 0.17 | 0.18 |
| Cd | – | 0.19 | – | 0.19 | – | 0.17 |
| Ce | 8.46 | 12.0 | 16.4 | 19.7 | 8.98 | 15.1 |
| Co | – | 3.32 | 3.20 | 3.19 | – | – |
| Cr | 103 | 21.3 | 24.9 | 37.1 | 63.4 | 51.7 |
| Cu | 9.22 | 6.27 | 7.32 | 9.17 | 7.69 | 10.4 |
| Ga | 7.56 | 8.04 | 11.2 | 10.8 | 7.24 | 10.3 |
| In | – | – | – | – | – | – |
| La | 4.88 | 8.44 | 10.8 | 11.9 | 6.95 | 10.00 |
| Li | 3.63 | 3.26 | 3.70 | 5.19 | 3.79 | 4.79 |
| Mo | 0.82 | 0.65 | 0.72 | 0.78 | 0.77 | 0.84 |
| Nb | 4.01 | 3.81 | 4.14 | 5.58 | 3.78 | 5.08 |
| Ni | 9.32 | 4.57 | 5.78 | 6.64 | 7.78 | 7.96 |
| Pb | 6.83 | 8.84 | 14.1 | 15.4 | 9.02 | 14.2 |
| Rb | 14.4 | 33.0 | 46.3 | 59.0 | 31.0 | 53.6 |
| Sb | – | – | – | – | – | – |
| Sc | 3.20 | 1.73 | 2.20 | 2.77 | 3.01 | 3.38 |
| Se | 0.84 | – | 0.77 | 0.84 | 0.76 | 0.78 |
| Sn | 1.25 | 0.97 | 1.17 | 1.09 | 1.17 | 1.21 |
| Sr | 7.17 | 48.2 | 64.0 | 47.3 | 14.7 | 31.8 |
| Th | 4.76 | 4.27 | 5.76 | 6.62 | 4.69 | 6.10 |
| U | 0.74 | 0.87 | 1.14 | 1.46 | 0.97 | 1.35 |
| V | 48.0 | 22.2 | 27.6 | 32.0 | 35.6 | 38.7 |
| W | 0.69 | 0.83 | 0.74 | 0.70 | 0.70 | 0.89 |
| Y | – | 3.44 | 3.45 | 4.06 | 2.57 | 3.44 |
| Zn | 12.7 | 12.8 | 16.1 | 18.8 | 13.8 | 19.3 |
| Zr | 50.5 | 53.6 | 58.6 | 67.4 | 50.6 | 61.8 |

Note: A dash denotes too many values below the detection limit for meaningful results

compared with E2g. The maximum $K_2O$ value (5.5%) and the geometric mean (1.3%) for E4g indicate that in many samples unaltered minerals remain mixed with weathered products. The slightly higher values for Cr, V, and Zn in E4g may reflect a minor 'mafic' component in the sediment or the adsorption of these elements on either iron oxides or clay.

### *Colluvial regime*

A large number of samples collected are sourced from granites, including over 400 samples of colluvium. The different units are generally distinguished by their physical characteristics and position in the topographic profile. The mean compositions of all units derived from granitoids (including the erosional units) are remarkably similar (Table 7). The variation in composition downslope (E2g to DC1 to DC3) is not systematic. The geometric means for $Fe_2O_3$, As, Ni, Sc, and V increase slightly from E2g to DC3(g), though many samples have no detectable As or Ni. There is also an overall increase in $TiO_2$, Cr, Cu, and Zn. As expected there is a slight, but unsystematic, decrease in some more 'mobile' elements including CaO, $Na_2O$, and Sr. There is little systematic variation for components such as $SiO_2$ and $K_2O$.

Except for a small decrease in CaO, $Na_2O$, and Sr, and an equally small increase in $K_2O$ and Rb and possibly in Ce, Cr, and V, the composition of DC1(g) strongly resembles that of E4g. Surprisingly, DC1 has the highest $K_2O$ (geometric mean value) of the granitoid-derived regolith units.

DC2(g) appears to have the highest eolian component of the colluvial units. It has the highest $SiO_2$ content (geometric mean 87.3%) and the lowest $Al_2O_3$ (5.22%) and $K_2O$ (0.63%) content, implying an increase in quartz sand at the expense of feldspar or mica (or clay). Mean values of Ce, La, and Zr are also low suggesting fewer contained resistate minerals.

Unit DC3(g) contains a higher $K_2O$ concentration (geometric mean 1.23%) than would be expected were feldspar breaking down into clay. The unit composition is chemically similar to E4g and DC1. The $K_2O$ content ranges from as low as 0.15% up to 6.15%; the high values may indicate a contribution to the sediment from subcropping rock.

## Regolith units in drainages: alluvium, salt lakes, and precipitates

The regolith units included in this section are DA4, DA5, DA6, DA7, and DA8. The geometric-mean data are presented in Table 8.

Unit DA4 (active alluvial channel) mainly relates to coarse polymictic detritus draining elevated areas, and occurs in close association with erosional units and DC1. Materials may be derived from variably sized catchments and/or from varied lithologies. As a result, there are wide ranges for most elements determined; for example, chromium varies from undetectable to 2550 ppm, with a geometric mean of 121 ppm, and $Fe_2O_3$ ranges from 0.8% to 49 %, with a geometric mean of 5.7%.

The DA5 unit represents areas close to playa lakes and palaeodrainages. Materials are usually a mixture of overbank/overflow sediments from floods with materials transported downslope from sheetwash fans/colluvial plains. Coarse clasts are rare. At this position in the landform profile, no attempt has been made to divide the units simply by parent materials. For some samples, however, a single lithological source appears dominant. For example, at site 126712 there is a strong greenstone influence (9.15% $Fe_2O_3$, 505 ppm Cr, 98 ppm Ni, and 150 ppm V) and at site 126526, a granite influence (2.64%

**Table 8 Geometric means of analytical results for regolith units from alluvial and lake areas**

| *Component* | *DA4* | *DA5* | *DA6* | *DA7* | *DA8* |
|---|---|---|---|---|---|
| Sample nos | N=117 | N=46 | N=12 | N=42 | N=11 |
| | | | **Percentage** | | |
| $SiO_2$ | 74.0 | 84.3 | 62.0 | 37.9 | 72.5 |
| $TiO_2$ | 0.25 | 0.22 | 0.25 | 0.38 | 0.42 |
| $Al_2O_3$ | 6.85 | 5.51 | 5.61 | 8.34 | 9.71 |
| $Fe_2O_3$ | 5.70 | 3.02 | 2.93 | 3.39 | 4.05 |
| MnO | 0.03 | 0.02 | 0.03 | 0.04 | 0.05 |
| MgO | 0.17 | 0.10 | 0.51 | 4.40 | 0.35 |
| CaO | 0.20 | 0.04 | 0.55 | 2.19 | 0.51 |
| $Na_2O$ | 0.37 | 0.07 | 0.28 | 2.25 | 0.11 |
| $K_2O$ | 0.82 | 0.85 | 0.77 | 0.90 | 1.43 |
| $P_2O_5$ | 0.04 | 0.04 | 0.04 | 0.06 | 0.05 |
| S | – | – | – | – | – |
| F | – | – | – | – | – |
| | | | **Parts per million** | | |
| As | 4.32 | 2.64 | 3.09 | 5.57 | 3.97 |
| Ba | 270 | 248 | 208 | 185 | 287 |
| Be | 0.72 | – | 0.65 | – | – |
| Bi | 0.22 | 0.18 | – | 0.20 | 0.19 |
| Cd | 0.17 | 0.17 | – | 0.18 | 0.20 |
| Ce | 13.2 | 13.0 | 15.1 | 18.1 | 23.8 |
| Co | 6.09 | 3.68 | 4.10 | 4.39 | 4.69 |
| Cr | 121 | 70.5 | 36.4 | 60.4 | 61.9 |
| Cu | 16.4 | 11.5 | 11.4 | 17.6 | 18.6 |
| Ga | 11.5 | 9.59 | 8.44 | 11.5 | 12.5 |
| In | – | – | – | – | – |
| La | 8.15 | 8.57 | 9.07 | 13.2 | 16.0 |
| Li | 3.62 | 5.06 | 4.92 | 9.44 | 9.89 |
| Mo | 0.98 | 0.96 | 0.94 | 1.78 | 1.36 |
| Nb | 3.42 | 3.82 | 3.63 | 5.47 | 5.86 |
| Ni | 19.8 | 11.0 | 10.4 | 18.4 | 18.8 |
| Pb | 11.9 | 10.9 | 7.49 | 10.9 | 13.6 |
| Rb | 29.5 | 37.1 | 28.3 | 35.3 | 56.1 |
| Sb | – | – | – | – | – |
| Sc | 5.16 | 3.70 | 4.29 | 6.17 | 6.47 |
| Se | 0.99 | 0.80 | 0.99 | 1.73 | 0.82 |
| Sn | 1.02 | 1.24 | 1.38 | 1.44 | 2.13 |
| Sr | 49.1 | 28.6 | 60.4 | 531 | 42.7 |
| Th | 4.19 | 5.21 | 3.47 | 5.99 | 7.20 |
| U | 0.96 | 1.77 | 2.56 | 21.3 | 3.25 |
| V | 74.2 | 42.9 | 41.9 | 71.9 | 49.6 |
| W | 0.86 | 0.69 | 0.86 | 1.20 | 1.05 |
| Y | 4.54 | 3.57 | 4.82 | 5.90 | 6.26 |
| Zn | 25.0 | 18.5 | 25.4 | 34.3 | 37.3 |
| Zr | 55.5 | 55.6 | 48.5 | 57.6 | 78.9 |

Note: A dash denotes too many values below the detection limit for meaningful results

$K_2O$ and 750 ppm Ba). The potassium at the latter site inhabits K-feldspar, suggesting either an origin in grus transported several kilometres, or the nearby presence of an unmapped granitic source.

Playa lake margin sediments (DA6) were expected to be very variable in composition, with some indications of the presence of gypsum. However, sediments of this unit have geometric means of only 0.55% CaO and 0.24% S. These mean values conceal several gypsum-rich samples, the highest having 30% CaO and 18% S. One sample has no gypsum but contains some calcrete — indicated by a relatively high CaO value (2.52%) and no sulfur. An elevated $Na_2O$ average for the DA6 unit (0.28%) suggests a marginal saline environment and a correct classification of materials .

Most of the 12 sites in the DA6 unit have unknown or mixed source materials, although two appear to be derived largely from greenstone. Sediments at both of these sites have mafic signatures for Cr, Cu, V, MgO, and Au. Site 126761 has the highest gold value of the map sheet (251 ppb), and is 'downstream' from the Sons of Gwalia gold mine.

Most lake sediments (DA7) are saline and many contain gypsum and calcrete. A few non-saline samples are included in this unit (rather than DA5) where the sampled sites are claypans within DA5. In general, the saline lakes are sites of accumulation of elements such as $Na_2O$, MgO, Li, U, and Sr, and have relatively high values of $P_2O_5$ ($\leq$0.14%) and F ($\leq$0.06%). There are at least 13 gypsum-rich sites, with the highest in the northwest of the map sheet (31.3% CaO, 21.56% S). There is also a strong mafic influence in some samples, reflecting materials transported from the greenstones (maximum values: 8.31% $Fe_2O_3$; V 135 ppm; Zn 83 ppm; Zr 135 ppm).

Extensive valley calcrete deposits (DA8) have been mapped in the palaeodrainages (Thom and Barnes, 1977; Churchward and Craig, in press). Samples from these areas do not always have high CaO concentrations. One sample was purposely collected away from visible calcrete and probably represented recent alluvial and/or eolian sediments ($SiO_2$ 84%, CaO 0.26%). At the same site the exposed calcrete contained 41.6% CaO. Possible explanations for the low CaO values at most sites are that most remnant calcrete particles are larger than the size fraction analysed (-2 mm to +0.45 mm), and in some cases, the unit mapped as calcrete appears to have been secondarily silicified. DA8 has the unlikely characteristic of having the highest geometric mean for any alluvial unit for $Al_2O_3$, $K_2O$, Ba, Ce, Cu, Ga, La, Nb, Pb, Rb, Sc, Sn, Th, Y, Zn, and Zr.

## Regional considerations

The most significant consideration on the regional scale is the difference in degree of weathering between the eastern and western portions of the sheet. In general, west of the line from Leonora to Agnew (and over the greenstones themselves), mechanical erosion of fresh rock has been the dominant process and the sediments are dominated by brokendown rock (grus) and primary minerals. East of this line, the dominant process has been erosion of chemically weathered and/or silicified bedrock, and the sediments are much more extensively altered and leached. They are more relict in character, containing fewer primary minerals and showing much less evidence of the underlying granitoids. In general, the land east of the greenstones is topographically higher than that to the west. Both grus and weathered products are diluted by eolian sand.

Principal Component Analysis (Rock, 1988) has been used on the analyses to separate the main geological groupings and establish which elements are the principal contributors to each group.

Principal components have been extracted from a subset of 21 elements whose value factor loadings (>0.60) have been determined as significant. Other elements were omitted either because of non-significant loadings or because too many values were below the detection limit. A principal component value has been established for each sample by multiplying the factor loadings for each element by its normalized concentration and then adding the modified element values together. Normalized concentration values have been achieved by expressing the specific site value for a given element as a percentage of its overall maximum concentration. This puts all principal components on the same ordinal scale and promotes the influence of those trace elements with lower values.

Figure 42 is a map of the first and second principal components for LEONORA, effectively representing greenstone and granitic terrains respectively. Principal Component 1 uses $TiO_2$, $Fe_2O_3$, As, Co, Cr, Cu, Ga, Ni, Sc, V, and Zn and represents 35% of the data. Principal Component 2 uses $K_2O$, Ba, Ce, Pb, Rb, and Th and represents 21% of the data. (Equations for the data are given in the caption to the figure.) Since all factor loadings for the first principal component are positive and are negative for the second principal component, on addition of the components high positive numbers reflect greenstone terrain and high negative numbers reflect granitoids. The figure indicates the position of greenstone belts, and demonstrates that there are chemical differences between some of them; for example, between the Mount Clifford and Malcolm/Murrin belts. The figure also identifies four centres of potassic granitoids.

## Differences between greenstone belts

Greenstones include a variety of igneous and sedimentary rock types. The chemical analyses have identified systematic compositional variation between soils associated with most of the previously identified greenstone belts (Agnew, Mount Clifford, Yandal South, Murrin, Malcolm, Mount Ida — see Figure 42). The results tend to support the suggested similarities between the Murrin and Malcolm Belts (Griffin, 1990b). It should be noted that the terms 'high' and 'low' are only map sheet comparisons.

The Agnew belt is high in most elements associated with the six greenstone belts (e.g. $Fe_2O_3$, $TiO_2$, MgO, MnO, As, Au, Co, Cr, Ni, Pd, Pt,V, Y, Zn, and Zr), with distinctive enrichment in Cd, In, Sb,and Sn, but little Ga and Se. The chemistry of the Mount Clifford belt is similar, including Sb enrichment but with some high values in Ce (max. 125 ppm). Ce enrichment is unusual for a greenstone belt and highlights the possible influence of small bodies of fractionated granite.

Ultramafic rocks east to northeast of the Wildara outcamp contribute a chemically distinct signature to part of the Mount Clifford greenstone belt. Although they have high MgO, MnO, Co, Cr, and Ni values (similar to those of the Agnew and Mount Clifford belts), sediments derived from these rocks are distinguished by low concentrations of $TiO_2$, As, Au, Ga, Sb, Se, V, and Y.

Distinctive high elemental concentrations for the Yandal South belt are detected near known mineralization. For example, high Cu, F, and Zn are centred around the Teutonic Bore mine, and high As and Se are associated with the Goanna Patch gold mine. Low values of MgO, MnO, and Co relate to the dominant felsic volcanic lithology.

The Murrin belt is characterized by low values for CaO, MgO, Cr, Cu, Pd, Pt, Ni, and V. Isolated high values of Ce, Se, and S appear to be related to felsic volcanic rocks, but possibly show a granitic influence. It is not possible to identify areas of felsic volcanics using the $K_2O$ concentrations alone.

The Malcolm belt is similar to the Murrin belt, with comparatively low values for MgO, Cu, Cr, and Ni. This again reflects the influence of the felsic volcanic lithology. As previously mentioned, the highest Au value for the sheet (251 ppb) is related to the Sons of Gwalia shear zone, downstream from the Sons of Gwalia mine.

The larger part of the Mount Ida belt outcrops on MENZIES (Kojan and Faulkner, 1994). The part outcropping on LEONORA has the lowest As, Ga, Pd, and Pt values of the six greenstone belts on the sheet, as well as low values of MgO, Cr, Cu, Ni, Sb, Se, V, and Y. The MgO and Ni values are higher than those of the felsic volcanics of Murrin, Malcolm, and Yandal belts. There are relatively high values of F and Nb, slightly higher values of Mo, and lower values of S compared with most other greenstone belts. A linear band of high Mo (≤10 ppm) extends southeast onto MENZIES and appears to be related to the BIF–granite contact. Higher values of Nb (≤30 ppm) in the area may be related to the mafic–granite contact. Within the Mount Ida belt, the influence of the BIF on the western side is distinguishable from that of the basalt to the east, by slightly higher $Fe_2O_3$ and Mo, and lower CaO, MgO, MnO, Co, Ni, and Zn.

There is a small outcrop of the Ilaara greenstone belt (in the southwestern corner of the sheet), which has no direct influence on LEONORA, except through sediments which drain from this belt.

## Identification of specific granitoid bodies

The granitoids of the Eastern Goldfields and Southern Cross Provinces are separated by the Mount Ida Fault. However, there is no distinguishable chemical change either side of the fault line. The greatest variations in regolith sediments over granitoids occur east and west of the main greenstones. More mobile elements, such as $K_2O$, Ba, and Rb, are considerably lower east of the greenstones, whereas more resistant elements (e.g. Cr, Ni, and Zr) do not vary much over the map sheet. The low $K_2O$, Ba, and Rb values for eastern granitic terrains of LEONORA, are similar to those shown by these elements over most of the MENZIES sheet (Kojan and Faulkner, 1994). These low values of the sediments reflect weathered or silicified rock and give little indication of the true nature of the granitoid except in the Dodgers Hill region. The high values to the west, however, are significantly higher than those on MENZIES, and reflect less weathered/altered, potassic granitoids.

Relatively high values of $Na_2O$ and Sr were detected at Mount Adamson (south-southeast of Lawlers) and at Pepperill Hill, suggesting the presence of more-sodic granitoids, such as granodiorite. The granitoid south of Lawlers has been classified into two phases; an older coarse-grained tonalite and granodiorite, and a younger leucogranite (Platt et al., 1978). The present results suggest a reasonably high $K_2O$ content, which indicates a dominance of the leucogranite at the surface. Samples near Pepperill Hill have slightly lower $K_2O$ values; the rock at Pepperill Hill is reported to be a deeply weathered gneiss/migmatite (Thom and Barnes, 1977).

A fractionated granite south of Lake Raeside is identified by elevated Ce, La, Pb, and Th values. This granitoid continues south onto MENZIES (Davy et al., in press; Kojan and Faulkner, 1994). A similar granitoid may be present to the south and west of Mount Ross: above-average values of Ce, La, and Th are associated with the granite–greenstone boundaries and north at the Mount Stirling mine.

No further subdivision of the granitoids is possible as analyses of trace elements near their detection limits are not considered accurate.

# Economic geology

## Gold contours and known mineralization

Figure 41 presents contoured gold values from the current study, with the known historical production from major mines (>30 kg) superimposed. The diameter of the circle is proportional to the production (in kilograms). The name, location, past production, in-ground resources, and total gold values for these mines and prospects are given in Appendix 1. Most known gold mineralization closely follows the major north-northwest trending greenstone belts running from Leonora to Agnew. Most major deposits lie within the areas of higher gold values (≥2 ppb) identified during the project. However, the position of the Bannockburn mine was not picked out by the regional patterns. The sample downstream from the mine represents a large catchment area and the input from the mine may have been diluted. The highest gold value reported in this project (251 ppb) is found in Lake Raeside approximately three kilometres downstream from the Sons of Gwalia mine. The second highest Au value (72 ppb) occurs downstream from the Mount Stirling mine, in the Mount Clifford greenstone belt, adjacent to a granite–greenstone contact.

There are a few areas, with no known mines or prospects, in which the regolith contains >3 ppb Au. A value of 9 ppb in Lake Raeside west-northwest of the Leonora townsite may be due to sediment sourced from the Mount Clifford greenstone belt (Mount Davis and Mount Clifford). Higher values (5, 6, and 7 ppb) near the southwest corner of the map sheet highlight the Mount Ida greenstone belt (Mount Alexander). A single value of 20 ppb near the southwestern corner of the sheet may represent materials transported from the Ilaara greenstone belt (most of which outcrops on the adjacent YOUANMI sheet), or may reflect a greenstone enclave within granitoids.

Anomalous arsenic (>50 ppm) has been used to suggest the presence of sulfide-bearing, possibly mineralized rocks (Boyle and Jonasson, 1973). The positions of As-bearing samples on LEONORA show strong correlation with the contour plot of the gold values. The results suggest that mineralization associated with sulfides is common within the Agnew, Malcolm, and Mount Clifford greenstone belts. Two examples of this are the Harbour Lights and Trump mines, both situated in the Leonora area.

There are two lake samples with particularly high Au values (9 and 12 ppb) in the southeast of the map sheet. These highlight contamination from mines and/or possible accumulation from the Malcolm greenstone belt.

## Other mineralization and potential for mineralization

Copper, Zn, and Ag have been mined at the Teutonic Bore mine, and a small amount of copper has been extracted in the Agnew area. Chrysoprase has also been mined at Marshall Creek. Hitherto unexploited deposits include nickel (Mount Clifford and Weebo Bore), uranium (Lake Raeside), lead (Wilsons Patch) and molybdenum (Dodgers Hill). Their positions are marked by element symbols on Figure 2.

Relatively high values of copper and zinc are predominantly confined to the greenstone belts. The highest Cu values (Fig. 20) are found southwest of Agnew townsite (280 ppm) and south of Teutonic Bore minesite (255 ppm). There are noticeable variations between greenstone belts. Agnew, Mount Clifford, and Yandal South belts are relatively enriched in Cu with respect to the Malcolm, Mount Ida and Murrin belts.

The plot of zinc concentration (Fig. 38) is similar to that of copper (Fig. 20). The highest values (342 and 242 ppm) are found south of the Teutonic Bore mine, and there are also relatively high values (>100 ppm) in the Agnew greenstone belt, and near Mount Clifford and Wildara outcamp. The high values of Cu and Zn south of Teutonic Bore may reflect an extension to the known mineralized zone, although contamination from recent mining operations is possible.

Silver values are predominantly low and do not indicate known mineralization. The highest value (3.4 ppm) occurs in the northwest of the sheet (Fig. 41). It may reflect a feature on the adjacent YOUANMI map sheet, or be an analytical artefact. Samples to the south of Teutonic Bore with higher values of Cu and Zn do not contain any Ag above 1 ppm — a contrast with the main Teutonic Bore mineralization (Greig, 1984).

All high Ni values (maximum 1340 ppm) correspond to known occurrences of ultramafic rock. Near the largest deposit, Weebo Bore, which has little surface expression (Marston, 1979), Ni does not display anomalous concentrations. However, there are high values for Ni in the vicinity of the Mount Clifford groups of deposits.

The higher Pb concentrations are predominantly associated with the granites, although the highest value is in a lake sample (120 ppm). Elevated Pb values (~50 ppm) in the south of LEONORA continue onto the MENZIES map sheet (Kojan and Faulkner, 1994). The value of 84 ppm Pb in the southeast corner of the sheet may be an expression of the felsic volcanics in the Malcolm greenstone belt. There are no unusually high values in the vicinity of Teutonic Bore or near the reported Pb occurrence near Wilsons Patch (Thom and Barnes, 1977).

The concentrations of Mo are generally low (Fig. 40). The highest value (32 ppm) was found in a sample from Lake Raeside that has an unusual composition and has possibly been influenced by both granitic and mafic sources (7.65% MgO, 6.49% $Na_2O$, 1.28% $K_2O$, 27 ppm As, 111 ppm Cr, and 38 ppm La). A weakly defined low-level anomaly (≤10 ppm Mo) along the western side of the Mount Ida greenstone belt continues onto the MENZIES sheet (Kojan and Faulkner, 1994) and may derive from the contact zone of the BIF with volcanic rocks. A value of 14 ppm was determined in a sample to the north east of Wildara outcamp, close to the granitic gneiss–ultramafic rock boundary. The Mo occurrence southeast of Dodgers Hill is not reflected in the sediments sampled.

The higher U values are concentrated in the lakes and adjacent main palaeodrainages, with Lake Raeside displaying the highest concentrations (≤165 ppm).

One area of interest is in the southwest corner of the map sheet, where higher values of $P_2O_5$, coupled with higher Ba and a nearby aeromagnetic dipole, may indicate the presence of a carbonatite vein.

## Chalcophile indices

Smith et al. (1989) proposed that chalcophile and associated elements in lateritic materials could be used to define potentially mineralized geochemical provinces in bedrock of the Yilgarn Block. These authors proposed a number of indices, most calculated empirically and based on the analysis of lateritic materials, to define areas potentially containing chalcophile mineralization. The intent was to highlight known mineralized areas and point to areas for further exploration. Although this study did not directly sample laterite, these published indices have been tested on the stream sediment and soil samples. Many indices showed generally similar patterns: two of the plots generated are illustrated (Figs 43 and 44).

The CHI-6*X index uses a combination of the elements As, Sb, Bi, Mo, Ag, Sn, W, and Se (Fig. 43). The higher values exist in the greenstone belts, with anomalies corresponding to the Agnew/Emu, Goanna Patch, and Mount Clifford mining districts. The Sons of Gwalia deposit was not highlighted by this technique.

A pegmatite index (using As, Sb, Sn, and Nb), based on the PEG-4 index of Smith et al. (1989) but omitting Ta (which was not determined), also shows high values in greenstones at Agnew, Mount Clifford and ultramafics to the north, and Goanna Patch (Fig. 44). A small area with a high index value occurs near Maroon Range in granitic terrain.

Both indices indicate that much of the *Czl* (laterite) unit of Thom and Barnes (1977), particularly east of Mount Clifford, is associated with greenstone parent materials. An area east of Goanna Patch also appears anomalous, based on either index. Both indices show a trail of greenstone source material into Lake Raeside east of Sturt Meadows station.

# Summary and conclusions

The major products of this study are geochemical and regolith-materials maps of LEONORA. These are supported by a 1:250 000 map showing the positions of 'open file' projects which have used surface-exploration geochemistry.

The sampling program at an approximate sampling density of 1 per 16 $km^2$ yielded 1042 samples including 453 stream-sediment, 546 soil, and 43 lake samples. Chemical analysis of the samples used 'total' acid-dissolution methods to determine 47 components. Results are presented in a digital data file and as element distribution maps (Figs 4–40), which display 45 components at the 1:1 000 000 scale, with 11 of these represented as plots of only the higher values.

The regolith-materials map displays 17 classes of regolith units; three corresponding to a relict regime, five to an erosional regime, and nine to a depositional regime. Sediments of the depositional regime have not been divided by source materials on the map, unlike the erosional regime which is closer to source material and can be broadly divided into granitoid- and greenstone-derived sediments. The colluvial regime has been divided by rock source in discussion of the analytical data. The results show a surprising amount of grus, particularly in the western two-thirds of the sheet. Weathering has been more extensive in the northeastern part of the sheet, with sediments consisting mainly of quartz and secondary minerals.

As with MENZIES (Kojan and Faulkner, 1994), the results of the analyses found that there was little difference between stream-sediment and soil samples, as both were generally representative of their underlying lithologies. The underlying source material and its weathering history are the most important factors in determining the regolith composition. Active stream channels, however, may carry influence from the more resistant greenstones into granitic terrain.

As expected there is a distinct chemical difference between the granite and greenstone groups. Sediments derived from greenstones are generally characterized by a higher concentration of $Fe_2O_3$, $TiO_2$, Cr, Cu, Ni, and V; those from granitoids by a higher concentration of $K_2O$, Ba, Ce, Pb, and Rb.

With increasing distance from source materials, chemical variation involves non-systematic leaching of easily weathered minerals, some ferruginization, and dilution from eolian sands. K-feldspar is present surprisingly far from source granitoids, indicating mechanical erosion, rather than chemical alteration, is the dominant process — especially in the west of the map sheet.

Differences between the six greenstone belts are shown by different element associations, which outline the general position of the mafic, ultramafic, and felsic volcanic rocks within these belts. Variation within the granitoids can only be determined on the western side of the main greenstone belt where less-altered materials closely resemble source rock. In this part of the map sheet there have been three centres of potassic granitoids suggested by principal component analysis. A fractionated, potassic granitoid enriched in Ce, La, Pb, and Th has also been identified in the south of the map sheet extending onto MENZIES. It has been suggested that leucogranite outcrops south-southeast of Lawlers, in an area previously identified as tonalite.

Gold mineralization on LEONORA is associated with granite–greenstone contacts and shear zones. Most gold mineralization lies within greenstones; however, granitoids are also known to host mineralization. An association of Au with As is common. The contouring of the gold values shows that the 2 ppb contour highlights the majority of the known gold deposits, although the Bannockburn deposit is not identified.

The Cu, Zn, and Ag deposit at Teutonic Bore is represented by relatively high Cu and Zn values, south of the deposit. There are high Ni values in the vicinity of the Mount Clifford nickel deposits; however, there is little surface expression of the Weebo Bore (Ni), Wilsons Patch (Pb), or Dodgers Hill (Mo) deposits. The highest uranium values are found in Lake Raeside.

# References


AGSO (AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION), 1993, Connecting the Riverina and Waroonga Gneisses, Eastern Goldfields: AGSO Research Newsletter 18 May 1993, p. 4–5.

AHMAT, A. L., 1986, Metamorphic patterns in the greenstone belts of the Southern Cross Province, Western Australia: Western Australia Geological Survey, Report 19, Professional Papers for 1984, p. 1–21.

ALLEN, A. D., 1995, Hydrogeology, *in* An inventory and condition survey of the north-eastern Goldfields, Western Australia *edited by* H. J. R. PRINGLE, A. M. E. VAN VREESWYK and S. A. GILLIGAN: Western Australia Department of Agriculture, Technical Bulletin 87, p. 36–58.

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* An international conference on crustal evolution, metallogeny and exploration of the Eastern Goldfields, Excursion Guidebook *compiled 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.

AOUKAR, N., and WHELAN, P., 1990, Emu gold deposit, Agnew *in* Geology of the mineral deposits of Australia and Papua New Guinea: volume 1 *edited by* F. E. HUGHES: Australasian Institute of Mining and Metallurgy, Monograph 14, p. 323–330.

BARLEY, M. E., and GROVES, D. I., 1988, Geological setting of gold mineralisation in the Norseman–Wiluna Belt, Eastern Goldfields Province, Western Australia: Bicentennial Gold 88, Excursion no. 6 Guide, part 1 edited by D. I. GROVES, S. E. HO, and G. M. F. HOPKINS: University of Western Australia, Department of Geology, Publication 14, p. 17–47.

BEARD, J. S., 1981, The vegetation of Western Australia at the 1:3 000 000 scale: Western Australia Forests Department, Explanatory Notes.

BESTOW, T. T., 1992, Groundwater regimes and their exploration for mining development in the Eastern Goldfields of Western Australia: Western Australia Geological Survey, Record 1992/3.

BETTENAY, E., and CHURCHWARD, H. M., 1974, Morphology and stratigraphic relationships of the Wiluna Hardpan in arid Western Australia: Geological Society of Australia, Journal v. 21, p. 73–81.

BINNS, R. A., GUNTHORPE, R. J., and GROVES, D. I., 1976, Metamorphic patterns and development of greenstone belts in the eastern Yilgarn Block, Western Australia, *in* The early history of the Earth *edited by* B. F. WINDLEY: London, John Wiley and Sons, p. 303–313.

BOYLE, R. W., and JONASSON, I. R., 1973, The geochemistry of arsenic and its use as an indicator element in geochemical prospecting: Journal of Geochemical Exploration, v. 2, p. 251–296.

BUNTING, J. A., and WILLIAMS, S. J., 1979, Sir Samuel, W.A.: Western Australia Geological Survey, 1:250 000 Geological Series Explanatory Notes.

BUTT, C. R. M., HORWITZ, R. C., and MANN, A. W., 1977, Uranium occurrences in calcrete and associated sediments in Western Australia: CSIRO Division of Mineralogy, Report FP16.

CHAN, R. A., CRAIG, M. A., HAZELL, M. S., and OLLIER, C. D., 1992, Kalgoorlie regolith terrain map commentary, Sheet SH51, Western Australia. 1:1 000 000 Regolith Series: Australia Bureau of Mineral Resources, Geology and Geophysics, Record 1992/8.

CHURCHWARD, H. M., and CRAIG, M. A., in press, Leonora regolith — landforms (1:250 000 scale map): Australian Geological Survey Organisation.

CLARKE, E. de C., 1925, The field geology and broader mining features of the Leonora–Duketon District, including part of the North Coolgardie, Mt Margaret and East Murchison Goldfields, and a report on the Anaconda copper mine and neighbourhood: Western Australia Geological Survey, Bulletin 84.

CRAIG, M. A., and ANAND, R. R., 1993, Kalgoorlie–Kurnalpi regolith — landforms: Australia Geological Survey Organisation, 1:250 000 (special edition).

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., (editor), 1990, International geochemical mapping — a new global project: Journal of Geochemical Exploration, v. 39, no. 1/2.

DAVENPORT, P. H., 1993, Introduction: Journal of Geochemical Exploration, v.49, no. 1/2, p. 3

DAVY, R., and GOZZARD, J. R., 1995, Lateritic duricrusts of the Leonora area, Eastern Goldfields, Western Australia: a contribution to the study of transported laterites: Western Australia Geological Survey, Record 1994/8.

DAVY, R., KOJAN, C., and BRADLEY, J. J., in press, Regional regolith geochemical mapping in Western Australia: Menzies and Leonora 1:250 000 map sheets: Proceedings 17th International Geochemical Symposium, Townsville, May 1995.

DEPARTMENT OF MINES, 1954, List of cancelled gold mining leases which have produced gold: Perth, Government Printer.

DUDLEY, R. J., SKWARNECKI, M. S., and MAKAR, M., 1990, Harbour Lights gold deposit, Leonora, *in* Geology of the mineral deposits of Australia and Papua New Guinea *edited by* F. E. HUGHES: Australasian Institute of Mining and Metallurgy, Monograph 14, p. 343–348.

GREIG, D. D., 1984, Geology of Teutonic Bore massive sulphide deposit, Western Australia: Australasian Institute of Mining and Metallurgy, Proceedings 289, June/July 1984, p. 147–156.

GRIFFIN, T., 1990a, Southern Cross Province, *in* Geology and mineral resources of Western Australia: Western Australia Geological Survey, Memoir 3, p. 60–76.

GRIFFIN, T., 1990b, Eastern Goldfields Province, *in* Geology and mineral resources of Western Australia: Western Australia Geological Survey, Memoir 3, p. 77–119.

GROVES, D. I., and BARLEY, M. E., 1988, Gold mineralisation in the Norseman–Wiluna Belt, Eastern Goldfields Province, Western Australia. Bicentennial Gold 88, Excursion no. 6 Guide, Part 2 *edited by* D. I. GROVES, S. E. HO, and G. M. F. HOPKINS: The University of Western Australia, Department of Geology, Publication 14, p. 47–66.

HALLBERG, J. A., 1976, A history of the geological studies in the Leonora–Laverton area — 1900–1976: CSIRO (unpublished report).

HALLBERG, J. A., 1985, Geology and mineral deposits of the Leonora–Laverton area, northeastern Yilgarn Block, Western Australia: Perth, Hesperian Press, Australia.

HICKMAN, A. H., in prep., Geology and gold mineralization in the Leonora–Wiluna region; 1:250 000 map: Western Australia Geological Survey.

HICKMAN, A. H., and KEATS, W., 1990, Gold *in* Geology and mineral resources of Western Australia: Western Australia Geological Survey, Memoir 3, p. 645–669.

KALNEJAIS, J., 1988, Sons of Gwalia gold mine. Bicentennial Gold 88, Excursion no. 6 Guide, Part 3 *edited by* D. I. GROVES, S. E. HO, and G. M. F. HOPKINS: University of Western Australia, Department of Geology, Publication 14, p. 135–137.

KALNEJAIS, J., 1990, Sons of Gwalia Gold Deposit, Leonora, *in* Geology of the mineral deposits of Australia and Papua New Guinea *edited by* F. E. HUGHES: Australasian Institute of Mining and Metallurgy, Monograph 14, p. 353–356.

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, *Geochemical mapping* of the Menzies 1:250 000 Sheet: Western Australia Geological Survey, Explanatory Notes.

LEGGE, P. J., 1975, Weebo nickel prospect, *in* Economic geology of Australia and Papua New Guinea, 1. Metals *edited by* C. L. KNIGHT: Australasian Institute of Mining and Metallurgy, Monograph 5, p. 147–148.

MAKAR, W. M., 1988 Harbour Lights mine gold project, *in* Bicentennial Gold 88, Excursion no. 6 Guide, Part 3 *edited by* D. I. GROVES, S. E. HO, and G. M. F. HOPKINS: University of Western Australia, Department of Geology, Publication 14, p. 132–133.

MARSTON, R. J., 1979, Copper mineralization in Western Australia: Western Australia Geological Survey, Mineral Resources Bulletin 13, p. 125 and 141.

MARSTON, R. J., 1984, Nickel mineralization in Western Australia: Western Australia Geological Survey, Mineral Resources Bulletin 14. p. 71–72 and 197–198.

PAIN, C. F., WILFORD, J. R., and DOHRENWEND, J. C., 1994, Regolith — landforms of the Ebagoola 1:250 000 Sheet Area (SD54-12) North Queensland: Australian Geological Survey Organisation, Record 1994/7.

PAINTER, S., CAMERON, E. M., ALLAN, R., and ROUSE, J., 1994, Reconnaissance geochemistry and its environmental relevance: Journal of Geochemical Exploration, v. 51, p. 213–246.

PASSCHIER, C. W., 1990, Report on the geology of the Leonora area, Western Australia: Australia Bureau of Mineral Resources, Geology and Geophysics, Record 1990/59.

PASSCHIER, C. W., 1994, Structural geology across a proposed Archaean terrane boundary in the eastern Yilgarn craton, Western Australia: Precambrian Research, v. 68, p. 43–64.

PLATT, J. P., ALLCHURCH, P. D., and RUTLAND, R. W. R., 1978, Archaean tectonics in the Agnew supracrustal belt, Western Australia: Precambrian Research, vol. 7, p. 3–30.

ROCK, N. M. S., 1988, Numerical geology: Berlin, Springer-Verlag, 412p.

SANDERS, C. C., 1969, Hydrogeological reconnaissance of calcrete areas in the East Murchison and Mt Margaret Goldfields: Western Australia Geological Survey, Annual Report 1968, p. 14–17.

SCHILLER, J. C., and HANNA, J. P., 1990, Tower Hill gold deposit, Leonora, *in* Geology of the mineral deposits of Australia and Papua New Guinea *edited by* F. E. HUGHES: Australasian Institute of Mining and Metallurgy, Monograph 14, p. 349–352.

SEMPLE, D. G., 1979a, 1978 Annual Report Lake Raeside — Project 839: ESSO Exploration and Production Australia Inc. (unpublished).

SEMPLE, D. G., 1979b, 1978 Annual Report Stakeyard Well — Project 884 , Mineral Claims 29/3141–3150 (inclusive): ESSO Exploration and Production Australia Inc. (unpublished).

SHARP, W. H., 1978, MC 29/2945 to 2957 and 29/3024 to 3027 'Lake Raeside' 1977 Annual Report to the Department of Mines W.A.: BP Minerals Australia Pty Ltd. (unpublished).

SKWARNECKI, M. S., 1988, The geology of the Leonora area, *in* Western Australian gold deposits, Bicentennial Gold 88 Excursion Guidebook no. 6 Part 3 *edited by* D. I. GROVES, S. E. HO, and G. M. F. HOPKINS: University of Western Australia, Department of Geology, Publication 14, p. 122–131.

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.

STOKES, M., NELSON, M., and TUTTLE, J., 1990, Great Eastern and McCaffery gold deposits, Lawlers, *in* Geology of the mineral deposits of Australia and Papua New Guinea *edited by* F. E. HUGHES: Australasian Institute of Mining and Metallurgy, Monograph 14, p. 331–336.

THOM, R., and BARNES, R. G., 1977, Leonora, Western Australia: Western Australia Geological Survey, 1:250 000 Geological Series Explanatory Notes.

TRAVIS, G. A., 1975, Mount Clifford nickel deposit, *in* Economic geology of Australia and Papua New Guinea, 1. Metals *edited by* C. L. KNIGHT: Australasian Institute of Mining and Metallurgy, Monograph 5, p. 144–146.

TRENDALL, A. F., 1990, Introduction, *in* Geology and mineral resources of Western Australia: Western Australia Geological Survey, Memoir 3, p. 4–5.

VAN DER HOR, F., and WITT, W. K., 1992, Strain partitioning near the Keith–Kilkenny Fault Zone in the central Norseman–Wiluna Belt, Western Australia: Australia Bureau of Mineral Resources, Record 1992/68.

WILKINSON, D., 1993, Focus on Tarmoola: Gold Gazette, Perth, Australia, Feb 8, p. 12.

WILKINSON, D., 1994, Gold (Western Australia), *in* 1994/95 Register of Australian Mining, p. 61 and 130.

WILLIAMS, P. R., and CURRIE, K. L., 1993, Character and regional implications of the sheared Archaean granite–greenstone contact near Leonora, Western Australia: Precambrian Research, v. 62, p. 343–367.

WILLIAMS, P. R., NISBET, B. W., and ETHERIDGE, M. A., 1989, Shear zones, gold mineralisation and structural history in the Leonora district, Eastern Goldfields Province, Western Australia: Australian Journal of Earth Sciences, v. 36, p. 383–403.

WILLIAMS, P. R., and WHITAKER, A. J., 1993, Gneiss domes and extensional deformation in the highly mineralised Archaean Eastern Goldfields Province, Western Australia: Ore Geology Reviews, vol. 8. p. 141–162.

# Appendix 1
## Details of gold mines and deposits

| Mining centre | Name | Total produced Au (kg) | Resources Au (kg) | Total (kg) | Easting | Northing |
|---|---|---|---|---|---|---|
| **MOUNT MARGARET GOLDFIELD** | | | | | | |
| MOUNT MALCOLM DISTRICT | | | | | | |
| **Diorite** | | | | | | |
| | Diorite King | 61.4 | – | 61.4 | 310061 | 6825454 |
| | Harlech | – | 312.0 | 312.0 | 325308 | 6819712 |
| | Mount Davis | – | 360.0 | 360.0 | 327750 | 6823420 |
| | Mount Stirling | 157.1 | – | 157.1 | 310994 | 6834237 |
| | Puzzle | 118.4 | – | 118.4 | 320745 | 6823529 |
| | Severn | – | 391.0 | 391.0 | 323993 | 6824188 |
| | Severn West | – | 87.0 | 87.0 | 323613 | 6824151 |
| | Tarmoola–King of the Hills | 7 430.8 | 51 800.0 | 59 270.8 | 320368 | 6826873 |
| **Goanna Patch** | | | | | | |
| | Double A–Goanna Patch | 783.6 | – | 783.6 | 304912 | 6884728 |
| **Leonora** | | | | | | |
| | Forrest | 2 675.6 | – | 2 675.6 | 334870 | 6806114 |
| | Gold Blocks | 518.8 | – | 518.8 | 332482 | 6809295 |
| | Gwalia North | 2.6 | 1 324.0 | 1 326.6 | 333460 | 6813305 |
| | Harbour Lights | 6 700.0 | 4 295.0 | 10 995.0 | 336213 | 6804693 |
| | Jasper–Aucklands | 1.6 | 1 950.0 | 1 951.6 | 328411 | 6817296 |
| | Pride of Leonora | 34.1 | – | 34.1 | 339334 | 6807840 |
| | Ping Pong | 91.5 | – | 91.5 | 332920 | 6805976 |
| | Poker | – | 362.0 | 362.0 | 334623 | 6807841 |
| | Pumping Station | – | 360.0 | 360.0 | 333453 | 6813637 |
| | Sons of Gwalia | 99 939.0 | 53 410.0 | 153 349.0 | 337337 | 6799906 |
| | Trump | 605.2 | – | 605.2 | 334168 | 6807435 |
| | Tower Hill | 2 050.0 | 582.0 | 2 632.0 | 336361 | 6801893 |
| **Malcolm** | | | | | | |
| | Blackies | – | 70.0 | 70.0 | 344749 | 6798561 |
| | Forgotten Four | – | 347.0 | 347.0 | 345179 | 6798905 |
| | Krang | – | 2 922.0 | 2 922.0 | 344340 | 6799180 |
| | Leonardo | – | 220.0 | 220.0 | 345510 | 6798170 |
| | Michaelangelo | – | 4 545.0 | 4 545.0 | 345813 | 6898052 |
| | Raeside Group | – | 133.0 | 133.0 | 345179 | 6898905 |
| **Mount Clifford** | | | | | | |
| | Bannockburn | 3 838.6 | 12 524.0 | 16 362.6 | 394651 | 6850129 |
| | Famous | 30.0 | – | 30.0 | 312699 | 6856213 |
| | Jungle Well | – | 423.0 | 423.0 | 303863 | 6855798 |
| | Mount Clifford | 2.2 | 403.0 | 405.2 | 309981 | 6849494 |
| | Royal Arthur Bore | 6.2 | 479.0 | 485.2 | 315150 | 6852950 |
| | Victory | 332.8 | – | 332.8 | 308391 | 6843285 |
| **Pig Well** | | | | | | |
| | Gambier Lass | 226.9 | – | 226.9 | 349142 | 6819055 |
| | Harriston | 95.4 | – | 95.4 | 351951 | 6813217 |
| **Wilsons Patch** | | | | | | |
| | Great Western | 338.0 | – | 338.0 | 321320 | 6866175 |
| | Wilsons Patch | – | 1 054.0 | 1 054.0 | 319824 | 6862395 |
| **EAST MURCHISON GOLDFIELD** | | | | | | |
| LAWLERS DISTRICT | | | | | | |
| **Lawlers** | | | | | | |
| | Birthday–Sunrise | 123.1 | – | 123.1 | 258674 | 6896849 |
| | Bounty Leases | 50.1 | – | 50.1 | 252578 | 6890589 |
| | Coxs–Asarco | 367.4 | – | 367.4 | 251790 | 6890086 |
| | Daisy Queen | 191.2 | 677.0 | 868.2 | 256932 | 6891115 |
| | Donegal | 161.4 | – | 161.4 | 253355 | 6888176 |

## Appendix 1 (*continued*)

| *Mining centre* | *Name* | *Total produced Au (kg)* | *Resources Au (kg)* | *Total (kg)* | *Easting* | *Northing* |
|---|---|---|---|---|---|---|
| **Lawlers** (*cont*) | | | | | | |
| | Emu Open Cut Group | – | 2 248.0 | 2 248.0 | 252656 | 6893122 |
| | Emu Underground Group | 16 023.3 | 49 100.0 | 65 123.3 | 254599 | 6899630 |
| | Great Eastern Extended | 54.6 | 672.0 | 726.6 | 258018 | 6891415 |
| | Hidden Secret | 51.9 | – | 51.9 | 253640 | 6899765 |
| | Lawlers Group | 7 611.9 | – | 7 611.9 | 257982 | 6891845 |
| | North Pit | – | 609.0 | 609.0 | 259572 | 6897021 |
| | McCafferys–Forsayth | 1 111.5 | – | 1 111.5 | 259635 | 6896591 |
| | McAuley Group | – | 1 385.0 | 1 385.0 | 251790 | 6890086 |
| | Waroonga | 820.1 | – | 820.1 | 254149 | 6900268 |
| | Wildcat | 92.0 | – | 92.0 | 258399 | 6894478 |

## Appendix 2

# Mineral production (other than gold) for LEONORA

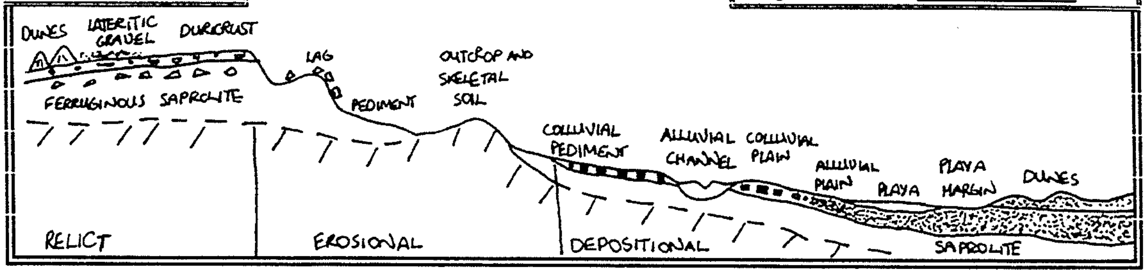
| *Name* | *Year* | *Copper (tonnes)* | *Silver (kg)* | *Zinc (tonnes)* |
|---|---|---|---|---|
| **Teutonic Bore** | | | | |
| (Seltrust Mining Corp PL) | 1981 | 783 | 8 494 | 3 613 |
| | 1982 | 14 149 | 46 927 | 48 018 |
| | 1983 | 7 993 | 21 408 | 13 158 |
| | 1984 | 8 397 | 30 956 | 35 640 |
| | 1985 | 6 590 | 26 421 | 21 936 |
| | 1986 | 4 182 | 15 101 | 9 886 |
| | **Prior to 1987** | **42 159** | **149 307** | **132 251** |
| **Silver (from gold production)** | | | | |
| Mount Margaret Goldfield | Prior to 1982 | | 8 182 | |
| | 1982 | | 3 | |
| | 1983 | | 1 | |
| | 1984 | | 3 | |
| | 1985 | | 721 | |
| | 1986 | | 571 | |
| | 1987 | | 673 | |
| | 1988 | | 651 | |
| | 1989 | | 1 197 | |
| | 1990 | | 806 | |
| | 1991 | | 865 | |
| | 1992 | | 1 130 | |
| | 1993 | | 647 | |
| | **Prior to 1994** | | **15 450** | |

## Appendix 3

## Form used to record sample-site details

| | | | |
|---|---|---|---|
| **Sheet** ________ | **Loc/n No**________ | **GSWA No**__________ | **Date**________ |
| **1:100K**________ | **East**____________E | **North**____________N | **Sampler**___ |

| | |
|---|---|
| **TYPE** | Single point☐ Multiple Point☐ Channel☐ Shtwsh☐ Laterite☐ Lag☐ Soil☐ |
| **Situation** | **Regolith code** ________ |




| **CLASTS** | Sizes Gravel ☐ Stones ☐ Cobbles ☐ Boulders ☐ | |
|---|---|---|
| **Lateritic** Abnt/Rare/Comn ☐ | **Non-Lat** Abnt/Rare/Comn ☐ | Lithic Abnt/Rare/Comn ☐ |
| ☐ Lateritic Pisoliths | ☐ Gossan fragments | ☐ Saprolite fragments |
| ☐ Lateritic Nodules | ☐ Iron segregations | ☐ Ferruginous Saprolite frag's |
| ☐ Brown Ferrug. duricrust | ☐ Ferrug lithic fragments | ☐ Saprock Fragments |
| ☐ Black ferrug. duricrust | ☐ Brown ferrug granules | ☐ Fresh B'rock frag's (below) |
| ☐ Black pisolitic ferrug duricrust | ☐ Black ferrug granules | ☐ Quartz |

*M*afic☐ *U*ltramafic☐ *F*elsic☐ Pelite/*S*ed's☐ Qtzite☐ *BIF*☐ *Q*uartz ☐ *G*ranite☐

| **Material** | Red | Orange | Yellow | L Brown | D Brown | L Grey | D Grey |
|---|---|---|---|---|---|---|---|
| ☐ Clay | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| ☐ Silt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| ☐ Sand | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

☐ Saline ☐ Calcareous ☐ Siliceous ☐ Ferruginous

| **Sample Site Geology** | | Hardpan☐ | Consolidated Collvm☐ | **Stream order:**________ | |
|---|---|---|---|---|---|
| *M* ☐ | *Q*tzite ☐ | Gypsum Dune☐ | Sand Dune☐ | ☐ Single | ☐ Incised |
| *U* ☐ | *BIF* ☐ | Duricrust☐ | Mottled Zone☐ | ☐ Braided | ☐ Broad |
| *F* ☐ | *Q* ☐ | Saprolite☐ | Saprock☐ | Osize - ____% | Usize - ____% |
| *P/S* ☐ | *G* ☐ | Bedrock☐ | | Size fr/n-______ | Depth-______ |

**REMARKS**

______________________________________________

______________________________________________

______________________________________________

______________________________________________

## Appendix 4

# Open-file geochemistry surveys

### KEY

**ID No.** Project reference number allocated specifically for these notes

**Map Sheet** 1:100 000 Sheet number (See Plate 3 key) to aid in project location

**Company** The company that carried out the geochemical exploration
Expl: Exploration

**I No.** GSWA catalogue reference number (Item number)

**A No.** GSWA report reference number (Accession number)

**Yr.** The year of reporting

**Medium** How the sample was obtained

- RAB: Rotary air blast drilling
- RC: Reverse circulation drilling
- Percussion: Generally refers to rotary percussion but includes RC drilling in early reports
- Stream Sed: Stream sediment
- R Chip: Rock chip (only where column space was limited)
- Fe St.: Ironstone

**No. / Ag to Zn** The number of samples taken between 0 and 4 metres below the surface from the medium indicated, and each element determined marked 'X'. An 'X*' is used to show where less than the total number of samples tallied were analysed for that element. Multiple 0–4 m samples taken from a single drill hole are tallied as single samples.

**Method/Analyst** Blanks occur in these columns if the information is not indicated in the company report.

- AAS: Atomic absorption spectrophotometry
- BLEG: Bulk leach extractable gold
- ETA: Electrothermal absorption
- FA: Fire assay
- ICP (MS): Inductively coupled plasma (mass spectrometry)
- XRF: X-ray fluorescence
- AAL: Australian Assay Laboratories
- ALS: Australian Laboratory Services
- Anal: Analytical
- Ass: Assay
- Aus: Australia
- Dev: Development
- Inter: International
- Lab(s): Laboratories
- Metall: Metallurgical
- RDG: Resource Development Group
- Res: Resource
- SGS: Societe Generale de Surveillance
- WMC: Western Mining Corp Ltd

**Deep Drill** 'Y' marked in this column indicates that the report includes drilling to a depth greater than four metres.

**Comments on Samples** Further sample details with regards to collection, analysis and data presentation.
Dish estimates: Refers to visible gold after panning.

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3141 | Western Mining Corp. Ltd | 61 | 1592 | 66 | Vacuum | 50 | | | X | | | | | | |
| 2 | 3140 | Western Mining Corp. Ltd | 1357 | 829 | 67 | Vacuum | 125 | | X | X | | | | | | |
| 3 | 3140 | Western Mining Corp. Ltd | 1714 | 82, 830, | 69 | Percussion | 137 | | | | | X* | X* | X | X | |
| | 3141 | | | 1767, | -71 | Percussion | 115 | | | X* | | X | X | X | X* | |
| | 3040 | | | 1775, | | Soil | 11100 | | | | | | | X | | |
| | 3041 | | | 1942-7, | | Soil | 46800 | X | X | | | X | X | X | X | X |
| | | | | 2248-9, | | Ironstone | 64000 | X | X | | | X | X | X | X | X |
| | | | | 2340-2, | | Ironstone | 4350 | X | X | X | | X | X | X | X | X |
| | | | | 2841-3, | | Vacuum | 125 | | X | X | | | | | | |
| | | | | 4256-60, | | Vacuum | 142 | | | | | X* | X* | X | X* | |
| | | | | & 4262-6 | | Vacuum | 195 | | | | | X | X | X | X* | |
| | | | | | | Auger | 40 | | | | | X | X | X | X* | |
| 4 | 2940 | CRA Expl. P/L | 473 | 1069-70 | 67 | Soil | 350 | | | X | | X | X | X | | |
| | | | | 2165 | 71 | Soil | 5040 | | | | | | | X | | |
| 5 | 3041 | Seltrust Mining Corp. P/L / | 3837 | 10146-52 | 69 | Soil | 12100 | | | | | | | X | | |
| | 2941 | Western Selcast P/L | | 10158-59 | -72 | Auger | 5700 | | | | | | | X | | |
| | | | | 10161-67 | | Percussion | 410 | | | | | | | X | | |
| | | | | 10169-76 | | | | | | | | | | | | |
| | | | | 10186 | | | | | | | | | | | | |
| 6 | 3041 | Seltrust Mining Corp. P/L | 3839 | 5634 | 74 | Auger | 1040 | | | | | | | X | | |
| | | | | | | Percussion | 23 | | | | | | | X | | |
| 7 | 3041 | BP Minerals Aust. P/L | 5737 | 16009 | 84 | Stream Sed | 12 | X | X | X | X | X | X | X | X | X |
| | | | 5738 | 14583 | 84 | Rock Chip | 41 | X | X | X | X | X | X | X | X | X |
| | | | 5739 | 14233 | 84 | Rock Chip | 55 | X | X | X | X | X | X | X | X | X |
| | | | | 15803 | 84 | RAB | 39 | X | X | X | X | X | X | X | X | X |
| 8 | 3041 | Australian Selection P/L / | 6181 | 1321 | 67 | Soil | 810 | | | | | X* | | X | | |
| | 2941 | Seltrust Mining Corp. P/L | | 1327 | -71 | Soil | 6350 | | | | | | | X | | |
| | | | | 2298 | | | | | | | | | | | | |
| | | | | 2686 | | | | | | | | | | | | |
| 9 | 3140 | Western Mining Corp. Ltd | 917 | 137 | 66 | Percussion | 30 | | | | | | | | | |
| | | | | | -67 | | | | | | | | | | | |
| 10 | 3041 | Western Mining Corp. Ltd | 1715 | 125 | 68 | Rock Chip | 51 | | | | | X | X | X | | |
| | 3141 | | | 6869-70 | -75 | Percussion | 21 | | | | | X | X | X | X* | X* |
| | | | | 6873 | | Vacuum | 136 | | | | | X | X | X | X* | X* |
| | | | | 14476 | | Soil | 4500 | | | | | X | X | X | X* | X* |
| | | | | 15396 | | | | | | | | | | | | |
| | | | 4464 | 16248 | 84 | Rock Chip | 27 | X | X | | | | | X | | |
| | | | | | | Percussion | 12 | X | X | | | | | X | | |
| 11 | 3041 | CRA Expl. P/L | 1716 | 135 | 69 | Percussion | 12 | X | | X* | | | X | X | | |
| | | Western Mining Corp. Ltd | | 6807 | -77 | Percussion | 3 | | | | | X | X | X | X | |
| | | | | 7603 | | Gossan | 6 | X | | | | X | X | X | | X |
| | | | | | | RAB | 150 | | | | | | | X | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep Drill | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | 0-3m; Traverse |
| | | | | | | | | | | | | | | Y | 'Dish estimates' and analyses |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | 0-3m |
| | | | | | | | | | | | | | | | |
| | X | X* | | | | | | | | | X | AAS | WMC | | 0-3m |
| | X | | | | | | | | | | X | AAS | WMC | | 0-4m; Also Mg*; Au few |
| | X | | | | | | | | | | | AAS | WMC | | |
| | X | | | | | | | | | | X | AAS | WMC | | Also Ca & Mg |
| | X | | | | | | | | | | X | AAS | WMC | | Also Ca & Mg |
| | X | | | | | | | | | | X | AAS | WMC | | Also Ca, Mg & Te |
| | | | | | | | | | | | | AAS | WMC | | 0-3m |
| | X | | | | | | | | | | X | AAS | WMC | | 0-3m; Also Mg* |
| | X | | | | | | | | | | X | AAS | WMC | | 0-4m; Also Mg* |
| | X | | | | | | | | | | X | AAS | WMC | Y | 0-3m; Also Mg* |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | | X | | | | 0-3m; Traverse |
| | | | | | | | | | | | | | | | 'Dish estimates' and analyses |
| | X | | | | | | | | | | | | Amdel | Y | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | Ni & Cu mapped |
| | X | | | | | | | | | | X | | | | 0-4m; Ni & Cu mapped |
| | X | | | | | | | | | | X | | | | 0-4m; Ni & Cu mapped |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | | | | 0-4m |
| | X | | | | | | | | | | X | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| X | X | X | | | | | X | | X | | X | ICP; BLEG | Analabs | | Also Al, Mg, Ca, Na, K, $TiO_2$, $P_2O_5$, |
| | | | | | | | | | | | | | | | Sr, La, Y, Be, Ce, & Zr |
| X | X | X | | | | X | X | | X | | X | ICP; BLEG | Analabs | | Also Al, Mg, Ca, Na, K, $TiO_2$, $P_2O_5$, |
| | | | | | | | | | | | | | | | Sr, La, Y, Be, Ce, & Zr |
| X | X | X | | | | X | X | | X | | X | ICP; BLEG | Analabs | | Also Al, Mg, Ca, Na, K, $TiO_2$, $P_2O_5$, |
| | | | | | | | | | | | | | | | Sr, La, Y, Be, Ce, & Zr |
| X | X | X | | | | X | X | | X | | X | ICP; BLEG | Analabs | | 0-4m; Also Al, Mg, Ca, Na, K, $TiO_2$, |
| | | | | | | | | | | | | | | Y | $P_2O_5$, Sr, La, Y, Be, Ce & Zr |
| | | | | | | | | | | | | | | | |
| | X* | | | | | | | | | | X* | | | | 6"depth |
| | X | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| X | | | | | | | | | | | | AAS | WMC | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | | X | | WMC | | |
| | X | | | | | | | | | | X | | | | 0-4m |
| | X | | | | | | | | | | X | | | | 0-4m |
| | X | | | | | | | | | | X | | | | |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | | X | | WMC | | |
| | X | X | | | | | | | | | X | | WMC | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | X* | | | | | | | | | X* | | | | 0-4m |
| | X | | | | | | | | | | X | | | | 0-4m |
| | X | X | | | | | | | | | X | | | | |
| | X | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 3041 | Western Mining Corp. Ltd | 1472 | 6810 | 76 | Percussion | 5 | | | | | X | X | X | X | |
| | 3141 | | | | | Vacuum | 13 | | | | | X | X | X | X | |
| | | | | 6812 | | Ironstone | 9400 | | | | | X | X | X | X | X |
| | | | | 7732-3 | | Percussion | 200 | | | | | X | X | X | X | |
| 13 | 3041 | Western Mining Corp. Ltd | 1719 | 6809 | 74 | Percussion | 16 | | | | | X | X | X | X | X |
| | | | | | | Soil | 690 | | | | | | | X | | |
| 14 | 3140 | Hill Minerals NL | 1082 | 2130 | 71 | Soil | 3380 | | | | | | | X | | |
| | | | | 2131 | | Costean | 29 | | | | | X* | X* | X | | |
| 15 | 3041 | Gippsland Minerals NL | 1842 | 2173 | 70 | Soil | 2210 | | | | | | | X | | |
| | 2941 | | | | | Percussion | 38 | | | | | | | X | | |
| 16 | 3141 | Academus Minerals NL | 3197 | 2215 | 70 | Soil | 815 | | | | | X | | X | | |
| 17 | 3041 | Newmont P/L | 1176 | 2367 | 72 | Surface Rock | 15 | | | | | | X | X | | |
| | | | | | | Soil | 840 | | | | | | | X | | |
| | | | | | | Auger | 24 | | | | | | X | X | | |
| | | | | | | Percussion | 34 | | | | | | | X | | |
| 18 | 3140 | Newmont P/L | 2548 | 2485 | 71 | Soil | 260 | | | | | | X | X | | |
| | | | | 3602 | -73 | Surface Rock | 15 | | | | | | X | X | | |
| | | | | | | Rock Chip | 95 | | | | | | X | X | | |
| | | | | | | Auger | 27 | | | | | | X | X | | |
| | | | | | | Percussion | 6 | | | | | X | X | X | | X |
| 19 | 3040 | Mines Administration P/L / | 2647 | 2538 | 71 | Soil | 810 | | | | | | X* | X | | |
| | 3041 | Asarco (Aust.) P/L | | | | Percussion | 6 | | | | | | X* | X | | |
| | | | 1474 | 2582 | 71 | Soil | 9 | | | | | | X | X | | |
| | | | | | | Rock Chip | 30 | | | | | | X | X | | |
| | | | 1846 | 2583 | 71 | Soil | | | | | | X | X | X | | |
| | | | | | | Percussion | 11 | | | | | X | X | X | | |
| | | | | 5364 | 74 | Soil / R. Chip | 252 | | | | | | X | X | | |
| 20 | 3141 | Mines Administration P/L | 2500 | 2586 | 70 | Soil | 20 | | | | | | X | X | | |
| | | | | | | Percussion | 10 | | | | | X | X | X | | X |
| 21 | 3140 | Pacminex P/L | 2769 | 3172 | 71 | Soil | 378 | | | | | | X | X | | |
| 22 | 3041 | Mines Administration P/L | 107 | 3137 | 72 | Soil | 740 | | | | | | | X | | |
| | | | | | | Costean | 9 | | | | | | | X | | |
| | | | | | | Percussion | 27 | | | | | X | X | X | | |
| 23 | 3140 | Mines Administration P/L | 260 | 3138 | 72 | Costean | 4 | | | | | | | X | | |
| | | | | | | Percussion | 46 | | | | | X | X | X | | |
| 24 | 2941 | LeNickel (Aust.) Expl. P/L | 214 | 3461 | 72 | Lake Sediment | 15 | | | | | | | | | |
| | | | | | | Halite | 2 | | | | | | | | | |
| | | | | | | Soil | 2 | | | | | | | | | |
| | | | | | | Cuttings | 19 | | | | | | | | | |
| | | | | | | Evaporite | 1 | | | | | | | | | |
| | | | | | | Clay | 1 | | | | | | | | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Drill | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | 0-4m |
| | X | | | | | | | | | | X | | | | 0-4m |
| | X | | | | | | | | | | X | | | | |
| | X | | | | | | | | | | X | | | | 0-4m |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | 0-4m |
| | X | X | | | | | | | | | X | | | Y | 6"-9" |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | | | | 2"-6" |
| | X | | | | | | | | | | X* | | | | To max. depth 3m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | Traverse contours only, no locations |
| | X | | | | | | | | | | X | | | Y | 21 @ 0-1.7m & 17@0-3m |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | | X | AAS | | | 6"depth |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | AAS | Sheen Labs | | |
| | X | | | | | | | | | | | AAS | Sheen Labs | | |
| | X | | | | | | | | | | | AAS | Sheen Labs | | 0-4m |
| | X | | | | | | | | | | | AAS | Sheen Labs | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | Sheen Labs | | |
| | X | | | | | | | | | | | AAS | Sheen Labs | | |
| | X | | | | | | | | | | X | AAS | Sheen Labs | | |
| | X | | | | | | | | | | | AAS | Sheen Labs | | 0-4m |
| | X | | | | | | | | | | | AAS | Sheen Labs | Y | 0-3m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | AAS | | | 6"; Contour only |
| | X | | | | | | | | | | | AAS | | | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | | | |
| | X | | | | | | | | | | X | AAS | | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | AAS | | | 9"; Contour & log-prob only, |
| | | | | | | | | | | | | | | | Sample data/locations not given |
| | X | | | | | | | | | | X | AAS | | | 0-4m |
| | X | | | | | | | | | | X | AAS | | Y | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | 12" |
| | X | | | | | | | | | | X | AAS | | Y | 0-1.5m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | Trace Element Labs | | 12" |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | |
| | X | | | | | | | | | | | | | | Depths not clear |
| | X | | | | | | | | | | X | | | Y | 1.3-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | | | | Depths not clear |
| | X | | | | | X* | | | | | X | | | Y | 1.3-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | X | | | | | | | 0.1-2m; Also Ca*, Mg*, K*, P2O5*, |
| | | | | | | | | | | | | | | | SiO2*, SO2* & Th* |
| | | | | | | | | X | | | | | | | 0.2-0.3m; Also Ca, Mg, K, P2O5, |
| | | | | | | | | | | | | | | | SiO2, SO2 & Th |
| | | | | | | | | X | | | | | | | 0.3m; Also Ca, Mg & Si |
| | | | | | | | | X | | | | | | | 2-4m; Also Ca*, Mg*, K*, P2O5*, |
| | | | | | | | | | | | | | | | SiO2*, SO2* & Th* |
| | | | | | | | | X | | | | | | | 1-2m |
| | | | | | | | | X | | | | | | | 1-2m |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **25** | 3041 | Jododex Australia P/L | 1476 | 3548-9 | 72 | Soil | 2115 | | | | | | | X | | |
| | | | | 4241-4 | | Percussion | 30 | | | | | | | X | | |
| **26** | 3041 | Minefield Expl. NL | 2729 | 3832 | 71 | Soil | | | | | | | | X | | |
| | | | | | | Gossan | 187 | | | | | | | X | | |
| | | | | | | Costean | 30 | | | | | | | X | | |
| | | | | | | Percussion | 25 | | | | | | | X | | |
| **27** | 3041 | Newmex Expl. Ltd | 1497 | 4016 | 70 | Surface Rock | 93 | | X* | | | | | X | | |
| | | | | | | Soil | 1200 | | | | | | | X | | |
| | | | | | | Percussion | 15 | | | | | X | | X | | |
| **28** | 3140 | Newmex Expl. Ltd | 3132 | 4017 | 70 | Soil | 760 | | | | | | X | X | | |
| | | | | | | Percussion | 2 | | | | | | X | X | | |
| **29** | 3041 | BP Minerals Aust. P/L | 5481 | 4128 | 72 | Soil | 315 | | | | | | X | X | | |
| | | Newmont P/L | | 11667 | -81 | Auger | 121 | | | | | | X | X | | |
| | | Samson Expl. NL | | 14562 | | Ironstone | 28 | | | | | | | X | | |
| | | Seltrust Mining Corp. P/L | | | | Percussion | 33 | X* | X | | | | X* | X | | |
| | | | | | | Costean | 7 | | | | | | X | X | | |
| **30** | 3140 | Asarco Australia P/L | 144 | 4657 | 74 | Grab Samples | 67 | | | | | X | X | X | | |
| **31** | 3041 | Allstate Expl. NL | 2812 | 5227 | 71 | Ironstone | 34 | | | | | | | X | | |
| | | Occidental Minerals Corp. | | 5717-8 | -76 | Percussion | 27 | | | | | | | X | | |
| **32** | 3041 | Australian Selection P/L | 636 | 5550 | 73 | Rock Chip | 27 | | | | | | | X | | |
| | | | | | | Percussion | 3 | | | | | | | X | | |
| **33** | 3040 | Australian Selection P/L | 637 | 5552 | 74 | Percussion | 30 | | | | | | | X | | |
| **34** | 3140 | Australian Selection P/L | 2432 | 5630-1 | 73 | Percussion | 35 | | X* | | | | X* | X | | |
| | | Seltrust Mining Corp. P/L | | 10298 | -80 | | | | | | | | | | | |
| **35** | 3141 | CRA Expl. P/L | 1862 | 5725 | 75 | Rock Chip | 61 | X | | | | X | X* | X | X* | X |
| | | | | 6285 | -76 | | | | | | | | | | | |
| **36** | 3140 | Australian Selection P/L | 638 | 5791 | 73 | Rock Chip | 19 | | | | | | | X | | |
| | | | | | | Auger | 40 | | | | | | | X | | |
| **37** | 3041 | International Nickel Australia Ltd | 540 | 6014 | 73 | Rock Chip | 148 | | | | | | | X | | |
| | | | | 6427 | -76 | Soil | 925 | | | | | | | X | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | Auger | 24 | | | | | | | X | | |
| | | | | | | RAB | 60 | X* | | | | | | X | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Drill | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | Sheen Labs | | |
| | X | | | | | | | | | | X | AAS | Sheen Labs | Y | 1.5-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | AAS | Geochemical and | | Contours only; Locations not given |
| | X | | | | | | | | | | X | | Mineralogical | | |
| | X | | | | | | | | | | X | | Labs P/L | | |
| | X | | | | | | | | | | X | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | | | |
| | X | | | | | | | | | | | | | | 6" |
| | X | | | | | | | | | | X | | | Y | 0-3m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | | | | 6" |
| | X | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | AAS | Sheen Labs | | Fine and coarse fraction analyses |
| | X | | | | | | | | | | | | | | 0-4m |
| | X | | | | | | | | | | X | | | | |
| | X | X | | | | | | | | | X | | | | 0-4m |
| | X | | | | | | | | | | X | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | Anal. Services | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | | | |
| | X | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | |
| | X | | | | | | | | | | X | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | 0-4m |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | | X | AAS | Analabs | | Incl. gossan samples |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | | | | |
| | X | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | Zinc Corp. | | Also MgO% |
| | X | | | | | | | | | | X | | | | Coarse fraction contours only |
| | | | | | | | | | | | | | | | Sample data/locations not given |
| | X | | | | | | | | | | | | | | 0-4m |
| | X | X* | | | | | | | | | X | | | Y | 0-4m |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 3140 | Australian Selection P/L | 4029 | 6164 | 74 | Rock Chip | 1040 | X* | X* | X* | X* | X* | | X* | X* | X* |
| | 3141 | BP Minerals Aust. P/L | 5892 | 7295-6 | -89 | | | | | | | | | | | |
| | | Carpentaria Expl. Co. P/L | 3404 | 8321 | | Soil | 35 | | | X | | | | | | |
| | | Chevron Expl. Corp. | 5984 | 10299-00 | | | | | | | | | | | | |
| | | Seltrust Mining Corp. P/L | | 13496 | | Pisolites | 230 | | X | X | | | X* | | X | |
| | | | | 15005-6 | | | | | | | | | | | | |
| | | | | 17489 | | Stream Sed | 40 | | | X | | | | | | |
| | | | | 20221 | | | | | | | | | | | | |
| | | | | 20560 | | Auger | 70 | X* | X | | | X* | | X | X* | X* |
| | | | | 20565 | | | | | | | | | | | | |
| | | | | 21876-7 | | Percussion | 770 | X* | X* | X* | X* | | X* | X | X* | |
| | | | | 23569 | | | | | | | | | | | | |
| | | | | 24630 | | | | | | | | | | | | |
| 39 | 3141 | Aquitane Aust. Minerals P/L | 3273 | 6784 | 76 | Gossan | 60 | X | | | | X* | | X | | |
| | | BP Minerals Aust. P/L | | 7191 | -78 | Soil | 230 | | | | | | | | | |
| | | Chevron Expl. Corp. | | 8230 | | Percussion | 2 | X | | X* | | | | X | | |
| | | Esso Expl. Aust. Inc. | | | | | | | | | | | | | | |
| | | Walgardy P/L | | | | | | | | | | | | | | |
| 40 | 3141 | BP Minerals Aust. P/L | 5832 | 6269 | 76 | Gossan | 9 | X | | | | X | | X | | |
| | | Carpentaria Expl. Co. P/L | | 11128-9 | -85 | Percussion | 47 | X* | X* | X* | | | | X | | |
| | | Chevron Expl. Corp. | | 12152 | | Percussion | 20 | X | X | | X | X | X | X | X | X |
| | | Esso Expl. Aust. Inc. | | 15725 | | | | | | | | | | | | |
| | | MIM Expl. P/L | | | | | | | | | | | | | | |
| | | Seltrust Mining Corp. P/L | | | | | | | | | | | | | | |
| 41 | 3140 | Carpentaria Expl. Co. P/L | 1089 | 6276 | 75 | Rock Chip | 30 | | | | | | X* | X | | |
| | | | | 8787 | -79 | Percussion | 10 | | | | | | X | X | | |
| 42 | 3140 | Carpentaria Expl. Co. P/L | 1090 | 9421 | 77 | Rock Chip | 109 | | X | X* | | | | X | | X |
| | | | | | | Ironstone | 22 | | X | | | | | X | | |
| 43 | 3140 | CRA Expl. P/L | 130 | 6293 | 75 | Percussion | 3 | | | | | | X | X | | |
| | | | | | | Gossan | 160 | | | | | | | X | | |
| | | | | | | Gossan | 40 | | | | | | X | X | | X |
| 44 | 3040 | Esso Expl. Aust. Inc. | 793 | 6846 | 76 | Percussion | 105 | | | | | | | | | |
| | | | | 6910 | -78 | | | | | | | | | | | |
| | | | | 7512 | | | | | | | | | | | | |
| | | | | 8239 | | | | | | | | | | | | |
| 45 | 2941 | International Nickel Aust. Ltd | 504 | 6544 | 75 | Percussion | 50 | | | | | | X* | X | | |
| | | | | 7379 | | | | | | | | | | | | |
| 46 | 3140 | Pennzoil Australia Ltd | 2203 | 6816 | 77 | Percussion | 2 | X | | | | X | | X | | |
| | | | | 7785 | -78 | Rock Chip | 34 | X | | X | | X | | X | | X |
| 47 | 2941 | Western Mining Corp. Ltd | 436 | 6895 | 77 | Auger | 160 | | | | | | | | | |
| | | | | | | Percussion | 4 | | | | | | | | | |
| 48 | 3141 | Asarco Australia P/L | 3282 | 7432 | 77 | Gossan | 1200 | X* | X* | | | | X* | X | X* | X* |
| | 3140 | | 1156 | 9611 | | | | | | | | | | | | |
| | | | 498 | 7435 | | | | | | | | | | | | |
| 49 | 3140 | Esso Expl. Aust. Inc. | 1578 | 9042 | 80 | Rock Chip | 37 | X | X | X | X* | X* | X* | X | | |
| | | | 2394 | 9690 | -86 | Costean | 178 | X | X | X | X | X | | X | | |
| | | | 3847 | 14288 | | Percussion | 520 | X* | X | X* | X* | X* | X* | X* | | |
| | | | | 18729 | | | | | | | | | | | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep Drill | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| X* | X* | X* | | | X* | X* | X* | | | X* | X | AAS | Analabs, | | Gossan incl.; Also Cd* |
| | | | | | | | | | | | | (when given) | Pilbara Labs, | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | AAL, | | |
| | | | | | X | | | | | X | | | | | |
| | | | | | | | | | | | | | ALS | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| X* | X* | X | | | | | X* | | | | X | | | | 0-4m; Also $K_2O$* & $TiO_2$* |
| | | | | | | | | | | | | | | | |
| X* | X* | X* | | | X* | X* | X* | | | | X | | | | 0-4m; Also $TiO_2$* |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X* | X | | | | | | | | | X | AAS | Analabs | | |
| | | | | | | | | | | | | | | | 10-15 cm; Tested for Hg |
| | X* | X | | | | | | | | | X | | | | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | | X | | | | | | | | | X | AAS | Analabs | | |
| | X* | X | | | | | | | | | X | AAS | | | 0-4m |
| X | X | X | | | | | X | | X | | X | ICP | | | 0-4m; Also $Al_2O_3$, Be, CaO, Ce, $K_2O$, |
| | | | | | | | | | | | | | | | La, MgO, $Na_2O$, $P_2O_5$, Sr, $TiO_2$, Y, Zr |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X* | X* | | | | | | | | | X | AAS | Assoc. Labs of Aus. | | |
| | X | | | | | | | | | | X | | Analabs | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | X | | | | | | | | | X | AAS | | | Also tested for P by XRF |
| | | X | | | | | | | | | X | Au by FA | | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | Anaconda | | 0-4m |
| | X | | | | | | | | | | X | | | | |
| | X | | X* | | | | | | | | X | | | Y | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | X | | | | | | | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | Inter. Nickel Labs | | 0-4m |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | | X | | | | | | | | | X | AAS | Analabs | | 0-4m |
| | | X | | | | | | | | | X | | | Y | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | X | | | | | | | 0-1.5m |
| | | | | | | | | X | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| X* | X* | X | | | X* | | X* | | | | X | AAS | Analabs | | $Al_2O_3$*, MgO*, $SiO_2$* & $TiO_2$* |
| | | | | | | | | | | | | | Anal. Services Aust. | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| X* | X | X | | | | | | | | X* | X | AAS | Analabs | | |
| | X | X | | | | | | | | | X | Colourimetry | | | 0-3m |
| X* | X | X* | | | X* | | | | | X* | X* | for As | | | 0-4m |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50** | 3040 | Urangesellschaft Australia P/L | 568 | 7584 | 78 | Soil | 52 | | | | | | | X | | |
| | | | | | | Rock Chip | 2 | | | | | | | | | |
| | | | | | | RAB | 7 | | | | | | | | | |
| **51** | 3141 | Esso Expl. Aust. Inc. | 3046 | 7588 | 77 | Gossan/FeSt. | 200 | X | | X* | | | | X | | |
| | 3041 | | | | | | | | | | | | | | | |
| **52** | 3041 | Abminco NL | 2328 | 7898 | 78 | Ironstone | 89 | X | X* | X* | | | | X | X* | X* |
| | | | | 8214 | | Percussion | 3 | | | | | | | | | |
| **53** | 3140 | Abminco NL | 3008 | 7900 | 78 | Ironstone | 580 | X | X* | X* | | | | X | X* | X* |
| **54** | 2941 | Aust. Consolidated Minerals Ltd | 2243 | 8564 | 79 | Percussion | 34 | | | | | | | | | |
| **55** | 3041 | BP Minerals Aust. P/L | 4881 | 13994 | 84 | Rock Chip | 400 | X | X | X* | X* | X* | X* | X | X* | X* |
| | 3141 | Western Mining Corp. Ltd | | 13996 | -90 | | | | | | | | | | | |
| | | | | 15516 | | Percussion | 270 | X* | X* | X* | X* | X* | X* | X | X* | X* |
| | | | | 15518 | | | | | | | | | | | | |
| | | | | 18117 | | Stream Sed | 80 | | | X | | | | | | |
| | | | | 21087 | | | | | | | | | | | | |
| | | | | 24430 | | | | | | | | | | | | |
| **56** | 3141 | BP Minerals Aust. P/L | 3276 | 16230 | 85 | Rock Chip | 56 | X | X | X | X | X | X | X | X | X |
| | 3140 | | | | | | | | | | | | | | | |
| **57** | 3041 | Australian Selection P/L | 3921 | 9572-3 | 80 | Rock Chip | 240 | X* | X | X* | X* | X* | X* | X | X* | X* |
| | 3141 | BP Minerals Aust. P/L | | 12472-3 | -85 | | | | | | | | | | | |
| | | Seltrust Mining Corp. P/L | | 13933 | | Auger | 50 | | X* | | | | | X | | |
| | | | | | | Percussion | 90 | | X* | | | X* | | X | | X* |
| **58** | 3141 | Australian Selection P/L | 3921 | 16687 | 84 | Rock Chip | 30 | X | X | X | X | X | X | X | X | X |
| | 3140 | BP Minerals Aust. P/L | | | -85 | | | | | | | | | | | |
| | | Seltrust Mining Corp. P/L | | | | Percussion | 2 | X | X | X | X | X | X | X | X | X |
| **59** | 3140 | Australian Selection P/L | 1158 | 8232 | 78 | Rock Chip | 100 | X | X | X* | | X* | | X | X* | X* |
| | | BP Minerals Aust. P/L | 2207 | 8234-5 | -83 | Percussion | 12 | X* | X | X* | | | | X | | |
| | | Seltrust Mining Corp. P/L | | 10297 | | | | | | | | | | | | |
| | | | | 10623 | | | | | | | | | | | | |
| | | | | 13216 | | | | | | | | | | | | |
| **60** | 3141 | Australian Selection P/L | 1579 | 8236 | 78 | Rock Chip | 37 | X | X | | | X* | | X | X* | X* |
| | | | | 10417 | | Auger | 4 | | X | | | | | X | | |
| | | | | | | Percussion | 5 | | X | | | | | X | | |
| **61** | 3140 | Chevron Expl. Corp. | 1442 | 9294 | 79 | Rock Chip | 115 | X | | | | X | | X | | X |
| | | | | | -82 | | | | | | | | | | | |
| | | | | 10208 | | Rock Chip | 147 | X | X | X* | | | | X | X | X |
| | | | | | | Percussion | 37 | X | | X* | | | | X | X* | X |
| **62** | 3040 | Aust. Consolidated Minerals Ltd | 1259 | 9328 | 80 | Rock Chip | 85 | | | | | | | | | |
| | 2940 | Pavino P/L | | | | Auger | 4 | | | | | | | | | |
| | | PNC Expl. Aust. P/L | | | | | | | | | | | | | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Drill | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | X | | | | | | | |
| | | | | | | | | X | X | | | | | | Also Th |
| | | | | | | | | X | X | | | | | Y | 0-4m; Also Sr & Th |
| | | | | | | | | | | | | | | | |
| | | X | | | | | | | | | X | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| X* | X* | X | | | X* | | X* | | | | X | AAS | | | Also Hg*, P*, S*, SiO2* & TiO2* |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| X* | X* | X | | | X* | | X* | | | | X | AAS | | | Also Hg*, P*, S*, SiO2* & TiO2* |
| | | | | | | | | | | | | | | | |
| | | | | | | | | X | X | | | U - Fluorimetry | Mining & Agricult. | | 0-4m |
| | | | | | | | | | | | | V - AAS | Labs of Perth | Y | |
| | | | | | | | | | | | | | | | |
| X* | X* | X | | | | | X* | | X* | | X | ICP | | | Also (Al2O3, Be, CaO, Ce, K2O, La, |
| | | | | | | | | | | | | | | | MgO, Na2O, P2O5, Sr, TiO2, Y, Zr)* |
| X* | X* | X* | | | | | X* | | X* | | X* | ICP | | | 0-4m; Also (Al2O3, Be, CaO, Ce, K2O, |
| | | | | | | | | | | | | | | | La, MgO, Na2O, P2O5, Sr, TiO2, Y, Zr)* |
| | | | | | | | | | | | | BLEG | Analabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| X | X | X | | | | X* | X | | X | | X | ICP | | | Also (Al2O3, Be, CaO, Ce, K2O, La, |
| | | | | | | | | | | | | | | | MgO, Na2O, P2O5, Sr, TiO2, Y, Zr)* |
| | | | | | | | | | | | | | | | |
| X* | X | X | | | | X* | X* | | X* | | X | ICP | | | Also (Al2O3, Be, CaO, Ce, K2O, La, |
| | | | | | | | | | | | | | | | MgO, Na2O, P2O5, Sr, TiO2, Y, Zr)* |
| | X | X | | | | | | | | | X | AAS | | | 0-4m |
| | X | X | | | | | | | | | X | AAS | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| X | X | X | | | | X* | X | | X | | X | ICP | | | Also (Al2O3, Be, CaO, Ce, K2O, La, |
| | | | | | | | | | | | | | | | MgO, Na2O, P2O5, Sr, TiO2, Y, Zr)* |
| X | X | X | | | | X* | X | | X | | X | ICP | | | 0-4m; (Al2O3, Be, CaO, Ce, K2O, La, |
| | | | | | | | | | | | | | | Y | MgO, Na2O, P2O5, Sr, TiO2, Y, Zr)* |
| | | | | | | | | | | | | | | | |
| X* | X* | X | | | | X* | X* | | | | X | | | | Also CO3* & K2O* |
| | X* | X* | | | | | | | | | X | | | | 0-4m; Also K2O* |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| X* | X* | X | | | | | X* | | | | X | | | | |
| | X* | X | | | | | | | | | X | | | | 0-4m; Also K2O |
| | X | X | | | | | | | | | X | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| X | X | X | | | | | | | | | X | AAS | Amdel | | |
| | | | | | | | | | | | | | | | |
| X | X | X | | | | | X | | | X | X | AAS | Pilbara Labs | | |
| | X | X | | | | | X* | | | | X | | | | 0-2m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | X | | | | XRF | | | |
| | | | | | | | | X | X | | | XRF | | | 0-1m; Also Th |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63 | 3041 | Amax Expl. Aust. Inc. | 3047 | 9248 | 80 | Surface | 380 | X | | X* | X* | X* | X* | X | | X* |
| | 3141 | Amax Iron Ore Corp. | | 10322-4 | | RAB | 18 | X | X* | | | X* | X* | X | | X* |
| | | Samantha Expl. NL | | | | Percussion | 6 | X | | | | | X | X | | |
| | | Seltrust Mining Corp. P/L | | | | | | | | | | | | | | |
| 64 | 3140 | Austwhim Resources NL | 7420 | 11157 | 82 | Surface | 61 | X | X | X | | X* | X | X | | X* |
| | | CRA Expl. P/L | | 12211 | -88 | | | | | | | | | | | |
| | | Forrest Gold P/L | | 13478 | | | | | | | | | | | | |
| | | | | 14739 | | Surface | 100 | | | X | | | | | | |
| | | | | 17002 | | Costean | 225 | | | X | | | | | | |
| | | | | 19392 | | | 17 | X | X | | | X | | X | | |
| | | | | 20060 | | RAB | 468 | | | X | | | | | | |
| | | | | 26440-1 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | Percussion | 60 | | | X* | | | | | | |
| 65 | 3041 | Texasgulf Australia Ltd | 1910 | 11318 | 81 | Soil | 3300 | X* | X | X | | X* | X | X | | |
| | | | | 11733 | -82 | Percussion | 70 | X* | X* | X | X* | | X* | | | |
| | | | | 11735 | | | | | | | | | | | | |
| 66 | 2941 | Texasgulf Australia Ltd | 1911 | 11319 | 81 | Trench | 270 | | | X | | | | | | |
| | 3041 | | | 11736-8 | -82 | RAB | 45 | X | X | X | | | | X | | |
| | | | | | | Percussion | 100 | | | X | | | X* | | | |
| 67 | 3140 | Texasgulf Australia Ltd | 1913 | 11320-1 | 80 | Trench | 3500 | X | X | X | | | | X | X | |
| | | | | 11730 | -82 | | | | | | | | | | | |
| 68 | 3141 | Southern Goldfields Ltd | 3638 | 15813 | 84 | RAB | 172 | | | X | | | | | | |
| | | | | | -86 | | | | | | | | | | | |
| 69 | 3041 | Cliffminex NL | 2264 | 12697 | 71 | Soil | 1100 | | | | | | | X | | |
| | | Clifford Minerals Ltd | | | | | | | | | | | | | | |
| | | Kia Ora Gold Corp. NL | | | | | | | | | | | | | | |
| 70 | 3140 | Samson Expl. NL | 1908 | 12789 | 83 | Rock Chip | 40 | X | | X | | | | X | | X |
| | | Samantha Expl. NL | | | | | | | | | | | | | | |
| 71 | 3140 | Southern Goldfields Ltd | 5441 | 12897 | 83 | RAB | 24 | | | X | | | | | | |
| | | | | 14889 | -86 | Percussion | 10 | | | X | | | | | | |
| 72 | 3140 | Anaconda Australia Inc. | 2401 | 12965 | 83 | Rock Chip | 60 | X | | | | X | X | X | X | X |
| | | | | | | | | | X | | | | | | | |
| | | | | | | | | | | X | | | | | | |
| 73 | 3140 | Golden Plateau NL | 5669 | 13820 | 83 | Rock Chip | 90 | | | X | | | | | | |
| 74 | 3140 | Aztec Expl. Ltd | 3502 | 14228 | 84 | Soil | 102 | | X | X | | | | | | |
| | | Aztec Mining Co. Ltd | | 24805 | -88 | RAB | 33 | | X | X | | | X | | | |
| 75 | 2941 | Asarco Australia P/L | 4774 | 31140 | 90 | Lag | 880 | | | X | | | | | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Drill | |
| | | | | | | | | | | | | | | | |
| X* | X | X | | | | | X* | | | | X | | | | Also Cd* & Hg* |
| | X | X | | | | | | | | | X | | | | 0-4m |
| | X | X | | | | | | | | | X | | | | 0-4m |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | X* | | | | X | 50 AAS | Analabs | | |
| | | | | | | | | | | | | 11 AAS | Amdel | | |
| | | | | | | | | | | | | | Au-FA-Classic Labs | | |
| | | | | | | | | | | | | FA | Classic Labs | | |
| | | | | | | | | | | | | FA | Classic Labs | | 0-2m |
| | X | X | | | | | | | | | X | AAS | Analabs | | |
| | | | | | | | | | | | | 52 AAS | Pilbara Labs | | 0-4m |
| | | | | | | | | | | | | 16 AAS | Genalysis | | |
| | | | | | | | | | | | | 400 FA | AAL | | |
| | X* | | | | | | | | | | | 6 AAS | Classic Labs | | 0-4m |
| | | | | | | | | | | | | 12 AAS | Genalysis | | |
| | | | | | | | | | | | | 42 FA | AAL | Y | |
| | | | | | | | | | | | | | | | |
| | X | X* | | | | | | | | | X* | AAS | Genalysis | | 0-10cm |
| | X* | | | | X* | | | | | | | AAS | Genalysis | | 0-4m |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA | Pilbara Labs | | 0-1m |
| | X | | | | | | | | | | X | AAS, FA(Au) | Pilbara Labs | | 0-4m |
| | X* | | | | | | | | | | | AAS | Pilbara Labs | | 0-4m |
| | | | | | | | | | | | | FA(Au) | Classic Labs | Y | |
| | | | | | | | | | | | | | | | |
| | | X | | | X | | | | | | X | AAS | Pilbara Labs | | 0-4m; Also Hg, K, & Te |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | | | | Contours about sample points only; |
| | | | | | | | | | | | | | | | individual values not given |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | X | | | | | | | | | X | AAS | Analabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | AAL | | 0-4m |
| | | | | | | | | | | | | | AAL | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | X | | X | ICP-MS | | | Also Al, Ba, Ca, Mg, Sr & Ti |
| | | | | | | | | | | | | Atomic Fluor. | | | |
| | | | | | | | | | | | | AAS | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | AAS | Analabs | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **76** | 3141 | Asarco Australia P/L | 5991 | 32894-5 | 89 | Rock Chip | 3 | | | X | | | | | | |
| | 3140 | | | 35471 | -92 | Lag | 980 | | | X | | | | | | |
| | | | | 35473 | | Soil | 266 | | | X | | | | | | |
| | | | | | | RAB | 22 | | X* | X | | X* | | X* | | |
| **77** | 3041 | Asarco Australia P/L | 5994 | 30167-71 | 89 | Lag | 3450 | | | X | | | | | | |
| | 2941 | | | 35474 | -94 | Soil | 90 | | | X | | | | | | |
| | | | | 41385 | | Stream Sed | 39 | | | X | | | | | | |
| **78** | 2941 | Asarco Australia P/L | 6119 | 35466 | 90 | Lag | 75 | | | X | | | | | | |
| | 3041 | | | | | | | | | | | | | | | |
| **79** | 3041 | Asarco Australia P/L | 6289 | 36884 | 88 | Lag | 600 | | | X | | | | | | |
| | 2941 | | 6709 | 36958 | -90 | Soil | 40 | | | X | | | | | | |
| | | | | 37384 | | | | | | | | | | | | |
| **80** | 3140 | Southern Ventures NL | 3261 | 14449 | 83 | RAB | 55 | | | X | | X* | X* | X* | | |
| | | | | | -85 | | | | | | | | | | | |
| **81** | 3141 | Aztec Expl. Ltd | 4685 | 15541 | 85 | Rock Chip | 32 | X | X | X | | | | X | | |
| | | Golden Plateau NL | | | -87 | Costean | 17 | | | X | | | | | | |
| | | | | | | Percussion | 27 | | | X | | | | | | |
| **82** | 3140 | Freeport of Australia Inc. | 2594 | 15507 | 85 | Rock Chip | 44 | | | X | | | | | | |
| **83** | 3041 | Forsayth NL | 5968 | 18498 | 86 | Rock Chip | 200 | | | X | | X* | X* | X* | | |
| | | | 3585 | 22434 | -88 | | | | | | | | | | | |
| | | | | | | Soil | 310 | X | | X | | X | | X | | |
| | | | | | | Laterite | 85 | | X | | X | | X | | | |
| **84** | 3041 | Dechow & Co. P/L | 7394 | 15619 | 85 | Soil | 135 | | | X | | | | | | |
| | 3141 | Mizenhead P/L | | 19575 | -86 | Percussion | 6 | | | X | | | | | | |
| **85** | 3140 | Mount Edon Mines P/L | 4163 | 15737 | 84 | Rock Chip | 38 | | | X | | | | | | |
| | | | | | -85 | Costean | 60 | | | X | | | | | | |
| **86** | 3140 | Balmoral Resources NL | 5614 | 15866 | 84 | Rock Chip | 60 | | X | X | | | X | X | X | X |
| | | | | | | Stream Sed | 19 | | | X | | | | | | |
| | | | | | | Pisolites | 73 | | X | X | | | X | X | X | |
| **87** | 2940 | Electrolytic Zinc Co | 4689 | 31067 | 90 | Rock Chip | 27 | X* | X | X | X | X* | | X | | |
| | | Geopeko | | | | Stream Sed | 134 | | | X | | | | | | |
| | | Norgold Ltd | | | | | | | | | | | | | | |
| **88** | 3041 | Chevron Expl. Corp. | 2795 | 16277 | 85 | Pisolites | 37 | | X | X | | | | | | |
| **89** | 3140 | Aztec Expl. Ltd | 4781 | 17866-7 | 84 | Soil | 435 | | | X | | | | | | |
| | | | | 18131 | -87 | Percussion | 16 | | | X | | | | | | |
| **90** | 2940 | Aust. Consolidated Minerals Ltd | 4410 | 17437 | 85 | Soil | 200 | | X | X | | | X | X | | |
| | | Austamax Resources Ltd | | | -88 | Stream Sed | 45 | | | X | | | | | | |
| | | Electrolytic Zinc Co | | | | Laterite | 10 | X | X | X | X | | X | X | X | X |
| | | Norgold Ltd | | | | Rock Chip | 19 | X | X | X | X | | | X | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep Drill | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA; AAS | | | |
| | | | | | | | | | | | | FA; AAS | | | |
| | | | | | | | | | | | | FA; AAS | | | |
| | X* | X* | | | | | | | | | X | AAS | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X* | | | | | | | | | | X* | AAS | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA(Au), AAS | AAL | | |
| | | | | | | | | | | | | FA | | | 0-4m |
| | | | | | | | | | | | | FA | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X* | | X* | X* | | | | | | | | FA (Au) | Res. Dev. Labs | | |
| | | | | | | | | | | | | ICP(PGE) | | | |
| | X | | | | | | | | | | X | AAS(Other) | Amdel | | |
| X | | X | | | X | X* | X | | | X | | XRF(Laterite) | Amdel | | Also Ge, Nb & Ta |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Genalysis | | |
| | | | | | | | | | | | | | Lab Services | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | 0-4m |
| | | | | | | | | | | | | | | | |
| X | X | X | | | | | | | | X | X | | | | Also Ba, Ti & Zr |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | X | X | | | | |
| | | | | | | | | | | | | | | | |
| | | X | | | X* | | | | | | X | | Aust. Anal. Labs | | |
| | | | | | | | | | | | | BLEG | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | X | | | | | | | | Pilbara Labs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Pilbara Labs | | |
| | | | | | | | | | | | | FA; AAS | Pilbara Labs | | 0-4m |
| | | | | | | | | | | | | | AAL | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | | X | AAS | Analabs | | 10-40cm |
| | | | | | | | | | | | | FA; AAS; BLEG | | | |
| X | X | X | | | X | | | | | | X | AAS | Genalysis | | Surface |
| X | | X | | | X | | | | | | X | AAS | | | |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 91 | 3140 | Chevron Expl. Corp. | 3544 | 18154 | 86 | Gravel | 38 | | X | X | | | | X | | |
| | | | | 24019 | -88 | Soil | 109 | | | X | | | | | | |
| | | | | | | Rock Chip | 21 | X* | X | X | | | | X* | | |
| | | | | | | Stream Sed | 12 | | X* | X | | | | | X* | |
| | | | | | | RAB | 1 | | | | | | | | | |
| 92 | 3041 | Chevron Expl. Corp. | 4499 | 20615 | 87 | Rock Chip | 69 | X* | X* | X | | | | X* | | |
| | 3141 | | | 23783 | -89 | Stream Sed | 45 | | X* | X | | | | | X* | |
| | | | | 27133 | | Pisolites | 130 | | X | X | | | | | X* | |
| | | | | 27135 | | RAB | 144 | | X | X | | | | | X | |
| 93 | 3141 | Minsaco Resources P/L | 4321 | 19153-4 | 86 | Soil | 2060 | | X* | X | | | | X* | | |
| | 3140 | | 3513 | 26192-3 | -90 | Rock Chip | 63 | | X* | X | | | | | | |
| | | | | 29017-8 | | Costean | 98 | | X | X | | | | | | |
| | | | | 31649-50 | | RAB | 40 | | | X | | | | X* | | |
| | | | | 20345 | | Percussion | 13 | | | X | | | | | | |
| 94 | 3140 | Kalgoorlie Southern | 4072 | 19259 | 86 | Rock Chip | 17 | X | X | X | | | | X | | |
| | | Goldmines NL | | | | Rock Chip | 18 | X | X | | X | X | X | X | X | X |
| | | | | | | RAB | 50 | | | X | | | | | | |
| 95 | 3140 | Billiton Australia | 2800 | 19747 | 87 | Soil | 140 | | | X | | | | | | |
| | | | | | | Rock Chip | 7 | X | X | X | | | | X | | |
| 96 | 3141 | Nippon Mining of Australia P/L | 4200 | 28669-72 | 89 | Soil | 585 | | | X | | | | | | |
| | | | | | | RAB | 170 | | | X | | | | | | |
| | | | | | | RC | 24 | | | X | | | | | | |
| 97 | 3140 | Mt. Burgess Gold Mining Co. NL | 5064 | 25175 | 87 | Rock Chip | 56 | | | X | | | | | | |
| | | | | 25180 | -88 | RC | 15 | | | X | | | | | | |
| | | | | | | Percussion | 95 | | | X | | | | | | |
| 98 | 3040 | Noble Resources NL | 3550 | 20708 | 87 | Rock Chip | 14 | | | X | | | | X | | |
| | 3041 | | | 25356 | | Gossan | 21 | | | X | | | | | | |
| | | | | | | RC | 16 | | | X | | | | X | | |
| 99 | 3140 | Charter Mining NL | 3767 | 20824 | 87 | RC | 43 | | | X | | | | | | |
| 100 | 3141 | Conquest Mines NL | 4566 | 24524 | 88 | Rock Chip | 146 | | | X | | | | | | |
| | | Broadarrow Gold Mines P/L | | 25077 | -89 | | | | | | | | | | | |
| | | | | 29376 | | RC | 16 | | | X | | | | | | |
| | | | | | | Percussion | 8 | | | X | | | | | | |
| 101 | 3041 | BHP Gold Mines Ltd | 4800 | 25896 | 88 | Lag | 332 | | X | X | | | | X | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | Stream Sed | 8 | | | X | | | | | | |
| | | | | | | Soil | 95 | | | X | | | | | | |
| 102 | 3140 | AFMECO P/L | 3975 | 21815 | 87 | Soil / R Chip | 13 | | X | X | | | | | | |
| | | | | 24711 | -88 | Percussion | 51 | | | X | | | | | | |
| 103 | 3140 | Balmoral Resources NL | 3936 | 22148 | 87 | Rock Chip | 51 | | X | X | | | | | | |
| | | Equity Minerals Ltd | | 23857-8 | -88 | RAB | 240 | | | X | | | | | | |
| 104 | 3140 | Chevron Expl. Corp. | 3855 | 23141 | 88 | Stream Sed | 16 | | | | | | | | | |
| | | | | 27130 | -89 | RAB | 225 | | X | X | | | | | X | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Drill | |
| | | | | | | | | | | | | | | | |
| | | X | | | X | | X | | | X | X | | | | |
| | | | | | | | | | | | | AAS | ALS | | 0-20cm |
| | | X* | | | X* | | X* | | | X* | X* | AAS | Analabs | | Also Ti* & Zr* |
| | | | | | | | | | | | | AAS | ALS | | |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | X* | | | | | | | | | X* | FA; AAS | ALS | | |
| | | | | | | | | | | | X* | FA; AAS | ALS | | |
| | | | | | X* | | | | | X* | | FA; AAS | ALS | | |
| | | | | | | | | | | | | FA; AAS | Analabs | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | X* | | | | | | | | | X* | FA; AAS | AAL | | 0-20cm |
| | | | | | | | | | | X* | | | | | |
| | | | | | | | | | | X | | FA; AAS | Res. Dev. Labs | | 0-4m |
| | | X* | | | | | | | | | X* | | | | 0-4m |
| | | | | | | | | | | | | | SGS/Classic Labs | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | X | | | | | | | | | X | | Pilbara Labs | | |
| | X | X | | | | | | | | | X | | Pilbara Labs | | Also Al, Ca, K, Mg, Na, P & Ti |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | AAL | | |
| | X | X | X | X | | | | | | X | X | FA (Au) | Comlabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ETA | SGS | | |
| | | | | | | | | | | | | ETA | AAL | | 0-4m |
| | | | | | | | | | | | | FA | SGS | Y | 0-2m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | | | 0-1m |
| | | | | | | | | | | | | AAS | Minlabs | Y | 0-2m |
| | | | | | | | | | | | | | | | |
| | X | | X | X | | | | | | | | | | | |
| | | | X | X | | | | | | | | | | | |
| | X | | X | X | | | | | | | | | Anal. Services | Y | 0-2m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA | Classic Comlabs | | |
| | | | | | | | | | | | | BLEG | Anal. Services | | |
| | | | | | | | | | | | | | | | 0-2m |
| | | | | | | | | | | | | | | Y | 1-2m |
| | | | | | | | | | | | | | | | |
| | | X | | | | | | | | | X | FA (Au) | Comlabs | | |
| | | | | | | | | | | | | XRF (As) | | | |
| | | | | | | | | | | | | AAS(Cu, Pb, Zn) | | | |
| | | | | | | | | | | | | FA | Comlabs | | |
| | | | | | | | | | | | | BLEG | Comlabs | Y | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | 0-2m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | AAL | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG/AAS | ALS | | |
| | | | | | | | | | | | | AAS | Res. Dev. Labs | Y | 0-4m |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **105** | 3041 | Kailis, M.G. | 5085 | 23136 | 90 | Grab Sample | 93 | | | X | | | | | | |
| | 3141 | | | | | | | | | | | | | | | |
| **106** | 3140 | Intercontinental Gold | 5390 | 27150 | 88 | Soil | 930 | | | X | | | | | | |
| | | and Minerals NL | | | | RAB | 56 | | | X | | | | | | |
| **107** | 3040 | CSR Ltd | 3482 | 24221 | 88 | Stream Sed | 57 | X | | X | | | | X | | |
| | 3041 | | | | | | | | | | | | | | | |
| **108** | 3140 | Sons of Gwalia NL | 3717 | 25577 | 88 | Soil | 2130 | | X | X | | | | | | |
| | | | | | | Soil | 160 | | X | X | | | | | | |
| | | | | | | RAB | 145 | | | X | | | | | | |
| **109** | 3041 | Miralga Mining NL | 3858 | 24635 | 88 | Rock Chip | 68 | X* | | X | | | X | X | | |
| | | | | | | Stream Sed | 88 | X* | | X | | | X* | X | | |
| **110** | 3041 | Golden Valley Mines NL | 5958 | 26796 | 88 | Soil | 24 | | | X | | | | | | |
| | | | | 27223 | -91 | Pisolite | 8 | X | X | | X | X | | X | | |
| | | | | 34241 | | Rock Chip | 33 | | | X | | | | | | |
| | | | | | | Lag | 1110 | | | X | | | | | | |
| **111** | 3041 | BP Minerals Aust. P/L | 5762 | 24370 | 88 | Lag | 51 | | X | X | | | | | | |
| | 3141 | Forsayth NL | 4287 | 27986 | -91 | Stream Sed | 30 | | | X | | | | | | |
| | | | | 31460 | | Soil | 44 | | X | X | | | | | | |
| | | | | 31501 | | RAB | 2 | | | X | | | | | | |
| | | | | | | Rock Chip | 7 | X | X | X | | X | X | X | X | X |
| **112** | 2940 | Riverina Gold NL | 3886 | 24377 | 87 | Soil | 190 | | X | X | | | | X* | | |
| | | | | 27179 | -89 | Rock Chip | 113 | | X | X | | | X* | X* | | |
| | | | | | | Stream Sed | 134 | | | X | | | | | | |
| **113** | 3140 | Mr. Crew, R.F. | 4094 | 24640 | 88 | Soil | 29 | | | X | | | | | | |
| | | Mr. Holloran, W.F. | | | | Percussion | 7 | | | X | | | | | | |
| | | Mr. Wright, J.G. | | | | | | | | | | | | | | |
| **114** | 3141 | Chevron Expl. Corp. | 3636 | 24823 | 88 | Rock Chip | 14 | | X | X | | | | X | | |
| | | | | 25853 | | RC | 3 | | X | X | | | | | X | |
| | | | | | | RAB | 39 | | X | X | | | | | X | |
| **115** | 3141 | Swan Resources Ltd | 5292 | 25310 | 88 | Rock Chip | 110 | | | X | | | | | | |
| | | | | | | Rock Chip | 36 | X | | X | | | | X | | |
| **116** | 3140 | Randwick NL | 3735 | 25565 | 88 | Soil | 730 | | | X | | | | | | |
| | | | | | | RC | 5 | | | X | | | | | | |
| **117** | 3141 | BHP Minerals Ltd | 5295 | 27064 | 88 | Soil | 268 | | X* | X | | | | | | |
| | | | | | | Rock Chip | 368 | | X | X | | | | | | |
| **118** | 3041 | Forsayth NL | 5117 | 26443 | 89 | Stream Sed | 74 | | | X | | | | | | |
| | | | | | | Soil | 5 | | | X | | | | | | |
| | | | | | | Rock Chip | 23 | | | X | | | | | | |
| **119** | 3140 | Sons of Gwalia NL | 3866 | 26605 | 88 | Soil | 620 | | | X | | | | | | |
| | | | | | | Rock Chip | 8 | | | X | | | | | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep Drill | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA/AAS | AAL | | |
| | | | | | | | | | | | | | Anal. Services | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | | | Y | 0-2m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | Classic Labs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG/ICP | Anal. Services | | |
| | | | | | | | | | | | | ETA/AAS | Analabs | | |
| | | | | | | | | | | | | AAS | Analabs | Y | 0-2m |
| | | | | | | | | | | | | | | | |
| | X | | X | X | | | | | | | X* | ICP/AAS | Anal. Services | | |
| | | | | | | | | | | | | | RDG | | |
| | | X* | X* | X* | | | | | | | X* | ICP/AAS/ETA | Anal. Services | | |
| | | | | | | | | | | | | | Genalysis | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG/AAS | ALS | | |
| X | | X | | | X | X* | X | | | X | X | XRF/AAS | Classic / Comlabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA/ETA | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | Analabs | | |
| | | | | | | | | | | | | ETA/AAS | Genalysis | | |
| | | | | | | | | | | | | BLEG | Rapley Wilkinson | | 0-4m |
| | X | X | | | | | | | | | X | ICP/AAS (Au) | Analabs | Y | |
| | | | | | | | | | | | | | | | |
| | | | X | X | | | | | | | | | | | |
| | X* | | X* | X* | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | ALS | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA/AAS | Analabs | | |
| | | | | | | | | | | | | FA/AAS | Analabs | | 0-2.5m |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | X | AAS | Analabs | | 0-2m |
| | | | | | | | | | | | | AAS | Analabs | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | AAL | | |
| X | X | X | | | | | | | | X | X | | AAL | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ETA | Genalysis | | |
| | | | | | | | | | | | | AAS | Genalysis | Y | 0-1m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG/AAS | Analabs | | |
| | | | | | | | | | | | | ETA/AAS | Analabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | | | |
| | | | | | | | | | | | | BLEG | | | |
| | | | | | | | | | | | | BLEG | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | Sheen/Analabs | | 30cm |
| | | | | | | | | | | | | FA | AAL | | |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **120** | 3140 | Aust. Consolidated Minerals Ltd | 3874 | 26916 | 89 | Soil | 58 | X | | X | | | | X | | |
| | | | | | | Stream Sed | 4 | X | | X | | | | X | | |
| **121** | 3041 | Melbourne Expl. NL | 3999 | 26931 | 89 | Soil | 53 | | | X | | | | | | |
| **122** | 2940 | SIPA Resources Ltd | 4618 | 28808 | 89 | Lag | 108 | | X | X | | | | X | | |
| **123** | 3040 | Aust. Consolidated Minerals Ltd | 5125 | 28101 | 89 | Soil | 1050 | X | X | X | | | | X* | | |
| | 3140 | | | | | | | | | | | | | | | |
| | | | | | | Stream Sed | 90 | X | | X | | | | X | | |
| | | | | | | Lag | 173 | X | X | X | | | | X | | |
| | | | | | | RAB | 80 | X | X | X | | | | X | | |
| **124** | 3140 | ACM Gold Ltd | 5618 | 28128 | 89 | Stream Sed | 7 | X | | X | | | | X | | |
| | | | | | | Soil | 154 | X | | X | | | | X | | |
| | | | | | | Soil | 21 | X | X | X | | | | X | | |
| | | | | | | Lag | 21 | X | X | X | | | | X | | |
| **125** | 3140 | Coopers Resources NL | 7549 | 28947 | 84 | Rock Chip | 6 | | X | X | | | | | | |
| | | Dominion Mining Ltd | | 29101 | -92 | RAB | 11 | | | X | | | | | | |
| | | | | 37570 | | RC | 20 | | | X | | | | | | |
| **126** | 3140 | Ashton Gold WA Ltd | 4627 | 30516 | 89 | Stream Sed | 330 | | | X | | | | | | |
| | | | 5782 | 33540 | -90 | Rock Chip | 64 | | X* | X | | | | | | |
| | | | 4440 | 30517 | | Soil | 2170 | | X | X | | | | X* | | |
| | | | 6003 | 33543 | | | | | | | | | | | | |
| | | | 5905 | 33593 | | | | | | | | | | | | |
| | | | | | | Vacuum | 20 | | | X | | | | | | |
| | | | | | | RAB | 44 | | X | X | | | | | | |
| **127** | 3140 | ACM Gold Ltd | 5487 | 29035 | 89 | Stream Sed | 5 | X | | X | | | | X | | |
| | | | | | | Soil | 64 | X | X | X | | | | X | | |
| **128** | 3141 | Western Mining Corp. Ltd | 6628 | 36810 | 87 | Lag | 2068 | | X | X | X | | | X | X | X |
| | | | | 38592 | -93 | | | | | | | | | | | |
| **129** | 3041 | Dalrymple Resources NL | 4023 | 29797 | 89 | Soil | 80 | | | X | | | | | | |
| | | | | | | Stream Sed | 7 | | | X | | | | | | |
| | | | | | | Rock Chip | 7 | X | | | | | | X | | |
| **130** | 3140 | Southern Ventures NL | 4754 | 30116 | 90 | Soil | 272 | | | X | | | | | | |
| **131** | 3141 | Asarco Australia P/L | 4987 | 30363 | 90 | Lag | 2674 | | | X | | | | | | |
| **132** | 3140 | Asarco Australia P/L | 4445 | 30366 | 90 | Rock Chip | 57 | | X | X | | X | | X | | |
| | | | | | | Lag | 800 | | | X | | | | | | |
| | | | | | | RC | 23 | | | X | | | | | | |
| **133** | 3041 | Western Mining Corp. Ltd | 6315 | 36549 | 92 | Lag | 125 | | X | X | | X | X | X | X | X |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Drill | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | Rapley Wilkinson | | |
| | | | | | | | | | | | | BLEG | Rapley Wilkinson | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ETA (Au) | Genalysis | | Scraping of top 2.5cm from 1 sq. m |
| | | | | | | | | | | | | AAS (Cu, As) | Genalysis | | |
| | | | | | | | | | | | | | | | |
| | | X* | | | | | | | | | X* | BLEG | Perth Metall. Labs | | |
| | | | | | | | | | | | | ETA (Au, Ag) | SGS | | |
| | | | | | | | | | | | | XRF (As) | SGS | | |
| | | | | | | | | | | | | AAS (other) | SGS | | |
| | | | | | | | | | | | | BLEG (Au) | Ass. Research Aust. | | |
| | | X | | | | | | | | | X | XRF (As) | Classic Comlabs | | |
| | | | | | | | | | | | | AAS (other) | Classic Comlabs | | |
| | | X | | | | | | | | | X | FA (Au) | AAL | | 0-4m |
| | | | | | | | | | | | | Other ? | AAL | Y | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | Rapley Wilkinson | | |
| | | | | | | | | | | | | BLEG | Rapley Wilkinson | | |
| | | X | | | | | | | | | X | XRF (As) | SGS | | |
| | | | | | | | | | | | | ETA (Au, Ag) | SGS | | |
| | | | | | | | | | | | | AAS (Cu, Pb, Zn) | SGS | | |
| | | X | | | | | | | | | X | FA (Au); ICP | AAL | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | Genalysis | | |
| | | | | | | | | | | | | | Analabs | | 0-4m |
| | | | | | | | | | | | | FA | Genalysis | Y | 0-3m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG/AAS | ALS | | |
| | | | | | | | | | | | | FA (Au) ; AAS | AAL | | |
| | | X* | | | | | | | | | X* | BLEG/AAS | Genalysis | | 0-30 cm |
| | | | | | | | | | | | | FA/AAS (Au) | Minlab | | |
| | | | | | | | | | | | | AAS (other) | Minlab | | |
| | | | | | | | | | | | | FA/AAS | Minlab | | 0-4m |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG; AAS | ALS | | |
| | | X | | | | | | | | | X | XRF (As) | SGS | | |
| | | | | | | | | | | | | AAS (other) | SGS | | |
| | | | | | | | | | | | | | | | |
| X | | X | | | | | | | | | X | AAS | WMC | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | AAL | | |
| | | | | | | | | | | | | BLEG | AAL | | |
| | X | X | | | | | | | | | X | | AAL | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEG | ALS | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ETA | Analabs | | |
| | | | | | | | | | | | | | | | |
| | X | X | | | | | | | | | X | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | 0-2m |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | AAS | WMC | | |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **134** | 3141 | Summit Gold Australia P/L | 6437 | 31255 | 90 | Soil | 738 | | X | X | | | | | | |
| | | MIM Expl. P/L | | 34972 | -91 | Rock Chip | 2 | | | X | | | | | | |
| | | | | | | Lag | 625 | | | X | | | | | | |
| | | | | | | RAB | 87 | | | X | | | | | | |
| **135** | 3140 | Placer Exploration Ltd | 6598 | 31293-4 | 89 | Rock Chip | 3385 | | | X | | | | | | |
| | 3141 | Expl. Research Aust. P/L | | 34827 | -91 | Rock Chip | 8 | X | | X | | | | | | |
| | | | | | | Lag | 1030 | | | X | | | | | | |
| | | | | | | Stream Sed | 23 | X | | X | | | | X | | |
| **136** | 3041 | Forsayth NL | 6580 | 37183 | 89 | Soil | 465 | | X* | X | | | | | | |
| | 3141 | Plutonic Operations Ltd | 7007 | 40501 | -91 | Rock Chip | 28 | X | X | X | | X | | X | | |
| | 3040 | | | | | Stream Sed | 36 | | X* | X* | | | | | | |
| | | | | | | Percussion | 35 | | X | X | | | | | | |
| **137** | 3141 | Dakota Gold Mines NL | 7441 | 34122-3 | 89 | Stream Sed | 15 | X | X | X | X | X | | X | | |
| | | | | | -91 | Rock Chip | 11 | X | X | X | X | X | | X | | |
| | | | | | | Soil | 424 | | X* | X | | | | | | |
| | | | | | | RAB | 39 | | X | X | | | | | | |
| **138** | 3041 | Hunter Resources Ltd | 4992 | 31681 | 90 | Laterite | 41 | | X | X | | | | | | |
| | | | | | | Rock Chip | 31 | | X | X | | | | | | |
| | | | | | | Stream Sed | 125 | X* | | X | | | | X* | | |
| **139** | 3141 | Mt Martin Gold Mines NL | 5154 | 32241 | 90 | Soil | 350 | | | X | | | | | | |
| | | | | | | Rock Chip | 14 | | | X | | | | X* | | |
| **140** | 3041 | Mt Edon Gold Mines NL | 6697 | 37727 | 93 | Soil | 632 | | | X | | | | X | | |
| | 3141 | | | | | | | | | | | | | | | |
| **141** | 3141 | Carpentaria Expl. Co. P/L | 6513 | 33233 | 91 | Soil | 600 | X* | X | X* | | | | | | |
| | | | | | | Rock Chip | 7 | X* | X | X* | | | | | | |
| **142** | 3041 | Spargos Mining NL | 6863 | 38180 | 93 | Rock Chip | 23 | | | | | X | X | X | | |
| | 3141 | | 7494 | 40555 | -94 | Soil | 32 | | | X | | X | X | X | | |
| | | | | | | Stream Sed | 132 | | X* | X* | | X* | X* | X | | |
| **143** | 3041 | Kriston P/L | 7042 | 35103 | 92 | Lag / Soil | 356 | | | X | | | | X | | |
| | 3141 | | | | | | | | | | | | | | | |
| **144** | 3141 | Western Mining Corp. Ltd | 5520 | 33766 | 91 | Lag | 905 | | X | X | | X | X | X | X | X |
| **145** | 3140 | Towson Holdings P/L | 7565 | 37067 | 92 | Soil | 96 | | X | X | | | | | | |
| | | | | 38899 | -93 | RAB | 25 | | | X | | | | | | |
| **146** | 3140 | Hunter Resources Ltd | 6042 | 35380 | 92 | Lag | 160 | | X | X | | | | | | |
| **147** | 3141 | MIM Expl. P/L | 6422 | 36359 | 92 | Soil | 2165 | | X | X | | | | | | |
| | | | | | | Rock Chip | 30 | | | X | | | | | | |
| | | | | | | RAB | 58 | X* | X | X* | | | | X* | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep Drill | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA (Au); XRF | Rapley Wilkinson | | 0-20cm |
| | | | | | | | | | | | | FA/AAS | Rapley Wilkinson | | |
| | | | | | | | | | | | | ETA | Rapley Wilkinson | | |
| | | | | | | | | | | | | FA/AAS | Rapley Wilkinson | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA | AAL/SGS | Y | |
| | | | | | | | | | | | | AAS | | | |
| | | | | | | | | | | | | ETA | Sheen Labs | | |
| | | | | | | | | | | | | BLEG/ICP | Sheen Labs | | |
| | | | | | | | | | | | | BLEG/ETA | Assay Research | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | Analabs | | |
| X | X | X | | | X | X | X | | | X | X | | Analabs | | Also B |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| X | X | X | | | X | X | X | | | X | X | AAS | Analabs | | |
| X | X | X | | | X | X | X | | | X | X | AAS | Analabs | | |
| | | | | | | | | | | | | AAS | Analabs | | 10-20cm |
| | | | | | | | | | | | | AAS | Analabs/Sheen | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | AAL | | |
| | | | | | | | | | | | | | AAL | | |
| | | | X* | | | | | | | | | | AAL | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ETA | Genalysis | | |
| | X* | X* | | | | | | | | | X* | ETA | Genalysis | | |
| | | | | | | | | | | | | | | | |
| | X* | | | | | | | | | | X | ETA/AAS | Genalysis | | 0-5 cm |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA (Au) | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X | X | X | X | | | | | | | X | FA (Pt, Pd);AAS | Classic Labs | | |
| | X | X | | | | | | | | | X | BLEG; AAS | Classic Labs | | |
| X* | X | X | X* | X* | X* | | | | | X* | X | BLEG | Classic Labs | | |
| | | | | | | | | | | | | FA (Pt, Pd) | | | |
| | | | | | | | | | | | | XRF (As, Sb, W) | | | |
| | | | | | | | | | | | | AAS | | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | AAS | Analabs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | X | ETA (Au); AAS | WMC | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA (Au) | AAL | | |
| | | | | | | | | | | | | | | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AAS | SGS | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA | | | 0-15cm |
| | | | | | | | | | | | | | | | |
| | | X* | | | | | | | | | X* | AAS | AAL | Y | 0-4m |
| | | | | | | | | | | | | | | | |

| ID No. | Map Sheet | Company | I No. | A No. | Yr. | Medium | No. | Ag | As | Au | Bi | Co | Cr | Cu | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **148** | 3041 | Helix Resources NL | 6605 | 36999 | 92 | Pisolite / Lag | 57 | | X | X | | | | | | |
| | | | | | | Pisolite / Lag | 169 | | X | X | | | | X | | |
| | | | | | | Rock Chip | 8 | | | X | | | X | X | X | |
| | | | | | | Rock Chip | 7 | | X | X | | | | X | | |
| | | | | | | Soil | 30 | | | X | | | | X | | X |
| **149** | 3140 | Triton Resources Ltd | 7126 | 39576 | 93 | Soil | 1677 | | X | X | | | | | | |
| **150** | 3140 | Dominion Mining Ltd | 7255 | 37690 | 93 | Lag | 320 | | | X | | | | | | |
| **151** | 3041 | Plutonic Operations Ltd | 7469 | 41837 | 94 | Stream Sed | 61 | | X | X | | | | X | | |
| | | | | | | RAB | 16 | | X | X | | | | | | |
| **152** | 3140 | Tem Minerals NL | 7541 | 39876 | 93 | Soil | 5570 | | | X | | | | | | |

| Mo | Ni | Pb | Pd | Pt | Sb | Se | Sn | U | V | W | Zn | Method | Analyst | Deep | Comment on Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Drill | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FA/AAS | Analabs | | |
| | X | | | | | | | | | | | ETA/AAS | Genalysis | | |
| | X | X | | X | | | | | | | X | FA/AAS(Au, Pt) | Classic Labs | | |
| | | | | | | | | | | | | ICP | | | |
| | X | | X | X | | | | | | | | ICP (Au, PGE) | Genalysis | | |
| | | | | | | | | | | | | AAS | | | |
| | X | | | | | | | | | | | AAS | Classic Labs | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | Genalysis | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | Genalysis | | |
| | | | | | | | | | | | | | | | |
| | X | | | | | | | | | | | BLEG | Analabs | | |
| | | | | | | | | | | | | AAS | Multilab | Y | 0-4m |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | Anal. Services | | |

# Figures

1. Locality plan
2. Geological interpretation with mining localities and prospects
3. Generalized regolith map

**Element-distribution maps (4–40)**
(prepared by A. J. Rogers and K. L. Smith)

4. Titanium oxide
5. Aluminium oxide
6. Iron oxide
7. Magnesium oxide
8. Calcium oxide (high)
9. Calcium oxide (low)
10. Sodium oxide
11. Potassium oxide
12. Phosphorus oxide
13. Manganese oxide
14. Arsenic
15. Gold
16. Barium
17. Cerium
18. Cobalt
19. Chromium
20. Copper
21. Fluorine
22. Gallium
23. Lanthanum
24. Nickel
25. Lead
26. Palladium
27. Platinum
28. Rubidium
29. Sulfur
30. Antimony
31. Scandium
32. Strontium
33. Thorium
34. Uranium
35. Vanadium
36. Yttrium
37. Zinc
38. Zirconium
39. Beryllium, lithium, molybdenum, niobium, tin
40. Silver, bismuth, cadmium, indium, selenium, tungsten

41. Gold deposits and contoured gold geochemistry
42. Map of first and second principal components
43. Map of the data using the CHI-6*X chalcophile index
44. Map of the data using a pegmatite chalcophile index (based on PEG-4)

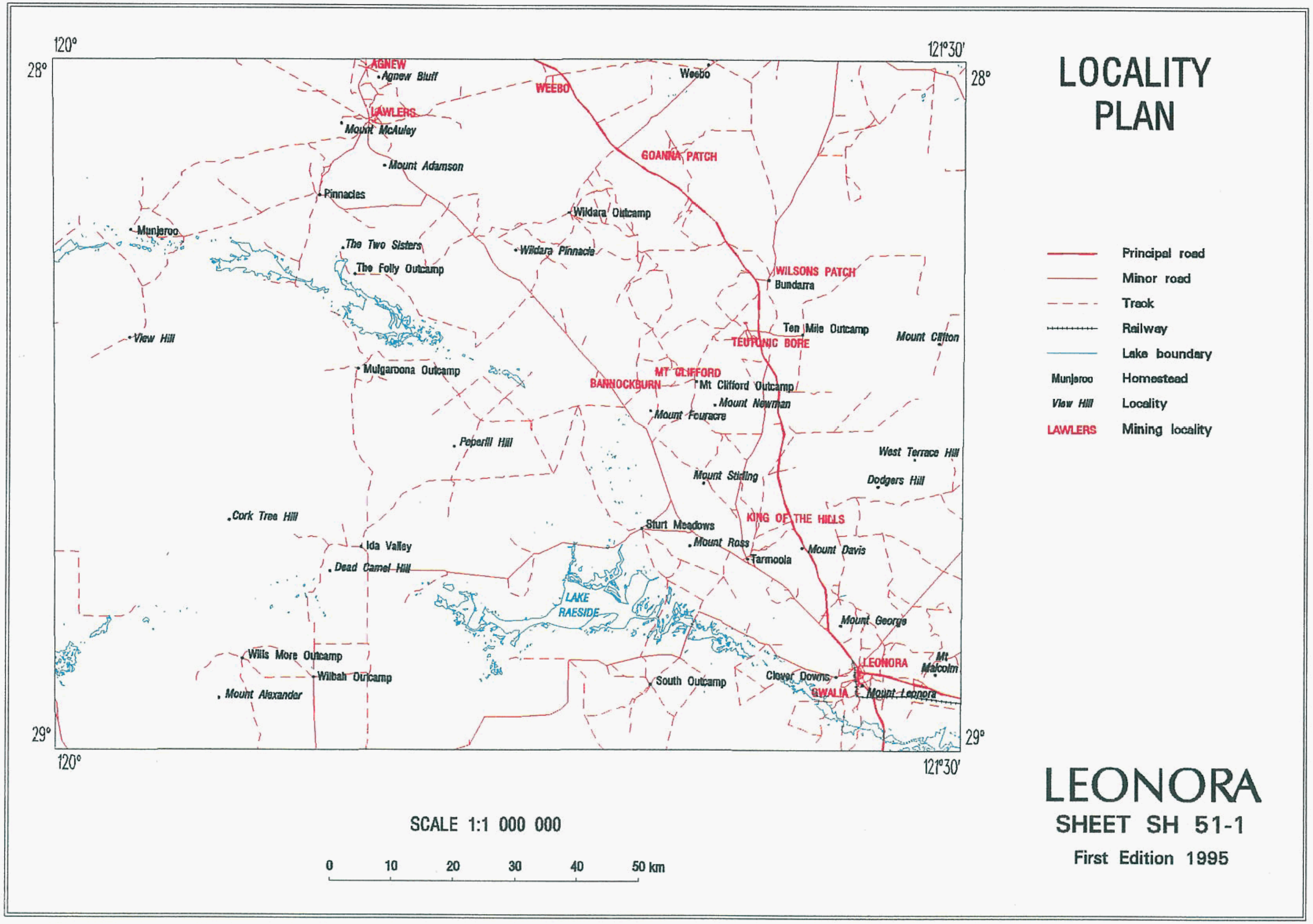

LOCALITY
PLAN
Principal road
Minor road
Track
Railway
Lake boundary
Munjeroo
Homestead
View Hill
Locality
LAWLERS
Mining locality
120°
121°30'
28°
29°
AGNEW
Agnew Bluff
LAWLERS
Mount McAuley
Mount Adamson
Pinnacles
Munjeroo
The Two Sisters
The Folly Outcamp
View Hill
Mulgaroona Outcamp
Peperill Hill
Cork Tree Hill
Ida Valley
Dead Camel Hill
Wills More Outcamp
Wilbah Outcamp
Mount Alexander
WEEBO
Weebo
GOANNA PATCH
Wildara Outcamp
Wildara Pinnacle
WILSONS PATCH
Bundarra
Ten Mile Outcamp
TEUTONIC BORE
Mount Clifton
MT CLIFFORD
BANNOCKBURN
Mt Clifford Outcamp
Mount Newman
Mount Fouracre
West Terrace Hill
Dodgers Hill
Mount Stirling
KING OF THE HILLS
Sturt Meadows
Mount Ross
Tarmoola
Mount Davis
LAKE RAESIDE
Mount George
LEONORA
Mt Malcolm
Clover Downs
GWALIA
Mount Leonora
South Outcamp
SCALE 1:1 000 000
0
10
20
30
40
50 km
LEONORA
SHEET SH 51-1
First Edition 1995

Figure 1.

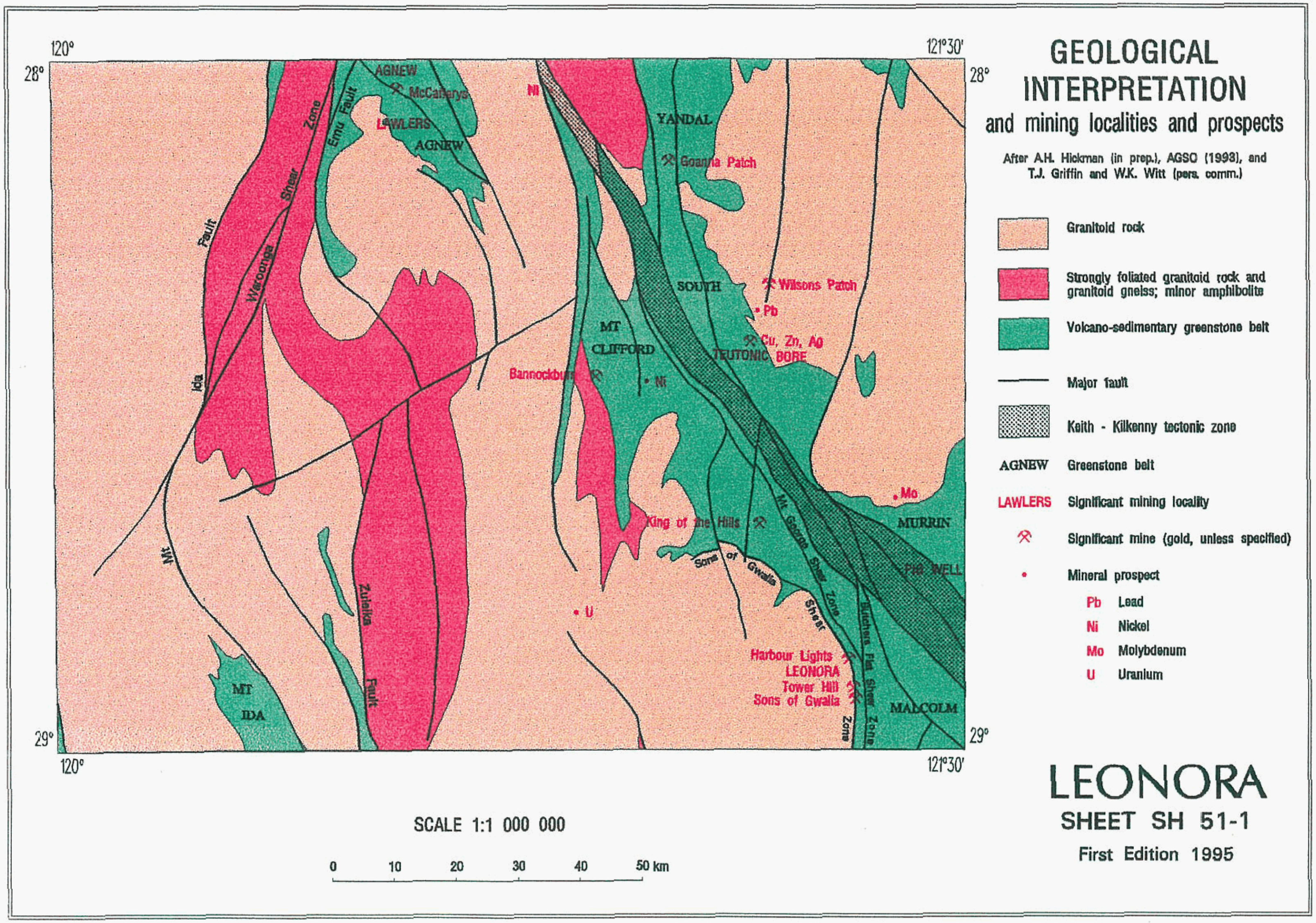

GEOLOGICAL INTERPRETATION
and mining localities and prospects
After A.H. Hickman (in prep.), AGSO (1993), and T.J. Griffin and W.K. Witt (pers. comm.)
Granitoid rock
Strongly foliated granitoid rock and granitoid gneiss; minor amphibolite
Volcano-sedimentary greenstone belt
Major fault
Keith - Kilkenny tectonic zone
AGNEW Greenstone belt
LAWLERS Significant mining locality
Significant mine (gold, unless specified)
Mineral prospect
Pb Lead
Ni Nickel
Mo Molybdenum
U Uranium
LEONORA
SHEET SH 51-1
First Edition 1995
SCALE 1:1 000 000
0 10 20 30 40 50 km
120°
121°30'
28°
29°
AGNEW
McCaffery's
LAWLERS
YANDAL
Goanna Patch
SOUTH
Wilsons Patch
Pb
Cu, Zn, Ag
TEUTONIC BORE
MT CLIFFORD
Bannockburn
Ni
Mo
MURRIN
King of the Hills
Sons of Gwalia
PIG WELL
U
Harbour Lights
LEONORA
Tower Hill
Sons of Gwalia
MALCOLM
MT IDA
Emu Fault
Zone
Shear
Waroonga
Fault
Ida
Mt
Zuleika
Fault
Mt George Shear Zone
Shear Zone
Bunchers Flat Shear Zone

Figure 2.

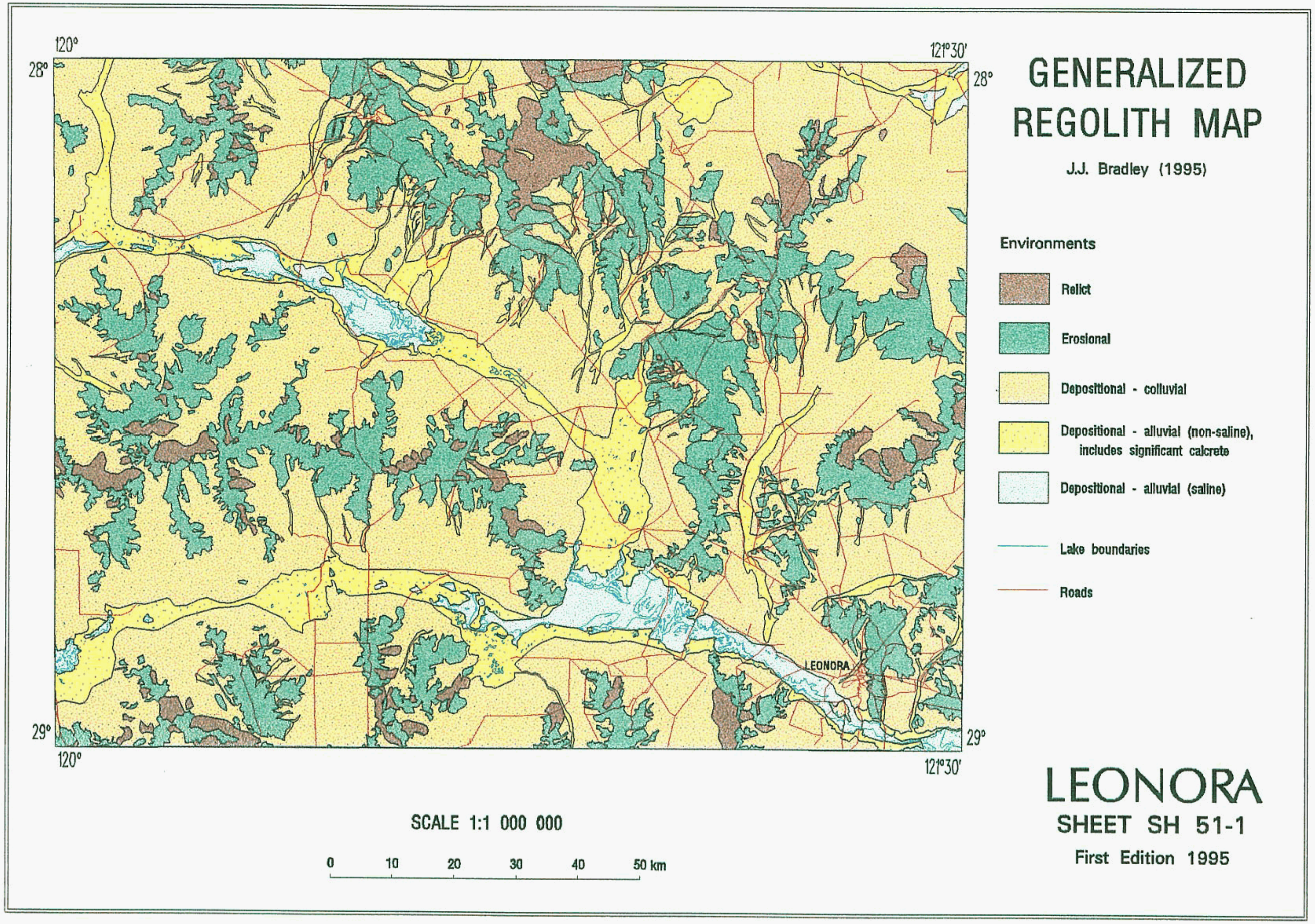

GENERALIZED REGOLITH MAP
J.J. Bradley (1995)
Environments
Relict
Erosional
Depositional - colluvial
Depositional - alluvial (non-saline), includes significant calcrete
Depositional - alluvial (saline)
Lake boundaries
Roads
LEONORA
120°
121°30'
28°
29°
SCALE 1:1 000 000
0 10 20 30 40 50 km
LEONORA
SHEET SH 51-1
First Edition 1995

Figure 3.

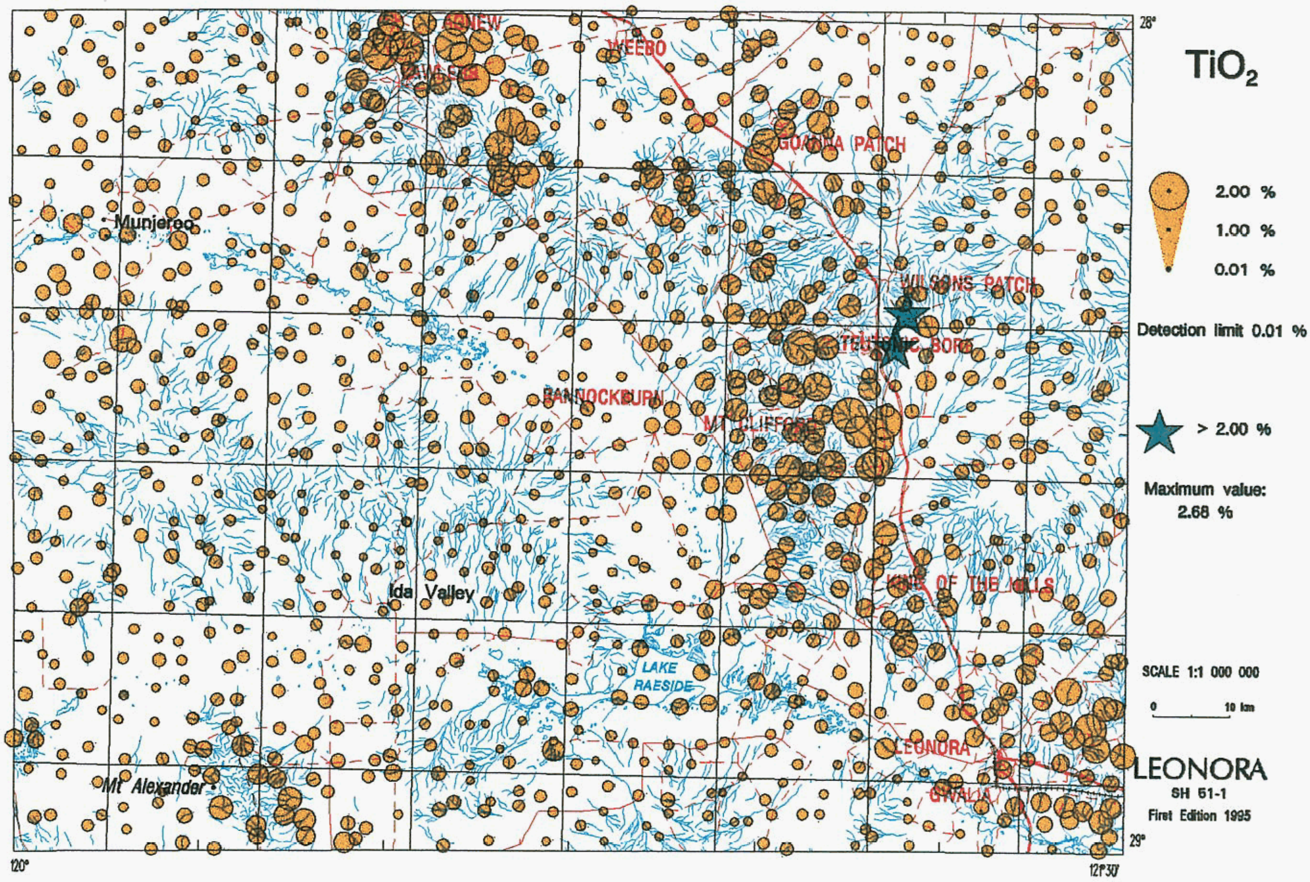



Figure 4.

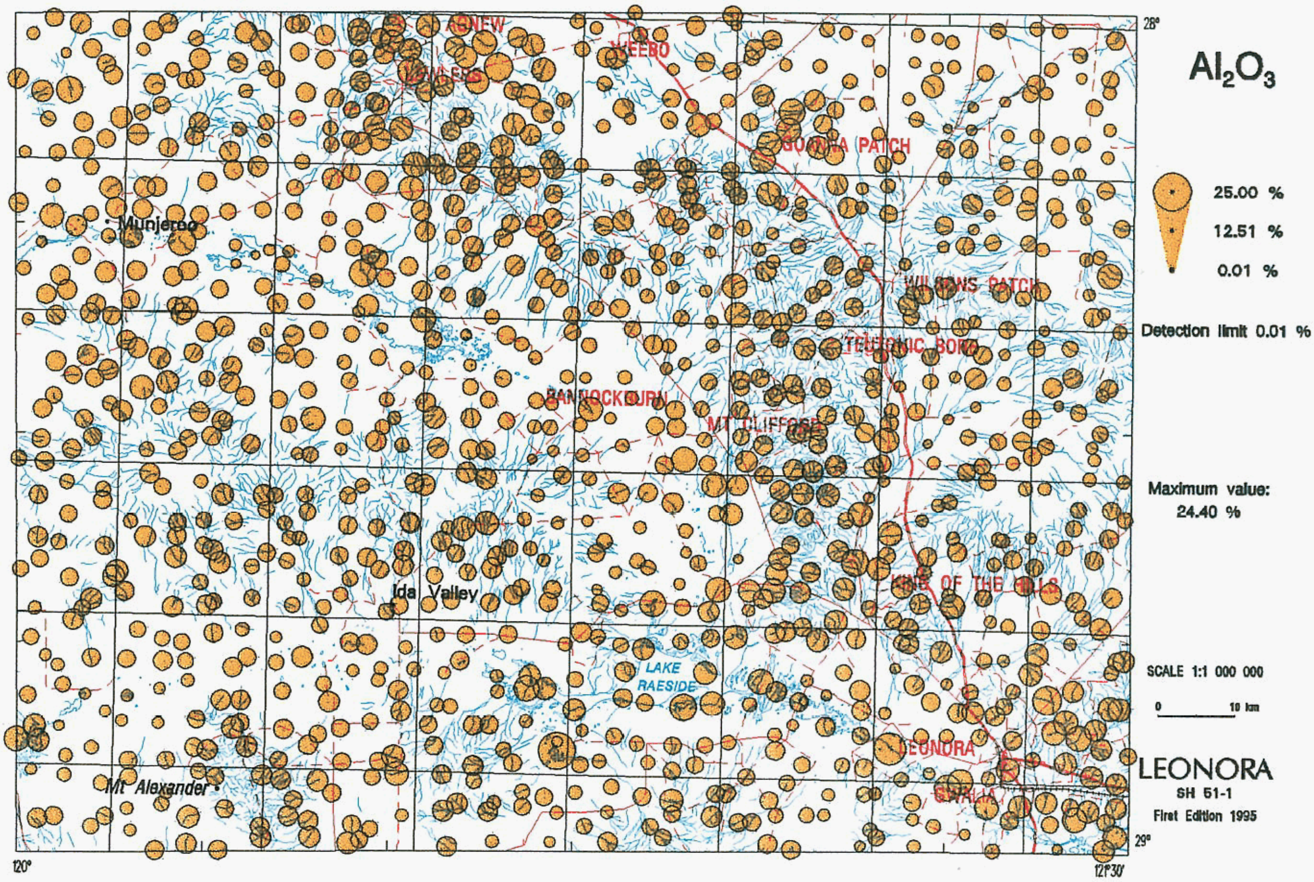



Figure 5.

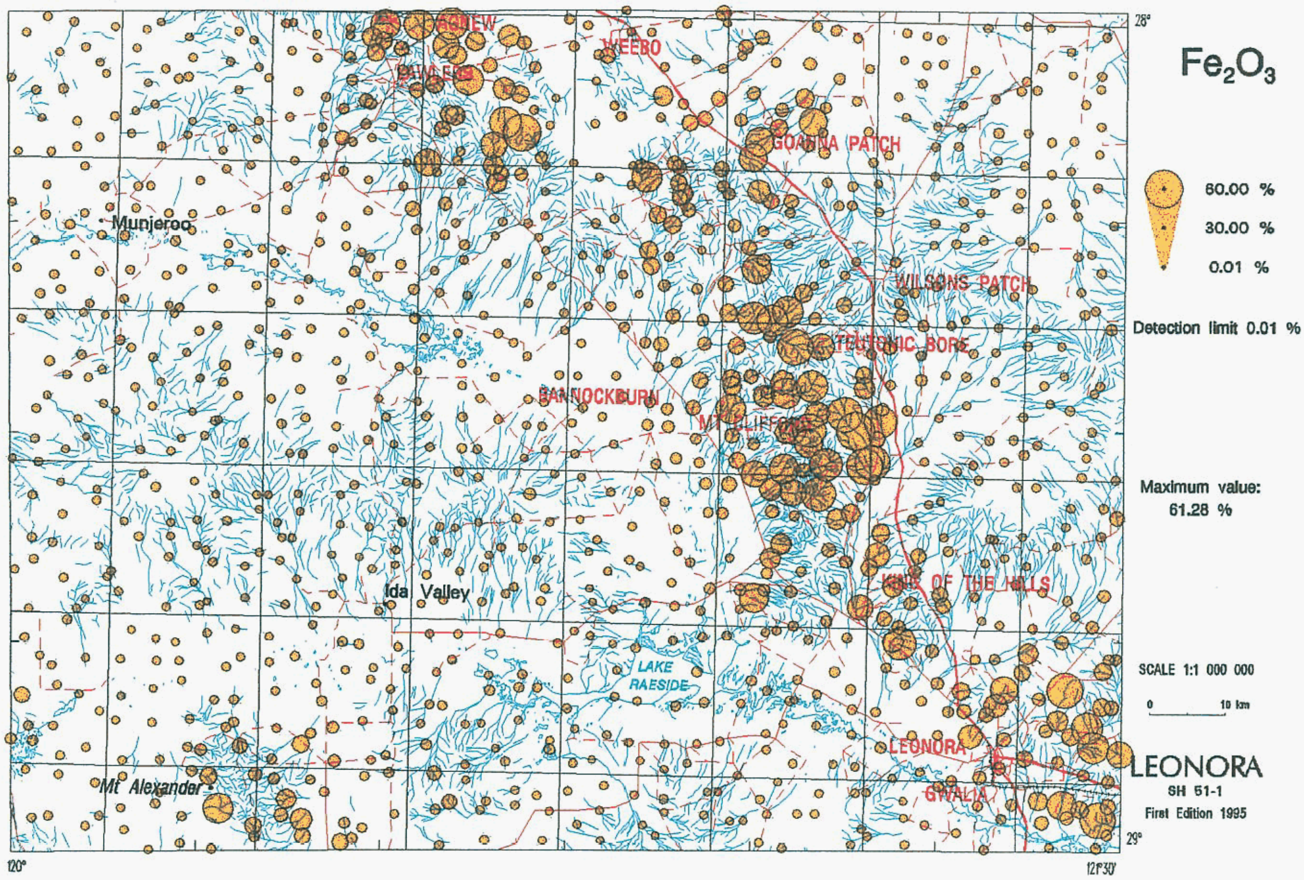



Figure 6.

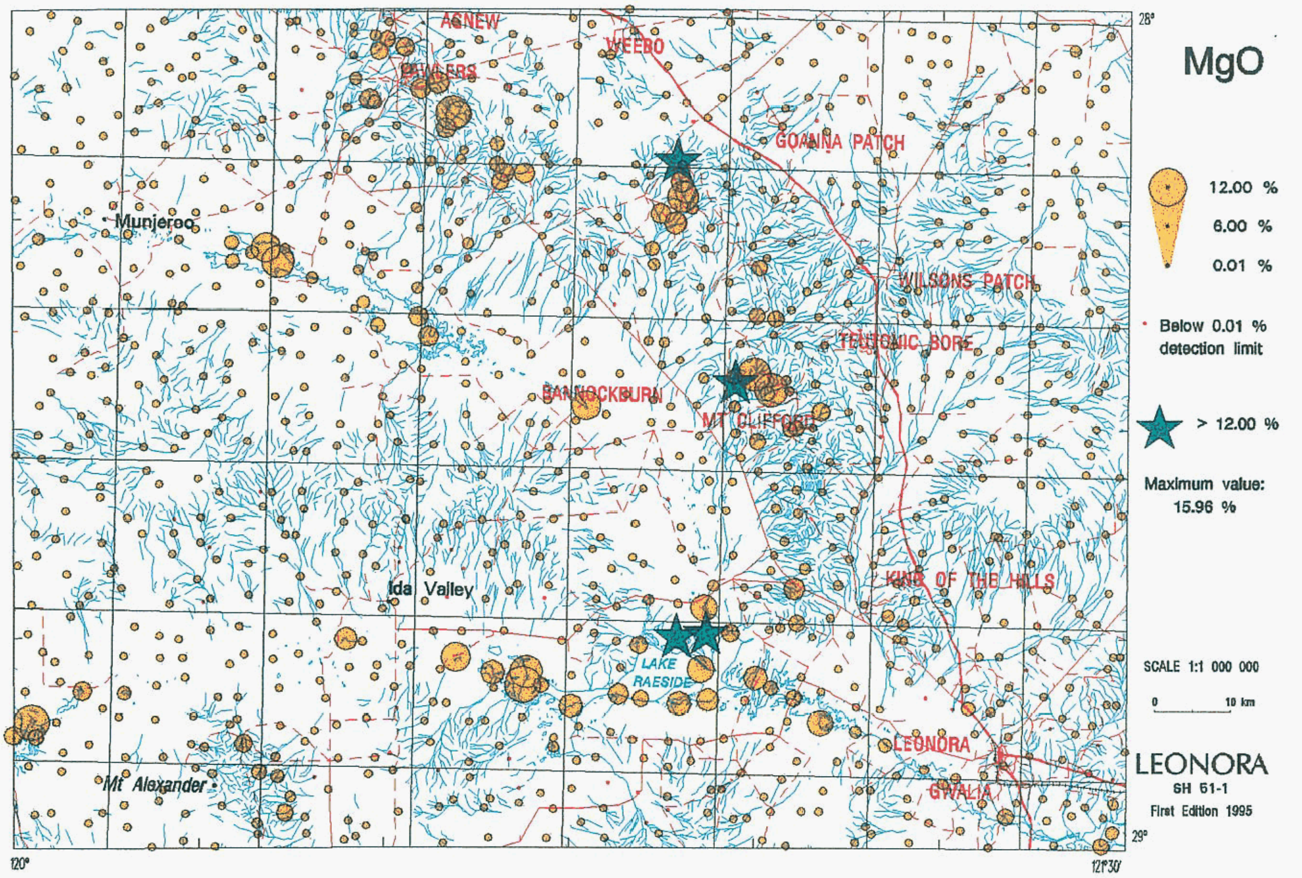



Figure 7.

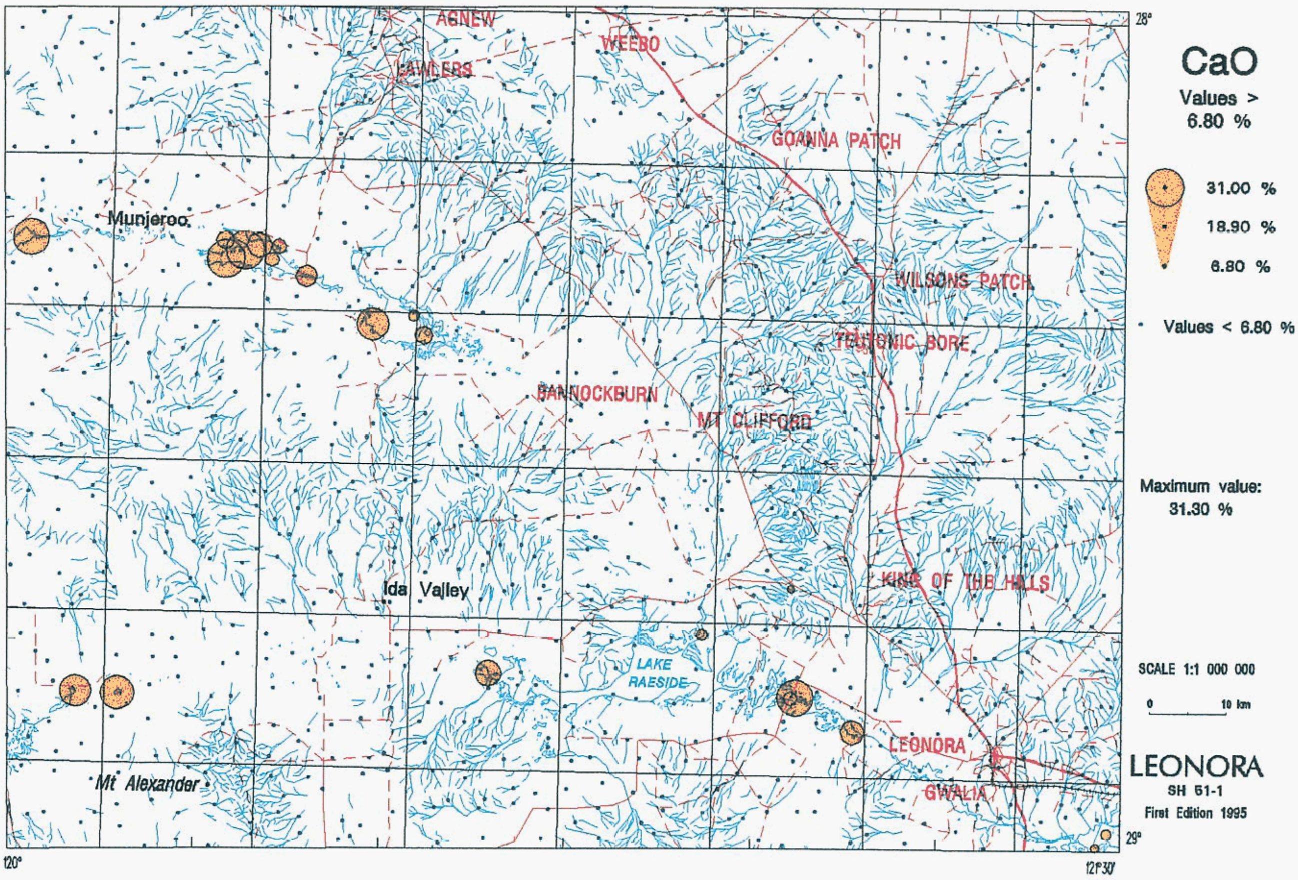



Figure 8.

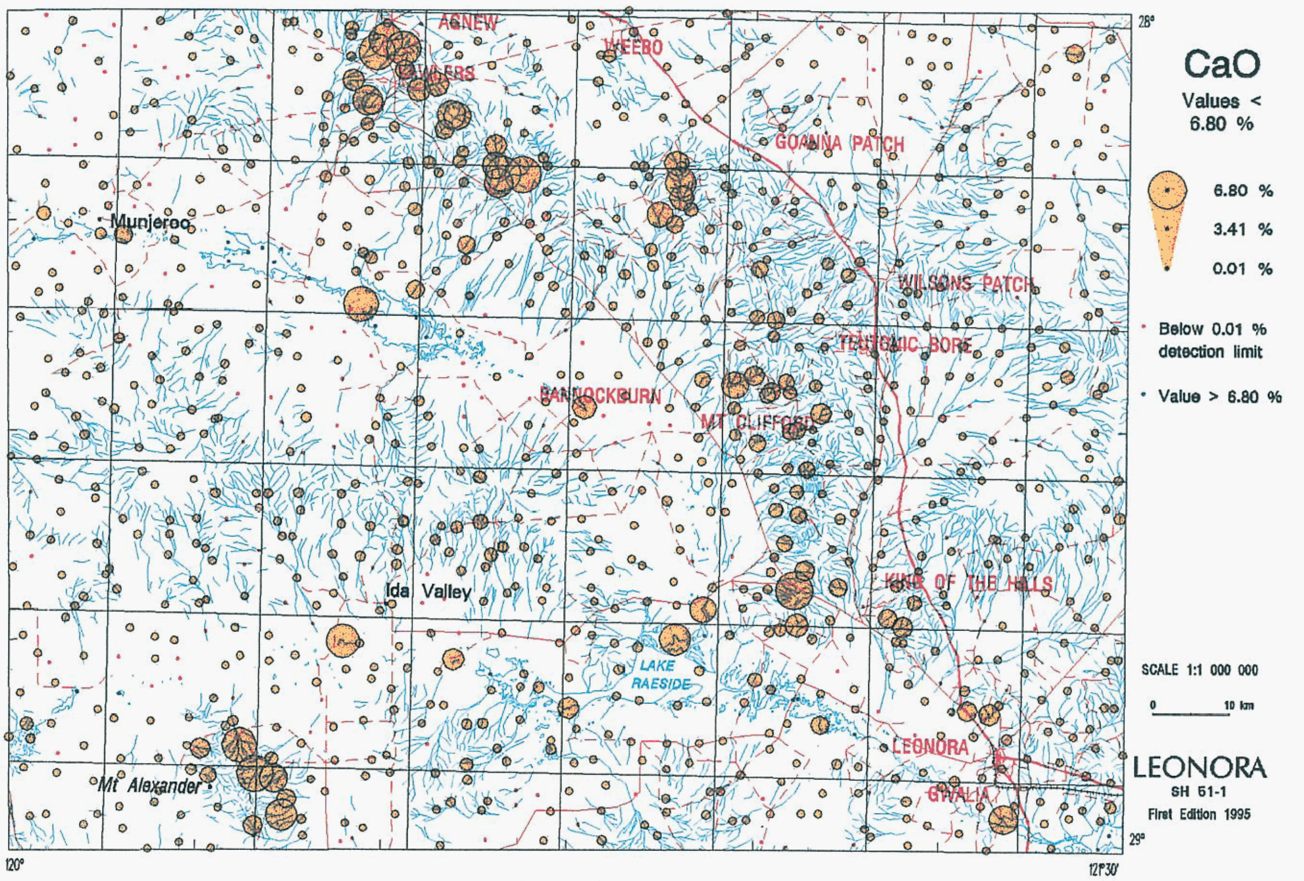



Figure 9.

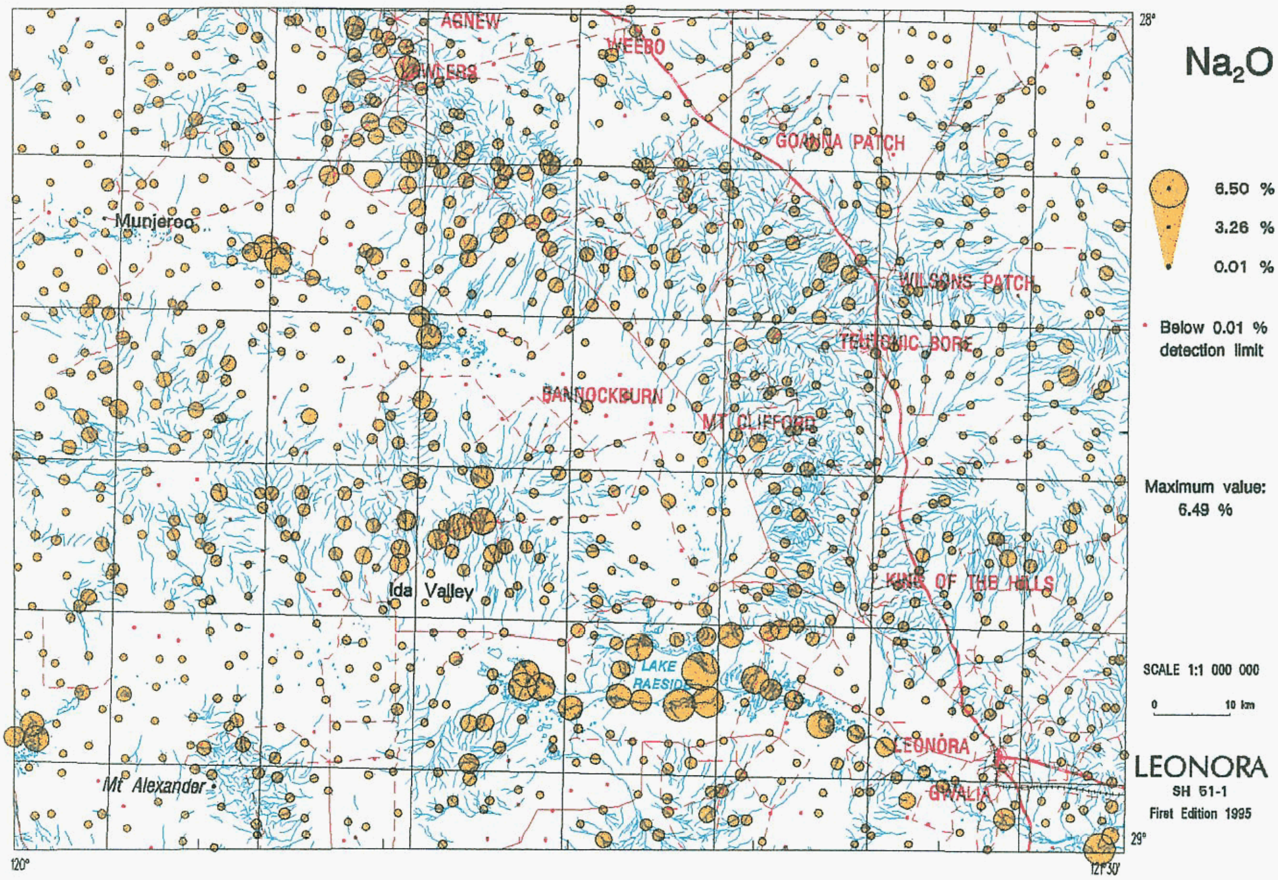



Figure 10.

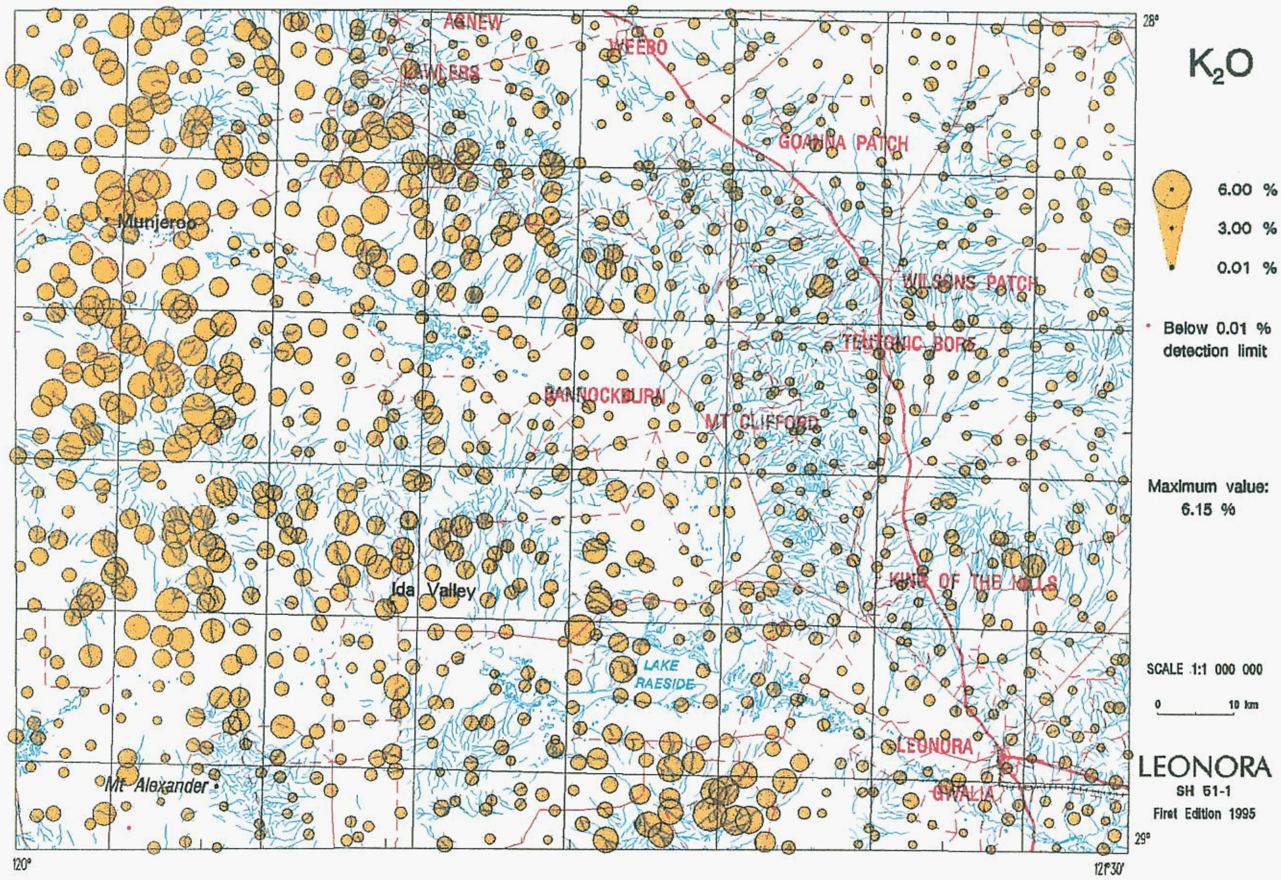



Figure 11.

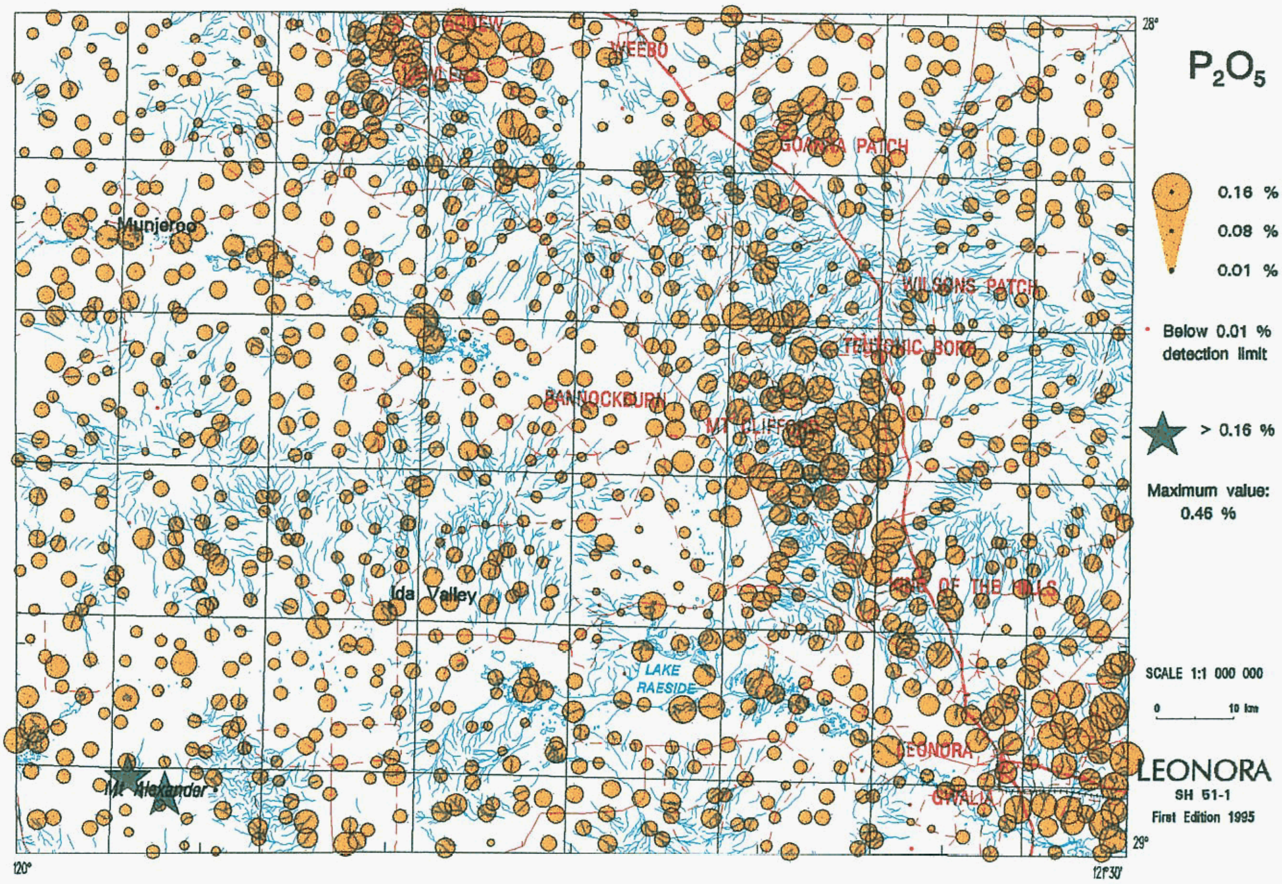



Figure 12.

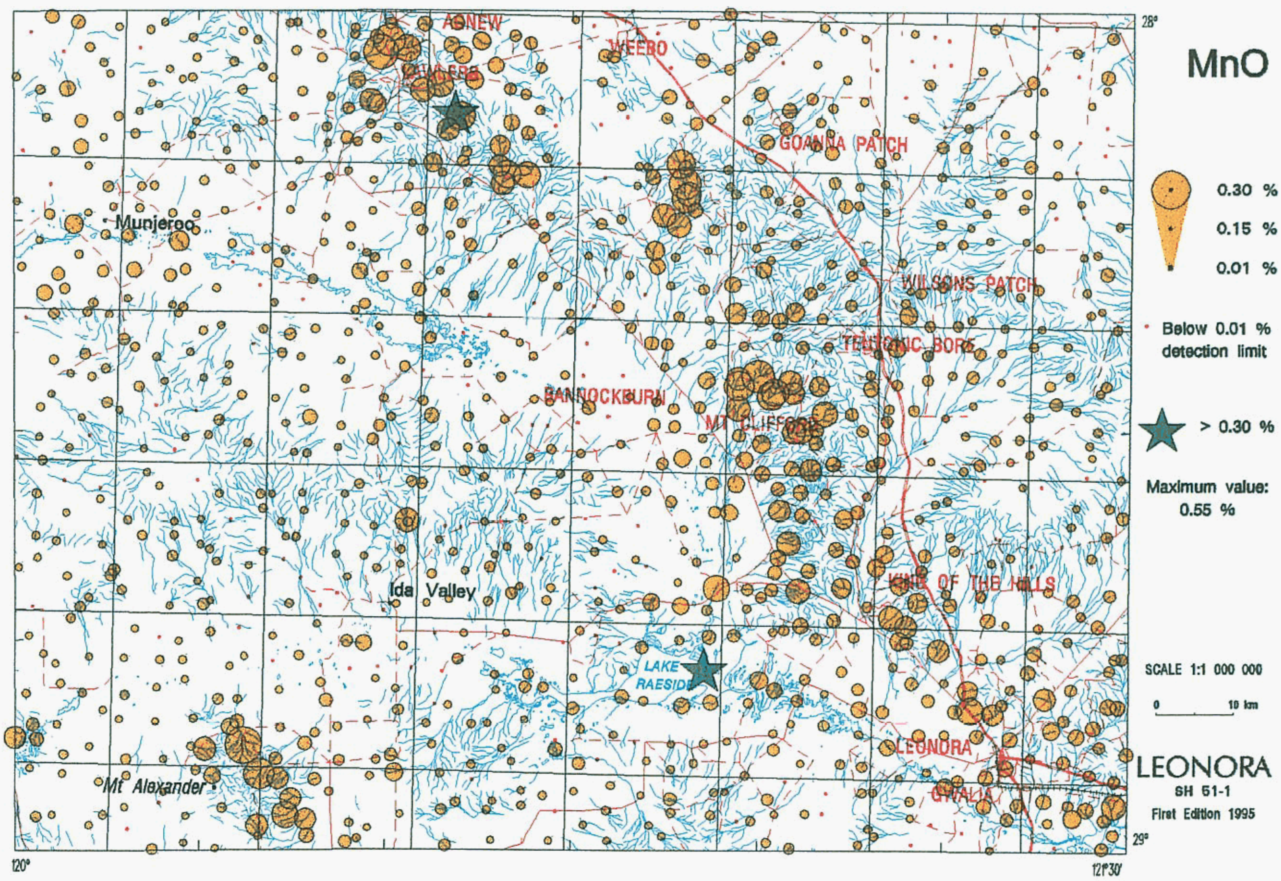



Figure 13.

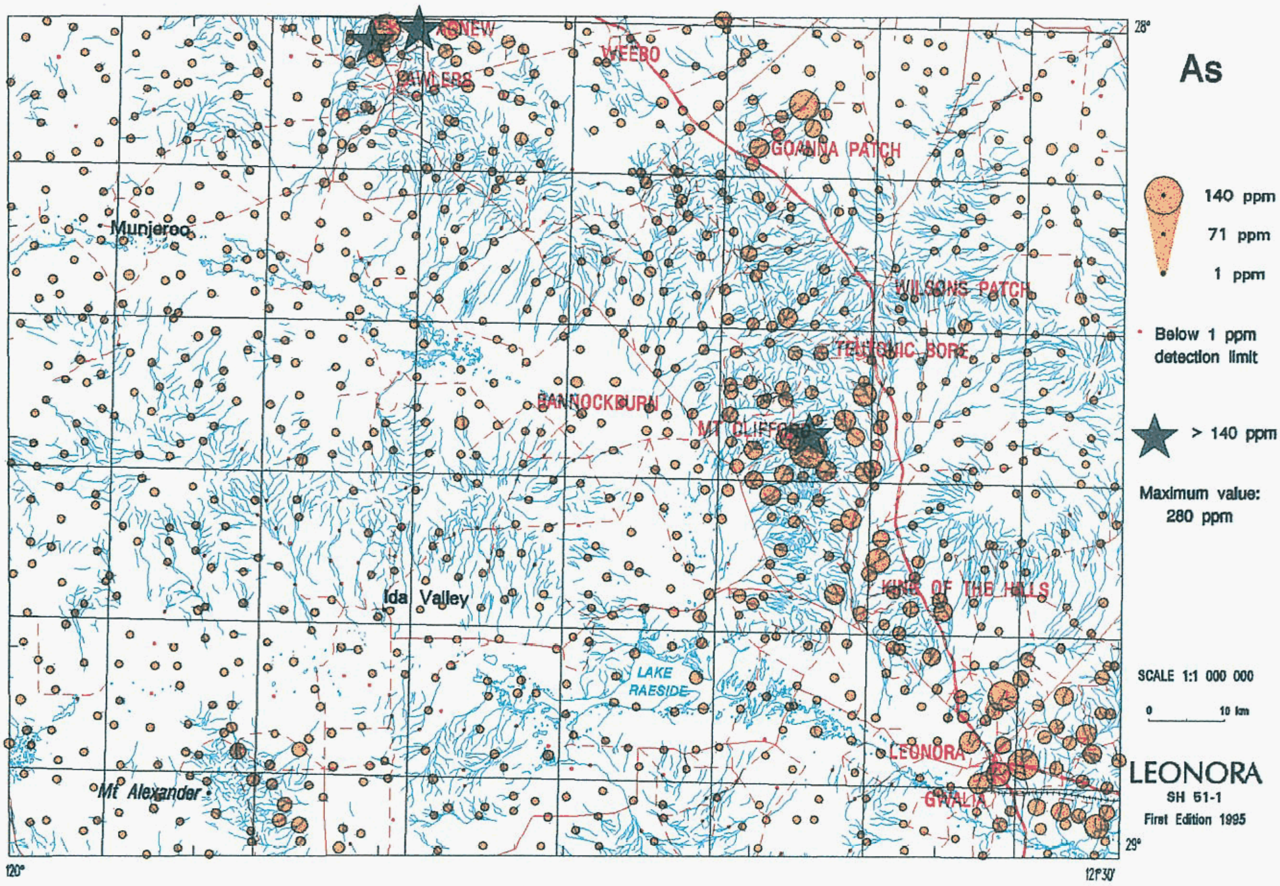



Figure 14.

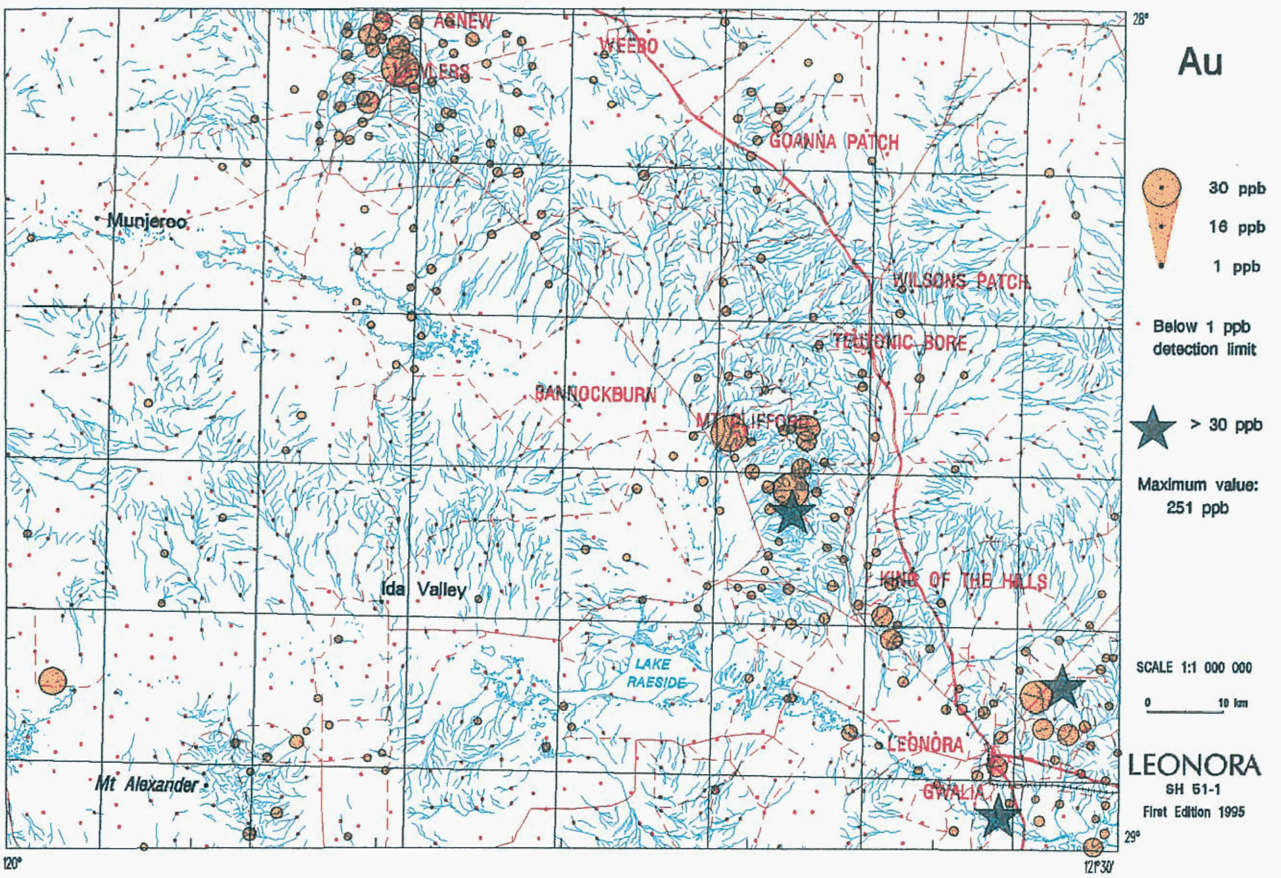



Figure 15.

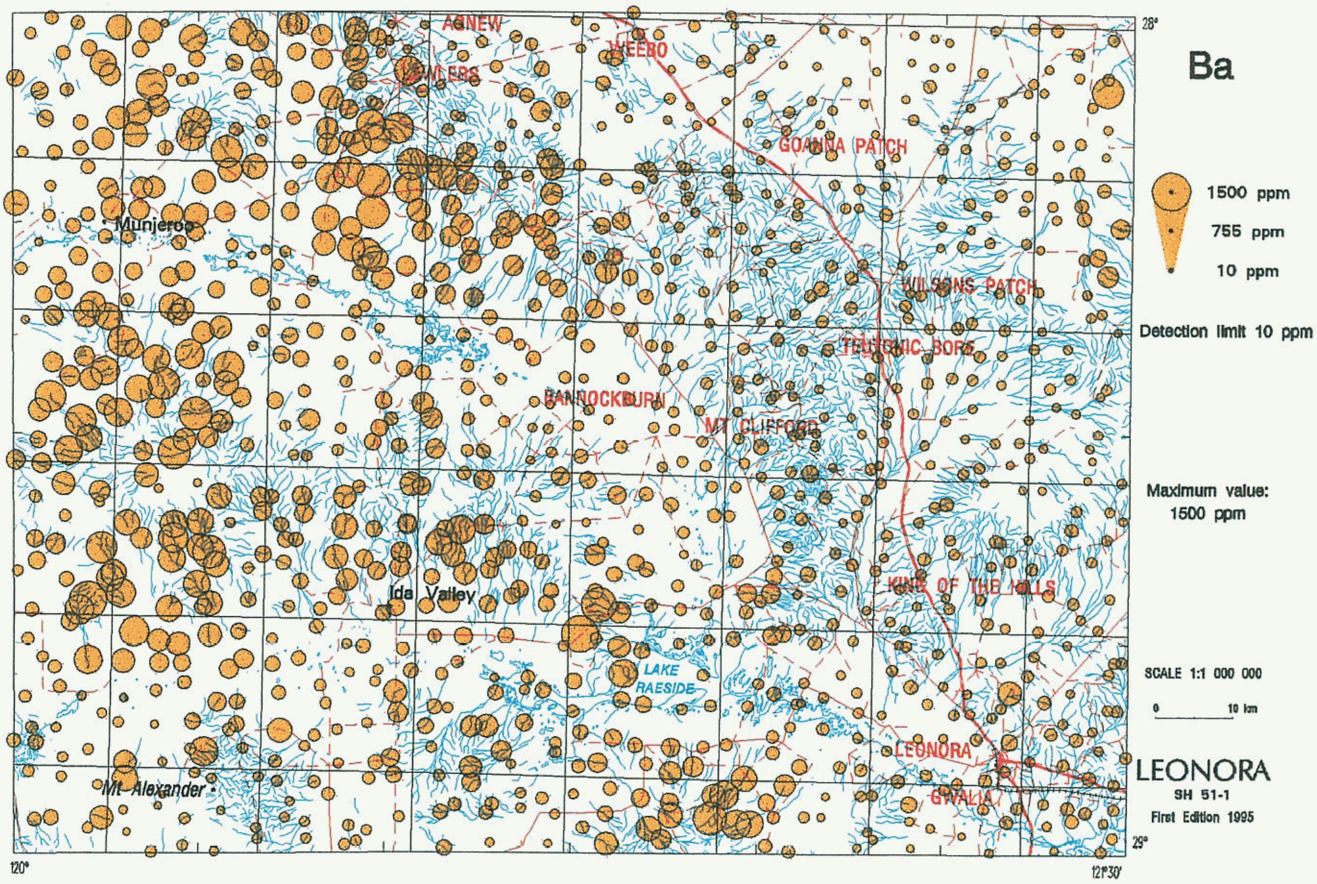



Figure 16.

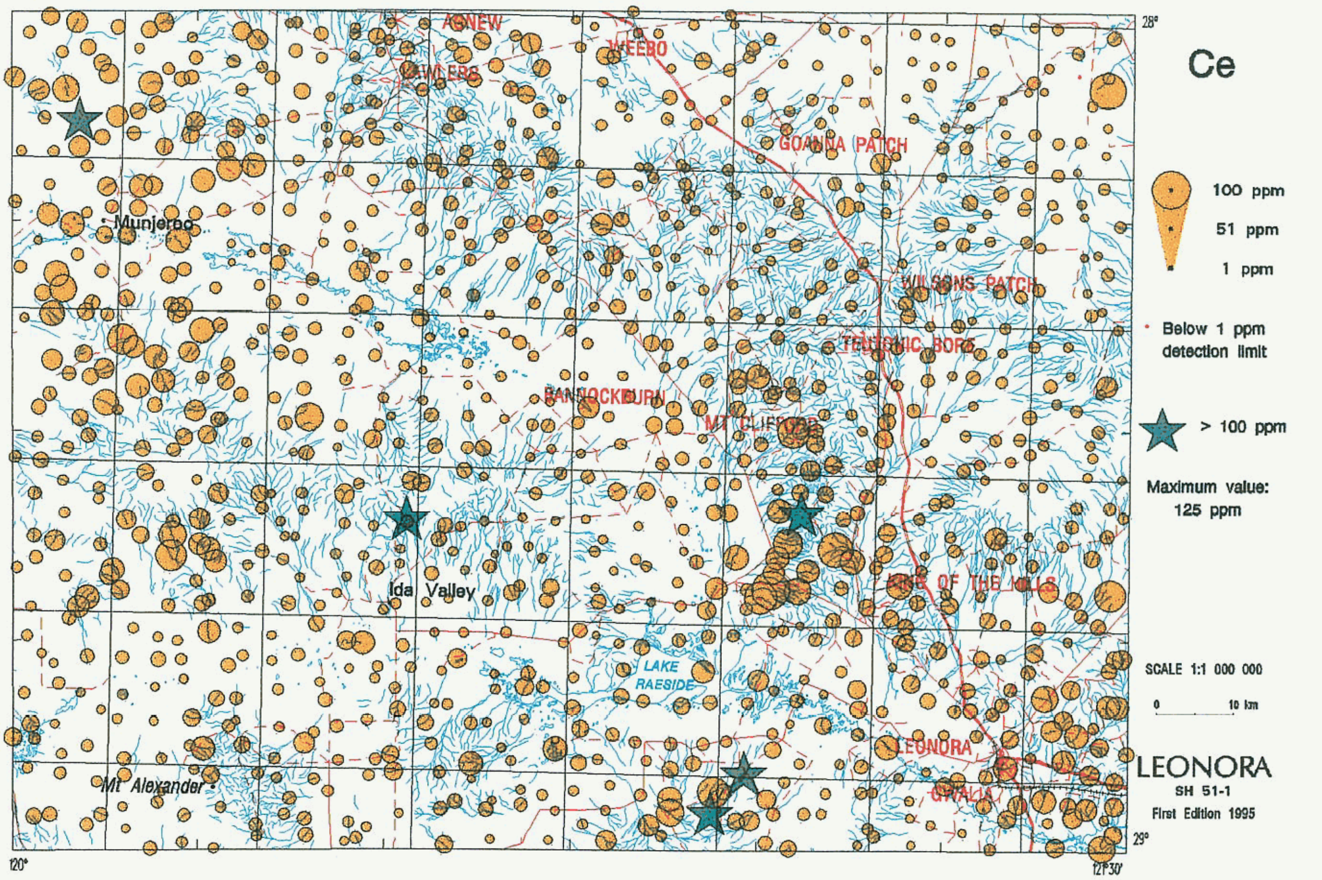



Figure 17.

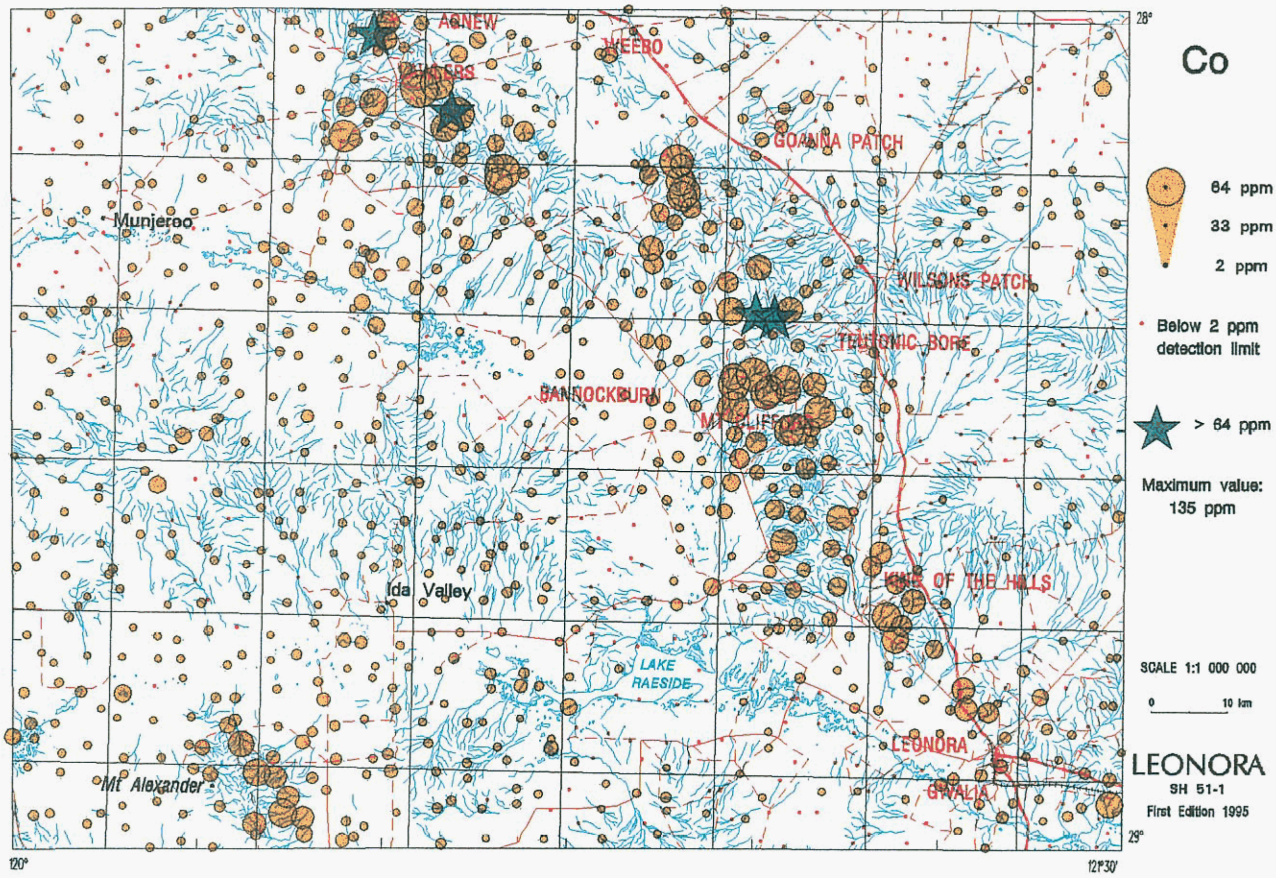



Figure 18.

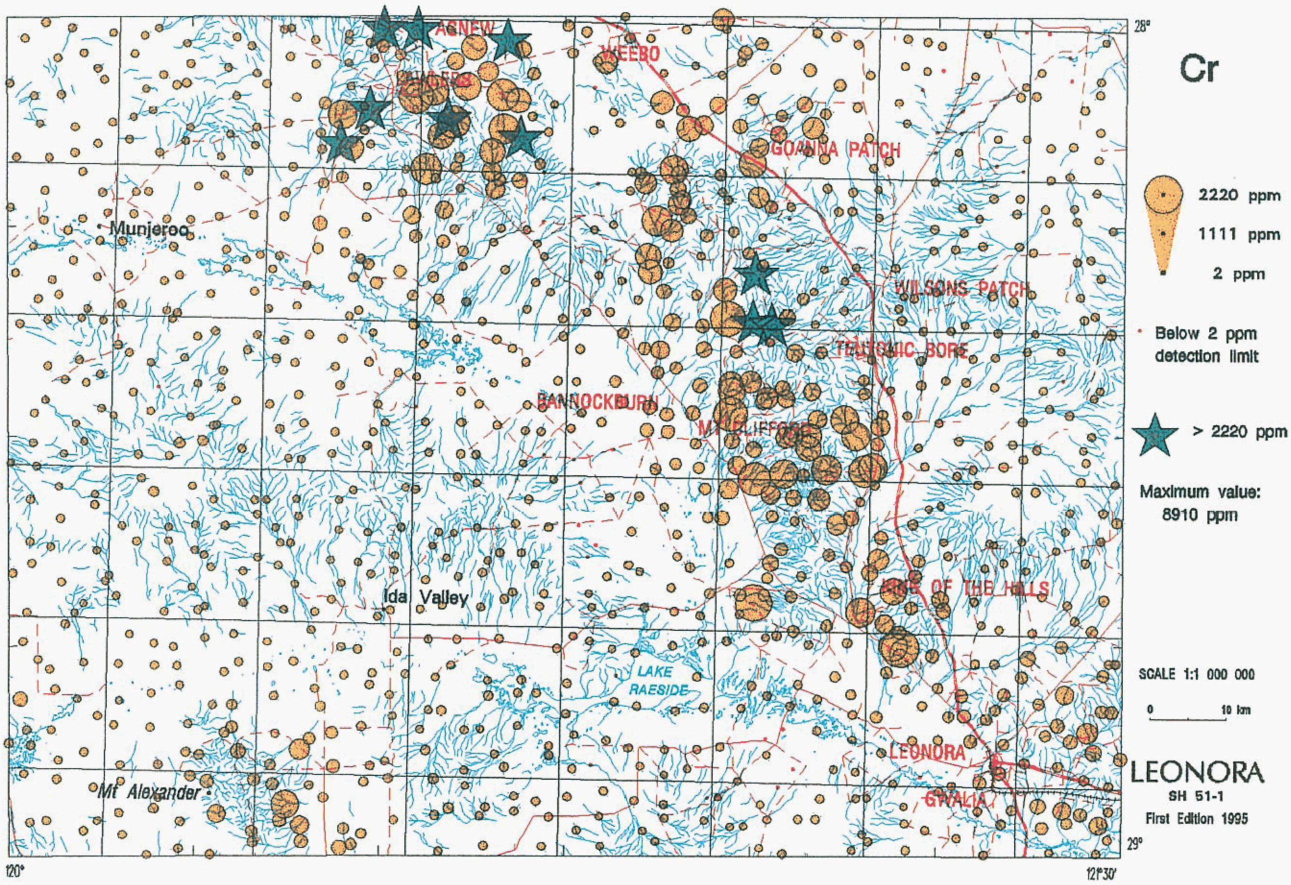



Figure 19.

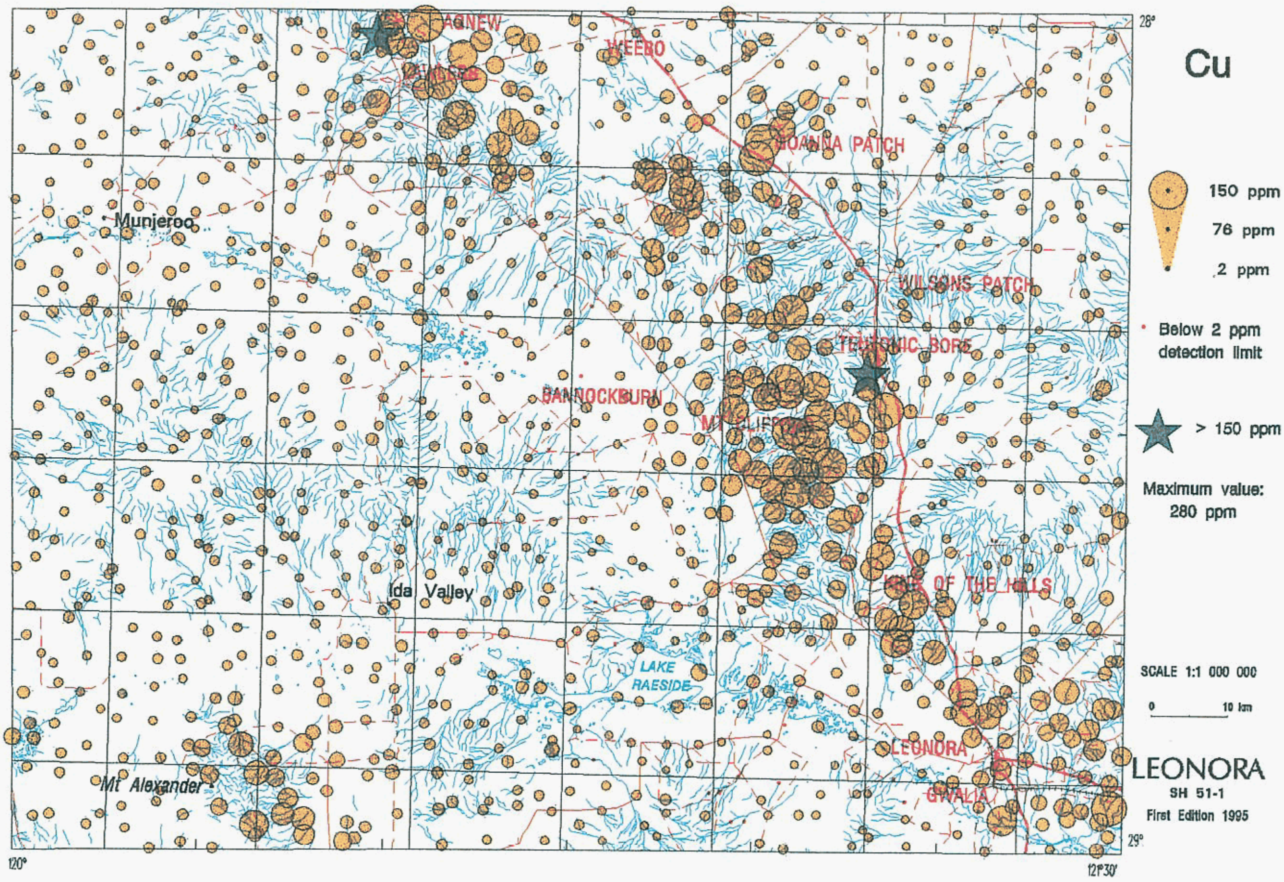


Figure 20.

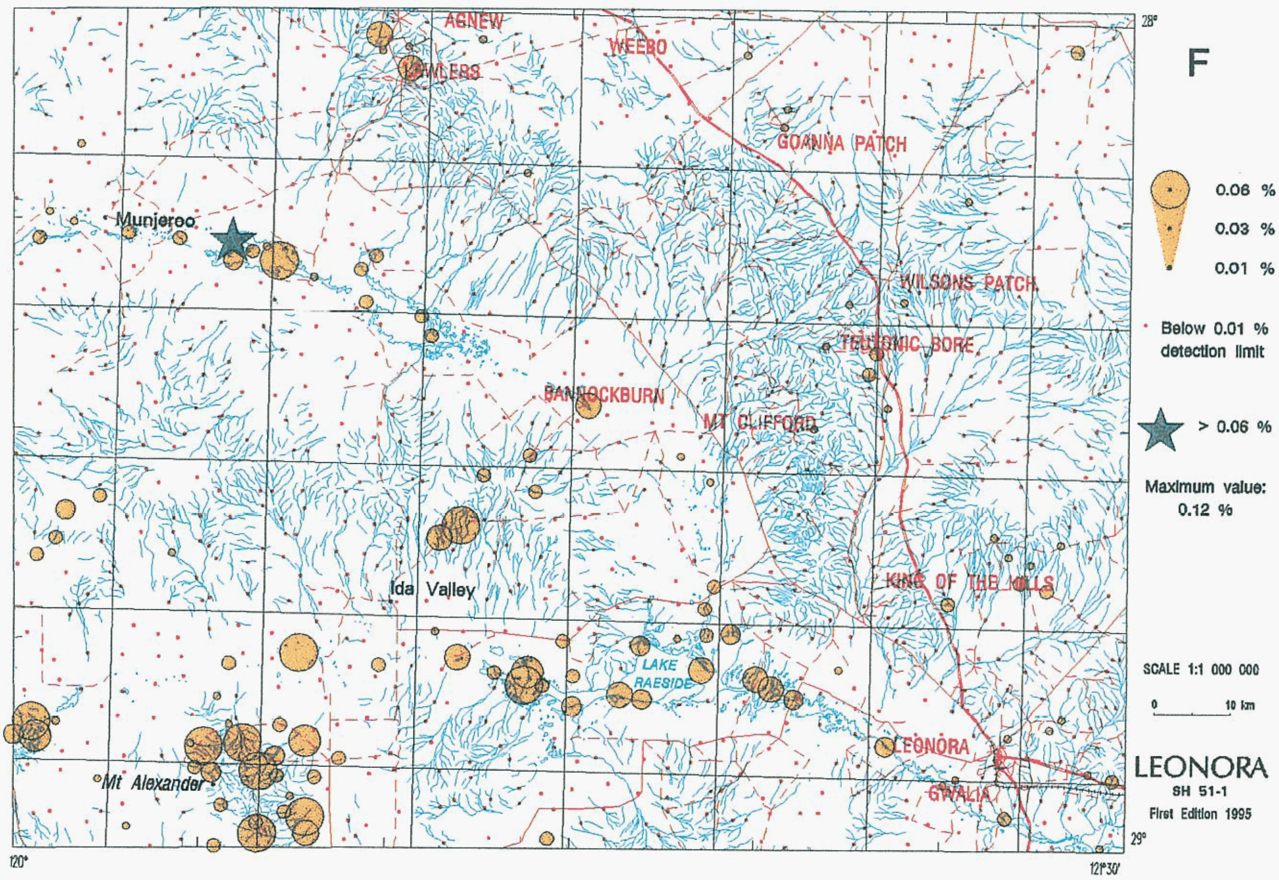


Figure 21.

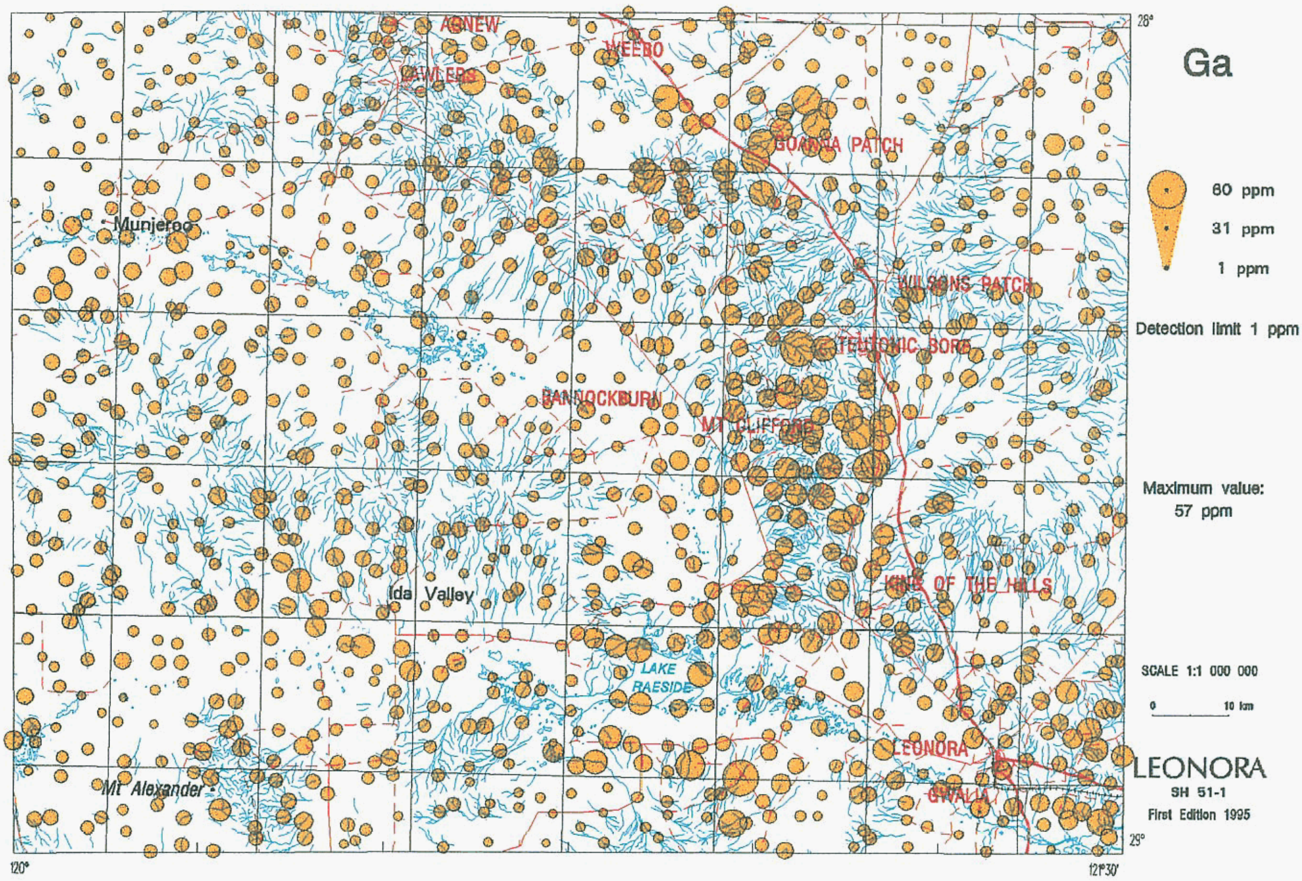



Figure 22.

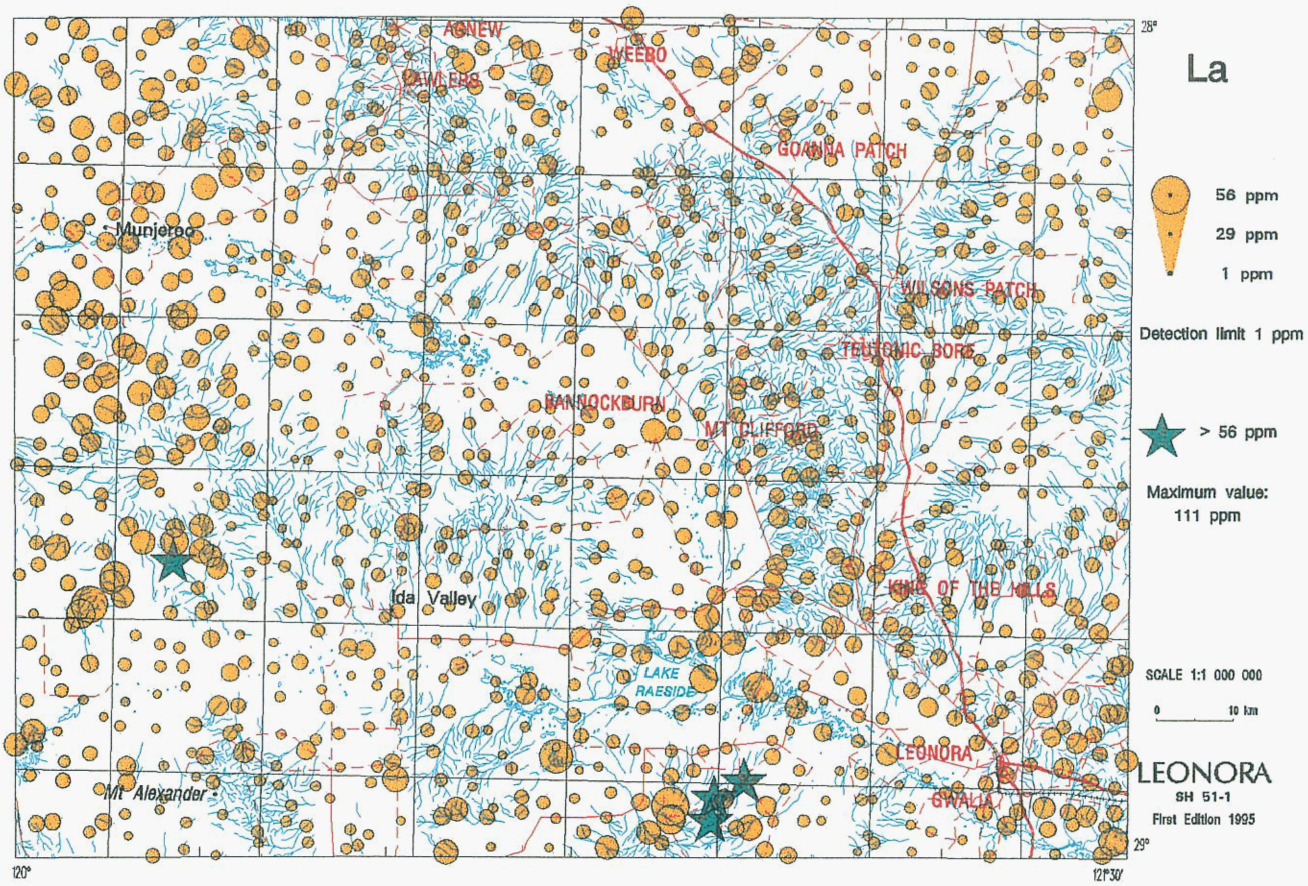



Figure 23.

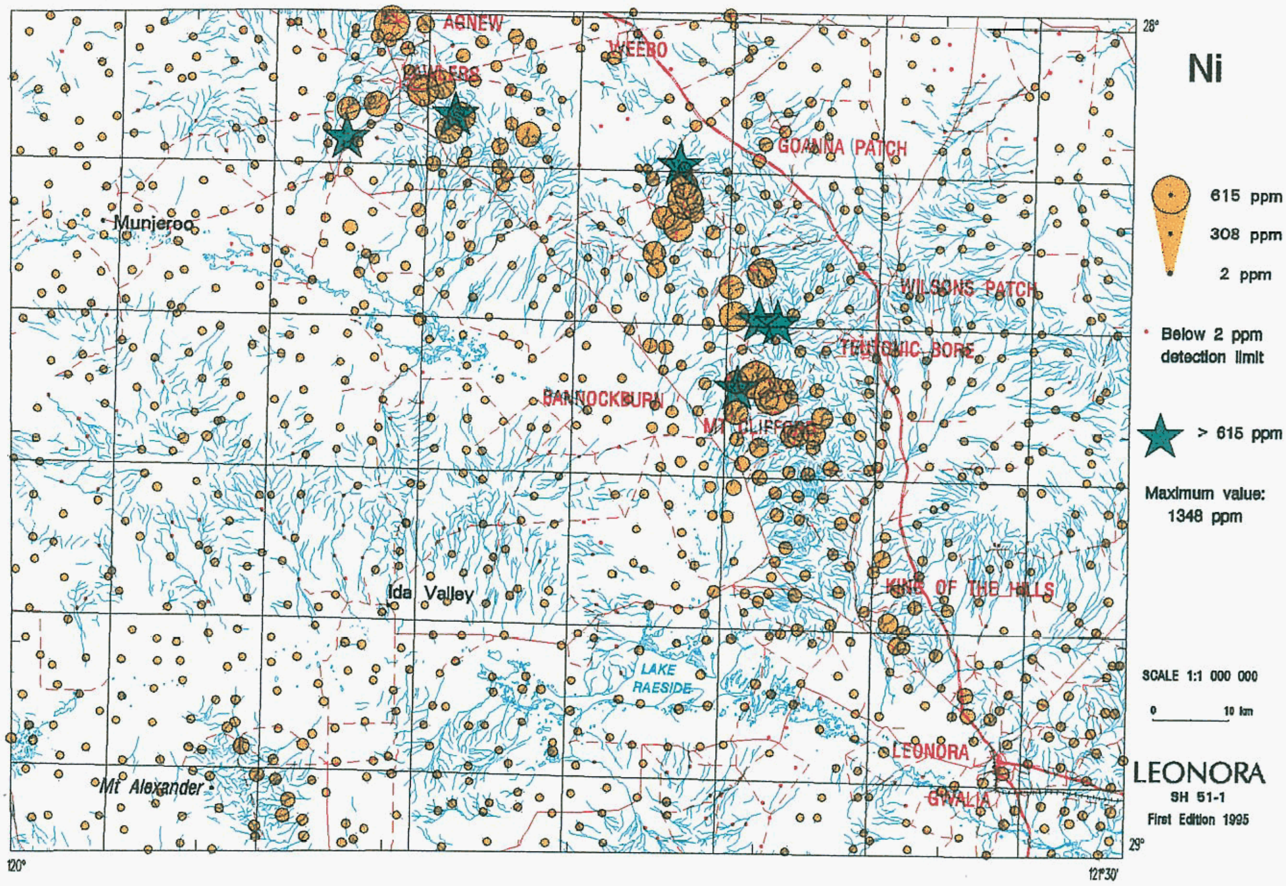



Figure 24.

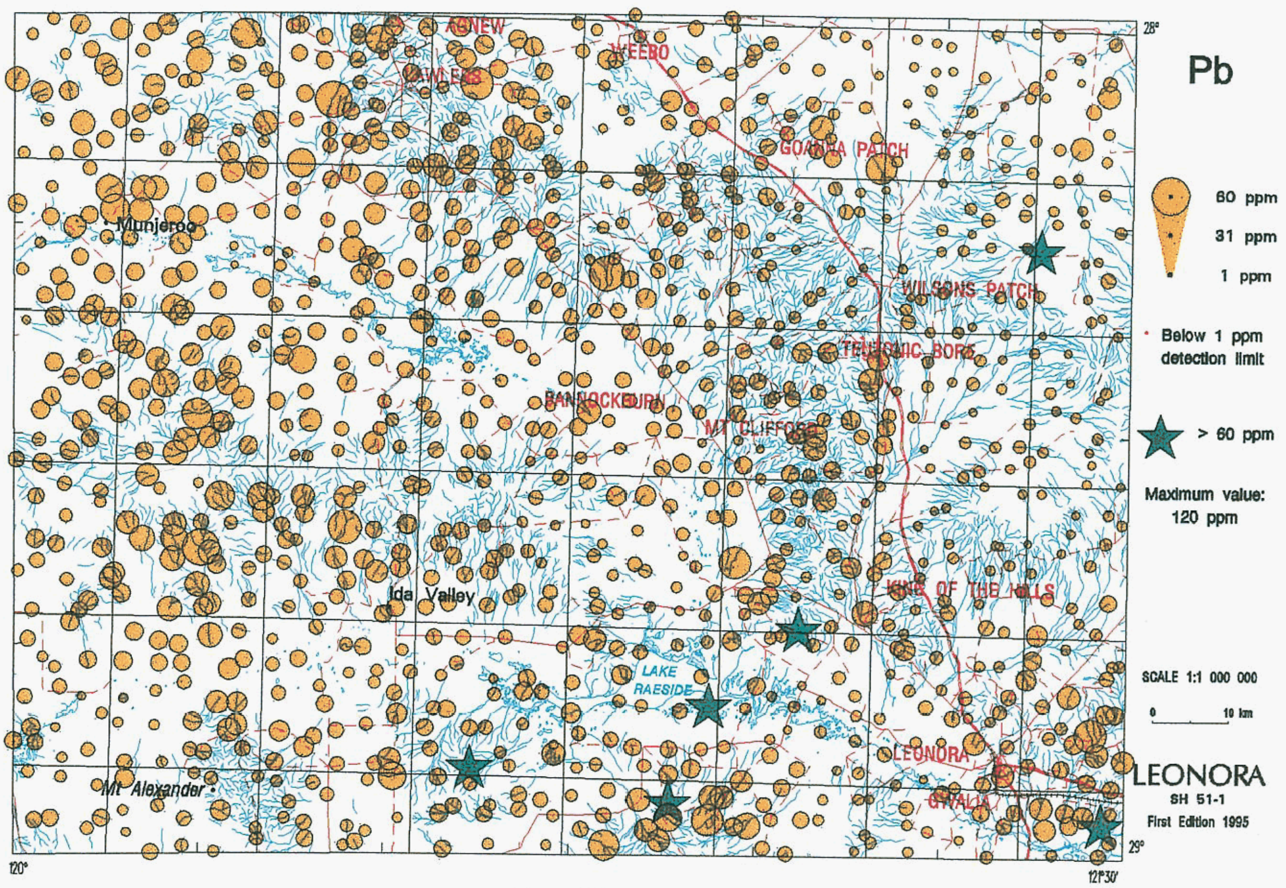



Figure 25.

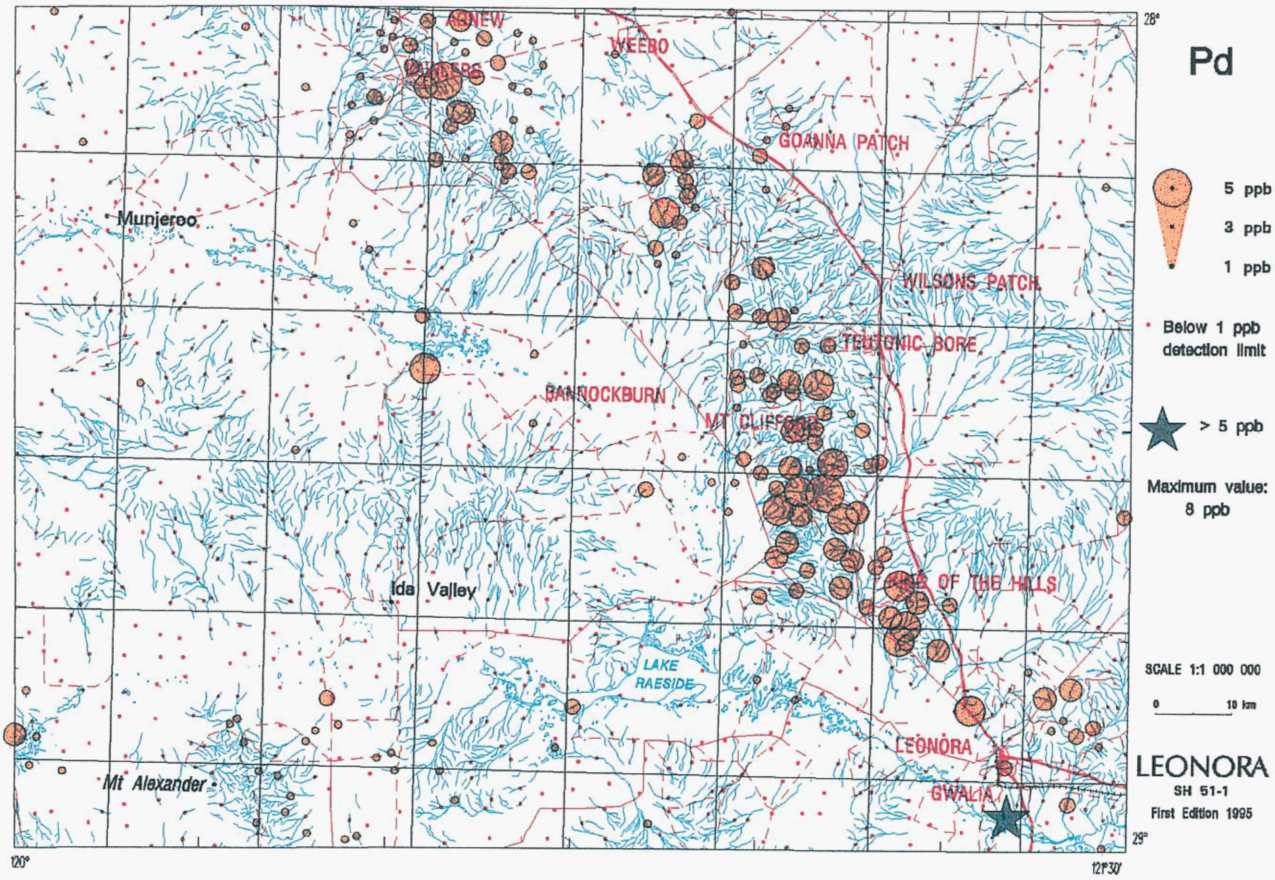



Figure 26.

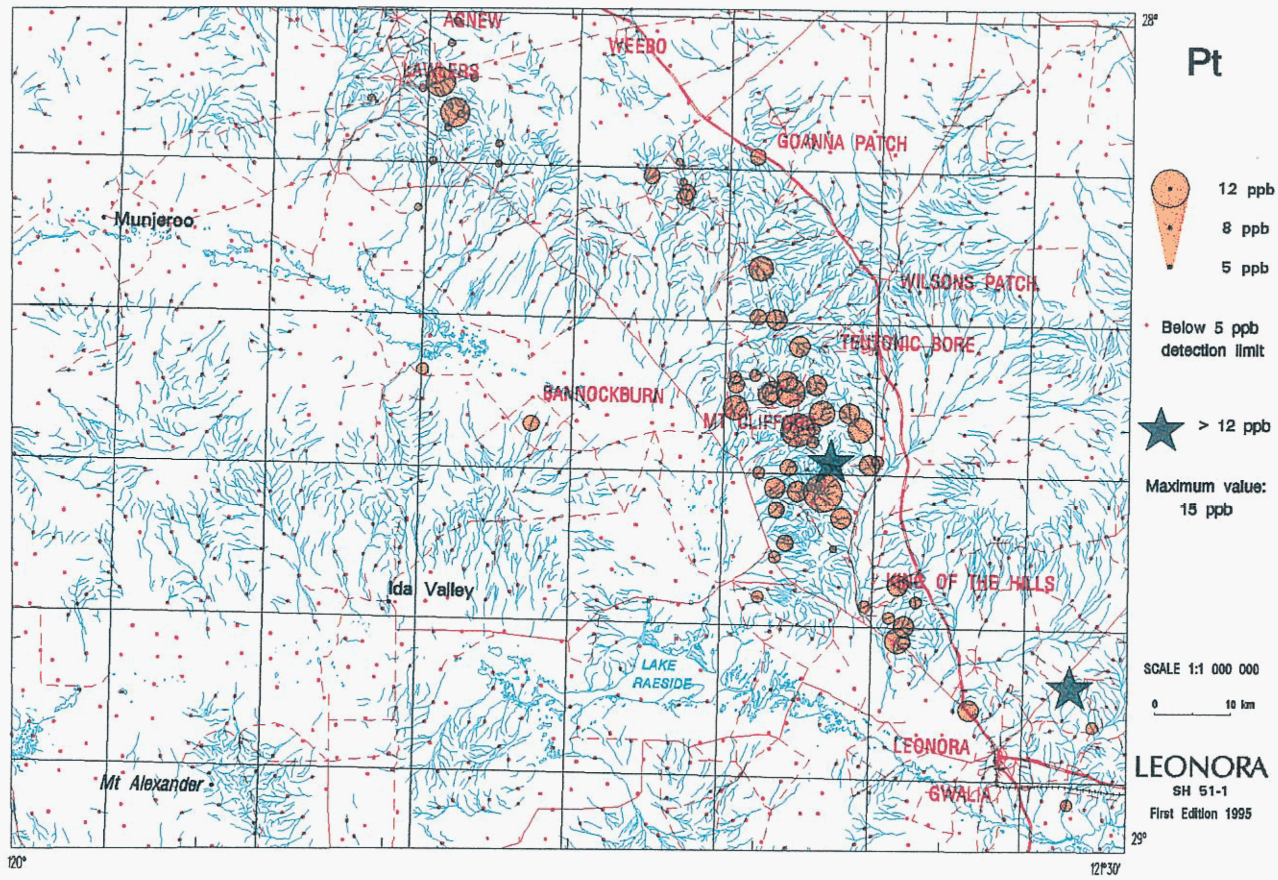



Figure 27.

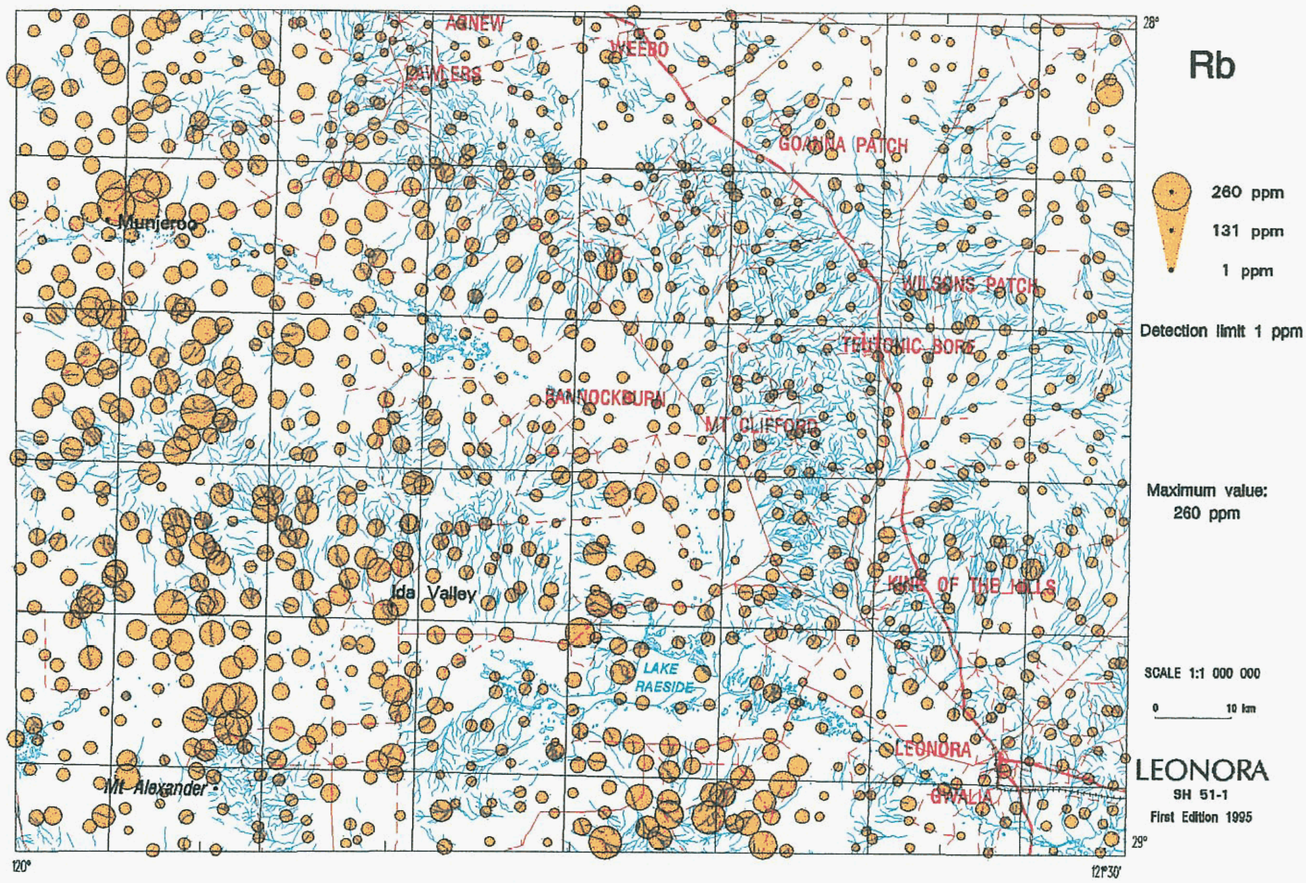



Figure 28.

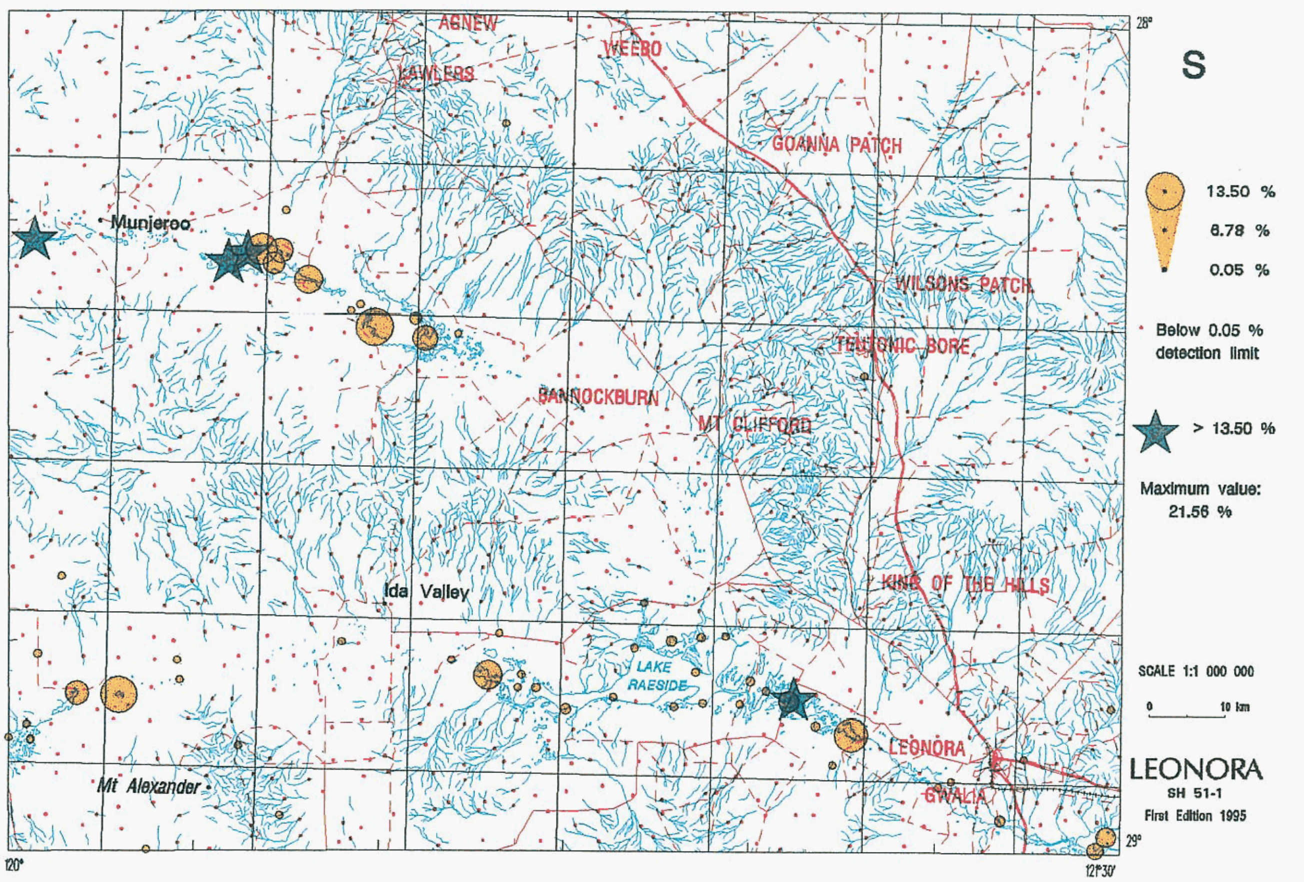



Figure 29.

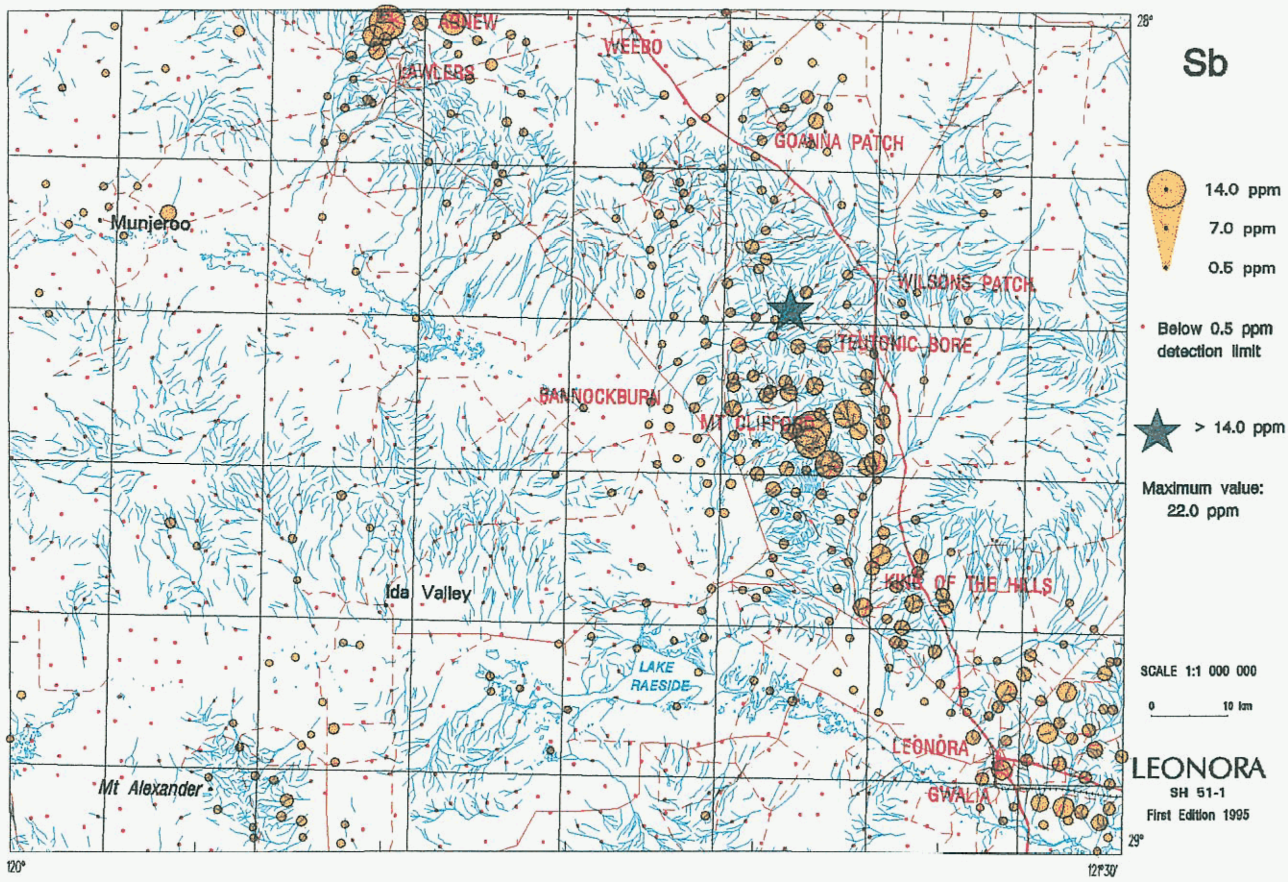



Figure 30.

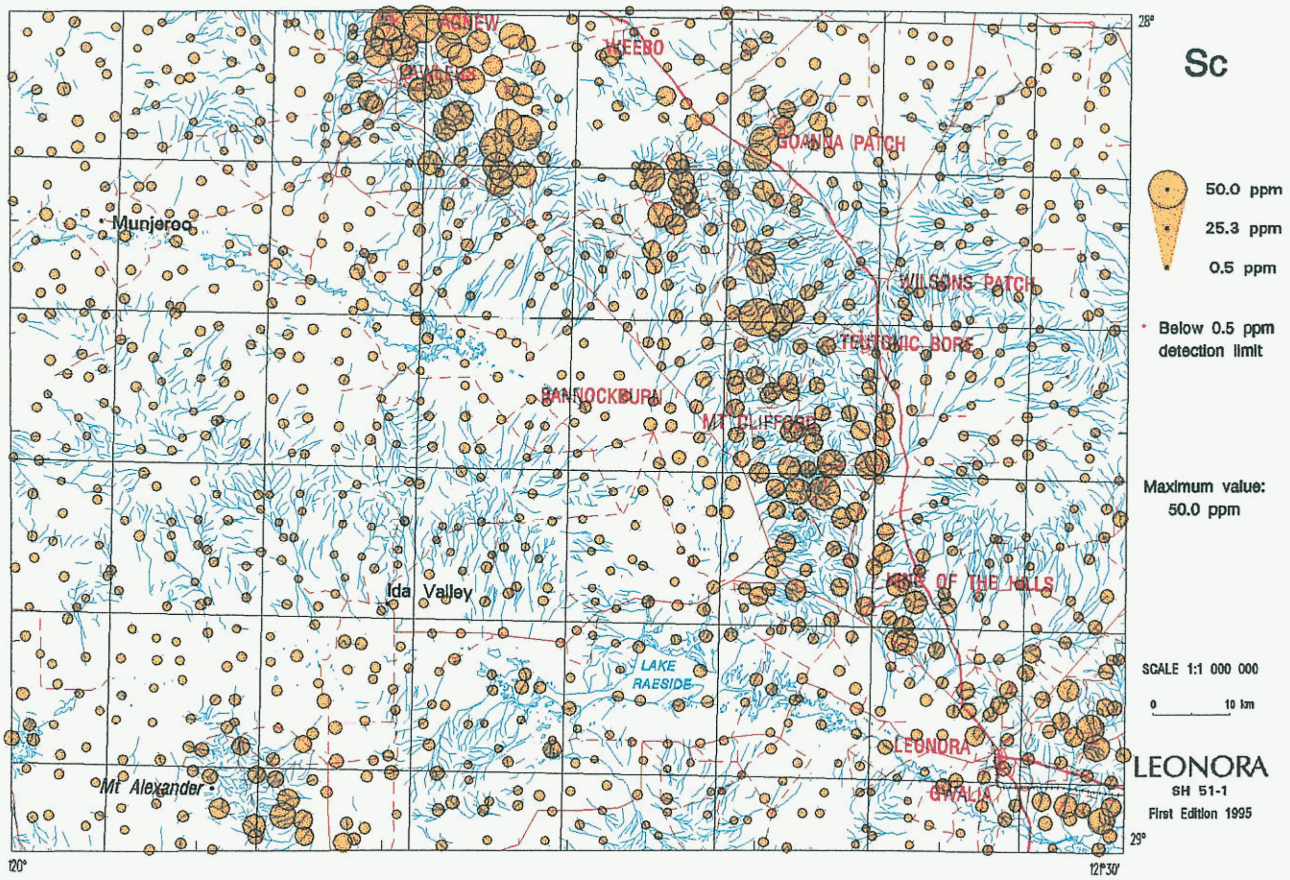



Figure 31.

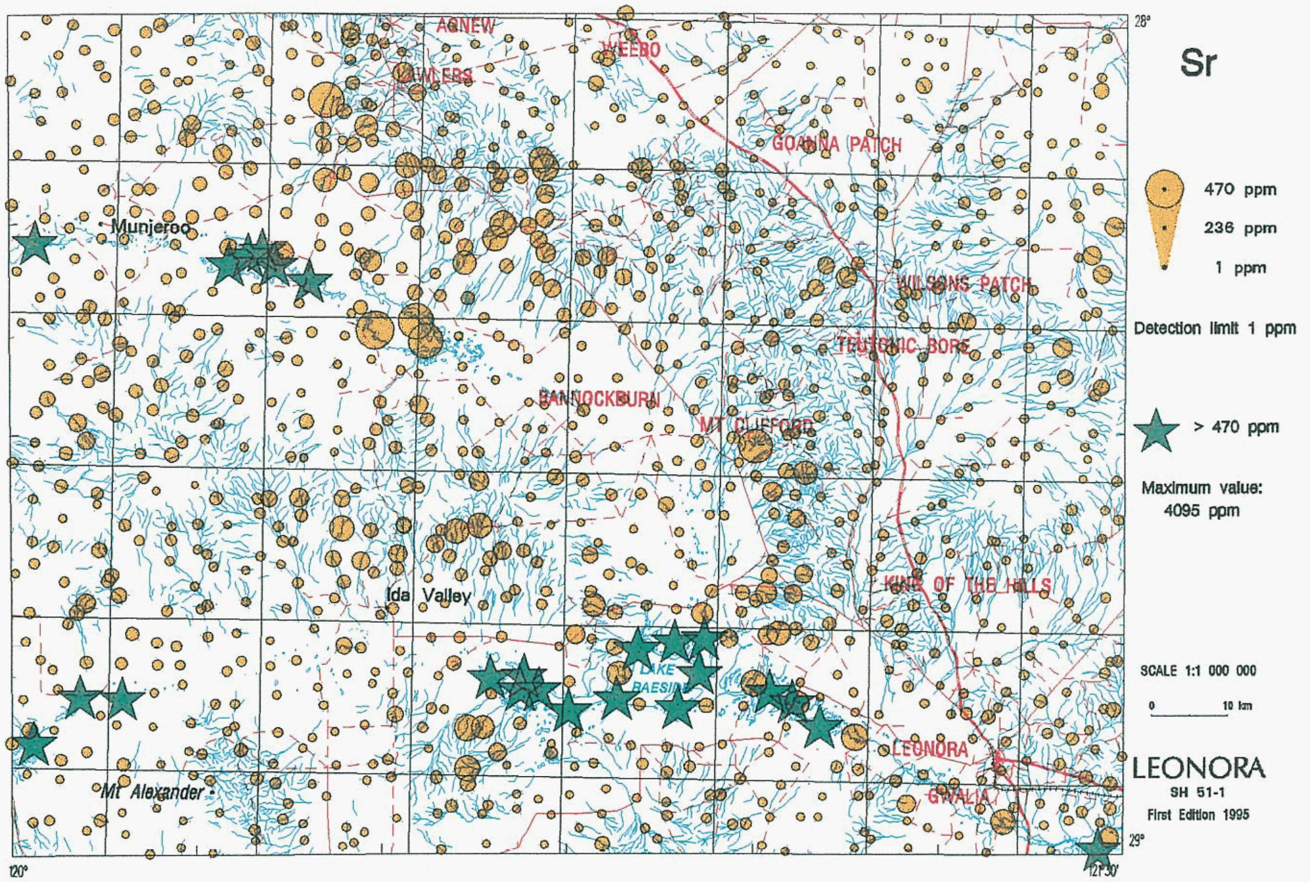



Figure 32.

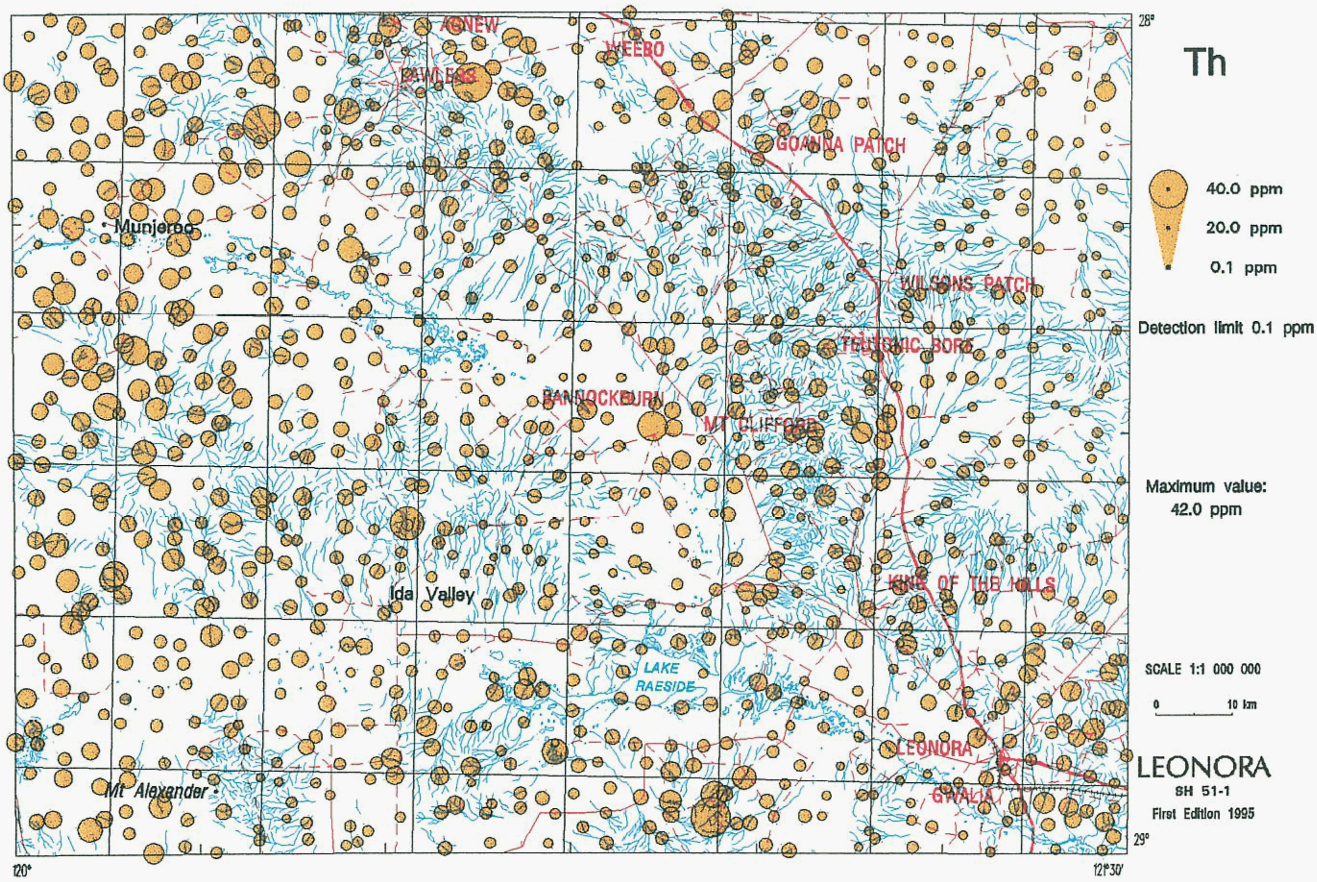



Figure 33.

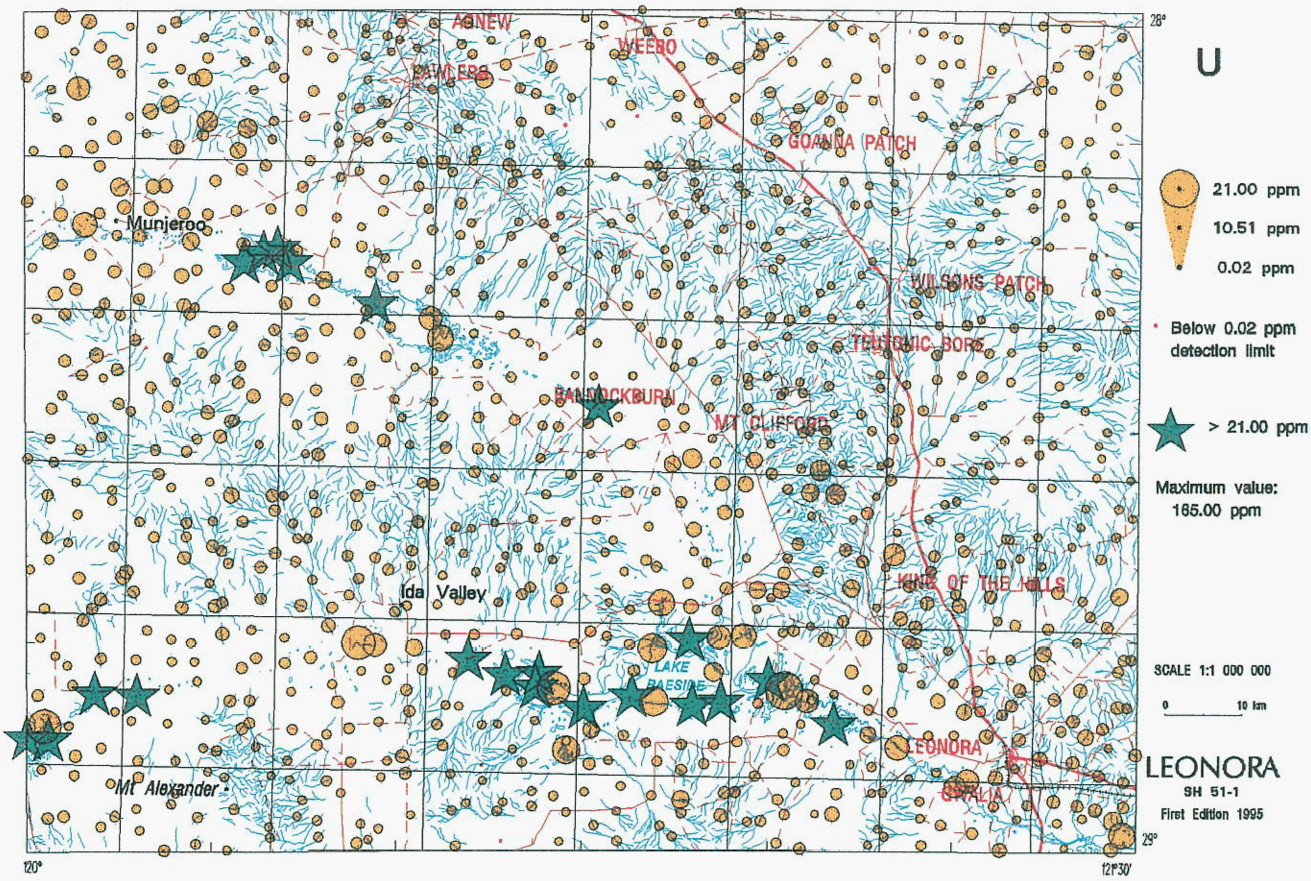



Figure 34.

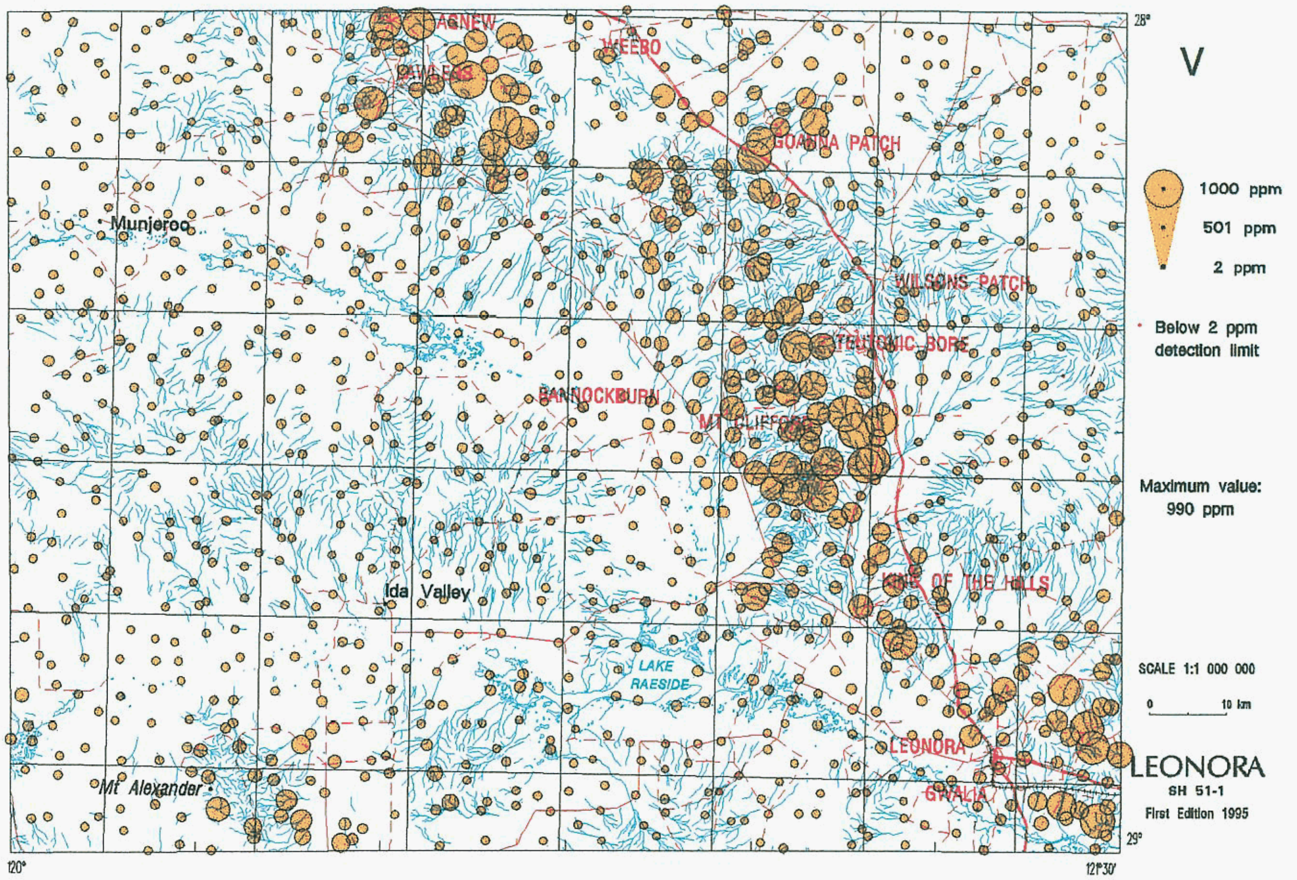



Figure 35.

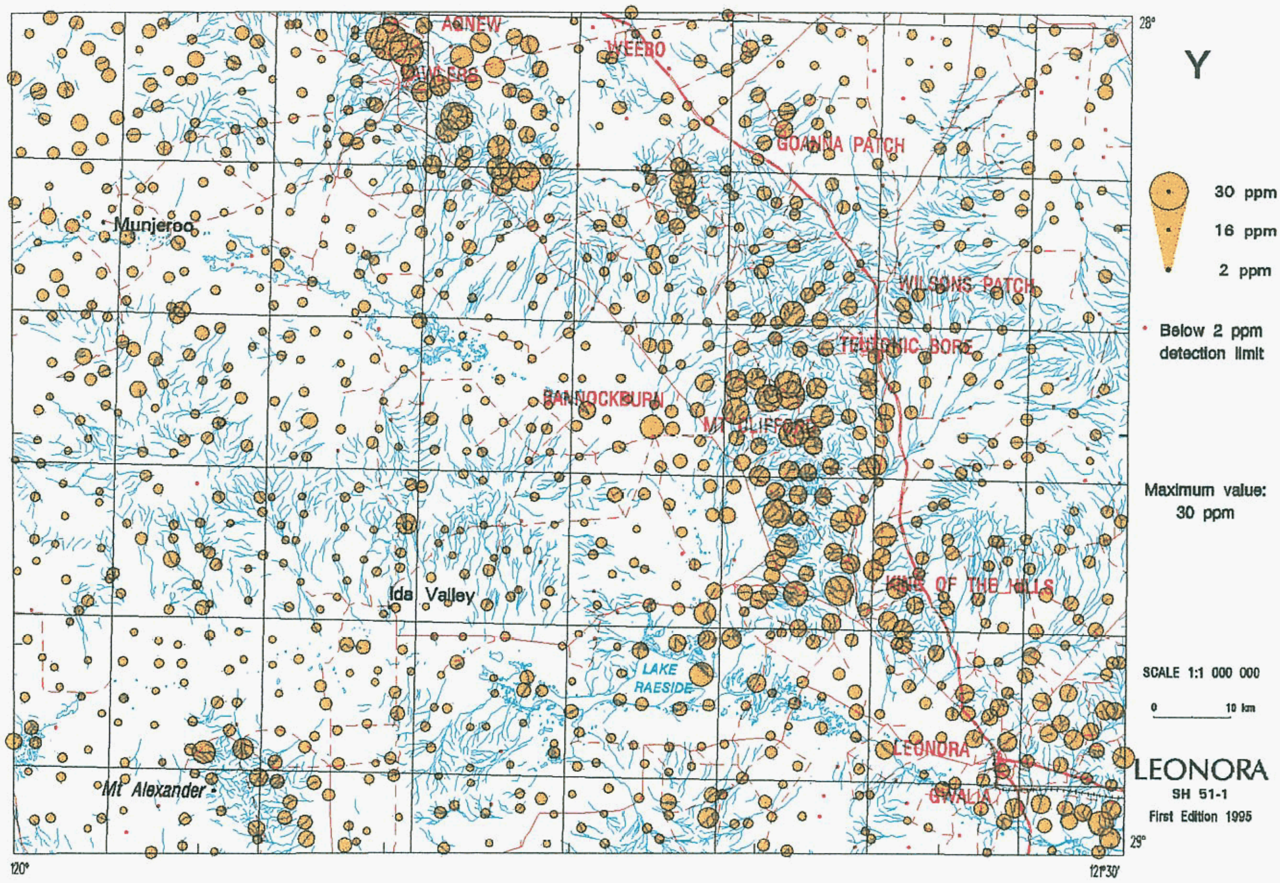



Figure 36.

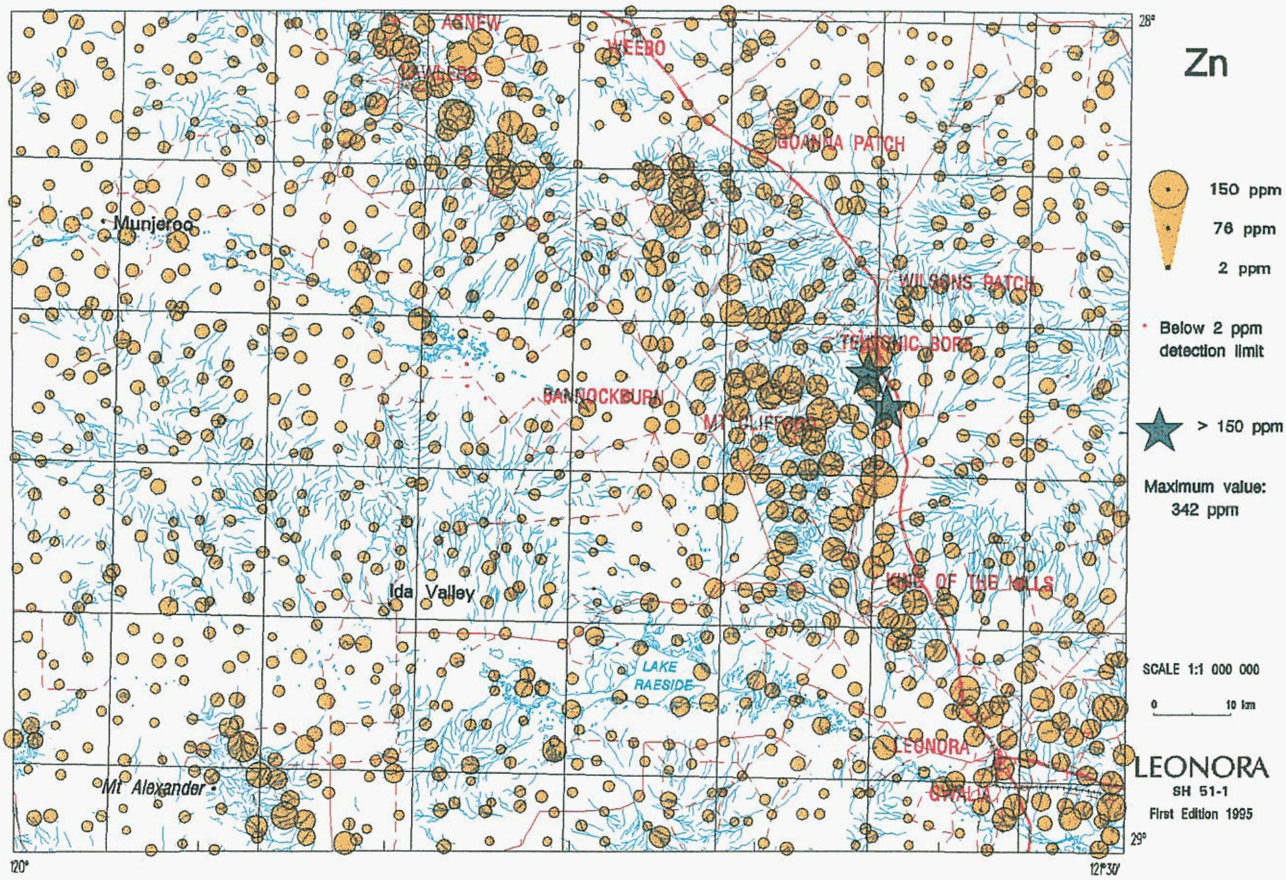



Figure 37.

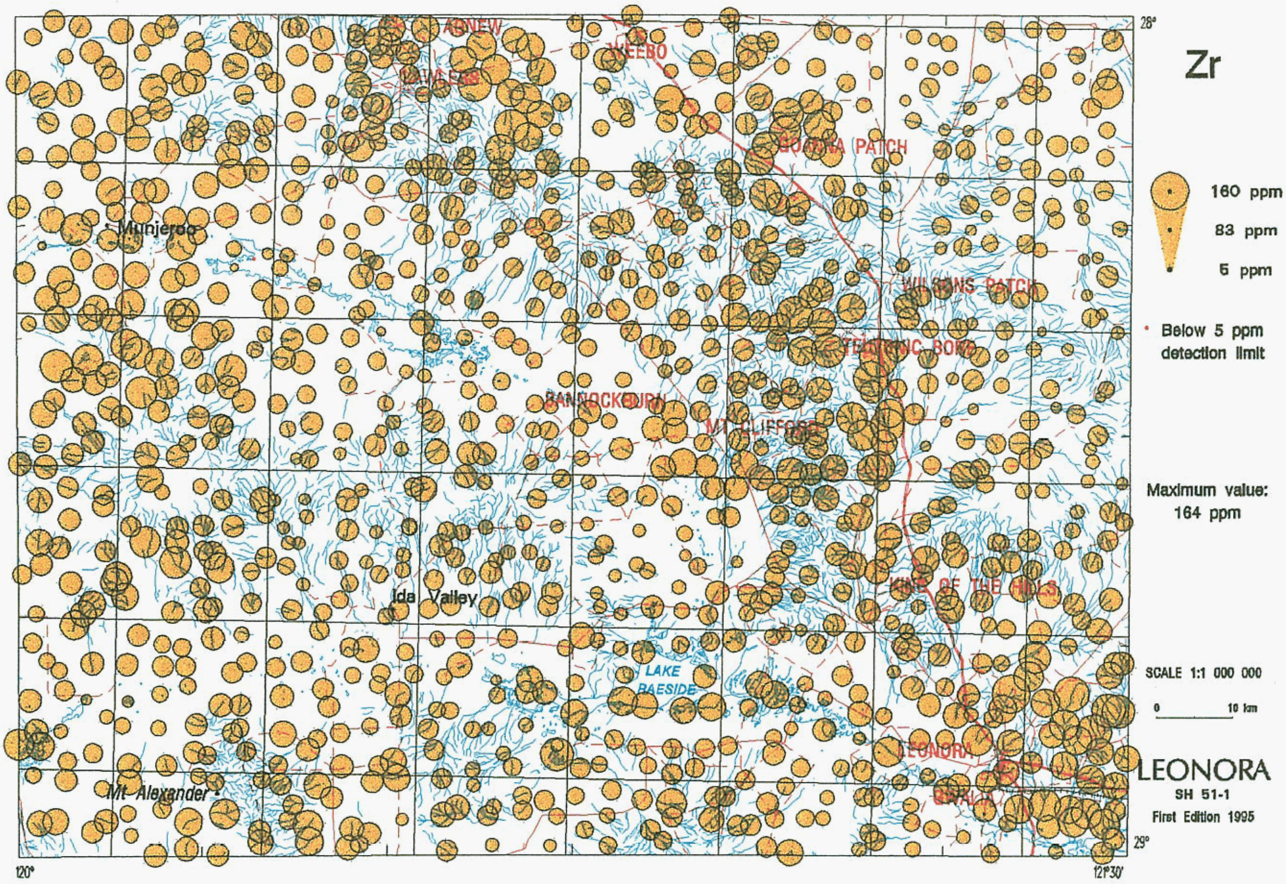

Zr
160 ppm
83 ppm
5 ppm
Below 5 ppm detection limit
Maximum value: 164 ppm
SCALE 1:1 000 000
LEONORA
SH 51-1
First Edition 1995
AGNEW
YEELIRRIE
BOORARA PATCH
WILSONS PATCH
BANNOCKBURN
MT CLIFFORD
KING OF THE HILLS
LAKE RAESIDE
LEONORA
GWALIA
Munjeroo
Ida Valley
Mt Alexander
28°
29°
120°
121°30'

Figure 38.

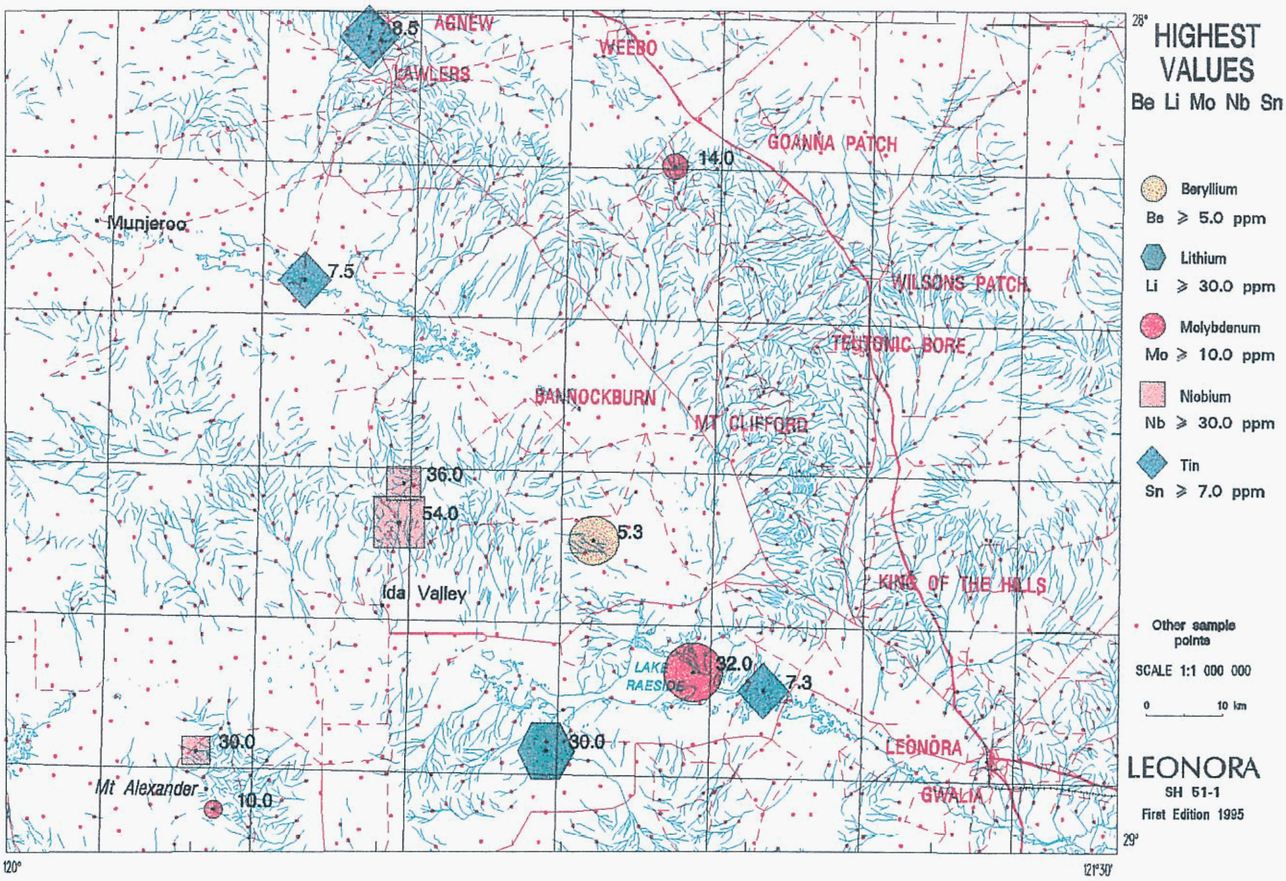



Figure 39.

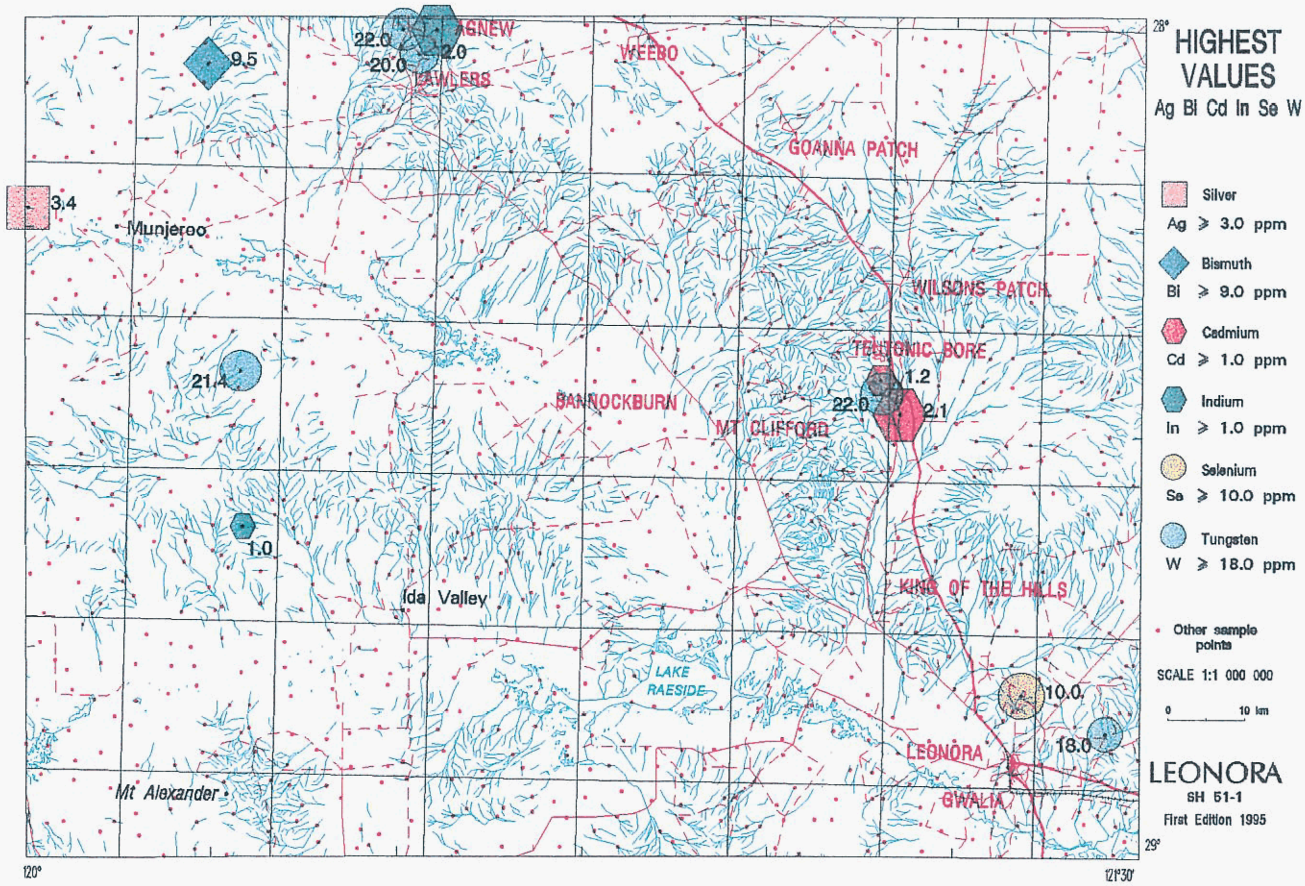



Figure 40.

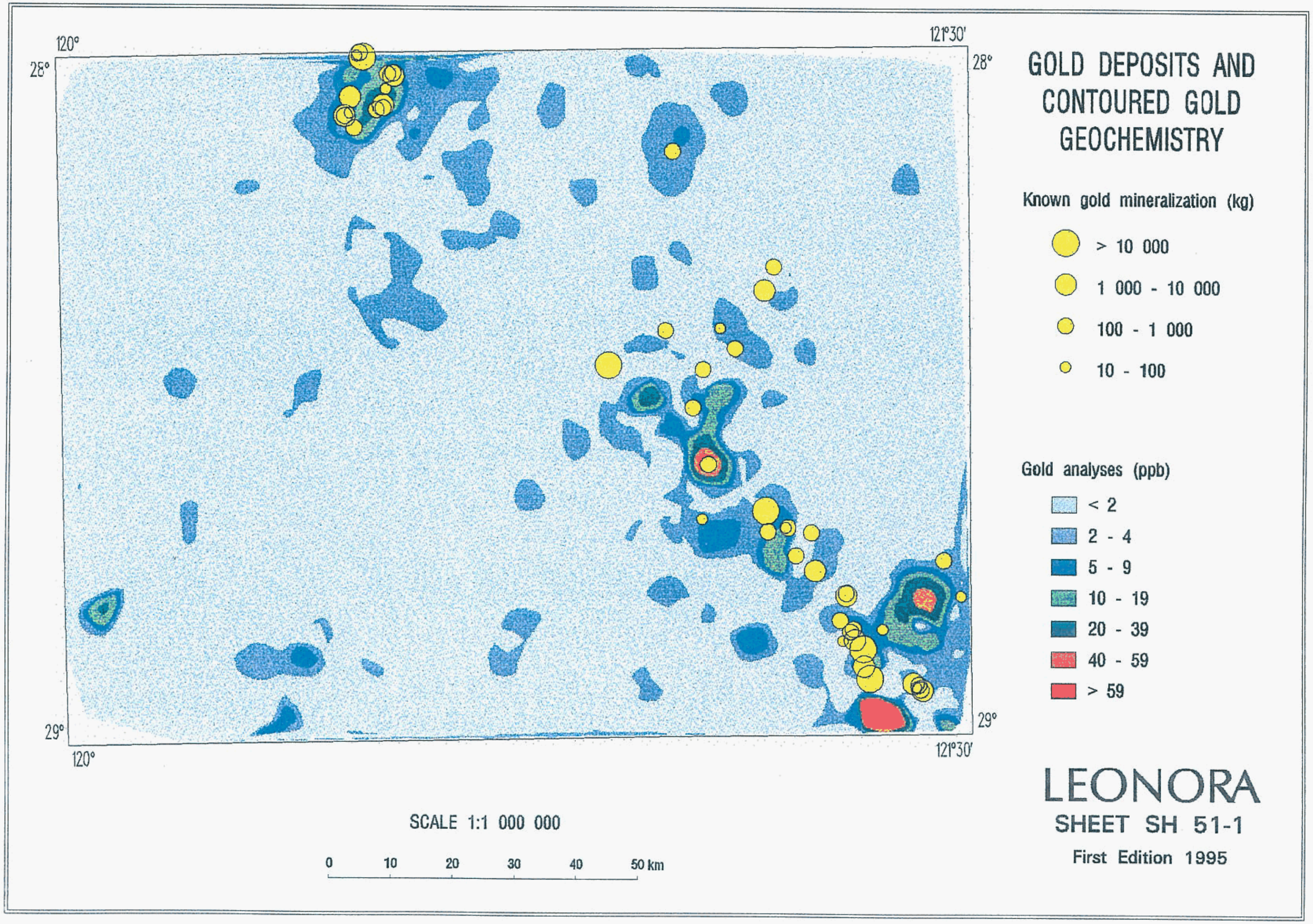
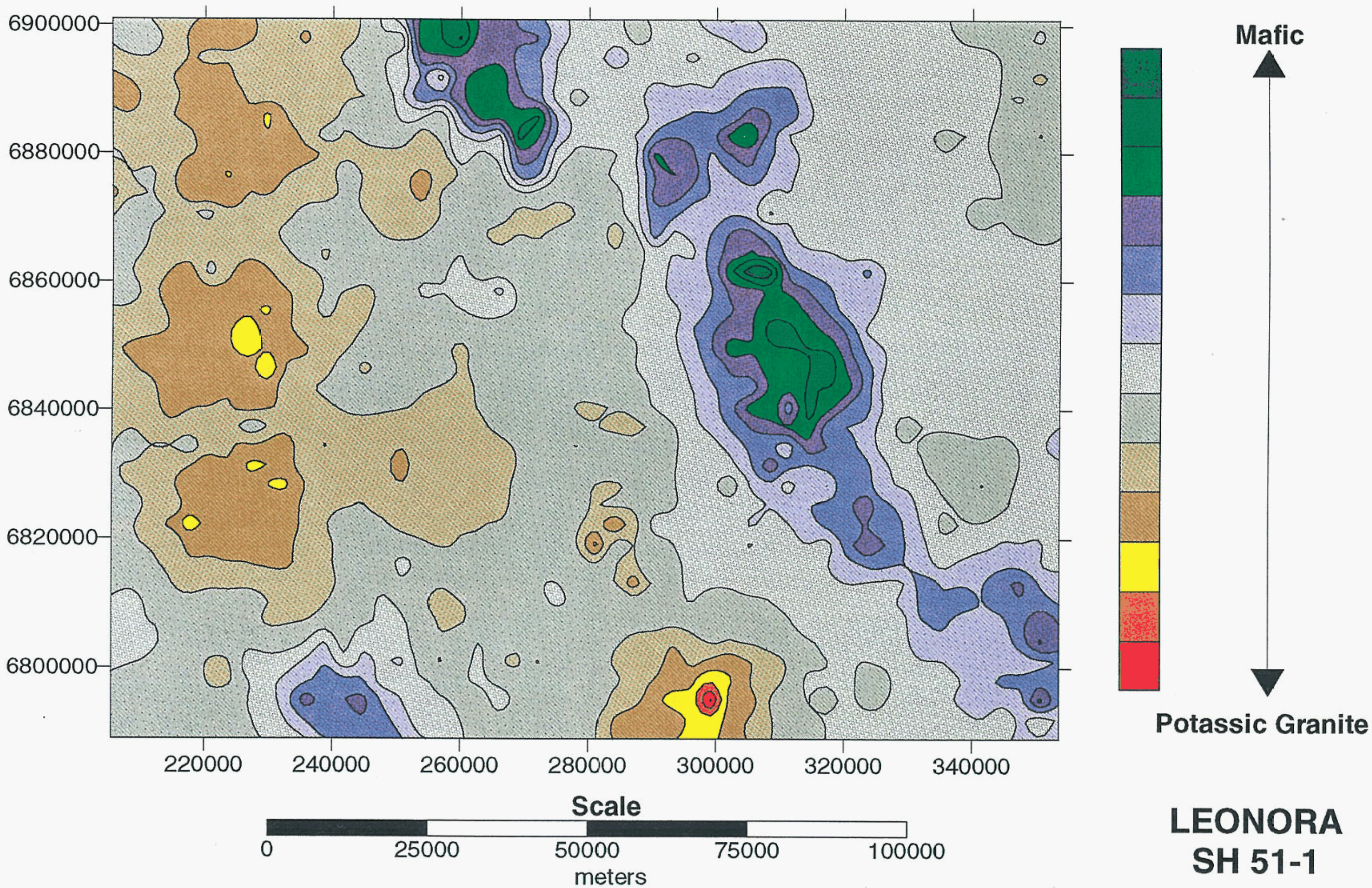

GOLD DEPOSITS AND CONTOURED GOLD GEOCHEMISTRY
Known gold mineralization (kg)
> 10 000
1 000 - 10 000
100 - 1 000
10 - 100
Gold analyses (ppb)
< 2
2 - 4
5 - 9
10 - 19
20 - 39
40 - 59
> 59
120°
121°30'
28°
29°
SCALE 1:1 000 000
0
10
20
30
40
50 km
LEONORA
SHEET SH 51-1
First Edition 1995

Figure 41.




**Generation Formulas**

Normalised Data % = element/element(max)*100
Principal Component 1 = ((0.85*TiO2)+(0.88*Fe2O3)+(0.65*As)+(0.62*Co)+(0.65*Cr)+(0.84*Cu)+(0.63*Ga)+(0.60*Ni)+(0.91*Sc)+(0.87*V)+(0.75*Zn))
Principal Component 2 =-((0.80*K20)+(0.72*Ba)+(0.64*Ce)+(0.66*Pb)+(0.79*Rb)+(0.63*Th)

**Figure 42. Plot of Principal Component 1 + Principal Component 2**

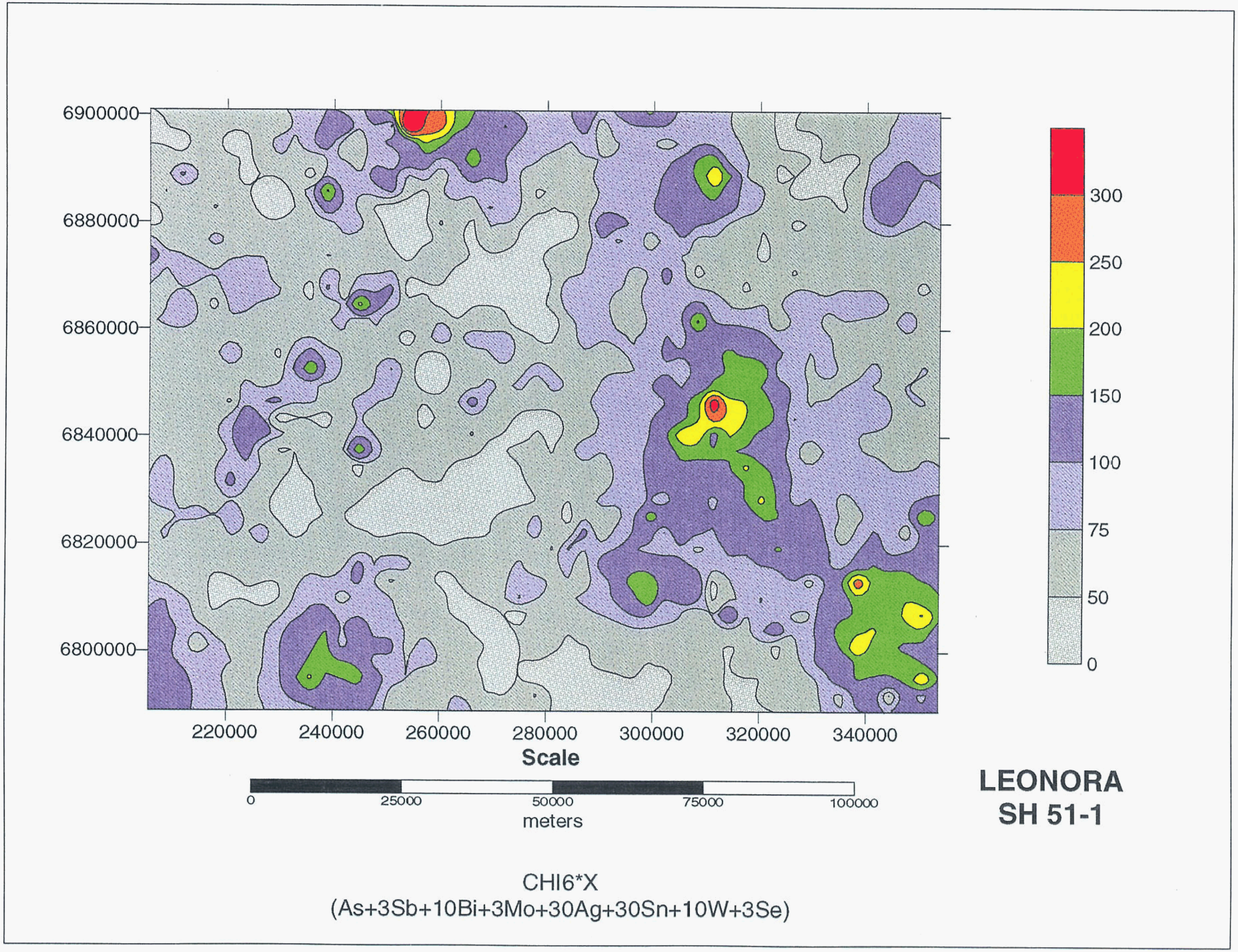



**Figure 43. Plot of CHI-6*X**

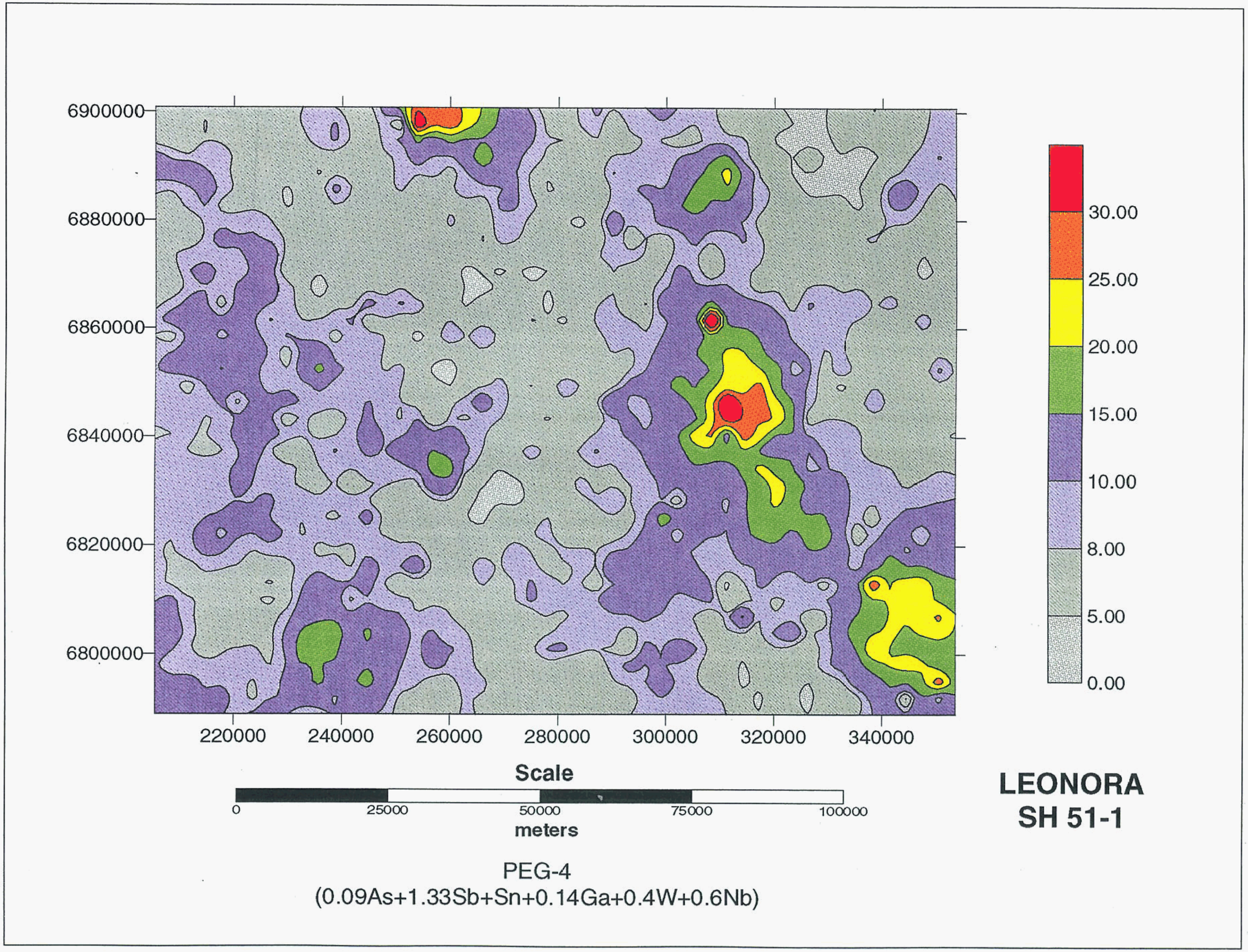


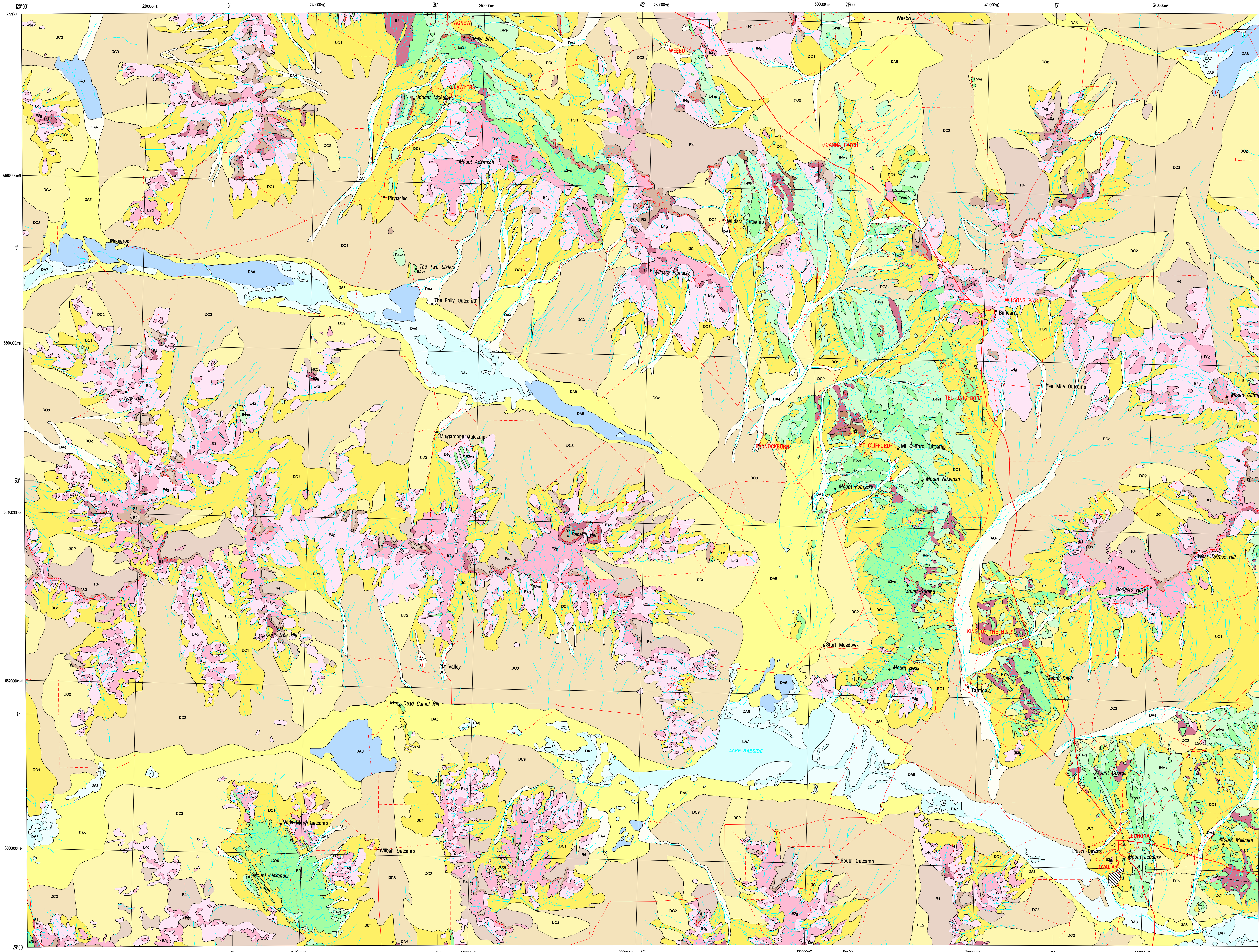

**Figure 44. Plot of PEG-4**

# LEONORA

1:250 000 REGOLITH MATERIALS SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-1




## REFERENCE

### RELICT REGIME

| | | CSIRO (1) | CSIRO (2) | AGSO |
|---|---|---|---|---|
| R2 | Iron-rich lateritic duricrust | LT2 LT3 | R1 | DS42 |
| R3 | Silcrete and silicified granitoid rock | -- | -- | DS60 |
| R4 | Sands overlying presumed or known lateritic material | ES3 LS4 | D9 | WR22 |

### EROSIONAL REGIME

| | | CSIRO (1) | CSIRO (2) | AGSO |
|---|---|---|---|---|
| E1 | Exposed mottled zone and saprolite | SP1 | E3 E4 | WR11 |
| E2g | Granitoid and granitoid gneiss saprock, bedrock, and ferruginous bedrock | BR3 | E6-E9inc | gWR12 |
| E2vs | Volcano-sedimentary greenstone saprock, bedrock, and ferruginous bedrock | BR3 | E6-E9inc | vsWR12 |
| E4g | Lag of lithic detritus and/or feldspar in a sand-rich matrix associated with actively eroding outcrop/subcrop; mainly confined to granitoid terrains | SS5 | -- | gWR21 |
| E4vs | Lag of locally derived ferruginous and lithic detritus in a sandy clay matrix associated with actively eroding outcrop/subcrop; mainly confined to greenstone terrains | MI1-MI5inc LA4 | E1 | vsWR21 |

### DEPOSITIONAL REGIME

DOMINANTLY COLLUVIAL

| | | CSIRO (1) | CSIRO (2) | AGSO |
|---|---|---|---|---|
| DC1 | Medium to coarse detritus, mainly of lithic or ferruginized lithic clasts (most >25 mm) in colluvium with a sand or sandy clay matrix | MI3 CS3 | D4 | gSC05 vsSC05 |
| DC2 | Fine to medium detritus of 2 types: ferruginized lithic clasts (most 4-25 mm) in colluvium with a sandy clay matrix (greenstone terrains); quartz, feldspar and granitoid clasts in sandy colluvium (granitoid terrains) | MI2 CS1 | D2 D3 | gSC05 vsSC05 |
| DC3 | Sand and clay (with or without feldspar clasts) dominated colluvium or sheetwash; merges into alluvial plains (DA5) | CS1-2 SS6 | D4 | SC05a SC05b |
| DC3f | Detritus, mainly non-lithic ferruginous (most clasts <10 mm); may be magnetic in red sandy clay; includes significant buckshot gravel | MI2 CS1 | D4 | SC05a SC05b |

DOMINANTLY ALLUVIAL

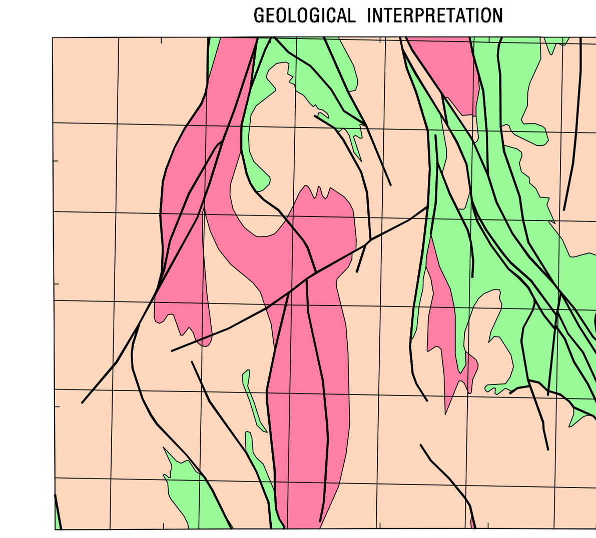
| | | CSIRO (1) | CSIRO (2) | AGSO |
|---|---|---|---|---|
| DA4 | Gravelly sands and sandy clays of active alluvial channels with mixtures of lateritic, non-lateritic, and variably altered lithic clasts | AS1 AS2 | D1 | SA01 |
| DA5 | Sand- or clay-rich alluvium on or adjacent to broad drainage floors with negligible detritus; calcrete nodules common | AS4 | D5 | SA02 |
| DA6 | Gypsiferous alluvial and eolian sediments adjacent to playa lakes; usually vegetated | AS5 | D7 D8 | SE00 |
| DA7 | Saline clays and sandy clays of playa lakes; usually unvegetated | ES1 ES2 | D6 | SL00 |
| DA8 | Extensive and continuous calcrete outcrop in broad drainage floors (valley calcrete) | -- | -- | DS20 |

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 | |
| Railway | |
| Breakaway | |
| Watercourse, ephemeral | |
| Homestead | Weebo |
| Locality | *Mount Ross* |
| Mining locality | LAWLERS |
| Mining area, made ground | |

## GEOLOGICAL INTERPRETATION




Geological interpretation after A.H. Hickman (in prep.), AGSO (1993), and T.J. Griffin and W.K. Witt (pers. comm.)


## INDEX TO ADJOINING SHEETS

| | | |
|---|---|---|
| SANDSTONE SG 50-16 | SIR SAMUEL SG 51-13 | DUKETON SG 51-14 |
| YOUANMI SH 50-4 | LEONORA SH 51-1 | LAVERTON SH 51-2 |
| BARLEE SH 50-8 | MENZIES SH 51-5 | EDJUDINA SH 51-6 |

Edited by C. Strong and G. Loan

Cartography by: K. Smith and C. Bartlett

Compiled and produced using computer-assisted graphic applications, and available in digital form

Topographic base supplied by Australian Surveying and Land Information Group

Published by and available from the Geological Survey of Western Australia, Department of Minerals and Energy, 100 Plain Street, East Perth, 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 51

PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Compiled by J.J. Bradley 1995

Field observations by: J. Storey and J. Bradley (GSWA), and G. Mehri, D. Ellis and G. Kjellgren (Geochemex)

The recommended reference for this map is: BRADLEY, J.J., and STOREY, J.M., 1995, Leonora, W.A. (prelim. ed.): Western Australia Geological Survey, 1:250 000 Regolith Materials Series

This map complements Leonora Regolith-landforms map: CHURCHWARD, H.M., and CRAIG, M.A., 1993, Leonora, W.A. (prelim. ed.): Australian Geological Survey Organisation, 1:250 000 Regolith-landforms Series

REGOLITH MATERIALS SERIES

# LEONORA

SHEET SH 51-1

PRELIMINARY EDITION



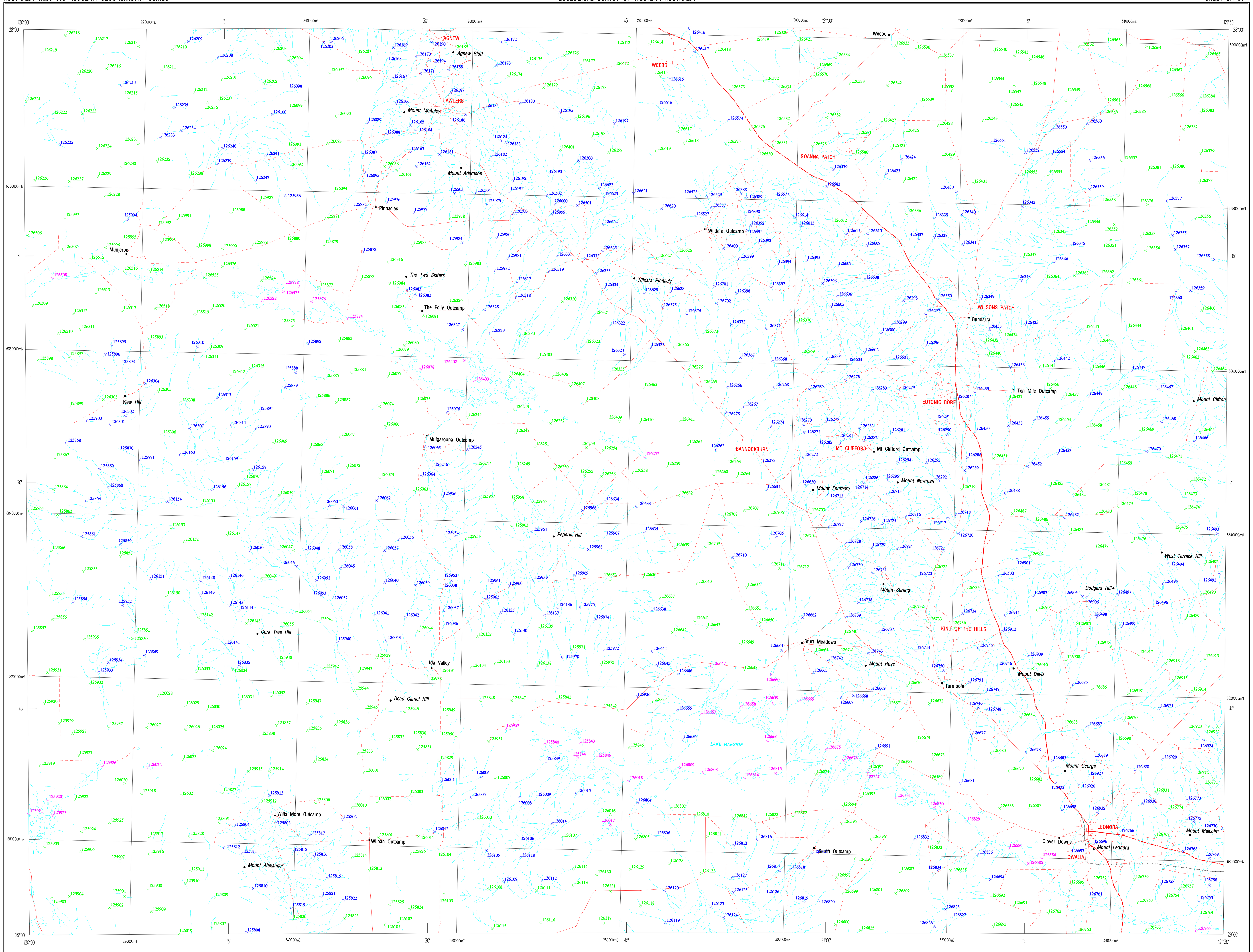
WARNING: Inks are water soluble and will fade with prolonged exposure to light

# LEONORA

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-1




# SAMPLE LOCATIONS

Sample point references

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

Principal road

Minor road

Track

Watercourse and lake boundaries

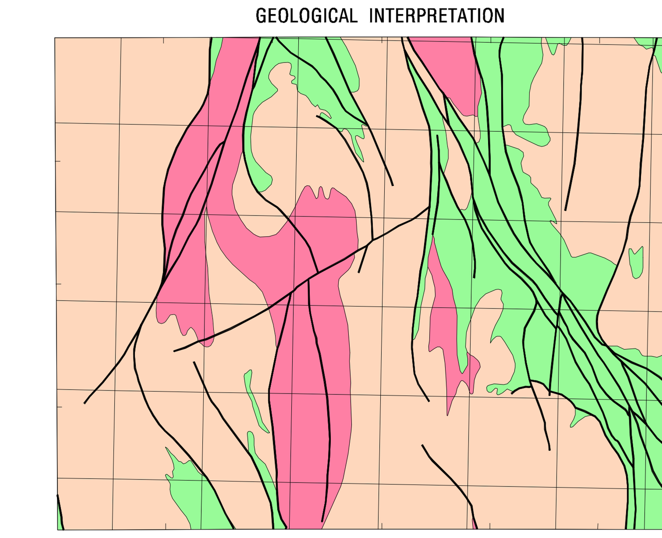
Railway

Mount Ross — Locality

Weebo — Homestead

LAWLERS — Mining locality

GEOLOGICAL INTERPRETATION



Granitoid rock

Strongly foliated granitoid rock and granitoid gneiss; minor amphibolite

Volcano-sedimentary greenstone belt

Major fault

Geological interpretation after A.H. Hickman (in prep.), AGSO (1993), and T.J. Griffin and W.K. Witt (pers. comm.)


INDEX TO ADJOINING SHEETS

| | | |
|---|---|---|
| SANDSTONE SG 50-16 | SIR SAMUEL SG 51-13 | DUKETON SG 51-14 |
| YOUANMI SH 50-4 | LEONORA SH 51-1 | LAVERTON SH 51-2 |
| BARLEE SH 50-8 | MENZIES SH 51-5 | EDJUDINA SH 51-6 |

# SAMPLE LOCATIONS

REGOLITH GEOCHEMISTRY SERIES

# LEONORA

SHEET SH 51-1

FIRST EDITION 1995



Edited by: C. Strong and G. Loan

Cartography by: K. Smith and A. Rogers

Topographic information supplied by the Australian Surveying and Land Information Group

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, and 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, 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 0 5 10 15 20 25 30

METRES KILOMETRES

TRANSVERSE MERCATOR PROJECTION

Grid lines indicate 20 000 metre interval of the Australian Map Grid Zone 51

PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Sampling by: J.M. Storey and J.J. Bradley (GSWA) with assistance from G. Mehri, D. Ellis and G. Kjellgren (Geochemex) 1994

Total sample sites: 1042; 453 stream sediment, 43 lake sediment, and 546 soil

Analyst: AMDEL Laboratories. 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: BRADLEY, J.J., SANDERS, A.J., VARGA, Z.S., and STOREY, J.M., 1995, Leonora, W.A. -- Sample locations: Western Australia Geological Survey, 1:250 000 Regolith Geochemistry Series

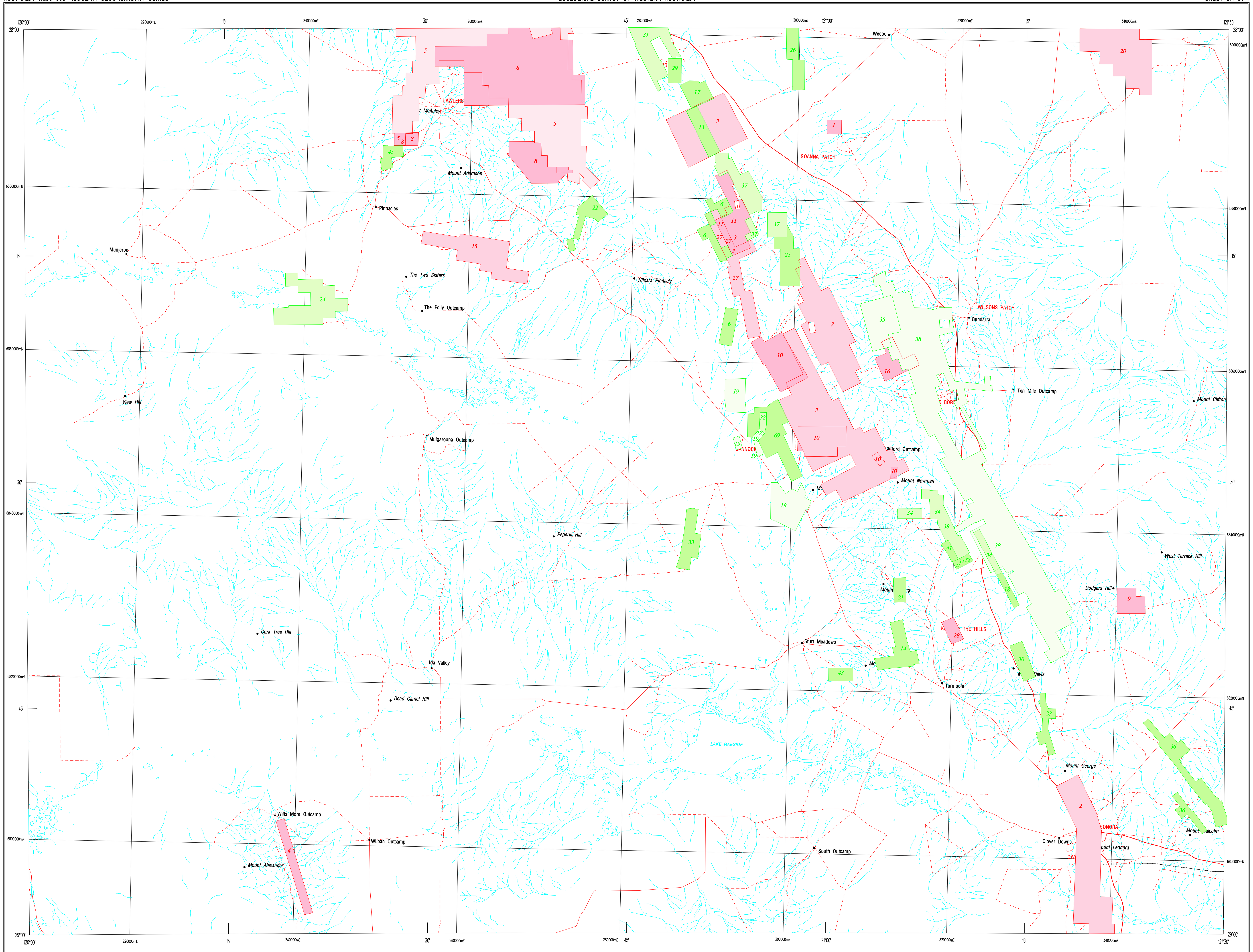
WARNING: Inks are water soluble and will fade with prolonged exposure to light

# LEONORA

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-1




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

## PROJECTS COMMENCED BETWEEN 1966 AND 1975

**Project Commencement Period**

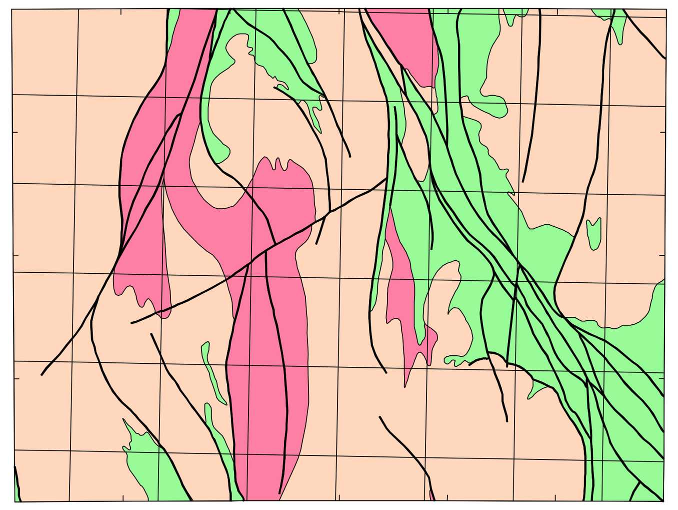
(Various colour shades used for ease of project indentification)

- 1966 - 1970
- 1971 - 1975
- 1976 - 1980
- 1981 - 1985 (1976 - 1985: See PLATE 4)
- 1986 - 1990
- 1991 - 1994 (1986 - 1994: See PLATE 5)

Number within project area is a database ID number (See Appendix 4)

- Principal road
- Minor road
- Track
- Watercourse and lake boundaries
- Railway
- • Mount Ross — Locality
- ▪ Weebo — Homestead
- LAWLERS — Mining locality

GEOLOGICAL INTERPRETATION



- Granitoid rock
- Strongly foliated granitoid rock and granitoid gneiss; minor amphibolite
- Volcano-sedimentary greenstone belt
- Major fault

Geological interpretation after A.H. Hickman (in prep.), AGSO (1993), and T.J. Griffin and W.K. Witt (pers. comm.)

INDEX TO ADJOINING SHEETS

| | | |
|---|---|---|
| SANDSTONE SG 50-16 | SIR SAMUEL SG 51-13 | DUKETON SG 51-14 |
| YOUANMI SH 50-4 | LEONORA SH 51-1 | LAVERTON SH 51-2 |
| BARLEE SH 50-8 | MENZIES SH 51-5 | EDJUDINA SH 51-6 |


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

| | | |
|---|---|---|
| MUNJEROO 2941 | WILDARA 3041 | WEEBO 3141 |
| MOUNT ALEXANDER 2940 | WILBAH 3040 | LEONORA 3140 |

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

PROJECTS COMMENCED BETWEEN 1966 AND 1975

REGOLITH GEOCHEMISTRY SERIES

## LEONORA

SHEET SH 51-1
FIRST EDITION 1995



Edited by: C. Strong and G. Loan

Cartography by: K. Smith and S. Collopy

Topographic information supplied by the Australian Surveying and Land Information Group

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, and 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, 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 51

PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Compiled by: Z.S. Varga 1995

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

The recommended reference for this map is: VARGA, Z.S., 1995, Leonora, W.A. -- Company projects with surface geochemistry data in open file reports (at January 1995) projects commenced between 1966 and 1975: 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

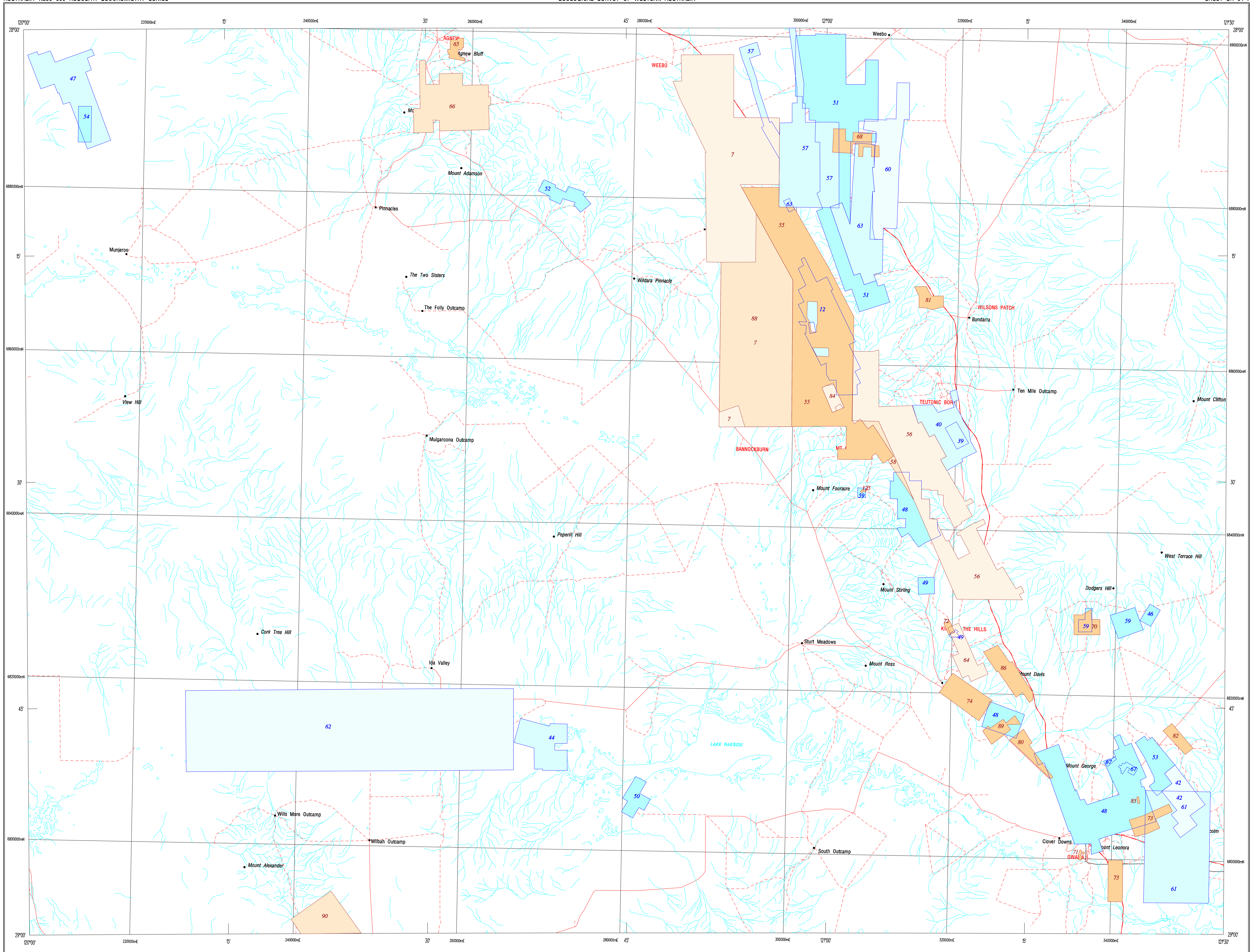
WARNING: Inks are water soluble and will fade with prolonged exposure to light

# LEONORA

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-1




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

## PROJECTS COMMENCED BETWEEN 1976 AND 1985

**Project Commencement Period**

(Various colour shades used for ease of project indentification)

1966 - 1970
1971 - 1975
See PLATE 3

1976 - 1980

1981 - 1985

1986 - 1990
1991 - 1994
See PLATE 5

Number within project area is a database ID number (See Appendix 4)

Principal road

Minor road

Track

Watercourse and lake boundaries

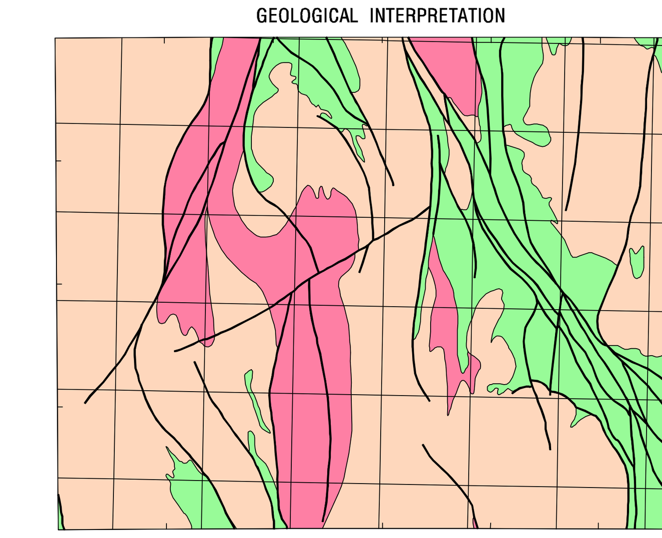
Railway

Mount Ross — Locality

Weebo — Homestead

LAWLERS — Mining locality

GEOLOGICAL INTERPRETATION



Granitoid rock

Strongly foliated granitoid rock and granitoid gneiss; minor amphibolite

Volcano-sedimentary greenstone belt

Major fault

Geological interpretation after A.H. Hickman (in prep.), AGSO (1993), and T.J. Griffin and W.K. Witt (pers. comm.)


INDEX TO ADJOINING SHEETS

| | | |
|---|---|---|
| SANDSTONE SG 50-16 | SIR SAMUEL SG 51-13 | DUKETON SG 51-14 |
| YOUANMI SH 50-4 | LEONORA SH 51-1 | LAVERTON SH 51-2 |
| BARLEE SH 50-8 | MENZIES SH 51-5 | EDJUDINA SH 51-6 |

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

| | | |
|---|---|---|
| MUNJEROO 2941 | WILDARA 3041 | WEEBO 3141 |
| MOUNT ALEXANDER 2940 | WILBAH 3040 | LEONORA 3140 |

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

PROJECTS COMMENCED BETWEEN 1976 AND 1985

Edited by: C. Strong and G. Loan

Cartography by: K. Smith and S. Collopy

Topographic information supplied by the Australian Surveying and Land Information Group

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, and 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, 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 0 5 10 15 20 25 30
METRES KILOMETRES

TRANSVERSE MERCATOR PROJECTION
Grid lines indicate 20 000 metre interval of the Australian Map Grid Zone 51

PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Compiled by: Z.S. Varga 1995

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

The recommended reference for this map is: VARGA, Z.S., 1995, Leonora, W.A. -- Company projects with surface geochemistry data in open file reports (at January 1995) projects commenced between 1976 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

REGOLITH GEOCHEMISTRY SERIES

LEONORA

SHEET SH 51-1
FIRST EDITION 1995



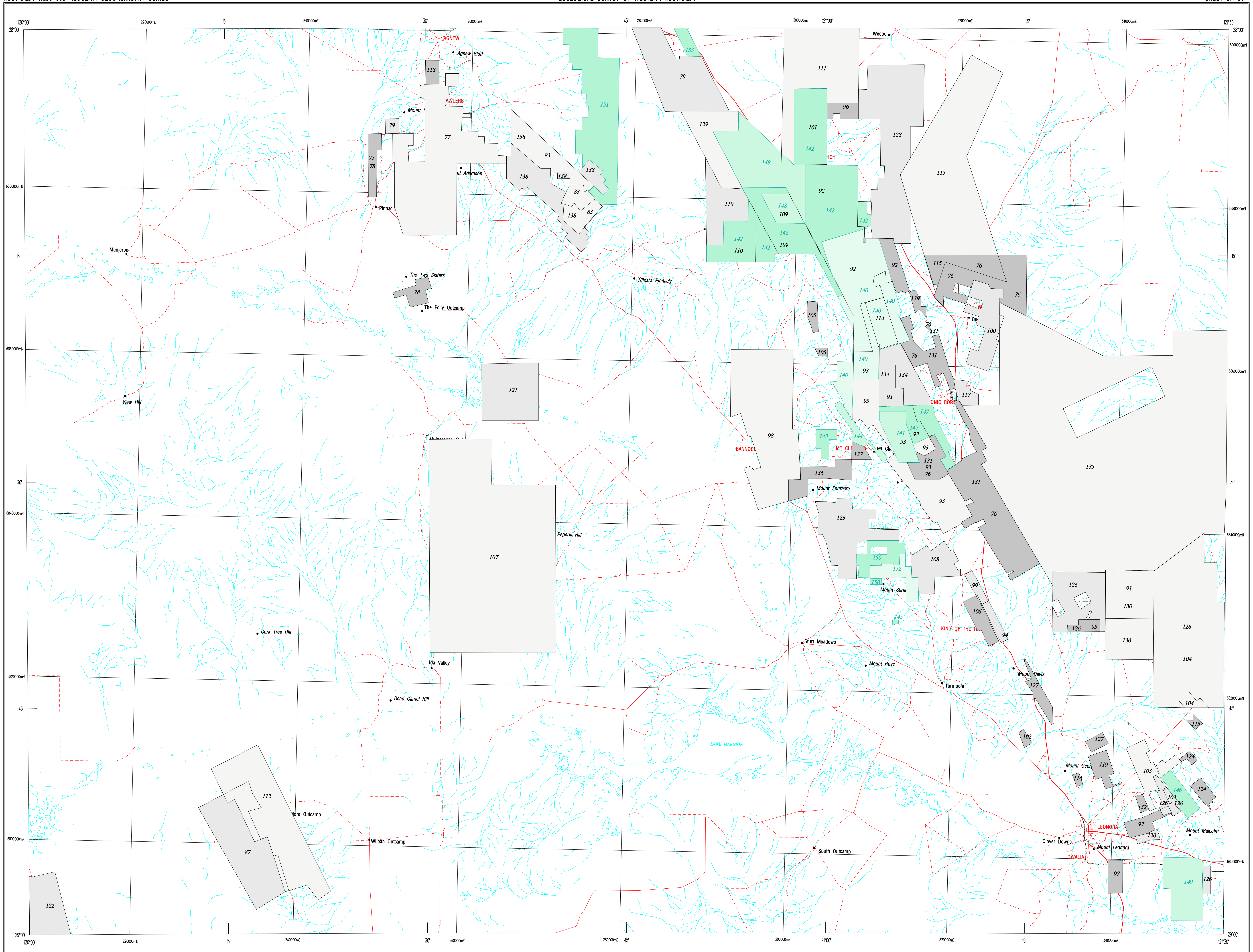
WARNING: Inks are water soluble and will fade with prolonged exposure to light

# LEONORA

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-1




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

## PROJECTS COMMENCED BETWEEN 1986 AND 1994

**Project Commencement Period**

(Various colour shades used for ease of project indentification)

1966 - 1970
1971 - 1975 } See PLATE 3

1976 - 1980
1981 - 1985 } See PLATE 4

1986 - 1990

1991 - 1994

Number within project area is a database ID number (See Appendix 4)

Principal road

Minor road

Track

Watercourse and lake boundaries

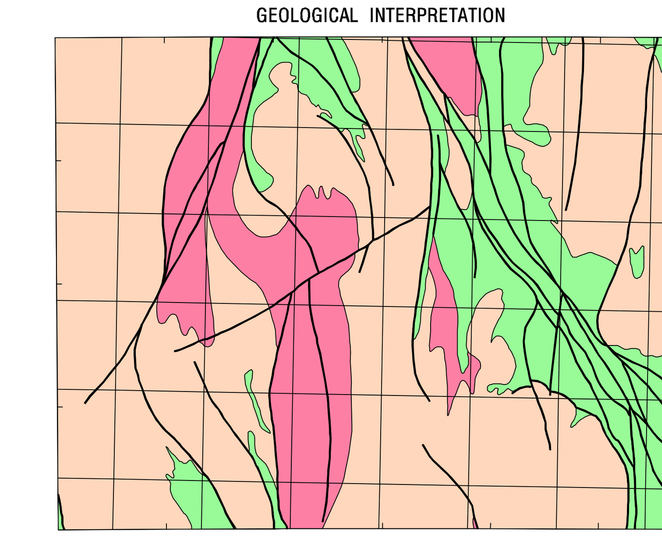
Railway

Mount Ross — Locality

Weebo — Homestead

LAWLERS — Mining locality

GEOLOGICAL INTERPRETATION



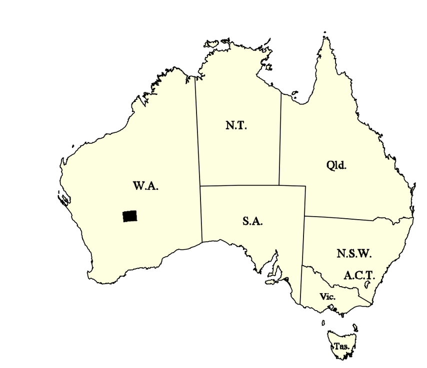
Granitoid rock

Strongly foliated granitoid rock and granitoid gneiss; minor amphibolite

Volcano-sedimentary greenstone belt

Major fault

Geological interpretation after A.H. Hickman (in prep.), AGSO (1993), and T.J. Griffin and W.K. Witt (pers. comm.)




INDEX TO ADJOINING SHEETS

| | | |
|---|---|---|
| SANDSTONE SG 50-16 | SIR SAMUEL SG 51-13 | DUKETON SG 51-14 |
| YOUANMI SH 50-4 | LEONORA SH 51-1 | LAVERTON SH 51-2 |
| BARLEE SH 50-8 | MENZIES SH 51-5 | EDJUDINA SH 51-6 |

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

| | | |
|---|---|---|
| MUNJEROO 2941 | WILDARA 3041 | WEEBO 3141 |
| MOUNT ALEXANDER 2940 | WILBAH 3040 | LEONORA 3140 |


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

PROJECTS COMMENCED BETWEEN 1986 AND 1994



Edited by: C. Strong and G. Loan

Cartography by: K. Smith and S. Collopy

Topographic information supplied by the Australian Surveying and Land Information Group

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, and 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, 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 51


PIETRO GUJ
DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Compiled by: Z.S. Varga 1995

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

The recommended reference for this map is: VARGA, Z.S., 1995, Leonora, W.A. -- Company projects with surface geochemistry data in open file reports (at January 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

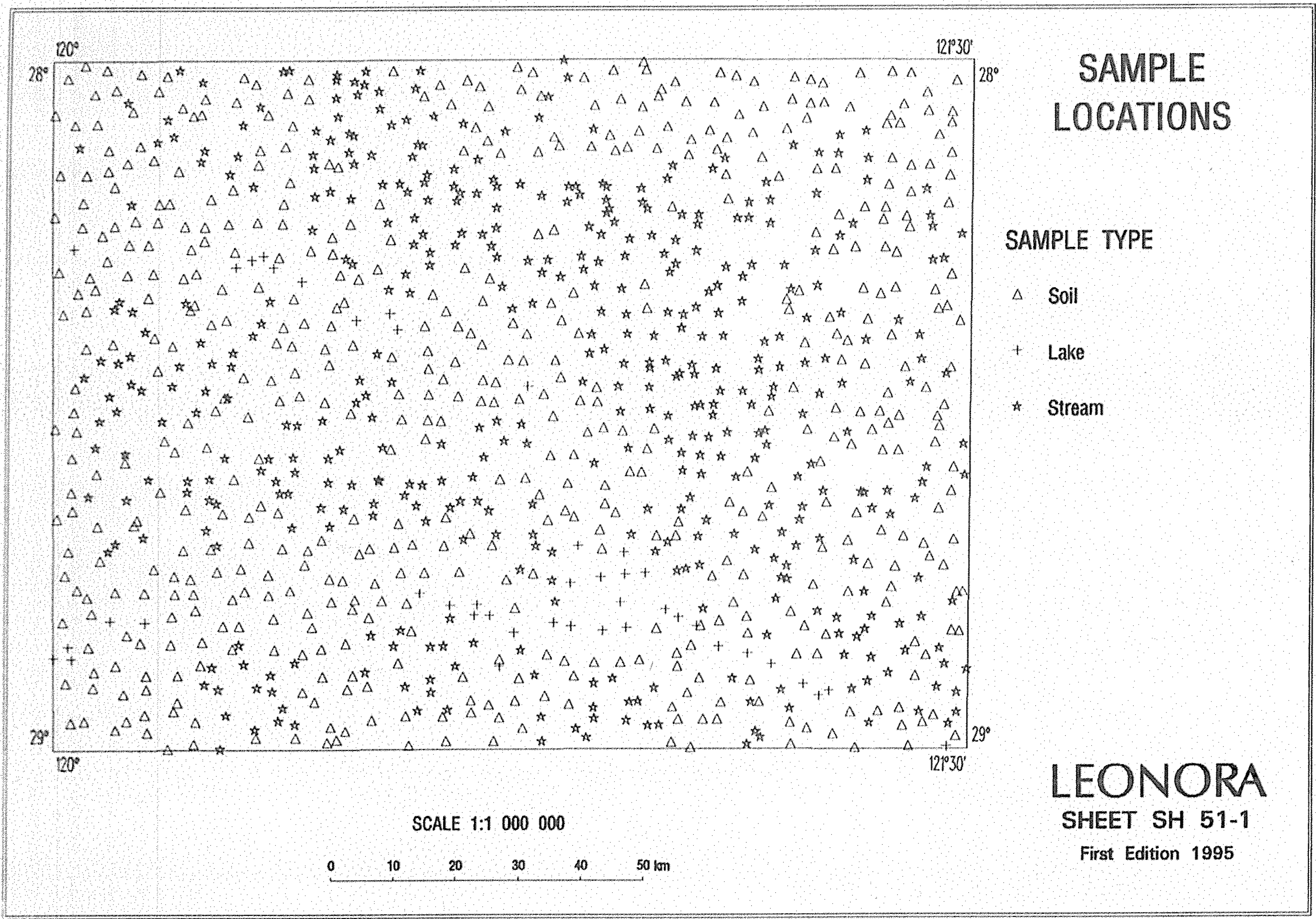

REGOLITH GEOCHEMISTRY SERIES

LEONORA

SHEET SH 51-1
FIRST EDITION 1995

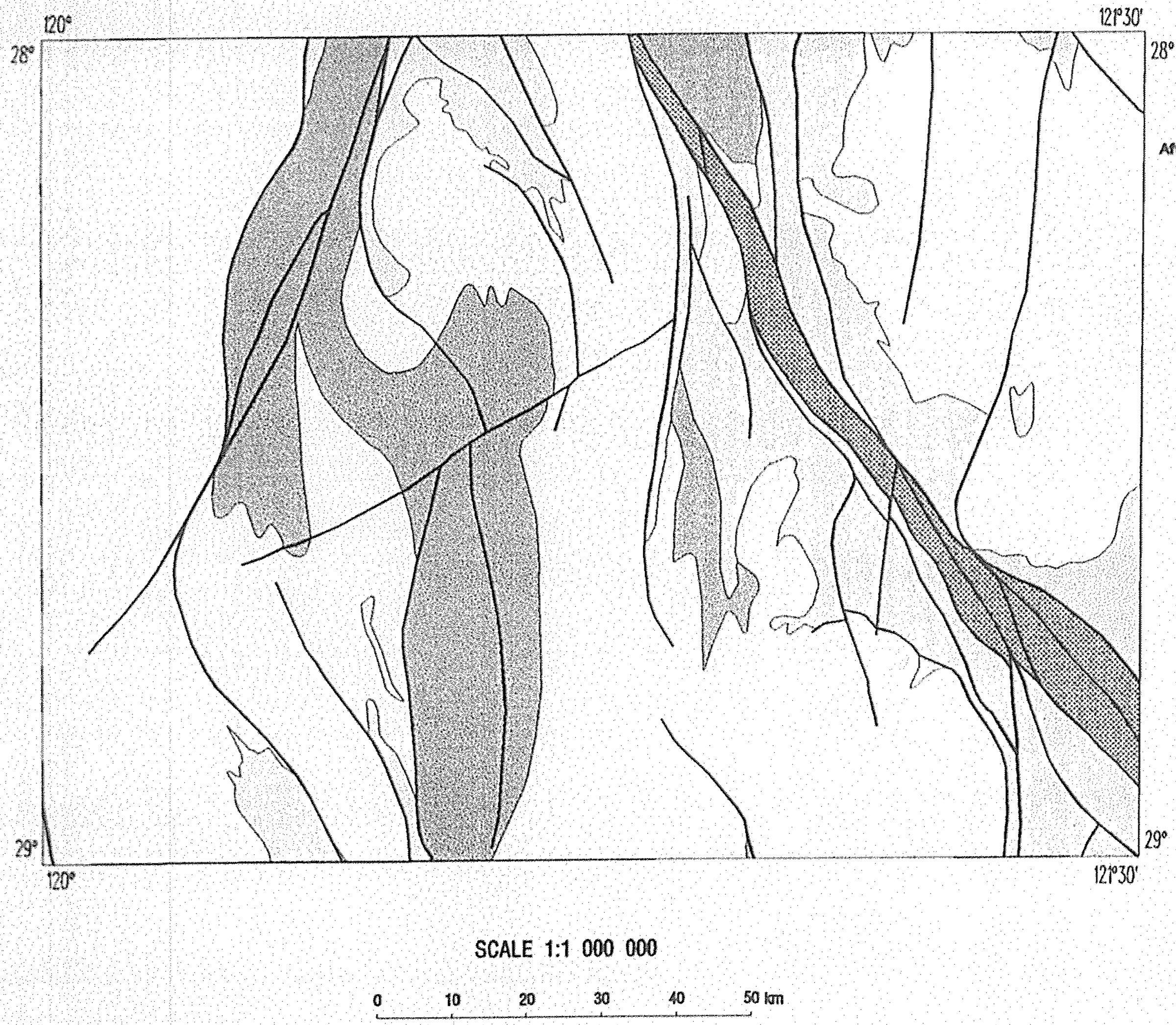



WARNING: Inks are water soluble and will fade with prolonged exposure to light



120°
121°30'
28°
29°
SAMPLE LOCATIONS
SAMPLE TYPE
Soil
Lake
Stream
SCALE 1:1 000 000
0
10
20
30
40
50 km
LEONORA
SHEET SH 51-1
First Edition 1995


PLATE 6




# GEOLOGICAL INTERPRETATION

After A.H. Hickman (in prep.), AGSO (1993), and T.J. Griffin and W.K. Witt (pers. comm.)

Granitoid rock

Granitoid gneiss and minor amphibolite

Volcano-sedimentary greenstone belt

Major fault

Keith - Kilkenny tectonic zone

# LEONORA

## SHEET SH 51-1

First Edition 1995

PLATE 7