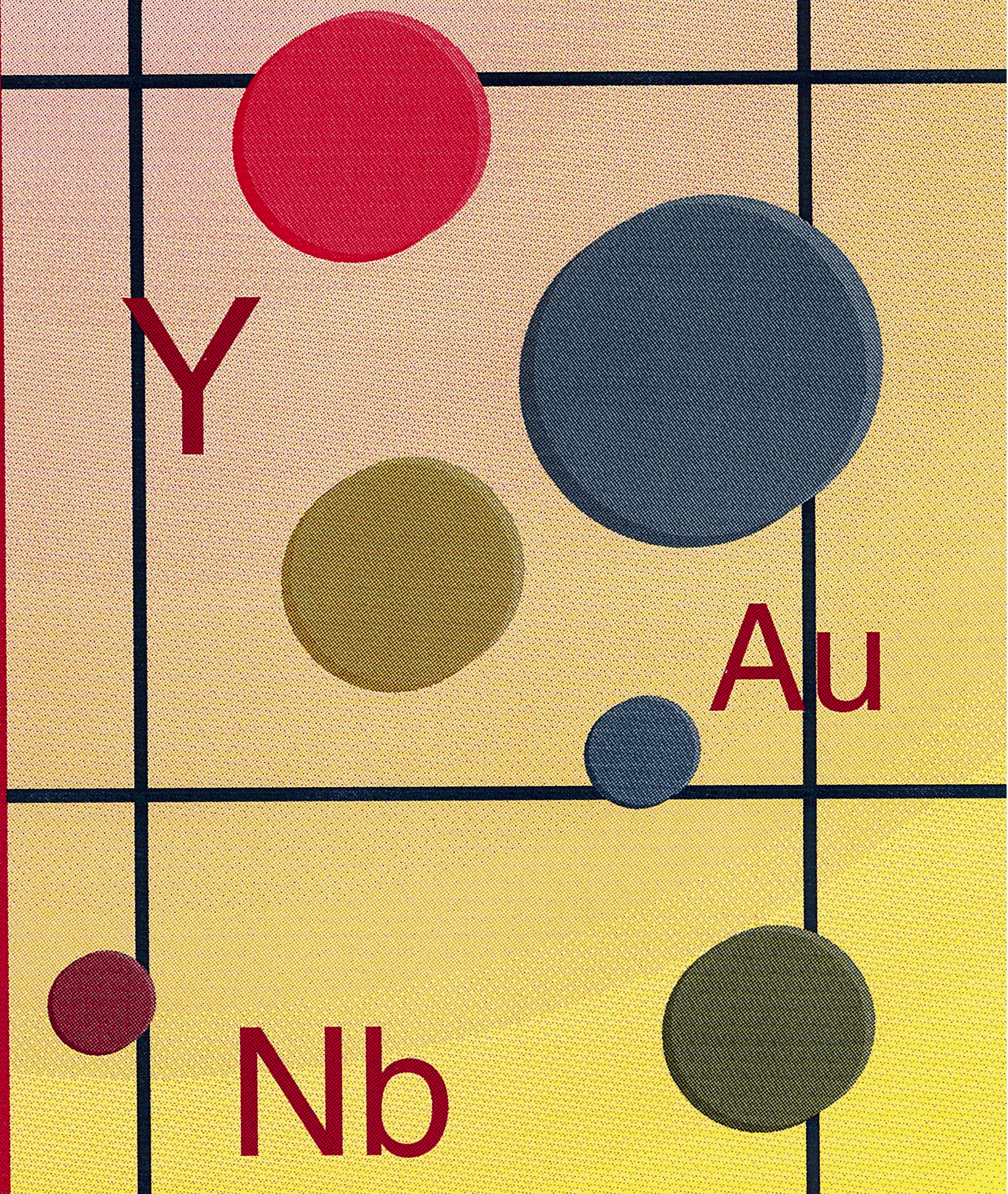
EXPLANATORY NOTES

GEOCHEMICAL MAPPING OF THE MENZIES 1:250 000 SHEET

by C.J. KOJAN and J.A. FAULKNER



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

DEPARTMENT OF MINERALS AND ENERGY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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C. J. Kojan and J. A. Faulkner

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Geochemical mapping of the Menzies 1:250 000 sheet

by

C. J. Kojan and J. A. Faulkner

Abstract

A regolith materials map and a sample locations plan have been prepared for the MENZIES 1:250 000 sheet area. Regolith samples collected at a nominal density of one sample per 16 km^2 have been analysed for 48 components. Distribution plots of 30 of the components, and of the higher values for a further 8 trace elements, are presented at the 1:1 000 000 scale. All analytical data are included in a digital data file with these notes; copies of the element distribution maps are available on demand at the 1:250 000 scale. A 1:250 000-scale map has also been prepared showing the positions of projects, held on open file, in which surface exploration geochemistry has been used.

In all, 1072 samples were collected. Of these, 413 were stream sediment, 580 soil, 44 lake sediment, and 35 'laterite'. Comparison of results from soils and stream sediments suggests that the source material has more influence on composition than sample medium.

Regolith materials have been simplified into 18 units; 4 corresponding to a relict regime, 6 to an erosional regime, and 8 to a depositional regime.

The results sharply define the greenstone belts, and suggest different elemental associations for the various belts, or for different domains within the same belt. These associations include not only rock-forming components, but also elements of economic interest. The results confirm that most granitoids are potassic. However, some sediments overlying the granitoids are so leached that indications of the granitic source no longer exist. Over both granitoid and greenstone, the composition of regolith sediments changes systematically from erosional to depositional areas. Lake sediments are characterized by chemical precipitates that include not only salt and gypsum, but also Sr and U.

Regional results for gold show the 3 ppb contour enclosing most known gold mining areas, and also suggesting areas with further potential for mineralization. However, the areas of Bottle Creek and Twin Hills are not highlighted. The Ilaara and the eastern side of the Menzies–Broad Arrow greenstone belts have anomalous As and Sb. Other areas with anomalous As, Sb, Mo, Nb, Se and U have been identified.

KEYWORDS: Menzies, Yilgarn Craton, geochemical maps, regolith, regional surveys, multi-element analysis

Introduction

Regional geochemical mapping involves the mapping of superficial materials (regolith), and the sampling and analysis of such materials, at regular intervals over large areas. It is undertaken for several purposes including

- provision of baseline geochemical data to assist interpretation of geochemical exploration results;
- identification of metallogenic provinces and specific areas with potential for undiscovered mineralization;
- identification of rock types and rock assemblages;
- provision of baseline geochemical data for use in agricultural and pastoral activities and environmental monitoring and regulation.

An International Geochemical Mapping project (IGCP-259) commenced in 1988, with the intention of providing a complete coverage of the continents by systematic multi-element geochemical mapping. Some findings from this project have been published by Darnley and Garrett (1991) and Davenport (1993). The limitations of the existing regional and project-related datasets are apparent to all scientists and geoscientists involved in mineral exploration and environmental monitoring.

Regional geochemical mapping programs have been implemented in a number of countries including the U.K., Greenland, East Germany, Hungary, Finland, Canada and China. Progress has been reviewed by Davenport (1993). Regional geochemical mapping in Australia has been undertaken by some of the larger companies and joint ventures involved in diamond exploration. However, the suite of elements analysed is generally limited and the results are commonly unavailable.

There is little recent published work on regional geochemical mapping in Australia with the exception of a stream-sediment study over the Ebagoola 1:250 000 sheet area in north Queensland (Cruikshank, 1994). These notes document the first regional geochemical mapping project undertaken by the Western Australian State Government.

The Menzies geochemical mapping project is the forerunner of several such projects for Western Australia. Regolith mapping and sampling of the Menzies area commenced in March 1994 with assistance from sampling teams provided by Geochemex Australia Pty Ltd. Analytical work was undertaken by Amdel Laboratories.

Setting

Access

The MENZIES* 1:250 000 sheet area (SH/51-5) lies between latitudes 29°00' and 30°00'S and longitudes 120°00' and 121°00'E and is named after the old mining town of Menzies. Menzies, with a population of 140, is located in the eastern part of MENZIES, about 130 kilometres north of Kalgoorlie (Fig. 1). The town is situated on the main Kalgoorlie–Meekatharra highway and is the administrative centre for the Shire of Menzies.

From Menzies the highway runs north to Leonora via Jeedamya and Melita stations. A formed road provides access to the mining centres of Niagara, Kookynie and Tampa. Other formed (unsealed) roads east of Menzies include the Pianto Road (formerly the Tonkin Road) and the road southeast from Morapoi. Both roads lead to Mulgabbie. Two main formed (unsealed) roads running west from Menzies link Menzies with Evanston and Sandstone. The Evanston road provides access to the southwest of MENZIES, which includes the mining centres of Riverina, Mulline, and Mulwarrie. Branch roads lead to Davyhurst to the south, and to Mount Ida and the Menzies–Sandstone road to the north. The Sandstone road provides access to the northwest of MENZIES, which includes Walling Rock station and the mining centres of Mount Ida, Copperfield, and Bottle Creek.

In off-road areas, access is highly variable. A network of tracks and survey grids covers most greenstone belts. Access in other areas is subject to the availability of well-mantained fence lines. Movement is relatively easy in the eastern MENZIES 1:100 000 sheet area (Jeedamya station) and over most of MELITA (Jeedamya and Melita stations) but is difficult over much of RIVERINA, MULLINE, MOUNT MASON, and BALLARD.

* Capitalized names in these notes refer to standard map sheets.

Climate and vegetation

MENZIES has a semi-arid climate with a mean annual rainfall of 250 mm. Most rain falls in the winter months, though occasional heavy rain may be experienced in summer as the result of thunderstorms or cyclonic activity. The most common wind direction in Kalgoorlie is easterly.

MENZIES lies within the Eremean botanical district (Beard, 1981). Variations in vegetation cover can be attributed to differences in bedrock, regolith, and rainfall. Sandplain upland areas underlain by granite are covered by spinifex and scrubby acacia. Ridges and hills of greenstone and iron-formation are usually densely vegetated in the southern and western parts of the sheet area. Mulga, sheoak and acacia are dominant on the rocky strike ridges, whereas eucalypts grow in the intervening valleys. Grasses, saltbush, and bluebush make up the understorey. Most greenstone hills north of Lake Ballard are sparsely vegetated with a cover of scrubby mulga, bluebush, saltbush, and extensive grass.

The sand and loam-covered plains are occupied by a woodland of mulga and scattered eucalypts. South and west of Lake Ballard, the woodland becomes dense and more variegated with a mix of mulga, eucalypt, cypress pine and sheoak, acacia, and grass. The major drainage floors, which correspond to palaeodrainages (Commander et al., 1991), contain the salt lakes and valley calcrete. The sandplain and dune areas bordering these lakes are commonly gypsiferous. These low-lying areas support a mix of halophytic vegetation: phreatophytes and salt bush, bluebush and samphire.

Topography and drainage

The terrain on MENZIES ranges from 354 to 594 m ASL, the lowest point being Lake Marmion and the highest point Mount Ida. Most of the area is located between 360 and 500 m ASL and generally increases in elevation from southeast to northwest. Local relief rarely exceeds 60 m.

The main features controlling the relief in the western part of MENZIES are the two large north-northwest trending greenstone belts. These are the Ilaara belt which extends from Lawrence Find to north of Ranford Peak, and the Mount Ida belt which extends from south of Mulwarrie to north of the Mount Ida mining centre (Fig. 1). Elsewhere on MENZIES, the main feature controlling the relief is the easterly trending Lake Ballard– northern Lake Marmion palaeodrainage and the associated northeasterly trending palaeotributaries represented by Lake Goongarrie–southern Lake Marmion and the lake system south of Ghost Rocks (Fig. 1).

Landforms and regolith development

Seven major landform types are recognized on MENZIES.

- Sand covered plateaus with breakaways underlain by granitoid
- Hills and ridges of greenstone
- Dissected plateau areas with duricrust remnants and abundant lag
- Low hills and rises of granitoid outcrop and deeply weathered granitoid
- Sediment plains in upland areas interrupted by areas of outcrop
- Major alluvial plains and sheetwash fans
- Major drainage floors containing salt lakes

For geochemical interpretation purposes it is convenient to consider these landforms and the associated regolith units in terms of residual, erosional, and depositional regimes as defined by Anand, Phang et al. (1993). The term *relict* is used in these notes in lieu of the term *residual*. The term relict applies to predominantly upland surfaces, including the lateritic duricrusts, which were developed prior to the more recent and continuing period of downcutting and erosion. Results of recent investigations in the Leonora area show that seven of the eight duricrusts tested, once thought to be residual, are of transported origin (Davy and Gozzard, in press). The granitoid plateau areas and lateritic breakaways/mesas are assigned to the relict regime. The greenstone hills and dissected plateaus and granitoid rises are assigned to the erosional regime. These are areas where active erosion is taking place with a net removal of weathered and eroded material. The remaining landform types are assigned to the depositional regime. In these areas, aggradation exceeds degradation. The distribution of these three regimes on MENZIES is shown in Figure 2.

The term regolith as used in these notes includes deeply weathered lateritic profiles consisting of duricrust, saprolite and saprock, and Cainozoic–Recent sediments derived from erosion of the weathered rock and underlying bedrock. The term regolith also includes chemical deposits of calcrete, salt, and gypsum. The Cainozoic–Recent sediments are generally thin and variable except in the palaeodrainages where up to 120 m of sediments of Eocene age infill incised palaeochannels (Allen, 1994).

Clarke (1994) reports that the palaeodrainages drilled in the Kambalda area have cut through the weathered cover to fresh rock. The deep weathering responsible for lateritization therefore largely predates the incision of these palaeodrainages. Initiation of the deep weathering throughout the Yilgarn may therefore be pre-Eocene, and probably continued until after deposition of red beds of probable Miocene age. Cainozoic sediments within palaeodrainages show evidence of weathering (Commander et al., 1991).

Data acquisition and previous geocientific investigations

Geological mapping

The first edition of the 1:250 000 geological map for MENZIES was compiled by Kriewaldt (1970). Since that time, geological maps have been published for the MENZIES (Swager, 1994), MELITA (Witt, 1994), BALLARD (Rattenbury, 1991), and MOUNT MASON (Duggan and Rattenbury, 1992) 1:100 000 map sheet areas. Geological maps for MULLINE and RIVERINA will be published in 1995 (Wyche, in press). Granitoid and greenstone outcrop areas shown on the 1:250 000 regolith-materials map (Plate 1) have been derived from these 1:100 000 geological maps. A new edition of the MENZIES 1:250 000 geological map is in preparation. Other geological maps which cover at least part of MENZIES include the 'Granitoid geology of the south-western Eastern Goldfields' (Witt, in press); and 'Gold mineralization in the Leonora–Wiluna region' (Hickman, in prep.). The geological interpretation plan (Fig. 3) has been compiled from the granitoid map with modifications in the Melita area based on the gold-mineralization map.

Regolith mapping

The Bureau of Mineral Resources, Geology and Geophysics (BMR), now renamed Australian Geological Survey Organisation (AGSO), has published two regolith maps which include MENZIES; one at the 1:1 000 000 scale (Chan, 1991) and another at the 1:250 000 scale (Churchward et al., 1993). The former provides an overview of the landforms and regolith on MENZIES; the latter is complemented by the Geological Survey of Western Australia (GSWA) regolith-materials map which accompanies these notes (Plate 1).

The Commonwealth Scientific and Research Organisation (CSIRO) is also involved in regolith mapping in the Yilgarn Craton. Results of some of this work are summarized by Anand, Churchward et al. (1993). CSIRO, in conjunction with AGSO, have also published a special edition 1:250 000-scale regolith-landforms map covering adjoining parts of the KALGOORLIE and KURNALPI sheets (Anand and Craig, 1994).

Hydrogeological investigations

Results of groundwater investigations in the Menzies–Wiluna region have been summarized by Allen (in press). In 1989, the hydrogeology section of the GSWA completed a drilling investigation of the low-lying area separating Lake Ballard and Lake Marmion. Twenty-seven holes were drilled on three separate sections. Results of this investigation show that the Lake Ballard palaeodrainage contains a sequence of Cainozoic sediments that reach a maximum thickness of 110 m. The sequence consists of an upper unit of red-brown sand containing sporadic calcrete that occupies the present-day palaeodrainage floor. In the marginal zones of the palaeodrainage this upper unit rests directly on weathered granitoid, or on silcrete developed on weathered granitoid. In the central zone of the palaeodrainage the upper unit overlies a middle unit consisting predominantly of clay. The lower unit consists of grey or buff-coloured sand which occupies the main original channel. The Cainozoic sediments in the central zone rest unconformably on a relatively thin veneer of weathered granite or, in places, directly on fresh granite.

Commander et al. (1994) have described the results of some age determinations obtained from water samples taken during this drilling investigation. Results indicate mixing of groundwater with recent rainwater. The chloride isotope data indicate that chloride has been present in the landscape for '...at least several hundred thousand years'.

Mineral resource and occurrence datasets

Mineral resource datasets include the records of past production published in the 'List of cancelled gold mining leases' (Department of Mines, 1954) and the unpublished figures kept by the Department of Minerals and Energy. The Minedex database maintained by the GSWA contains details of in-ground resources for individual mining projects. Information on mineral occurrences in the Menzies area was obtained from these and other sources including the annotations from the GSWA WAMEX database, Kriewaldt (1970), Marston (1979, 1984), Witt (1993, 1994), and Simpson (1948). Appendix 1 shows details of past gold production and reported resources (as at 1994) for mines and prospects on MENZIES.

Topographic and remote-sensing datasets

The topographic datasets used in the maps and figures accompanying these notes were obtained from the Australian Land Information Group (AUSLIG). Landsat Thematic Mapper scenes were obtained from the remote sensing group of the Department of Land Administration (DOLA). Scenes incorporating bands 2, 4, and 7 were provided in two separate formats, namely at 1:100 000 scale for two-dimensional viewing and as smaller scale stereo pairs for three-dimensional viewing. Both formats were used in the interpretation of regolith unit boundaries in the course of compiling the regolith-materials map (Plate 1). Other remote-sensing datasets acquired for data analysis and interpretation of the geochemical data include the available total magnetic intensity and gamma-ray spectrometer data.

Geology

The geology of MENZIES is typical for the Yilgarn craton and for Archaean granite–greenstone terranes in general. Large areas of granitoid and granitoid gneiss are separated by narrow, linear to arcuate belts of greenstone. Outcrop is very limited and rock relationships, especially in areas of granitoid, are difficult to interpret on account of deep weathering, lateritization and subsequent erosion, and deposition of extensive sheets of sand and gravel. The geological interpretation shown in Figure 3 is based on a combination of geological mapping and interpretation of aeromagnetic data, and is a simplified version of part of a 1:500 000-scale map (Witt, in press). Some changes have been made to the northeast part of the map following recent mapping in the Melita area (Hickman, in prep.). Three main rock types are shown on this map; volcano-sedimentary rocks or greenstone, granitoid, and granitoid gneiss.

The greenstones, as described by Griffin (1990a), comprise thick mafic to ultramafic volcanic sequences (tholeiite, high-Mg basalt, and komatiite); mafic to ultramafic intrusives, which commonly occur as sills; felsic and intermediate volcanic and subvolcanic sequences; pelitic and psammitic sedimentary sequences; and interbedded chert, banded iron-formation (BIF), and shale. They trend generally north-northwesterly and have been subjected to several episodes of folding and faulting. Bedding and foliation angles and directions are therefore highly variable. The greenstones have undergone varying degrees of metamorphism and are locally intruded by discordant granitoid bodies and dykes of porphyry and pegmatite. The greenstones are also locally altered and mineralized, and host many former and several current gold mines and prospects. The greenstones date from 2.7 Ga (Griffin, 1990a).

The areas shown as granitoid in Figure 3 include large areas of foliated and unfoliated granitoid, and small discordant granitoid stocks. The granitoid gneiss contains minor amphibolite and occurs as extensions or marginal zones to the larger greenstone belts.

Kriewaldt (1970), referring to an analysis of aeromagnetic anomalies by Young and Tipper (1964), stated that there are seven large dykes which cut across MENZIES, three of which are about 300 m wide. The east–west dykes, which form part of the Widgiemooltha dyke suite, generally consist of olivine dolerite or gabbro and date from 2.4 Ga (Griffin, 1990a; Myers, 1990).

Four major greenstone belts have been mapped on MENZIES; the Ilaara, Mount Ida, Menzies–Broad Arrow, and Malcolm belts (Griffin, 1990a,b). The Yerilgee belt crosses the southwest corner and the northern extremity of the Ora Banda belt extends across the MENZIES southern boundary. Small greenstone remnants have been mapped from the MULLINE and MENZIES 1:100 000 map sheet areas and are referred to as the Maninga and Alexandra Bore belts. Both the Mount Ida and Menzies–Broad Arrow belts have been further subdivided into domains. Each domain is characterized by a distinctive association of intrusive, volcanic and sedimentary rock types reflecting significant differences in stratigraphy and igneous activity. The domains and belts are assigned to either the Kalgoorlie or Barlee Terranes (Ahmat et al., 1993; Witt, in prep.). The Barlee Terrane corresponds to the eastern part of the former Southern Cross province and the Kalgoorlie Terrane corresponds to the former Eastern Goldfields province.

Barlee Terrane

The Barlee Terrane includes the Ilaara, Yerilgee, Maninga greenstone belts and the western domain of the Mount Ida belt (Fig. 3). The terrane is bounded to the east by the Mount Ida Fault, which has been described as a major crustal boundary fault (Goleby et al., 1993). On MENZIES, the Mount Ida Fault is interrupted by several post-tectonic granitoid intrusions. The main rock types in the Barlee Terrane are basalt, dolerite, gabbro, BIF, and sedimentary rocks. The sedimentary rocks include greywacke, quartzite, schist and some pyritic chert.

Kalgoorlie Terrane

The Kalgoorlie Terrane as originally defined by Swager and Griffin (1990) was, on MENZIES, confined to the eastern domain of the Mount Ida belt (east of the Mount Ida Fault) and the western domain of the Menzies–Broad Arrow belt. More recent work by Swager (1993) and Rattenbury (1993) indicates that the Kalgoorlie sequence is more extensive. Thus the entire Menzies–Broad Arrow belt, the Alexandra Bore belt and the Malcolm belt are also included in the Kalgoorlie Terrane.

Eastern Mount Ida and western Menzies–Broad Arrow belts

The main rock types in these domains are basalt, dolerite, gabbro, (serpentinized) komatiite, and (serpentinized) dunite. Ultramafic rocks (komatiite and dunite) occupy the entire central part of the Mount Ida belt and constitute most of the western Menzies–Broad Arrow belt. Mafic rock, mostly basalt, together with minor intercalated felsic volcanic and sedimentary rock dominate in the northern and southern parts of the Mount Ida belt and also occur in the Comet Vale and Ghost Rocks areas of the western Menzies–Broad Arrow belt.

Menzies shear zone

The Menzies shear zone separates the western and eastern domains of the Kalgoorlie–Broad Arrow belt and, according to Swager (1994), represents a separate tectono-stratigraphic domain. The shear zone hosted the major gold deposits formerly mined in the Menzies district. The main rock types consist of amphibolitic basalt, sedimentary rocks and relatively minor ultramafic schist. The sedimentary rocks include greywacke, conglomerate, slate, and schist.

Eastern Menzies–Broad Arrow belt

In the Comet Vale–Menzies area, this domain is bounded by the Menzies shear zone to the west and the Moriaty shear zone to the east. The domain includes the northern extension of the greenstone belt, from Menzies north to Twin Hills, which is bounded by granite and granite gneiss (Fig. 3). The main rock types within this domain are amphibolite, high-Mg basalt, highly altered felsic volcanic rocks, komatiite, and ultramafic schist. The geology of the area is described by Swager (1994) and Witt (1993b).

Malcolm and Alexandra Bore belts

The Malcolm belt includes the felsic volcanic-dominated greenstone sequence mapped by Witt (1994) in the eastern part of MELITA. The main lithologies are basalt, felsic volcanic, dolerite, and sedimentary rock. The basalt includes andesitic and high-Mg varieties. The felsic volcanic rock ranges from rhyolite to rhyodacite. The dolerite occurs in layered sills and complexes. The Niagara Complex also includes gabbronorite and gabbroic anorthosite. Other rock types present in the Malcolm belt include mafic gneiss, amphibolite and ultramafic rock. These rock types are largely confined to the more highly metamorphosed marginal areas of the belt. Ultramafic rock also occurs at the base of some of the dolerite sills. The Alexandra Bore greenstones are mainly gabbbro and amphibolitic basalt (Swager, 1994).

Mineralization

The mining centres, which represent areas of former significant gold production and selected prospects, are shown in Figure 3. Only two mines are in operation in 1994, namely the Lady Jane and Lady Gladys mines in the Mulline area (Fig. 3). According to Kriewaldt (1970) over 2.25 million ounces (70 tonnes) of gold have been produced from mines on MENZIES; silver production amounted to 50 000 ounces (1.5 tonnes). The mineral resource and occurrence datasets reviewed previously have been used to compile a statistical summary of gold production and resources for MENZIES. This summary appears in Appendix 1.

Details have been obtained for 130 separate mines with a combined production of 64 tonnes of gold. Resource details have been obtained for 23 separate localities comprising extensions to former mines and new prospects. Combined resources amount to 32 tonnes of gold. The most significant prospects are Riverina at 2825 kg, Orient Well (north of Kookynie) at 8490 kg, and Cosmopolitan (Kookynie) at 8855 kg.

Previous gold production and currently defined resources on MENZIES are largely confined to the Mount Ida, Menzies–Broad Arrow and Malcolm greenstone domains. Most production has been obtained from shallow underground workings in mineralized greenstones. However, significant gold concentrations also occur in palaeochannels (Kookynie) and laterite (Riverina and Tampa).

Apart from gold, silver production has been reported from mines in the Riverina area (unpublished information, Royalties Division, Department of Minerals and Energy). Other subeconomic mineral occurrences reported from MENZIES comprise antimony, arsenic, beryllium, bismuth, chromium, copper, emeralds, lead, lithium, molybdenum, nickel, palladium, platinum, tin, tungsten, uranium, vanadium and zinc. Apart from uranium, which is concentrated in salt lakes, these mineral occurrences are confined to the greenstone belts and are generally associated with gold mineralization. Details of gold and other mineral occurrences are reviewed in relation to individual greenstone belts (Fig. 3).

Barlee Terrane

This terrane is situated west of the Mount Ida Fault (Fig. 3). The location of this fault in the Mulline area is problematical. The main fault, or a splay off the main fault, may extend west of the Mulline mines, in which case these mines, which are geologically similar to the Riverina mines, are situated within the adjacent Kalgoorlie Terrane. Gold mineralization in the Mount Ida belt is largely confined to the eastern domain, which corresponds to the western part of the Kalgoorlie Terrane.

Gold has been reported from Metzke Find and Lawrence Find in the Ilaara belt but there has been very little production. Copper mineralization occurs north of Metzke Find and arsenopyrite occurs at Lawrence Find and near Lemon Rock.

Kalgoorlie Terrane

Eastern Mount Ida and western Menzies–Broad Arrow belts

These belts contain the former gold-mining centres of Mount Ida, Copperfield, Bottle Creek, Mulline, Mulwarrie and Comet Vale. Gold mining is currently confined to the Mulline centre (Lady Gladys and Lady Jane open pit operations). Past production from these centres amounts to about twenty-seven tonnes of gold and reported resources amount to eight tonnes. The gold mineralization is largely confined to basalt. Mineralization at the Mount Ida and Copperfield centres has been described by Gibson (1907), at the Mulline and Mulwarrie centres by Gibson (1904), and at the Comet Vale centre by Witt (1993a).

Gold occurs in a number of associations with other (subeconomic) metals of interest. The different associations may reflect variations in depth of formation and proximity to post-tectonic granitoids. The concept of vein zoning is described in Guilbert and Park (1986). Hypothermal-type associations occur at Mulwarrie (Au–W) Snake Hill (Au–W) and Comet Vale (Au–W–Bi–Cu–Pb–Zn). Mesothermal type associations occur at Mount Ida (Au–Cu), Copperfield (Au–Cu–As), Corida (Au–As–Cu–Pb–Zn), Mulline (Au–Pt–Pd, Au–Cu–Pb–Zn and Au–Zn), and Ghost Rocks (Au–Cu). Epithermal-type associations occur at Bottle Creek (Au–Sb–As–Ag) and Riverina (Au–Cu–Pb–Zn–Ag). Lithium- and beryllium-bearing pegmatites occur north of Riverina and have locally been mined for emerald. The main emerald occurrence corresponds to that of beryllium located north of Riverina (Fig. 3) and has been described by Garstone (1981).

Menzies shear zone

This shear zone contains most of the former mines of the Menzies centre. The mines extend from the Princess May north to St Albans (Fig. 3). Past production amounts to about twenty-two tonnes of gold and reported resources amount to about two tonnes. The mineralization is described by Witt (1993a). The reported mineral associations, which are of mesothermal type, include Princess May (Au–Cu–As), Lady Harriet (Au–As), Lady Shenton (Au–Cu–Pb–Zn–As), FirstHit/Robinson Crusoe (Au–As–Cu–Pb–Zn) and St Albans (Au–Cu) mines. Lithium-bearing pegmatites occur at the First Hit/Robinson Crusoe mine northwest of Menzies. Chromium occurs at the Princess May mine (Kriewaldt, 1970).

Eastern Menzies–Broad Arrow belt

The greenstones situated east of the Menzies shear zone contain several small and medium-sized former gold mines. The largest deposit, Twin Hills, is located north of Lake Ballard, on the northern extension of the domain (Fig. 3). The Twin Hills deposit remains largely unexploited. Past production from the domain amounts to about one tonne, and reported resources (from Twin Hills) amount to about 0.5 tonne. The mineralization is described by Witt (1993a).

Epithermal mineralization occurs at the Goodenough mine (Au–Cu–Pb–Zn–Ag). Elsewhere, mesothermal associations consisting of gold and copper predominate. Minor nickel mineralization occurs at the Goodenough mine and minor chromium mineralization occurs at the Emu mine.

Malcolm belt

The Malcolm belt contains the former gold-mining centres of Niagara, Kookynie (Cosmopolitan), Tampa and Desdemona. Witt (1994) reports some recent mining activity in the Kookynie area. Intensive exploration is continuing at both the Niagara and Tampa centres and a new mining project is scheduled for the Tampa centre (Orient Well). Past production from all centres amounts to 13.5 tonnes and reported resources amount to 21.5 tonnes. The mineralization is described by Witt (1994).

A hypothermal-type association (Au–W–Pb) has been reported from the Kookynie mines, including Cosmopolitan, Britannia, and Two Dees (Fig. 3). A mesothermal type association occurs at the Desdemona centre (Au–Cu–As) and at the nearby Coronation Well mine (Au–As). Nickel, platinum and palladium mineralization have been reported from peridotite and ultramafic schist in the Desdemona area (Carpentaria Exploration, 1988). An epithermal-type association is found in the former mines of the Niagara centre (Au–Sb–Ag–Bi–Cu–Pb–Zn). The association at Tampa is limited to pyrite and pyrrhotite (Witt, 1994).

The felsic volcanics in the Melita area in the northern part of the domain have been explored for stratabound base metal sulfide orebodies, as described in Witt (1994). Small, subeconomic concentrations of base-metal minerals were discovered at Melita airstrip (Cu–Pb–Zn), Mount Melita (Cu–Sn–Ag), and Snowy Well (Cu–Pb–Zn). These locations are shown as copper occurrences in Figure 3.

Witt (1994) reports that pegmatite dykes are abundant around the Galah Monzogranite and Carpet Snake Syenogranite in the vicinity of the Mount George shear on the western margin of the domain (AMG 320540 to AMG 340390). Witt points out that complex pegmatites in such areas may host lithium, beryllium (emerald), tin, tantalum, and rare earth elements.

Geochemical surveys on open-file company reports

Company mineral-exploration reports are lodged with the GSWA, in compliance with the conditions applying to tenement holders, and are listed on the GSWA WAMEX database. Geochemical-sampling information was extracted from open-file company reports and summarized in table form (Appendix 2).

The table reports information from surface geochemical exploration, but includes costean and shallow drill information for analyses produced from material sampled between the surface and a depth of four metres.

Each project is assigned an identification number (ID No.): the individual project boundaries together with the appropriate ID Nos are shown on Plate 2. The first column in the table (Appendix 2) is the ID No. Most projects are applicable to a single area, although in a few cases there may be two or more blocks of ground. Other fields include GSWA M-series number, report accession number, year, sample medium, number of samples, and elements analysed.

Reports covering the period 1967 to 1992 are tabulated in descending order, from the most recent GSWA project number (M No.) on open file to the earliest.

A preliminary analysis of the open-file surface geochemistry data for MENZIES shows that of the 134 projects listed in Appendix 2, 95 projects targeted gold mineralization, 35 targeted other metalliferous mineralization (mainly copper and nickel), and 4 targeted uranium. The most actively explored greenstone belts are the Mount Ida belt with 43 projects and 43 866 samples, and the Menzies–Broad Arrow belt with 33 projects and 30 362 samples. Exploration of the Ilaara belt involved 9 projects with 11 468 samples, and of the Malcolm belt 42 projects and 12 868 samples. Three other small greenstone areas (Yerilgee, Ora Banda, and Alexandra Bore) were each covered by one project. In all, 1768 samples were collected for the three projects. The four uranium projects are confined to the salt lake systems; 191 samples were reported. The total number of samples reported for MENZIES is 100 523.

The Mount Ida greenstone belt on MENZIES has been targeted primarily for copper and nickel mineralization (34 882 of 43 866 samples) whereas about equal numbers of samples for gold, and metallic elements excluding gold, have been collected from the other main belts represented on MENZIES (Menzies–Broad Arrow, Ilaara, and Malcolm). The most common elements determined have been Au, As, Ag, Cu, Pb, Zn, and Ni. The number of elements analysed for individual projects was highly variable ranging from one to eighteen and averaging about six.

Geochemical mapping

Regolith mapping and sampling of the MENZIES 1:250 000 sheet area commenced on March 1, 1994. The mapping and sampling was undertaken by C. Kojan (GSWA) with assistance from J. Bradley, D. Ellis, B. McCrow, and G. Mehri (Geochemex). The first phase of the program, involving sampling teams on the ground, was completed on March 31, 1994. The second phase (April–May) involved sampling teams operating both on the ground and by helicopter. Each sampling team consisted of a geologist and field assistant. The helicopter sampling was undertaken by two geologists operating in tandem.

Site selection

Recent overseas regional surveys have been carried out at sample densities ranging from one sample/km^2 in China (Xie Xujing and Ren Tianxiang, 1993) to one sample/ 30 km^2 in Scandinavia and Greenland (Steenfelt, 1990). A nominal sample density of one sample/16 km^2 was chosen for MENZIES and for subsequent regional geochemical mapping projects. This density translated to approximately 1000 samples for the sheet. This sample density was chosen after a literature survey of work carried out in other parts of the world and the studies of Fordyce et al. (1993) who, in simulation studies, showed that in northern Britain geochemical patterns were likely to become distorted at sample densities lower than one sample/25km^2 but were valid at higher densities. The selected density of one sample/16km^2 compares with the sample density of one per 10–15km^2 used by Cruikshank (1994) in northern Queensland.

Sample sites were selected using a basic 4x4 km grid superimposed onto 1:100 000 maps. Within each square a site was chosen after consideration of known geology, satellite imagery and topographic data, and aeromagnetic and radiometric information where available. The selected locations were digitized and site-reference numbers and AMG coordinates printed for field use. Sites were located on the ground using Trimble Ensign Global Positioning System (GPS) Units. The sampling geologist was allowed some discretion to move to a better sample site.

The preferred medium for regional geochemical mapping is active stream sediments; however, streams on MENZIES are confined largely to greenstone belts. The ideal catchment size of 16 km^2 was rarely achieved and, because of lack of drainage channels, alternative sample media were used to achieve full coverage of the sheet. The size of most catchments sampled varied between 3 and 8 km^2. Where streams were absent soil was the most common medium sampled. Vegetated, or partly vegetated, consolidated sheetwash found in the centre of shallow valleys and other depressions was classified as soil after inspection of results. Other sample media included lake sediments and 'laterite'. The latter included duricrust, loose ferruginous nodules and pisoliths (mainly from granitic sandplains) and ferruginous lag (mainly from greenstone belts).

Sample-site form

A sample-site form was completed at each sample site. An example of a sample-site form similar to the one used on MENZIES appears in Appendix 3. The geologist in each sampling team entered the required details for each sample site. The main categories of information concern sample numbers and location coordinates, sample type, landform type, clasts including relative abundance and description, secondary coatings, sample matrix, site geology, stream description, sample fraction distribution and depth. The form incorporates listings of possible options which can be selected by ticking an appropriate box. This format was designed to ensure that the geologist recorded all key data with minimum effort and to facilitate interpretation for determining regolith code and the transposition of data into a computerized database.

Sampling

Where the sample medium was stream sediment, soil or lake sediment, two samples were collected at each site. The first, for analysis in the current project, comprised 1.5 kg of -2 mm to +0.45 mm material. This size fraction was chosen to avoid heterogeneity associated with larger size fractions and to minimize collection of eolian sand present in large quantities in the 0.1–0.2 mm size fraction. In many places, a clay fraction was absent.

The surface material comprising vegetation debris and windblown sand was removed and a pit or channel was then excavated to depths of between 10 and 40 cm. The initial sample material was collected from multiple points. For streams, the sample material was taken either from the stream bed along the axis of the stream or by channel sampling in and adjacent to stream banks. Both active sediment and bank material were included. Soil sample material was taken from multiple pits. At least three pits were sampled and these were spaced about 50 m apart. At sites where there was some indication of a drainage or downslope direction, the soil sample pits were dug in a line at right angles to the inferred drainage direction Lake samples, most of which were obtained by helicopter were generally taken from a single pit.

The sample material from the different pits or channels was composited into a single sample. Dry samples were sieved on site with the exception of the samples taken by helicopter which were sieved at the field camp. Wet samples were dried and sieved in Perth. Both analytical and archive samples were labelled externally with a GSWA sample number. Tags showing the sample number were placed inside each bag; paper tags for the geochemistry samples and aluminium tags for the archive samples.

The few samples collected as laterite included large pieces of duricrust and large-sized ferruginous nodules. These samples were simply pulverized prior to analysis.

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

A total of 1085 samples were collected including 13 duplicates. The remaining 1072 samples comprised 413 stream sediment, 580 soil, 44 lake, and 35 laterite.

Regolith-materials mapping

A regolith materials map for MENZIES has been produced following interpretation of satellite imagery and reference to the regolith-materials information as recorded on the sample site forms. This regolith-materials map appears as Plate 1. The map focuses on materials, as providing a base for interpretation of the chemical data obtained. Eighteen map units or types of regolith material are shown. A preliminary edition of a regolith-landforms map (Churchward et al., 1993) was provided by AGSO to assist in choice of units, and the location of samples. The final map units are based on the scheme used by Craig and Anand (1993) for the Kalgoorlie–Kurnalpi regolith-landform map. Details for some individual unit descriptions were obtained from Anand et al. (1993). The units are described in the map legend and in Table 1. Five of these units consisting of varieties of bedrock (E1, E2g, E2vs, and E3) and lake sediments (DA7) are largely derived from the 1:100 000-scale geological maps of MENZIES, MELITA, RIVERINA, and MULLINE. The remaining units have been mapped using the regolith code or material description recorded on the sample-site forms. The boundaries of the map unit polygons have been drawn using 2D and 3D Landsat thematic mapper images.

Regolith-materials map units

The regolith-materials map units shown in Plate 1 and Table 1 have been grouped into relict, erosional and depositional regimes as discussed previously.

Relict regime

The relict regime is subdivided into four map units (R1, R2, R3, and R4). Units R1 and R4 form the sand-covered plateaus and breakaways developed on granitoid and granitiod gneiss. R1 consists of sand with variable amounts of ferruginous pisoliths and nodules. R4 typically consists of sand sheets and dunes; pisoliths and nodules are generally absent. Unit R3 (silcrete and silicified granite) is confined to breakaways and erosional remnants of former plateau areas. Unit R2 (duricrust) forms isolated mesas and plateau remnants within the greenstone belts.

Erosional regime

The erosional regime is subdivided into six map units (E1, E2g, E2vs, E3, E4g, and E4vs).

Unit E1 (mottled zone/saprolite) in granitoid terrain corresponds to unit *Csw* mapped by Witt (1990) on MELITA and unit DR1 (extensive deep weathering mantle) mapped by Chan (1991). This unit occurs extensively throughout the more dissected granitoid terrain north of Lake Ballard, typically forming large pediments developed below breakaways. The greenstone analogue of this unit is widely developed in dissected greenstone terrain.

Unit E2g (granitoid and granitoid gneiss–saprock, bedrock etc) and unit E3g (granitoid with residual sand cover) are closely related. Unit E3g corresponds closely to unit *Czg* on the GSWA 1:100 000-scale geological maps for MENZIES, MELITA, RIVERINA, and MULLINE. The E3g polygons exhibit a characteristic granitoid shape and pattern and differ from E2g (granitoid outcrop) on the false-colour imagery by being more diffuse and purple-grey in colour on the Landsat TM images. Unit E4g (feldspar- rich lag of granitoid origin) surrounds and overlies granitoid outcrop and subcrop (E2g and E3g) in areas of low to moderate relief where the overlying lateritic profile comprising units E1, R1, R3 and R4 has been removed (assuming it once existed).

Unit E2vs corresponds to greenstone outcrop and includes tholeiitic and high-Mg basalt, dolerite, gabbro, komatiite, dunite, iron formation (BIF), sedimentary rocks, and felsic volcanics and volcaniclastics. Many of these rock types are now represented by their sheared and altered equivalents. Unit E4vs (ferruginous lag) is found in areas of moderate relief fringing the main areas of greenstone outcrop. It generally overlies greenstone but can occur overlying granitoid in areas adjacent to greenstone terrain.

Depositional regime

This regime is subdivided into eight map units (DC1, DC2, DC3, DA4, DA5, DA6, DA7, and DA8). Units DC1, DC2 and DC3 are considered to be of colluvial origin. Units DA4, DA5 are of predominantly alluvial origin. Units DA6, DA7 and DA8 include chemically precipitated deposits. Sand dunes occur in unit DA6 and some of the finer grained material in the other units may be of eolian origin.

Unit DC1(coarse colluvium) represents locally derived material deposited close to source. It is therefore closely associated with erosional units E1 and E4g in granitoid terrain, unit E4vs in greenstone terrain and unit DA4 (active drainage). Greenstone derived DC1 material is highly ferruginous and granitoid derived DC1 material tends to be feldspathic. Unit DC2 (fine to medium colluvium) is largely confined to granitoid terrain where it occurs as sediment plains in upland areas and marginal colluvial plains in areas of lower relief. It is closely associated with unit E4g (upslope) and units DC3 and DA5 (downslope). Unit DC3 occurs as sheetwash fans that are generally very large and occupy broad valleys. Such valleys typically originate in major drainages (DA4) developed in greenstone terrain and terminate in or adjacent to alluvial plains (DA5) and drainage floors (DA6 and DA7).

Unit DA4 (alluvial channels) are largely confined to greenstone terrains and adjacent areas. Most stream-sediment samples are obtained from this unit and the composition of these samples is normally used to define the surrounding regolith units. Unit DA5 (alluvial plains) consists of fine-grained sediment on or adjacent to broad drainage floors. Calcrete nodules are common and hardpan (cemented colluvium) is locally exposed in stream banks and on the margins of the drainage floors. Unit DA6 (drainage floors adjacent to salt lakes) includes a wide range of deposits including both gypsiferous and silica-rich

Table 1. Regolith codes and descriptions

Regolith code	*Description*
Relict regime	
R1	Lateritic pisoliths and nodules with sand
R2	Iron-rich lateritic duricrust
R3	Silcrete and silicified granitoid 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
E3	Residual sands and sandy clays developed over (eroding) mottled zone, saprolite and bedrock
E4g	Lag of lithic detritus and/or feldspar in a sand-rich matrix associated with actively eroding outcrop/subcrop; 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 >25 mm), in colluvium with a sand or sandy clay matrix
DC2	Fine to medium detritus of two types: ferruginized lithic clasts (most 4–25 mm), in colluvium with a sandy clay matrix (greenstone terrains) or quartz, feldspar, and granitoid clasts in sandy colluvium (granitoid terrains)
DC3	Predominantly non-lithic ferruginous detritus (most clasts <10 mm), some magnetic, in a red sandy clay matrix in sheetwash areas; clasts may be absent
	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 aeolian sediments adjacent to playa lakes; usually vegetated
DA7	Saline clays and sandy clays of playa lakes; usually unvegetated
DA8	Extensive and continuous calcrete outrop in broad drainage floors (valley calcrete)

dunes. The unit is characterized by halophytic vegetation. Unit DA7 (salt lakes) consists of saline clays. Unit DA8 (extensive calcrete) has been mapped by AGSO (Churchward and Craig, 1993) from two areas in the western part of MENZIES. These calcrete areas are shown in Plate 1. Some additional small calcrete areas have been interpreted from northwest MENZIES (Plate 4). Sporadic calcrete was encountered in the drilling investigation in the area separating Lake Ballard and Lake Marmion.

Chemical analysis

The samples were analysed by Amdel Laboratories Ltd, Wangara, Perth. Samples were prepared using Labtechnics large capacity, chrome-free bowl pulverizers, capable of macerating up to 2kg of sample. Labtechnics reports the average analyses for these bowls: 0.14% C, 0.20% Si, 1.10% Mn, 0.020% P, and 0.025% Al. Possible trace elements reported by the steelmaker include Cr, Mo, V, and Ni. Results of Labtechnics test work indicate minor contamination with Mn (about 50 ppm) and Fe (about 5000 ppm) can be anticipated. There was no detectable contamination of the analyses for the trace elements Cu, Pb, Zn, Ni, Mo, Co, and V.

Forty-eight different constituents were determined: ten elements reported as oxides (SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, and P_2O_5); three anion elements (Cl, F, and S); 34 cation or 'trace' elements (Au, Pt, Pd, Ba, Be, Ag, As, Bi, Cd, Ce, Co, Cr, Cu, Ga, In, La, Pb, Li, Mo, Nb, Ni, Rb, Sb, Sc, Se, Sn, Sr, Th, W, U, V, Y, Zn, and Zr); and LOI (loss on ignition) reported as part of the 'silicate analysis'.

Analytical methods

Eight different methods were used for the sample analyses as follows:

- *Inductively coupled plasma mass spectroscopy (ICP–MS) using a combined hydrofluoric/multi acid digestion.* The pulverized sample is digested in a hydrofluoric/perchloric/nitric/hydrochloric mixture for a period of over 24 hours, evaporated to fume dryness and dissolved in dilute hydrochloric acid. The solution is then read using an ICP-mass spectrometer. Elements analysed by this method were Ag, As, Bi, Sb, Cd, Ce, Ga, In, La, Li, Mo, Nb, Pb, Rb, Sc, Se, Sr, Th, U, and W.

- *Inductively coupled plasma mass spectroscopy (ICP-MS) using an alkaline (lithium metaborate) fusion and dilute hydrochloric acid digestion.* Elements analysed by this method were Ba, Be, and Sn.
- *Inductively coupled plasma optical emission spectroscopy (ICP-OES) using a combined hydrofluoric/multi acid digestion.* The pulverized sample is digested in a hydrofluoric/perchloric/nitric/hydrochloric mixture for a period of over 24 hours, evaporated to fume dryness and dissolved in dilute hydrochloric acid. The solution is 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.* Elements analysed by this method were Al, Ca, Fe, Mg, Mn, P, K, Si, Na, Ti, and also LOI.
- *Fire assay extraction and atomic absorption spectroscopy measurement using graphite furnace atomisation.* Elements anlysed by this method were Au, Pt, and Pd.
- *Sulfur determination* by roasting the sample in a Leco furnace, absorption of the resultant gases in acidified potassium iodide solution and back titration using potassium iodate solution
- *Low-level fluorine and chlorine determinations* using sodium peroxide fusion, dissolution in water and selective ion electrode.
- *High-level chlorine determinations* using sodium peroxide fusion, dissolution in water and titration with silver nitrate using a potentiometric endpoint determination.

Quality control

Quality-control procedures are designed to monitor the variability associated with sampling and analytical methods to ensure that the sample results reflect genuine geochemical variations and are not artifacts of the analytical technique or sampling method. Reproducible sample results should normally be obtainable from the same sample site. Similarly, individual analytical determinations should be reproducible within set limits, except that variability will inevitably increase towards the detection limit.

About 50 randomly selected sites were revisited to ensure that the sample-site location was appropriate, that the sample had been collected correctly and that the location, sample and regolith details had been correctly recorded. In addition GSWA submitted several external standards as part of a program of monitoring and comparing sample accuracy for different analytical laboratories.

Four main quality-control procedures were employed for the analytical part of the geochemical mapping program.

- Inclusion of in-house standards on a regular basis;
- repeat analyses for gold;
- submission of duplicate samples from the same site;
- having check analyses carried out by a different laboratory.

Inclusion of in-house standards

Amdel included several determinations of 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. No standards for Cl, F or S were included and the standards used for Pt and Pd were inappropriate. The actual values, means, standard deviations and relative standard deviations (RSDs) were reported for all determinations of each element for each standard. Each standard was resubmitted at least four and up to six times within each batch of 200 samples.

Consistent results were achieved for most major elements. RSDs for SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, and MgO were less than 6.0 at all levels of concentration. Results for K_2O and P_2O_5 indicated higher, albeit satisfactory variabilities at low levels of concentration (around 0.1–0.2 %) with RSDs of about 20.0.

Results for trace elements were mixed. The multi-acid digest method for dissolution of samples does not necessarily extract all Ce, Cr, La, Mo, Nb, Th, Sn or Zr. Results for these elements may therefore be low, even where they are consistent. Consistency is good for Cu, Co, Cr, and Ni with RSDs less than 6.0, and is generally satisfactory for Au, U, Zn, Mo, Cd, Sr, and V with RSDs less than 25. Results were satisfactory for Ag >3 ppm, As >100 ppm, Li >10 ppm, Bi >100 ppm, Nb >8 ppm, Rb >40 ppm, W >70 ppm. Results were less satisfactory (RSDs ~ 30) for Pb (22–143 ppm), La (39–76 ppm), Ga (21–63 ppm), Ce (73–135 ppm), and Y (12–19ppm) in the standards, at least over the ranges shown in parenthesis.

Repeat analyses for gold

Amdel carried out repeat analyses for gold for 85 samples. Repeat analyses were undertaken for every twentieth sample and for most samples containing >5 ppb Au. Data for the 85 pairs of duplicate samples were compared using the 'paired t-test' (Koch and Link, 1970) which computes a confidence interval for the population mean of the

Table 2. Paired t-test results on thirteen duplicate samples

Element	t statistic	Different at 5% CL $t = 2.18$ (a)	Different at 10% CL $t = 1.78$ (b)	Number of values below detection limit
SiO_2	-1.15	no	no	0
TiO_2	-0.63	no	no	0
Al_2O_3	0.32	no	no	0
Fe_2O_3	0.71	no	no	0
MnO	-0.69	no	no	2
MgO	1.02	no	no	2
CaO	1.33	no	no	2
Na_2O	-1.42	no	no	1
K2O	-0.89	no	no	0
P_2O_5	-0.52	no	no	2
LOI	-0.32	no	no	0
Au	0.31	no	no	16
Pt	nd	-	-	26
Pd	-0.56	no	no	19
Ba	-1.07	no	no	0
Be	-0.33	no	no	2
Cl	0.70	no	no	17
F	0.43	no	no	22
S	0.83	no	no	21
Ag	1.09	no	no	8
As	-0.90	no	no	0
Bi	-0.68	no	no	2
Cd	1.00	no	no	2
Ce	-1.45	no	no	0
Co	1.04	no	no	2
Cr	1.23	no	no	0
Cu	0.45	no	no	0
Ga	1.48	no	no	0
In	1.05	no	no	9
La	-0.76	no	no	0
Pb	1.69	no	no	0
Li	-0.54	no	no	0
Mo	-1.07	no	no	0
Nb	1.30	no	no	0
Ni	-0.84	no	no	0
Rb	-0.53	no	no	0
Sb	-1.32	no	no	14
Sc	-0.64	no	no	0
Se	-1.04	no	no	6
Sr	1.02	no	no	0
Th	0.31	no	no	0
W	0.41	no	no	0
U	-1.00	no	no	0
V	1.28	no	no	0
Y	-0.18	no	no	0
Zn	-1.77	no	no	0
Zr	-0.36	no	no	0
Sn	0.04	no	no	0

CL: Confidence level
nd: not determined
(a) $t_{2.5\%} = 2.18$ (5% confidence level with 12 degrees of freedom)
(b) $t_{5.0\%} = 1.78$ (10% confidence level with 12 degrees of freedom)

Table 3. Detection limits and number of samples below detection

Element	Detection limit	Number of values below detection limit
	percentage	
SiO_2	0.010	0
TiO_2	0.010	0
Al_2O_3	0.010	0
Fe_2O_3	0.010	0
MnO	0.010	189
MgO	0.010	97
CaO	0.010	113
Na_2O	0.010	24
K_2O	0.010	5
P_2O_5	0.010	29
LOI	0.010	0
Cl	0.010	769
F	0.010	910
S	0.050	986
	parts per million	
Au	0.001	706
Pt	0.001	954
Pd	0.001	698
Ba	10.0	21
Be	0.500	272
Ag	0.050	447
As	0.500	102
Bi	0.100	136
Cd	0.100	59
Ce	0.050	0
Co	2.00	19
Cr	2.00	0
Cu	2.00	1
Ga	0.050	0
In	0.050	482
La	0.100	1
Pb	0.200	1
Li	0.500	3
Mo	0.200	9
Nb	0.500	4
Ni	2.00	14
Rb	0.020	0
Sb	0.500	594
Sc	0.500	16
Se	0.500	355
Sr	0.100	1
Th	0.020	0
W	0.100	55
U	0.020	6
V	2.00	1
Y	2.00	130
Zn	2.00	3
Zr	5.00	0
Sn	0.500	7

differences between the duplicate sample results. If the confidence interval includes 0, or the calculated t-statistic is inside the range t, it is concluded that the duplicate samples are not statistically different. Thirty-five of the 170 analyses reported were below the detection limit and assigned a value of 0. The calculated t-statistic for the 85 duplicate pairs is -0.81. The 5% confidence level with 84 degrees of freedom is 1.99 and the 10% confidence level with 84 degrees of freedom is 1.66. The t-statistic value is well within both confidence-level ranges (1.99 and 1.66) and the analyses are therefore considered to be statistically reproducible at the confidence levels tested.

Submission of duplicate samples

Duplicate geochemistry samples were collected at 13 separate sample sites to provide some measure of the overall reproducibility of the combined sampling and analytical procedures. Each duplicate sample was assigned a separate GSWA sample number. Data were compared using the previously described 'paired t-test'. Results are shown in Table 2. Owing to the high number of values below the detection limits, the results are not meaningful for Au, Pt, Pd, Cl, F, S, and Sb. Results for the other elements indicate no significant differences and the sampling and analysis are considered to be statistically reproducible at the confidence levels tested.

Check analyses at Chemistry Centre (W. A.)

Splits of twenty-five samples were submitted to the Chemistry Centre (W. A.) for analysis for the same 48 components. Although there were minor variations, there were no major discrepancies.

Data presentation

The main products from the regional geochemical mapping program for MENZIES include the maps, plans, tables and the digital datafile that accompany these notes, and the plans and maps which can be inspected and purchased at Mineral House.

It should be noted that all recent and current GSWA geology, regolith and geochemistry map products are produced from digital data. 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 3) at 1:250 000 scale, and element distribution maps (Figs 4–35) and contoured gold geochemistry plan (Fig. 36) at 1:1 000 000 scale. The regolith-materials map has been described previously. The sample-locations plan shows the location of each sample site and also the sample type (soil, stream sediment, etc) and GSWA sample number. Details of sampling, regolith materials, landforms, and geology for each site are recorded on a GSWA sample-site form. The element-distribution maps show the distribution in element concentration for MENZIES for a total of 38 different elements or elements reported as oxides (Fe_2O_3, Al_2O_3, K_2O, Na_2O, TiO_2, MgO, MnO, CaO, Cl, S, Au, Pt, Pd, As, Ba, Bi, Be, Co, Cu, Cr, Ce, Li, Mo, Nb, Ni, Pb, Rb, Sb, Se, Sn, Sr, Th, U, V, W, Y, Zn, and Zr) from a total of 1072 samples. The relationship of element distribution to sample type and geology can be examined by using the sample-location plan and geological-interpretation overlays (Plates 4 and 5).

The element-distribution maps generally show the full range of concentration, for that particular element, from the detection limit to the highest value. Precise values for a particular element at a particular location can be obtaining by determining the GSWA number from the sample location plan and then referring to the digital datafile (MENZCHEM.CSV) included with these notes. This ASCII file contains all the key data obtained from the MENZIES geochemical mapping project for all 1072 samples. Apart from the analytical data, the file contains fields for GSWA sample number, sample type, geology (granitoid, greenstone, mixed, or lake) regolith code (as per regolith map) and AMG coordinates.

Detection limits and the number of samples reported as below detection are shown in Table 3.

Reference sets of element-distribution maps for MENZIES for 47 of the 48 components analysed (LOI is omitted) at 1:250 000 scale are available for inspection at the public counter, Department of Minerals and Energy. 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. 36) shows the location of mines and prospects for MENZIES. The size of the circle symbol reflects the amount of total contained gold. A table (Appendix 1) shows location, past production, resources and total contained gold for 174 mines and prospects.

Company surface-geochemistry projects — map and table

A plan at 1:250 000 scale (Plate 2) showing the location of all company surface-geochemistry projects for MENZIES accompanies these notes. A table (Appendix 2) shows details for individual projects. Fields include company, GSWA reference numbers (M-series), year, sample medium, and elements analysed.

Results and discussion

The value of the data depends on the nature and quality of sampling, and on the quality of the chemical analysis. The present program, in its effort to provide regional coverage, has had to sample a variety of media. Two of these are distinctive enough for them to be considered as separate groups: lake sediments and laterites. Lake sediments include both playa and playa margin sediments; most are located within the main (palaeo)drainages. Lake sediments are substantially different from 'normal' stream sediments because of the chemical precipitates they contain. Laterites as samples included coarse duricrust and large (>2 cm) ferruginous nodules and were collected primarily for inclusion within the CSIRO–AGE database.

The majority of active stream courses are restricted to greenstone belts, though a few streams drain granitoids in the vicinity of breakaways and tors. Active small stream drainages cover only about 40% of the mapsheet, and lakes and saline main drainages between 10% and 15%. Slightly less than half the sheet has no active drainage. These areas include the relict and erosional regime map units developed on granitoid and surrounding colluvial units. Comparison between areas with active streams and the dominantly soil covered areas is therefore difficult. No satisfactory statistical means of comparison has yet been found, but the element plots suggest that the underlying rock is more significant than the nature of the sample medium. Plate 4, in the form of an overlay, is provided for assistance in interpretation of the data provided on Figures 4–35. Both soils and stream sediments taken over the greenstone belts seem to show 'greenstone' values, whereas over granitoids they show 'granitic' values. Plate 5, also an overlay, is provided for visual interpretation of differences between compositions of the sediments in granitoid and greenstone terrains.

Soil samples, though composite, naturally reflect a more limited source area than stream sediments. However, many soils are derived from sheetwash from periodic major flooding or from streams active in earlier wetter times, and may represent larger source areas than intuitively expected. Stream sediments and soil over greenstones and granitoids contain a substantial amount of broken down rock (grus) and alteration products. The granitoid areas north of Lake Ballard and east of the Mount Ida greenstone belt show more evidence of active erosion and greater development of saprolite (unit E1). Other granitoid areas show less active erosion, with extensive development of relict regime units (units R1 and R4) or granitoid 'lag' (unit E4g).

The results have been summarized in Figures 4–35, and should be used in conjunction with Plate 4. Data for SiO_2, P_2O_5, loss on ignition, Ag, Cd, F, Ga, In, La, and Sc are not reported in these figures although data are included in the accompanying datafile (MENZCHEM.CSV). Silica, P_2O_5, loss on ignition and Sc do not show obvious features of significance; La closely follows Ce; In values, though apparently real, are all less than 1 ppm, and Ag and Cd have poor reproducibility at low levels. Fluorine has a maximum value of 0.1% with no obvious patterns Gallium closely follows Al. Some elements, noted earlier, have poor reproducibility at low concentrations. These include Pt, Be, Mo, Nb, Se, Sn, and W. The highest values for these elements are portrayed on Figures 11 (Pt), 34 (Be, Se, and W) and 35 (Mo, Nb, and Sn). Most values for Li lie between 5 and 25 ppm; values exceeding 25 ppm Li are also shown on Figure 35. The following discussion provides some preliminary findings from the results. More detailed interpretation will be found in Davy et al. (in prep.).

Tables 4, 5, and 6 show the geometric means for most components for samples recognized as sourced from greenstone belts, granitoids and the main alluvial areas, including the main drainages. Elements with most results close to or below detection are omitted. Laterite samples and samples of mixed granitoid/greenstone origin are omitted from these tables, but are included in Figures 4–35, and in MENZCHEM.CSV. The geometric mean is used in preference to the arithmetic mean in this table to minimize the effect of rare, but very large, anomalous values. Higher values for specific elements are considered separately later.

Composition of regolith units

The following discussion relates to laterite, soil and stream sediment samples. These have been grouped according to their assigned regolith unit (refer to Plate 1 and the datafile MENZCHEM.CSV). Lake samples are considered separately.

Regolith units sourced by greenstones

Regolith units sourced by greenstones are recognizable not only through common components such as Fe_2O_3, TiO_2, Cr, Ni, and V present at the percent or high parts per million level, but also through elements such as In and Pd, present at the parts per billion level. Some samples sourced mainly from granitoids show elevated values for components such as TiO_2 and V. In some cases these higher figures can be related to nearby mafic dykes of Protoerzoic age, or they may indicate previously unrecognized mafic enclaves. Such samples are present over granitoids southwest of Menzies, north of Lake Ballard and northwest of Jeedamya.

Table 3 shows the geometric means for samples recognized as sourced from greenstone belts; samples with values suggesting a mafic source, but lying within granitoids, are not included.

Relict regime

The relict regime over greenstones generally comprises duricrust (unit R2) with a small proportion of nodules. The samples from this unit (13) appear to reflect mainly mafic rock or ultramafic rock. Samples from the unit are characterized by high Fe_2O_3 (>50%) and moderate SiO_2 and Al_2O_3, though they grade, in a few places, into a ferruginous silcrete with Fe_2O_3 as low as 20–30%. The proportion of other components is very variable, but R2 samples include the highest values of TiO_2 (6.45%), MnO (0.34%), As (530 ppm), Cr (4%), Cu (230 ppm), Mo (38 ppm), Pd (11 ppb, not included in Table 4), V (0.18%), and W (90 ppm). Alkali and alkaline earth elements are generally leached and show very low values.

Erosional regime

In general, samples derived from rock, saprolite, and residual materials (E1 and E2vs) within the erosional regime of greenstone belts are silicified, with a high average SiO_2 (63%) and a low Fe_2O_3 (10%) content. As the degree of alteration varies markedly so does the composition, although many samples reflect a mafic or ultramafic origin in their TiO_2, CaO, Cr, Cu, In, Ni, V, and Zn levels. Components such as MgO, CaO, Na_2O, K_2O and related elements are generally leached in comparison with their unweathered equivalents. However, the highest MgO values (up to 7.4%) highlight the position of ultramafic rocks. It is harder to identify the position of felsic and metasedimentary rocks within the greenstone belts in part because their signature is concealed by interference from the prevalent, more resistant mafic rocks (some of which are locally interleaved with the felsic rocks), in part by a heterogeneous composition, and in part by their deeper weathering and more extensive leaching. Sediments derived from banded iron-formations in the western part of the sheet have no higher Fe_2O_3 values than sediments from other rock sources.

Samples from areas dominated by ferruginous lags derived from greenstones (E4vs) lie on hill slopes. These lags are generally lower in the topographic profile than the above group, but the regime is still erosional. Table 4 shows enrichement in Fe_2O_3, TiO_2, Cr, Cu, Sc, V, and Zr balanced by depletion in SiO_2 and alkali and alkaline earth elements, compared with results from E1 and E2vs.

Gold and Pd values in E1 and E2vs are generally only a few ppb above the detection limit (1ppb) but overall are marginally higher than those obtained from ferruginous lags (E4vs).

Colluvial regime

The colluvial regime commences with a change from degradation to aggradation. Sheetwash occurs on the lower slopes of hills and ridges, and in fans emanating from valleys through the ridges. This regime includes sediments of relatively constant thickness lying on pediments as well as other, more general sheetwash areas. There is progression in composition as colluvium extends farther from its source.

These changes are well shown in Table 4 where the transitions from unit E4vs to DC1 and then DC2 appear largely continuous. By the time DC2 is reached SiO_2 has increased at the expense of almost all other components, the only exceptions being K_2O and Rb.

Table 4. Geometric means of analytical results for regolith units derived from greenstone belts

Component	*R2*	*E1, E2vs*	*E4vs*	*DC1*	*DC2*	*DC3*
Sample Nos	13	50	61	116	155	17
			percentage			
SiO_2	14.4	62.8	43.2	56.9	79.2	63.7
TiO_2	1.1	0.65	0.99	0.74	0.36	0.66
Al_2O_3	9.4	11.8	11.9	10.5	7.5	10.4
Fe_2O_3	56	10	28.5	17.7	5.3	15.4
MnO	0.03	0.08	0.08	0.07	0.03	0.04
MgO	0.04	0.51	0.26	0.35	0.09	0.12
CaO	0.01	0.54	0.23	0.31	0.05	0.02
Na_2O	0.04	0.30	0.13	0.18	0.09	0.08
K_2O	0.06	0.67	0.31	0.52	0.49	0.53
P_2O_5	0.05	0.05	0.07	0.06	0.05	0.07
			parts per million			
As	33	7	18	10	4	10
Ba	61	168	130	142	100	115
Bi	0.5	0.5	0.6	0.4	0.2	0.4
Ce	7	26	24	24	18	24
Co	13	21	19	20	9	13
Cr	1160	215	473	443	148	453
Cu	39	44	66	47	22	35
Ga	25	16	21	17	14	18
In	0.1	0.08	0.13	0.09	0.06	0.09
La	3	13	12	12	10	12
Pb	16	15	20	16	12	17
Li	3	10	6	7	7	7
Mo	3	1	2	1.5	1	2
Nb	5	6	6	5	5	5
Ni	72	62	71	76	31	55
Rb	2	35	17	25	27	27
Sb	0.97	0.52	1.4	0.9	0.3	0.8
Sc	33	15	28	18	11	19
Se	3	0.6	1.7	0.9	0.6	1
Sr	5	37	23	25	17	18
Th	8	8	11	9	8	10
Sn	3	2	2	2	<2	2
W	7	2	3	2	1	2
U	2.0	1.5	1.7	1.4	1.2	1.6
V	470	140	414	249	78	228
Y	3	9	8	8	5	5
Zn	26	47	46	42	26	32
Zr	71	72	100	84	59	93

Samples from unit DC3, a rather variable ferruginous unit which consist of mainly small- to medium-grained detritus in sand or clay and includes 'buckshot gravel', have a mean composition between those from DC1 and DC2. There are relatively few samples from this unit (17) and, with these results, its validity as a separate entity may be questioned.

Regolith units sourced by granitoids

Samples sourced by granitoids have been treated similarly to those sourced by greenstones. The geometric mean for the various units is given in Table 5.

Table 5. Geometric means of analytical results for regolith units derived from granitoids

Component	*R1 (soil)*	*R1 (nodules)*	*R4*	*E1–E3*	*E4g*	*DC1*	*DC2*	*DC3*
Sample Nos	33	20	17	56	61	55	155	45
				percentage				
SiO_2	80.8	42.6	92.4	81.1	85.6	82.5	88.0	87.5
TiO_2	0.24	0.47	0.08	0.20	0.18	0.22	0.16	0.16
Al_2O_3	6.0	19.9	2.6	8.0	5.8	6.8	4.3	4.6
Fe_2O_3	5.3	24.5	1.7	2.7	2.4	3.3	2.5	2.4
MnO	0.01	0.01	0.01	0.02	0.01	0.02	0	0.01
MgO	0.03	0.02	0.04	0.06	0.04	0.04	0.04	0.04
CaO	0.03	0.01	0.03	0.10	0.04	0.03	0.03	0.03
Na_2O	0.06	0.05	0.06	0.38	0.15	0.14	0.05	0.05
K_2O	0.20	0.08	0.08	1.0	0.98	0.68	0.31	0.43
P_2O_5	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03
				parts per million				
As	5	30	1.2	2	1.5	1.8	2	1.7
Ba	43	22	14	261	185	146	62	79
Bi	.3	.9	0.1	0.2	0.1	0.3	0.2	0.2
Ce	9	22	4	24	17	16	9	11
Co	4	7	2	5	4	4	4	4
Cr	177	665	61	55	66	77	81	73
Cu	11	20	6	11	10	11	9	10
Ga	10	44	4	14	9	10	7	7
In	0.04	0.13	0.03	0.04	0.03	0.04	0.03	0.03
La	5	5	2	14	10	9	5	6
Pb	10	36	3	16	12	13	7	9
Li	6	11	5	9	9	8	7	8
Mo	1	5	1	<1	<1	<1	<1	<1
Nb	3	7	2	5	4	4	3	3
Ni	17	41	7	9	12	11	12	11
Rb	13	6	6	45	50	31	17	23
Sb	0.4	0.8	0.3	0.3	0.3	0.3	0.3	0.3
Sc	6	16	2	5	4	5	3	4
Se	0.7	4.7	0.4	0.5	0.5	0.5	0.5	0.5
Sr	7	4	3	41	22	17	8	11
Th	12	62	5	11	9	8	6	6
Sn	<2	2	<2	2	<2	<2	<2	<2
W	<1	2	<1	1	<1	1	<1	<1
U	1.0	4.1	.5	1.5	1.2	1.2	<1	<1
V	77	426	24	34	31	44	33	33
Y	2	2	1	3	3	3	2	2
Zn	8	8	4	15	12	14	9	10
Zr	54	170	30	66	52	61	43	44

Relict regime

There are no ferruginous duricrusts and the relict regime is represented by ferruginous nodules (in varying proportion) in sand. The R1 unit includes two sample types (Table 5), sandy soils and ferruginous nodules. The nodules are richer in SiO_2 and poorer in Fe_2O_3 compared with greenstone duricrust (R2) as expected from their different origins, but Table 5 indicates that the nodules have a composition somewhat resembling E4vs. Some very distinct differences are probably related to the source material. For example, the R1 ferruginous nodules contain substantially higher amounts, on average, of Pb, Li, Th, U, and Zr than E4vs lag. As expected, the E4vs lag contains more Fe_2O_3, TiO_2, Cu, Ni, Sc, Sr, and Zn than the nodules. However, the nodules contain more Cr and Ga, and less alkali and alkaline earth elements than the lag. Other elements, whose values suggest a mafic contribution to some nodules, include As, Bi, In, Ni, and V. The nodules may have formed by similar processes to the lags; their general origin may be granitic but they may also contain material from hidden mafic sources.

Samples from the relict regime which are dominated by sand still contain significant Cr (to the hundreds of ppm) and V, but in general contain very low amounts of most trace elements.

Erosional regime

No erosional material derived from granitoids contains excessive Fe_2O_3 (the maximum value is 8.55%). As expected, the SiO_2 content is higher than that of the parent rocks and increases away from granitoid outcrop. Samples from regimes E1–3 include grus as well as completely weathered material. This has the effect of raising the mean for Na_2O higher than in samples from E4g. This feature is also shown in the Ba, Ce, and Sr values. The E4g lag is not enriched in Fe_2O_3 overall, compared with samples from E1–3 but does show enhanced K_2O values compared with those of the surrounding depositional units.

Colluvial regime

The results show relatively few differences between samples in the three colluvial regimes, and samples from the E4g unit. Silica, TiO_2, and Fe_2O_3 contents have similar means, although Fe_2O_3 (and Al_2O_3) are slightly higher over DC1 than other units. Components like K_2O, Ba, Ce, Rb, and Sr decrease generally from E4g to DC2, but rise slightly in DC3. The DC3 unit is again somewhat mixed; however, values from DC3 samples are generally similar to those from DC2.

Regolith units from main drainages; alluvium and salt lakes

Mean values for these units (DA5–7) are shown in Table 6.

Samples from unit DA5 are expected to approximate to the regional background for regolith sediments and to contain components from all sources in the area. The mean values from this unit, shown in Table 6, are very close to those for unit DC3 sourced from granitoids (though unlike DC3 sourced from greenstones) suggesting that in future the two regimes may be merged.

Samples from DA6, marginal to the playa lakes and considered as gypsiferous, proved to contain very little gypsum. The maximum S value is 0.25%; however, there are slight increases in Na_2O and Cl (maximum 0.84%) indicating the near-lake environment. Some high CaO values (up to 6.4%), without S, indicate a calcrete component for some samples. There are only 22 samples in this category, and the data suggest they come from mixed sources including mafic rocks — the maximum values for Cr and V are 480 and 190 ppm respectively.

Samples from the DA7 unit, however, contain both salt and gypsum, though not necessarily together. Calcrete may also be present. The geometric means for MgO, CaO, Na_2O, Cl, and S hide some very high values. Maxima for these components are 9.1%, 31.9%, 8.0%, 11.3%, and 18.2% respectively. Strontium accompanies gypsum; its highest value is 0.39%. Most lake sediments contain detectable F, but the maximum value is only 0.1%. Most lake sediments have a variably thick (10–30 cm) near-surface, black, manganiferous layer, but Mn values are not unduly high.

Table 6. Geometric means of analytical results for regolith units from alluvial and lake areas

Component	*DA5*	*DA6*	*DA7*
Sample Nos	42	22	44
		percentage	
SiO_2	86.8	79.4	42.3
TiO_2	0.17	0.24	0.34
Al_2O_3	4.4	4.9	6.1
Fe_2O_3	2.6	3.5	2.8
MnO	0.01	0.03	0.04
MgO	0.04	0.36	2.7
CaO	0.06	0.14	3.9
Na_2O	0.08	0.26	3.4
K_2O	0.49	0.61	0.88
P_2O_5	0.03	0.05	0.08
Cl		0.05	1.5
S		0.03	1.18
		parts per million	
As	1.5	1.7	2.7
Ba	113	163	171
Bi	0.14	0.26	0.17
Ce	12	16	18
Co	5	8	17
Cr	83	101	89
Cu	11	14	17
Ga	9	10	8
In	0.03	0.04	0.04
La	8	7	12
Pb	10	9	10
Li	8	8	12
Mo	<1	<1	1.2
Nb	3	3	5
Ni	15	18	23
Rb	26	19	30
Sb	0.3	0.3	0.3
Sc	6	4	5
Se	0.6	0.6	0.9
Sr	17	19	162
Th	7	6	9
Sn	<2	<2	2
W	<1	<1	1
U	1.0	1.1	4
V	36	45	42
Y	3	4	5
Zn	12	18	27
Zr	43	48	53

Regional considerations

Differences between greenstone belts

The major boundary between the Barlee Terrane and the Kalgoorlie Terrane is defined in the northern part of the Mount Ida greenstone belt (Fig. 1) by the Mount Ida fault. The position of this boundary is less clear farther south, but has been placed in the middle of the greenstone belt in the Mulline–Riverina area. One difference on MENZIES is the presence of banded iron-formations in the Barlee Terrane and their absence in the Kalgoorlie Terrane. Inspection of Figures 4–35 does not suggest any major chemical break between the two terranes. As indicated earlier, the distribution of rock types within the greenstone belts (or parts of them) is quite variable. These differences are reflected, in part, by the results obtained in this project.

Differences in concentration of MgO, CaO, Ni, V, Y, and Zr help define and separate greenstones. Thus, the results confirm that high-magnesium rocks are restricted to the east side of the central portion of the Mount Ida belt, and the Menzies–Broad Arrow belt, extending northwest to Ghost Rocks. High values of both K_2O and Na_2O (and moderate Ce and La) mark felsic volcanics east of Jeedamya.

Results of a preliminary analysis of the data (Figs 4–35) indicate that each greenstone belt (and domain) is characterized by distinctive geochemistry. The Yerilgee belt in southwest MENZIES shows very low Ca and Mg, low As, Sb, Bi, Pd, and Au, and high Cr. The Ilaara belt in western MENZIES shows low Ca and Mg, low Au and Bi, and high Sb and As. The main or eastern domain of the Mount Ida belt contains a central ultramafic-rich section. The northern and southern Mount Ida belt sections show high Ca, low Ni and Sb, and high V, Y, Au, Pd, and Bi. The northern section differs from the southern section in being enriched in Cu. The central Mount Ida belt shows high Mg, Cr, Co, and Ni, and low V, Y, Au, Sb, and Bi. The western domain of the Menzies–Broad Arrow belt (and adjacent Menzies shear zone) shows very variable element concentrations. Ca and Mg are generally low but are locally very high; Cr and Ni are also locally very high. Au and Pd are high and Au locally very high. Sb is low. The eastern domain of the Menzies–Broad Arrow belt also shows variable element concentrations; Ca and Mg are generally high, Au and Pd are moderately high, As and Bi are highly variable and Sb is high (in contrast to the western domain). The Alexandra Bore belt is low in Ca and Mg, Au is low, and Sb, Bi, and As are high. The Malcolm belt is low in Ca and Mg with high Au, generally low As and Pd, and generally high Sb and Bi.

Identification of specific granitoid bodies

Samples over granitoids in general confirm the field mapping of a dominance of monzogranites, particularly on the eastern, western and northern sides of the sheet. Figures 6 and 7 demonstrate the generally high values of K_2O and Na_2O in these areas.

By contrast, much of the ground between the Mount Ida and the Menzies–Broad Arrow belts represents a relict surface with little outcrop. Sediments in this area are extremely leached, and most elemental values are further diluted by input from eolian sand. Low values for many components occur also in a northwest trending zone north of Lake Ballard. Granitic rocks outcrop in this area but have been extensively silcreted.

Two areas contain significant Ce and La; on the northern boundary of the map northwest of the Last Chance outcamp, and north of Galah Rocks. Two other areas show moderately high Ce and La values; immediately west of the Mount Ida greenstones west of Mount Morley, and in the Morapoi area. Sediments over granitoid in the latter area are very similar in composition to those over the felsic volcanics of the adjacent Jeedamya area.

Analysis of trace elements at low levels of concentration is considered too imprecise for detection of the subtle variations in composition required to subdivide granitoids in other than the most broad terms. There are, however, indications that with better analytical accuracy and precision for elements such as Nb and Sn, some further separation of granitoids would prove possible.

Economic geology

Gold and known mineralization

Figure 36 is a plan showing gold mines and prospects on MENZIES superimposed on a contoured plot of the Au values obtained during the current program. The size of the circle symbol reflects the amount of contained gold. Appendix 1 gives the location, past production, resources and total gold for 174 mines and prospects.

The present survey has identified the general position of all the major gold-bearing areas with the exceptions of the Bottle Creek and Twin Hills districts. Twin Hills has a relatively small surface expression, whilst Bottle Creek has a large catchment and any contribution from the mines may have been diluted. Figure 36, however, indicates other areas with gold in regolith at or above 3 ppb where no mines or prospects have been reported. These include the Ilaara greenstones, an extension to the eastern line of mines southeast of Menzies, and isolated samples elsewhere. Areas of interest appear to include the iron-formation near Ranford Peak and the northeastern extension to the Menzies–Broad Arrow belt north of Lake Ballard. Gold in a drainage in the central southernmost part of the sheet may be derived from tailings or other contamination relating to the Davyhurst (KALGOORLIE 1:250 000) or Mulwarrie mining centres.

Silver has been reported from some mines listed in Appendix 1; in particular, at the Riverina mine where it has been extracted as a byproduct of gold. Silver is commonly leached near-surface, and values reported in this project are all low. Though a maximium value of 2.5 ppm Ag is recorded, repeat analyses gave lower concentrations and the significance of results for this element is unclear. The data are included in MENZCHEM.DAT.

Other mineralization and potential for mineralization

The only other minerals mined on MENZIES have been emeralds, and a small amount of copper at the Forrest Belle goldmine or the Mount Ida mining centre. Beryl and emeralds are associated with pegmatites which intrude ultramafic rocks in the Mount Ida belt (Garstone, 1981). Exploration for Cu and Ni has been extensive, particularly in the Mount Ida and Menzies–Broad Arrow belts, but no economic deposits have been found.

At the sample interval used for this project, it is unrealistic to expect, except by chance, the discovery of new mineralization. However, it is hoped that these results will help to define areas where further exploration is warranted. Any economic potential indicated as a result of this project must be balanced against the geochemical exploration which has already taken place — against the open-file company projects which have been identified in Plate 2. These company projects have been largely restricted to the greenstone belts and to three areas within the main drainages. Granitoids have barely been explored. There are, of course, other company projects still active and exploration is continuing.

With this in mind, a brief review follows of the location of samples with higher values of elements either of direct economic interest, or known as indicator elements.

Results indicate that the Ilaara greenstone belt is associated with anomalous As and Sb, and that the eastern part of the Menzies–Broad Arrow belt is associated with anomalous As and Sb and, possibly, Bi. Lower level As and Sb anomalies are present in the Tampa–Desdemona area of the Malcolm greenstones and the northern part of the Mount Ida belt. These values imply the presence of mineralized, probable sulfide-bearing rocks. All these greenstones contain (or have contained) economic gold mineralization, except for the Ilaara belt. Despite extensive previous exploration in the Ilaara belt economic mineral deposits of any sort are not yet known. The Alexandra Bore belt also shows traces of As, Sb, and Bi. Rocks of this belt are mainly altered mafic intusives.

The highest values for Cu and Zn are 230 and 200 ppm respectively. Though these values do not immediately suggest mineralization they are comparable with values found near the Teutonic Bore Cu–Zn mine on LEONORA (Bradley, J., 1994, pers. comm.). Both metals are highly leached under present conditions and low surface values do not necessarily deny mineralization at depth.

Nickel values in analysed samples reach 1000 ppm. All high occurrences are in areas with known ultramafic–komatiitic rocks.

Most samples contain less than 100 ppm lead. The highest value is 160 ppm in the Ilaara belt south of Lemon rock.

Values of uranium over 30 ppm are restricted to the drainage between the Ilaara and Mount Ida greenstone belts. Two samples with about 40ppm U, west of the Walling Rock outcrop, lie over muds reported by Butt et al. (1977) as containing 10–80 ppm U. Another 'high' value (42 ppm) suggests the whole drainage as far as Galah Rocks may contain anomalous U. The source of this uranium could be the granitic rocks immediately west of this drainage. The only non-lake sediments containing >10 ppm U occur at Ranford Peak (18 ppm) and over granitoids northwest of the Last Chance outcamp. The Ranford Peak anomaly is associated with anomalous Au (10 ppm) and Pd (6 ppb) and is apparently associated with iron formation. Uranium in the Last Chance area (11 ppm) is coupled with high Ca, La, and Th, and a fractionated granitoid source is suggested.

Molybdenum seems to collect in lateritic material, so that the significance of values in excess of 10 ppm overlying probable granitoids north and south of Lake Ballard is not known. Weakly anomalous Mo values are known in association with gold and may account for isolated 'high' values in most greenstone belts. However, there appears to be a linear anomaly with values to 28 ppm Mo, paralleling the iron–formation in the vicinity of Mount Mason (Fig. 35). This anomaly extends onto LEONORA (Bradley, in prep.).

Among other samples of interest one, northwest of Jeedamya, contains several hundred ppm of Nb (Fig. 35). The source appears to be a shear zone with associated quartz veins in biotite monzogranite–granodiorite. Two samples contain selenium over 10 ppm (Fig. 34), one in the Tampa area (100 ppm), the other near Yunndaga outcamp (38 ppm). Selenium shows no association with sulfur even in the playa system, and the cause of these anomalies is unknown.

Environmental concerns

The highest concentrations of Cl are to be found, as expected, in the playa lakes. However, analyses of some sediments away from the lakes (Fig. 32) show Cl values of several thousands of ppm. This suggests that many parts of the mapsheet, but in particular an area south of Morapoi, have the capacity to become extremely saline, particularly if overgrazing occurs or vegetation is destroyed.

Summary and conclusions

Geochemical and regolith maps have been prepared for MENZIES. A mixture of stream sediments, soils, lake sediments and laterite have been sampled at a nominal scale of one sample/16km^2, resulting in the submission of 1072 samples (413 stream sediment, 580 soil, 44 lake sediment, and 35 laterite) for chemical analysis. Locality and regolith-materials maps have been prepared at 1:250 000-scale. Chemical analysis has used total dissolution methods and 48 components have been determined. Results are presented in an attached digital datafile and as element-distribution maps. Results of 38 of these components have been presented on 1:1 000 000-scale maps, but 1:250 000-scale maps are available for purchase. A map has also been prepared, at the 1:250 000 scale, showing the position of projects, held on open file, which used surface-exploration geochemistry.

The regolith has been divided into eighteen mappable units; four corresponding to a relict regime, six to an erosional regime, and eight to a depositional regime. The last includes playa lakes and their marginal sediments.

Comparison of the results of analysis of soils and stream sediments suggests that the source material is of more significance than the type of sample in determining the composition of the sample. The composition primarily relates to underlying rock in the source area, with systematic changes in composition between regolith units as material is eroded and transported and subsequently redeposited.

The compositions of sediments over greenstones are markedly different from those over granitoids. Differences between greenstone belts and between different domains within greenstone belts are shown by distinctive element associations; these associations can be related, in part, to the various rock types within the belts. Sediments over granitoids include grus diluted by sand, and highly leached material. The former confirms the presence of abundant potassic granitoids (some of which are enriched in Ce and La), but all trace of the origin is lost from the latter. Areas of highly leached sediments occur north and south of Lake Ballard. Improved chemical determinations at low concentrations are needed before subtle differences in granitoid compositions can be distinguished.

The project has identified most of the known gold-mining areas, which are defined by gold values at or above 3 ppb; however, the Bottle Creek and Twin Hills areas were not picked out. On this basis, the Ilaara and the eastern part of the Menzies–Broad Arrow greenstones still have potential for more deposits, despite previous exploration. Several other single point anomalies were identified. Areas with other anomalous elements include the Ilaara, the eastern side of the Menzies–Broad Arrow, the Tampa Desdemona part of the Malcolm, and the northern part of the Mount Ida greenstone belts (all As and Sb); the west side of the northern part of the Mount Ida belt (Mo); and the main drainage west of the southern Mount Ida belt (U). Single value anomalies for Nb and Se have also been recognized.

A number of non-lake samples have Cl in the thousands of parts per million level; this suggests that much of the sheet has the potential to become extremely saline, particularly if vegetation is destroyed.

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Appendix 1

Details of mines and prospects

Mine or prospect	*Easting*	*Northing*	*Past production Au (kg)*	*Resources Au (kg)*	*Total Au (kg)*
Ilaara belt					
Metzke Find	213000	6758400	20	0	20
Lawrence Find	221000	6711500	0	0	0
		Subtotals	20	0	20
Mount Ida belt (north of Lake Ballard)					
Forrest Belle	256950	6786900	228	479	707
Boudie Rat	257050	6786150	27	193	220
Mount Ida	257750	6784600	0	0	0
Ida	257050	6783600	105	0	105
Copperfield–Kestrel	258750	6783650	0	0	0
Wedgetail	259100	6782050	0	154	154
Star of the East	252700	6786400	1	0	1
Tims Find	259650	6770600	0	151	151
Golden Ridge	259000	6780800	37	0	37
Gold Rock	258000	6779500	0	0	0
Meteor and Dave Lode	253000	6778950	267	234	501
Timoni and Copperfield	253000	6778500	8558	318	8876
Main Lode, Pactolus Ida Queen, Once More	253500	6778000	31	0	31
Federation	252900	6777800	175	0	175
South Timoni	253100	6777600	27	0	27
Unexpected	253700	6776600	596	0	596
Sandstone	258500	6775400	20	0	20
Golden Vale	257850	6776100	4	0	4
Jackson Bore	257000	6754300	0	0	0
Black Kite	260050	6775250	0	116	116
Golden Vale HL/Lucknow	257400	6775150	5	0	5
Bellbird	260600	6773900	1	0	1
Bottle Creek Group			6071	429	6500
Emu	251400	6772100	-	-	-
VB	252250	6769500	-	-	-
Boags	252700	6768300	-	-	-
Piantos Find	254900	6765200	1	0	1
52 Mile Group	255800	6762000	1	0	1
Nelly Bly, Corida	254300	6759200	20	0	20
Mckenzies	265600	6755100	0	0	0
Cobbanco Well	262000	6754000	0	0	0
Elsie May	261400	6750400	1	0	1
		Subtotals	16176	2074	18250
Mount Ida belt (south of Lake Ballard)					
Snake Hill	267600	6740000	0	0	0
Numerous diggings	267600	6736900	0	0	0
Craig Well(west of)	268000	6734200	0	0	0
Blue Well	266000	6730500	0	0	0
Hill Top	267000	6726200	1	0	1
Pentony	266700	6725400	0	0	0
Emerald	266200	6724500	80	0	80
Eighteen Mile Well(west of)	268700	6723200	0	0	0
Lancaster	261900	6718000	3	0	3

Appendix 1 *(continued)*

Mine or prospect	*Easting*	*Northing*	*Past production Au (kg)*	*Resources Au (kg)*	*Total Au (kg)*
Paramount	263600	6717700	1	0	1
Pascoe	263900	6716200	0	0	0
Golden Cockatoo	264500	6716000	4	0	4
Mabel Gertrude/Hazel Dawn	264300	6715000	73	0	73
First Hit	265300	6714700	236	0	236
Two Chinamen	264400	6714200	236	0	236
Cactus	264400	6711800	0	0	0
Golden Wonder	264500	6710900	85	0	85
Ajax West	263800	6708800	219	0	219
Golden Horn	260400	6707650	26	0	26
Dungan	262200	6707350	3	0	3
Riverina	264350	6706900	1442	2825	4267
Golden Lode	260900	6705700	1	0	1
Lady Mabel	260650	6704100	2	0	2
George Frederick	259700	6703750	8	0	8
Mulline	260500	6702800	84	0	84
Lady Jane	260200	6702150	0	768	768
Refuse/Mulline Rose	260900	6702050	2	0	2
Cooladdie/Reprieve	260050	6701500	245	0	245
Lady Florence	259300	6699950	22	0	22
Gold Standard/Acrobat	260100	6699900	10	206	216
Peach Tree	259800	6699300	34	0	34
Charlie/Cora/Karrakatta	260400	6699300	6	384	390
Young Australian	259650	6698900	364	0	364
Cemetery(Young Aust.)	260050	6698450	0	169	169
Delta	259250	6698000	0	126	126
Lady Gladys Group	258550	6696450	1330	1263	2593
Day Streak	258000	6698500	0	0	0
Mystery/Our Luck	257300	6696700	10	0	10
Rose and Shamrock	261500	6696700	2	0	2
Victoria	260400	6696100	3	0	3
Lady Lillian/Hit and Miss	259450	6694950	1	0	1
Shamrock	258700	6693700	88	0	88
Revenue	258950	6693000	1	0	1
Clinker/Matchless	259850	6692950	1	0	1
Red Leap	260500	6692900	230	166	396
Derby	259750	6692550	10	0	10
Offchance/Dead Finish	260100	6691700	119	0	119
Cuba	261200	6691400	1	0	1
Trio/Yale Lock	260950	6690600	3	0	3
Wildcat	266900	6689700	8	0	8
Pride of the Hills	262850	6680950	10	0	10
Star	264500	6680850	1	0	1
Perseverance	263500	6680450	1	0	1
Moonstone	264350	6680450	25	0	25
Saunders Find	263950	6680350	5	0	5
Mulwarrie/M.North etc	264050	6679500	289	0	289
Killaloe leases	263700	6678900	32	0	32
		Subtotals	5357	5907	11264
Western Menzies–Broad Arrow belt					
Lady Isobel	298400	6726300	2	0	2
Numerous diggings	299100	6724400	0	0	0
Sand Queen	319300	6684500	5568	0	5568
Happy Jack	319400	6685100	221	0	221
Lake View	320850	6685300	40	0	40
Lady Margaret	317100	6685350	90	0	90

Appendix 1 *(continued)*

Mine or prospect	*Easting*	*Northing*	*Past production Au (kg)*	*Resources Au (kg)*	*Total Au (kg)*
Lady Mack	315900	6686600	5	0	5
Goongarrie	321000	6681000	0	0	0
		Subtotals	5926	0	5926
Menzies shear zone					
St Albans	305800	6717100	35	0	35
European	307200	6716100	5	0	5
Dublin Castle	307500	6714900	128	0	128
Lady Sherry	307900	6714200	127	0	127
First Hit/Robinson Crusoe	308400	6713600	3787	196	3983
Maori	309250	6704200	46	0	46
Victory/Victory North	307300	6714250	48	0	48
Africander/Crown Cross	308300	6712000	160	0	160
Aspacia	307600	6713700	963	0	963
Warrior	309550	6710650	225	0	225
Alpha Group	309200	6711600	836	0	836
Lady Shenton Group	309000	6712300	6276	300	6576
Flying Fish/Friday	308750	6713050	598	0	598
Maori Chief	310200	6711400	38	0	38
Lincoln	310150	6711100	29	0	29
Lady Harriet	309900	6710000	111	0	111
Two Dicks	310600	6709800	29	0	29
Ballarat–Menzies	311000	6709800	10	0	10
Brittania	310800	6708700	6	0	6
Craig-y-nos/Guiding Star	311800	6708200	35	0	35
Black Jack/Lone Hand	313500	6707600	132	0	132
Yunndaga/Princess May	311500	6707300	8758	1293	10051
		Subtotals	22382	1789	24171
Eastern Menzies–Broad Arrow belt					
Goodenough	314000	6715400	264	0	264
Kensington	313400	6713600	49	0	49
Maranoa	313800	6713100	288	0	288
Sunday Gift	314300	6712800	43	0	43
Springfield	315700	6710300	22	0	22
Emu	316000	6709400	44	0	44
Spion Kopp	317100	6707000	7	0	7
Dunlop	316000	6704700	9	0	9
Brougtonville	317700	6703500	50	0	50
Queens Birthday	319900	6704800	25	0	25
Hills View	318300	6705900	30	0	30
Twin Hills main reef	317600	6740600	7	580	587
Twin Hills south	317700	6737700	11	0	11
Cock Robin	318100	6726700	8	0	8
		Subtotals	857	580	1437
Malcolm belt					
Maltese Well	347900	6781800	0	0	0
Desdemona/Othello	341350	6780100	220	0	220
Hawk	344800	6775200	0	0	0
Coronation Well	341100	6773800	0	0	0
Lady Nora	346400	6773200	0	0	0
Ulster	347700	6772400	0	0	0
Sunbeam/Bluebell	347100	6771700	0	0	0
Golden Butterfly	343300	6769900	253	770	1023
Copperhead	341650	6769150	0	82	82

Appendix 1 *(continued)*

Mine or prospect	*Easting*	*Northing*	*Past production Au (kg)*	*Resources Au (kg)*	*Total Au (kg)*
Butterfly North	342100	6769000	0	434	434
Admiral	341100	6768600	0	508	508
King	342400	6768300	0	893	893
Redlake	341700	6767650	0	494	494
Orient Well/Tampa	348500	6767350	0	8490	8490
Oriental	348100	6767300	46	0	46
Mignonette	349600	6767100	40	0	40
Fortuna/Grafter	350700	6766200	180	0	180
Perseverance	350400	6765100	37	0	37
Two Dees	337800	6762200	54	280	334
Britannia	350700	6760800	445	0	445
Treasure	350700	6759500	37	0	37
Whale	350200	6759100	90	0	90
Batavia	351600	6758900	272	0	272
Champion	352100	6757400	1050	0	1050
Thowell Well	350700	6756200	0	0	0
Kookynie palaeochannels	353700	6754400	0	600	600
McTavish	350400	6754000	0	66	66
Cosmopolitan and Cumberland Niagara	354000	6753800	9700	8855	18555
Lubra Queen	350600	6751950	123	123	246
Lily	348050	6750200	43	43	86
Challenge	347600	6749600	92	0	92
May/White Cross	346700	6749450	77	0	77
Mara	344250	6749100	38	0	38
Gladstone	342100	6749100	115	0	115
Missing Link	346800	6749000	110	0	110
Orion	346050	6748750	397	0	397
Justice	345300	6748400	25	0	25
Pine Lodge	348700	6747750	86	0	86
		Subtotals	13530	21638	35168
		TOTALS	**64248**	**31988**	**96236**

Appendix 2

Open-file geochemistry surveys

KEY

ID No.	Project reference number — allocated specifically for these notes
Map Sheet	1:100 000 sheet number (see Plate 2 key) to aid in project location
Company	The company that carried out the geochemical exploration Expl: Exploration
M No.	GSWA project reference number
A No.	GSWA report reference number
Yr	The year that the report was written
Medium	How the sample was obtained HMC: Heavy mineral concentrate HMS: Heavy mineral separates Mag Conc: Magnetic concentrate RAB: Rotary air blast drilling RC: Rerverse circulation drilling R Percussion: Rotary percussion drilling Stream Sed: Stream sediment
No. / Ag to Zn	The number of samples from the medium indicated, and each element determined marked 'X'. If more than one analytical method is used for a group of samples from a particular medium, a new line is taken to identify the elements relevant to each method.
Method / Analyst	Blanks occur in these columns if the information is not indicated in the company report. AAS: Atomic absorption spectrophotometry BCL: Bulk cyanide leach BLEG: Bulk leach extractable gold ETA: Electrothermal absorption FA: Fire assay ICP: Inductively coupled plasma ICP–MS: ICP–Mass spectrometry ICP–OES: ICP–Emission spectrophotometry Ass: Assay Dev: Development Kal: Kalgoorlie Metall: Metallurgical
Deep Drill	'Y' marked in this column indicates that the report includes drilling to a depth greater than four metres.
Comments	Further sample details with regards to collection and analysis. loc: location

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
1	3138	Asarco Aust Ltd	7795	37485	92	Lag	158			X						
2	3038	Western Mining Co Ltd	7588	36620	92	Lag	309		X	X			X	X	X	X
3	3138	GHG Taylor	6905	32696	91	Auger	33			X						
		GHG Taylor		35265	92	Auger	65			X						
										X						
4	3038	Aberfoyle Resources Ltd	6642	21456	90	Soil	153			X						
5	3139	Le Tissier & Hronsky	6613	34064	91	Soil	35			X						
6	3139	Hillmin Gold Mines P/L	6384	28929	89	Soil	222		X	X						
7	3038	Consolidated Expl Ltd	6373	28835	89	Soil	30			X						
8	2939	Sipa Resources Ltd	6225/2	28808	89	Lag	225	X		X						
									X						X	
9	3139	CRA Expl P/L	6116	31707	90	Auger	714			X						
								X	X			X	X	X	X	X
10	3038	Consolidated Expl Ltd	6065	26447	88	Soil	300			X						
11	3038	Consolidated Expl Ltd	6063	26446	88	Soil	118			X						
12	3139	Newmex Expl Ltd	6006/1	27053	88	Stream Sed	55	X		X					X	
13	2939	Battle Mountain Aust Inc	5979	28336	89	Pisolite	23	X	X	X				X	X	
				& 28337		Rock Chip	481	X	X	X		X	X		X	
						Soil	752			X						
									X						X	
						Stream Sed	160	X		X						
14	3139	Golden Valley Mines NL	5918	28688	89	Rock Chip	110			X						
15	3038	Carpentaria Expl Co P/L	5902	24964	88	Soil	32			X						
16	3038	Central Kalgoorlie Gold Mines NL	5868	25219	88	Soil	195		X	X						
							45	X		X					X	
17	3138	Lyco Resources	5841	28838	89	Vacuum	543			X						
18	3139	Viking Resources Ltd	5744	25111	88	RAB	31		X	X						
19	3138	Conquest Mines NL	5732	25125	88	Pisolite	50		X	X				X		X

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
X		X									X	AAS			Fraction: -6+2mm
												FA			Depth: 0.2-2.5m
												FA			Depth: 0-2.5m
					X							XRF			
												ETA			
												FA / AAS			
												AAS			
												BLEG			
												ETA			
												AAS			
												FA			Depth: 0.2-1.5m
X	X	X	X							X	X	ICP			
												BLEG			
												BLEG			
												FA			
			X			X					X				
			X			X									Selected samples only
												BLEG			Selected samples only
			X									AAS			
												BCL / HMS			Selected samples only
												BLEG			
												AAS			
			X								X	ETA			
												FA / AAS			Depth: 1-2m
															Depth: 2-3m
									X						Size: 0.5-4mm

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
20	2938	CRA Expl P/L	5707/1	24271	87	Rock Chip	90			X	X	X	X	X		X
	2939															
		CRA Expl P/L		24272	87	Laterite	80	X							X	
										X						
									X			X	X			
						HMC	80	X							X	
										X						
									X			X	X			
		CRA Expl P/L		28525	89	Auger	2 305	X		X						
									X							X
		CRA Expl P/L		31782	90	Auger	741			X						
									X				X		X	
		CRA Expl P/L		33953	91	Auger	558			X						
								X					X		X	X
									X			X		X		
		CRA Expl P/L		35122	91	Auger	396	X		X						
								X	X			X	X	X	X	X
21	3038	Conquest Mines NL	5635	24376	88	Pisolite	134		X	X				X		X
22	3139	Melita Mining NL	5600/2	34033	91	Soil	391			X						
23	3139	Noble Resources NL	5561	23696	88	Laterite	140		X	X					X	
		Freshwater Resources P/L				Rock Chip	40		X	X					X	
24	3138	Aberfoyle Resources Ltd	5434/1	24244	88	Auger	842			X						
									X							
						Rock Chip	538		X	X						
		Aberfoyle Resources Ltd		27898	89	Auger	100			X						
		Aberfoyle Resources Ltd		27899	88	Auger	184			X						
25	3138	Aberfoyle Resources Ltd	5434/2	24245	88	Rock Chip	35			X						
26	3039	BHP Minerals Ltd	5345/2	24909	88	Stream Sed	49			X						
								X	X				X		X	
27	3139	BHP Minerals Ltd	5344	23144	87	Lag	117		X							
										X						
															X	
						Rock Chip	8			X						
						Stream Sed	9	X		X					X	
28	3139	Western Reefs Ltd	5309/1	23142	88	Soil	105			X						
		Giralia Resources NL		28100	89	Laterite	38			X						
						Rock Chip	15			X						
						Soil	120			X						
29	3038	AUR NL	5198	23720	88	RC	39			X						
						Soil	22	X	X	X					X	
		AUR NL		27254	89	Soil	200			X						
30	3038	Julia Mines NL	5156	27446	89	Soil	294			X						
	3138								X							
31	3139	Hunter Resources Ltd	5087	23528	88	Soil	386			X						
				& 23529					X							
							273			X						
									X							
						Stream Sed	42			X						
									X							

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
X	X	X				X									Also for B, Cd & Ti
											X	AAS			
												ETA			
	X		X			X	X			X		XRF			Also for Ge, Nb, Se & Ta by XRF
											X	AAS			
												ETA			
	X		X			X	X			X		XRF			Also for Ge, Nb, Se & Ta by XRF
												FA / ICP-OES			Depth: 1-2m
												ICP-OES			
												FA			Depth: 1m
		X	X								X	AAS			
												FA			Depth: 1m
		X	X								X	AAS			
							X		X	X		XRF			Also for Ti & Zr by XRF
												FA			Depth: 1m
X	X	X	X							X	X	ICP-OES			Also for Cd by ICP-OES
										X					Selected samples only
														Y	
			X							X				Y	Selected samples only
			X							X					
												ICP -MS		Y	Depth: 0.2-1m
												ICP -OES			
												AAS			
												ETA		Y	Depth: 0.2-1m
												ETA		Y	Depth: 0.2-1m
												FA			
												BLEG			Fraction: -2mm
		X	X	X							X				
												XRF			
												FA			
												AAS			
												BLEG			
												FA / AAS			Fraction: -4mm
												ETA		Y	
												ETA			
												BLEG			
												FA	Classic Comlabs		Depth: 0-4m
			X									FA / AAS	Classic Comlabs		Depth: 0.05-0.1m
												AAS	Classic Comlabs		Depth: 0-0.3m
													Kal Assay Labs		
												AAS	Kal Assay Labs		
												FA	AAL	Y	Depth:0.15m, Fraction: -1mm
												BLEG	Perth Assay Lab		Depth:0.15m, Fraction: -1mm
												FA	Anal Services		
													Anal Services		

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
32	3139	Hallmark Gold NL	4981	26259	88	Auger	628			X						
									X							
		Hallmark Gold NL		33861	91	Vacuum	31			X						
33	3139	RH Finlayson	4971	22166	88	Rock Chip	55		X	X						
						Soil	16		X	X						
34	3138	Bruce Resources NL	4921	22065	87	Rock Chip	40			X						
35	3038	Norgold Ltd	4909	21958	87	Rock Chip	12			X						
	3039							X	X					X	X	
						Stream Sed	71	X		X					X	
		Norgold Ltd		26902	88	Rock Chip	7			X						
								X	X						X	
						Soil	590			X						
								X	X						X	
36	3038	Julia Mines NL	4867	27103	89	Soil	1 058			X						
	3138								X							
		Julia Mines NL		27945	89	RAB	37		X	X						
							34		X	X						
37	3038	Taurus Resources NL	4865	21887	87	Soil	242			X						
									X							
38	3038	AuDAX Resources NL	4856	21888	87	Rock Chip	143	X	X	X					X	
39	2939	Delta Gold NL	4738/1	21520	87	Stream Sed	53			X						
	3039						27			X						
							22			X						
						Rock Chip	35			X						
							4		X	X						
		Delta Gold NL		28264	89	Soil	64			X						
							66			X						
							50			X						
40	2939	Eastern Group Ltd	4583	22743	88	RC	19	X	X	X					X	
						Soil	19			X						
															X	
41	2939	Electrolytic Zinc Co	4564	20616	87	Laterite	95	X	X	X					X	
						Rock Chip	159	X	X	X					X	
						Stream Sed	15	X		X					X	
42	3038	Consolidated Expl Ltd	4533	20294	87	Soil	19			X						
									X						X	
		Consolidated Expl Ltd		20848	87	RC	8			X						
43	2939	Aust Consolidated Minerals Ltd	4516	19981	87	Rock Chip	28	X		X					X	
				& 21240		Stream Sed	32	X		X					X	
							31		X	X					X	
44	3138	CRA Expl P/L	4488	22143	87	Auger	108			X						
						Soil	206			X						
		CRA Expl P/L		25407	88	RAB	194			X						
						Soil	239			X						

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep *Drill*	Comment on Samples
													Minlab		Depth: 0.2-1m
												AAS	Minlab		
												AAS , ETA	Genalysis		Depth: 0.3-2m
														Y	
					X										Not all for Pt
												ETA	Genalysis		
	X		X			X					X	AAS	Genalysis		
										X		Colourimetry	Genalysis		
												AAS	Amdel		
												AAS	Analabs		
			X								X	ETA	Analabs		
												AAS	Analabs		
			X								X	ETA	Analabs		
													Kal Assay Labs		
												AAS	Kal Assay Labs		
												AAS	Analabs		Depth: 0-2m
												AAS	Analabs		Depth: 0-4m
												ETA	Genalysis		Depth: 0.1m
												AAS	Genalysis		
		X	X	X	X						X		Amdel		Not all for Ag, Ni, Pd, & Pt
														Y	
												AAS	SGS		
												ICP			Fraction: -1mm
												FA / AAS			
												AAS / ICP			
												ICP--MS			Fraction: -8mm
												FA / ICP--MS			Fraction: -8mm
												ETA			Fraction: -8mm
												FA			Depth: 0-1m, Selected samples only
												BLEG			
	X		X			X				X	X				Collected with magnet
	X		X			X				X	X				Selected samples only
												AAS			Fraction: -6mm
												ETA			Depth: 0.15m, Fraction: -5mm
			X								X	AAS			
										X		Colourimetry			
												AAS	Resource Dev Lab	Y	Depth: 0-1m
			X								X				Selected samples only
												BLEG			
			X								X				
														Y	Depth: 1-2m
															Depth: 0.3m
													Sheen Labs	Y	Depth: 0-4m
													Sheen Labs		Depth: 0.3m

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
45	3038	Freeport Aust Inc	4434	19512	86	Soil	29			X						
						Stream Sed	11			X						
		Freeport Aust Inc		22313	87	RAB	63			X						
		Consolidated Expl Ltd		28768	89	Soil	430			X						
46	3139	Glomex Mines NL	4397	19370	70	Rock Chip	14						X		X	
		Glomex Mines NL		19373	71	RAB	14						X	X	X	
						Rock Chip	21						X	X	X	
47	3138	BHP Minerals Ltd	4376/2	19326	86	RAB	14			X						
									X							
						Rock Chip	16		X	X					X	
		BHP Minerals Ltd		19329	86	RAB	18			X						
									X							
						Rock Chip	61			X						
		BHP Minerals Ltd		19330	86	Gossan	76			X						
						RAB	11			X						
		BHP Minerals Ltd		19332	86	RAB	16			X						
						Rock Chip	19			X						
		Mt Martin Gold Mines NL		28266	89	Soil	732			X						
48	3038	Aust Consolidated Minerals Ltd	4300/2	19451	86	Auger	378	X		X					X	
							436			X						
									X						X	
						RAB	66			X						
49	2939	Aust Consolidated Minerals Ltd	4271/2	19564	87	Rock Chip	40			X						
	3039							X	X						X	
						Soil	115	X		X						
									X			X			X	
						Stream Sed	21	X		X					X	
		Carpentaria Expl Co P/L		22450	87	Rock Chip	16		X	X					X	
							60			X						
50	3038	Delta Gold NL	4263	18799	86	Stream Sed	106			X						
	3039														X	
51	3138	Windsor Resources NL	4246	18545	86	RAB	47		X	X					X	
52	2938	Electrolytic Zinc Co	4194	18268	86	Laterite	50		X							
	3038					Rock Chip	27	X	X	X		X	X	X	X	X
						Soil	114	X	X	X		X			X	
		Pancontinental Mining Ltd		27106	89	Laterite	482			X						
		Norgold Ltd		28130	89	Laterite	112		X	X					X	
						Soil	112		X	X					X	
53	3038	Aztec Mining Co Ltd	4190/3	28424	89	Soil	530			X						
						Stream Sed	6			X						
54	3038	Pancontinental Mining Ltd	4139	23787	87	Laterite	446			X						
		New Holland Mining NL		26462	89	RAB	49			X						
						Soil	345			X						

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
														Y	
												FA	Analabs	Y	Depth: 0-2m
												BLEG	Genalysis		Fraction: -2mm
		X									X			Y	
		X												Y	Depth: 3-4m
		X									X				
												FA	Comlabs	Y	Depth: 0-4m
												XRF	Comlabs		
			X								X				
												FA	Comlabs	Y	Depth: 0-4m
												XRF	Comlabs		
												FA	Resource Dev Lab		
												FA	Comlabs	Y	Depth: 0-4m
												FA	Comlabs		
												FA	Comlabs	Y	Depth: 0-2m
													Comlabs		
												AAS	Amdel	Y	Depth:1-3m
													SGS		Depth: 1-3m, Selected samples only
			X			X					X	AAS	SGS		
	X											XRF	SGS		
										X		Colourimetry	SGS		
															Depth: 0-2m
												FA / AAS		Y	Channels: 3m
			X			X					X	AAS			
	X									X		Colourimetry			
												BLEG			
			X			X				X	X				
												BLEG			
												AAS	AAL		Channels: 1-6m
													Amdel		
												ETA	SGS		Fraction: -1mm
		X										AAS	SGS		
			X								X				Depth: 2-3m
												XRF	SGS		
X	X	X	X			X					X				
			X								X	AAS	SGS		
										X		ICP--MS	SGS		
												AAS	SGS		Fraction: +6mm
			X								X	AAS, ETA	Genalysis		Fraction: +6mm
			X								X	AAS, ETA	Genalysis		Fraction: -6mm
												ETA	Analabs		
												BLEG	Aust Lab Services		
												FA	AAL	Y	Depth: 0-2m
												BLEG	AAL		Fraction: -5mm

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
55	3138	Jeedamyah Gold Expl	4164/1	25367	88	Rock Chip	7	X		X						
						Soil	215			X						
									X							X
						Stream Sed	9	X		X					X	
56	2939	Austamax Resources Ltd	4124	17437	86	Laterite	95	X	X					X	X	X
						Soil	214		X	X				X	X	
						Stream Sed	100			X						
		Norgold Ltd		24031	87	Rock Chip	20	X	X	X		X			X	
						Soil	80			X						
57	3039	Indian Ocean Gold NL	4088	26305	88	RC	15			X						
						Soil	50			X						
58	2939	Electrolytic Zinc Co	4012/2	20156	87	Laterite	471	X	X	X						
	3039			& 20157												
		Norgold Ltd		22799	87	RAB	24	X	X	X						
						Stream Sed	90			X						
		Norgold Ltd	4012/2	24169	88	Rock Chip	27	X	X	X					X	
				& 24403			7	X	X	X					X	
						Soil	519	X	X	X						
		Norgold Ltd	4012/2	26709	89	RC	10	X	X	X					X	X
				& 26901			6	X	X	X					X	X
		Geopeko	4012/2	31063	90	Stream Sed	13			X						
		Geopeko	4012/2	30918	90	RAB	155		X	X						
				& 30919			39			X						
									X							
						Soil	229		X	X						
						Stream Sed	20		X	X					X	
						Vacuum	51		X	X						
							38		X	X						
		Geopeko	4012/3	30698	90	RAB	38		X	X						
						Soil	355		X	X						
						Stream Sed	7	X	X						X	
						Vacuum	8		X	X						
		Geopeko	4012/2	30916	90	RAB	53		X	X						
						Soil	650			X						
		Geopeko		31064	90	Stream Sed	18			X						
				& 31065												
		Geopeko		31066	90	Stream Sed	20			X						
		Geopeko	4012/2	32002	90	RAB	47			X						
						Stream Sed	12			X						
		Geopeko	4012/3	30755	90	RAB	14			X						
59	3139	Minplex Resources P/L	3973/1	16090	85	Rock Chip	22			X						
		Minplex Resources P/L		18281	86	Rock Chip	29			X						
60	3139	Golconda Expl P/L	3964/3	18668	86	Auger	57			X						
61	3138	Camborne Resource NL	3941/1	19051	86	Rock Chip	47			X						
						Soil	7			X						
62	3038	Mannkal Mining Ltd	3933/2	16283	85	Soil	47		X	X	X	X			X	X
						Laterite	16		X							
						Soil	16			X						

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
													Resource Dev Lab	Y	
												ETA	Analabs		Depth: 0.15m
												AAS	Analabs		
													Amdel		
X	X	X	X			X					X	AAS	Genalysis		
		X	X								X	AAS	Analabs		Depth: 0.1-0.4m
												AAS	Perth Metall Lab		Fraction: -6mm
	X		X			X					X			Y	
												ETA			
												AAS	Genalysis	Y	Depth: 0-4m
												AAS	SGS		
						X						AAS	Genalysis	Y	
						X									Depth: 2-4m
												ICP - MS			
			X			X					X	AAS	SGS	Y	
			X			X					X	AAS	Genalysis		
						X						AAS	SGS		Fraction: -6mm, Not all for Ag
			X								X	AAS	Analabs	Y	Depth: 0-4m, Not all for As
			X								X	AAS	Analabs		Depth: 0-2m, Not all for As
												BLEG			
												AAS	Genalysis	Y	Depth: 0-4m, Not all for As
												FA	AAL		Depth: 0-4m
												AAS	AAL		
												BLEG	Ass Research Aust		
												AAS	Genalysis		Depth: 0-2m
												ETA, ICP - OES	Genalysis		Depth: 0-2m
												AAS	Genalysis	Y	Depth: 0-4m
												BLEG	Ass Research Aust		
												AAS	Genalysis		Depth: 0-2m
												BLEG			
												BLEG			
												FA	AAL	Y	Depth: 0-4m
												BLEG			
												AAS	Genalysis	Y	Depth: 0-4m
												FA			
													AAL		
												FA	AAL		Depth: 0-1m
												FA	AAL		
												FA	AAL		Depth: 0.2-0.6m
X	X	X	X			X				X	X				Selected samples only
										X		XRF	SGS		
												AAS	SGS		

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
63	2938	BHP Minerals Ltd	3914	17595	85	Deflation Lag	133		X	X						
	2939						58		X	X	X					
															X	
											X					
						Rock Chip	25			X						
								X	X				X			
		Electrolytic Zinc Co		20733	87	Calcrete	27	X	X	X						
						Laterite	148	X	X	X					X	
						Rock Chip	44	X	X	X					X	
						Stream Sed	38	X		X					X	
		Norgold Ltd		21631	87	Rock Chip	84	X	X	X					X	
						Stream Sed	8	X		X					X	
		CW Reindler		15945	84	Rock Chip	44	X	X	X			X		X	
64	3139	Asarco Aust Ltd	3817	15693	85	Stream Sed	39	X	X	X					X	
		Asarco Aust Ltd		16942	86	Rock Chip	238	X		X					X	
									X					X		X
		Newmex Exploration Ltd		22 436	88	Iron Oxide	115	X	X	X					X	X
						Stream Sed	93	X		X					X	
65	3139	Forrest Gold P/L	3804/3	18744	86	Laterite	3			X						
		Forrest Gold P/L		21409	87	Percussion	7			X						
						RAB	1			X						
		Austwhim Resources NL		26651	89	RAB	75			X						
		Dominion Mining Ltd		31592	90	Deflation Lag	661			X						
		Dominion Mining Ltd		34567	90	Deflation Lag	715			X						
						RAB	160			X						
66	3139	Western Mining Corp Ltd	3734/2	15772	85	RC	7			X						
						Deflation Lag	129			X						
		Charter Mining NL		28787	89	Auger	279			X						
67	3139	Western Mining Corp Ltd	3734/4	17768	85	Deflation Lag	237			X						
						Soil	33			X						
68	3139	BP Minerals Aust P/L	3717	15498	85	Soil	140			X						
		BP Minerals Aust P/L		16711	85	Soil	105			X						
69	3038	Grants Patch Partners	3680	14917	84	Grab	29			X						
	3039					Rock Chip	11			X						
		Grants Patch Partners		14919	84	RC	28			X						
						Soil	200		X							
70	3139	Western Mining Corp Ltd	3667	16706	85	Deflation Lag	180			X						
						Percussion	41			X						
						Soil	21			X						
		Charter Mining NL		30347	90	RAB	80			X						
							7			X						

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
			X											Y	Fraction: -4 +1mm
												FA			Fraction: -5 + 1mm
			X								X	AAS			
	X											ICP			
									X	X		FA / ICP	Pilbara Labs		Also for Ti, Selected samples only
X		X	X				X				X	AAS	Pilbara Labs		
	X									X					
	X		X			X				X	X				Collected by magnet
	X		X			X				X	X				
												AAS			Fraction: -6mm
	X		X			X					X	AAS	Analabs		
										X		Colourimetry	Analabs		
												AAS	Amdel		
		X	X								X		Minlab		Not all for As, Co & Ni
												AAS	Analabs		Only 13 sites--3 fractions
		X	X								X	AAS			
												ICP - OES			
X			X								X	AAS			Collected with magnet
												BCL			Fraction: -6mm
												BLEG			Shallow open pit sampling
														Y	Depth: 0-1m
															Depth: 0-2m
													AAL	Y	Depth: 0-3m
												AAS, ETA	Genalysis		Surface , Fraction: -5.6+2mm
												ETA	Genalysis	Y	Surface , Fraction: -5.6+2mm
												AAS	Genalysis		Depth: 0-4m
													Western Mining	Y	Depth: 0-1m
															Surface , Fraction: -6.4mm
												BLEG	Genalysis	Y	Depth: 0-1.5m
													Western Mining		Surface , Fraction: -6.4mm
													Western Mining		Depth: 0.15m
												AAS	BP Minerals		
												AAS	BP Minerals		
												AAS	Analabs		Shallow workings sampling
												AAS	Analabs		
															Depth: 0-3m
										X					
													Western Mining	Y	Surface , Fraction: -6.4mm
												AAS	Western Mining		Depth: 0-1m
													Western Mining		Depth: 0.1-0.15m
												BLEG	Genalysis		Depth: 0-2m
												AAS	Amdel		Depth: 0-3m

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
71	3138	BHP Minerals Ltd	3644/2	18695	86	RAB	16			X						
									X							
		Ashton Gold WA Ltd		30512	90	Soil	137			X						
									X							
							371			X						
		Ashton Gold WA Ltd		30525	90	Soil	338			X						
									X							
72	3138	Golconda Minerals NL	3606	16371	85	Percussion	20		X	X						
						RAB	9		X	X						
						Rock Chip	172		X	X						
		Money Mining NL		23829	88	Costean	392		X	X						
						Rock Chip	14			X						
									X							
73	3138	Clackline Refractories Ltd	3561	14204	84	Gossan	11			X						
						Rock Chip	8			X						
						Vacuum	14			X						
74	3139	Helix Resources NL	3521	19252	86	Percussion	8			X					X	
		Carpentaria Expl Co P/L		25680	88	Soil	135			X						
75	3038	Hill Minerals NL	3398	13418	84	Soil	165	X		X			X		X	
							60			X			X		X	
76	2938	Pancontinental Mining Ltd	3392/2	14921	84	RAB	13	X		X					X	
	3038					Rock Chip	19			X						
				20838	87	Pisolite	41			X						
77	2938	Pancontinental Mining Ltd	3392/3	14922	84	Rock Chip	12			X						
		Pancontinental Mining Ltd		16831	85	Auger	47	X	X	X					X	
78	3038	Pancontinental Mining Ltd	3392/5	14924	84	RAB	47	X		X					X	
		Norgold Ltd		22624	86	Stream Sed	42	X		X						
79	2939	Pancontinental Mining Ltd	3392/7	15948	85	Rock Chip	10			X						
	3039								X					X	X	
						Stream Sed	54			X						
									X					X	X	
		Norgold Ltd		21935	87	Soil	87	X		X						
		Norgold Ltd		26509	88	Soil	30			X						
							30	X	X	X		X		X	X	
							90									
						Stream Sed	72	X		X					X	
		Geopeko		30753	90	RAB	96	X	X	X					X	
		Geopeko		30917	90	Rock Chip	4	X	X	X		X			X	
						Soil	12		X	X						
							16		X	X						

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
												FA	Comlabs	Y	Depth: 0-4m
												XRF	Comlabs		
												FA	Minlab		Only 17 sites -- 8 fractions
												AAS	Minlab		
												FA	Minlab		
												FA	Minlab		
												AAS	Minlab		
														Y	Depth: 1-2m
															Depth: 0-2m
												AAS	Pilbara Labs		
												AAS	Resource Dev Lab	Y	29 trenches, Depth: 0-2m, Width: 1-2m
												FA			
														Y	
												FA	AAL		Depth: 0-1m
		X		X	X									Y	Depth: 0-4m, Not all for Au, Pt & Pd
												BLEG	AAL		Depth: 0-0.2m
			X								X	AAS	SGS		
		X	X								X	AAS	Genalysis		
			X								X		SGS		Depth: 0-4m
												ETA	SGS		
												ETA	SGS		
											X				
		X	X	X	X						X	AAS	SGS	Y	Depth: 0-4m
												AAS	Amdel		
												FA			
		X													
				X	X							ETA			
												FA			
		X													
				X	X							ETA			
												BLEG		Y	
												ETA	Genalysis		
	X		X			X					X	ETA	Genalysis		Duplicates of above
													Genalysis		
												BLEG			
												AAS	Genalysis	Y	Depth: 0-4m
			X			X					X	AAS			
												BLEG			
												FA			

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
80	3139	Hill Minerals NL	3361	13130	84	RAB	29			X						
						RC	4		X	X						
		Hill Minerals NL		14106	84	Mag Conc	5		X	X		X			X	
						Pisolite	5		X	X		X			X	
		BP Minerals Aust P/L		15157	85	Rock Chip	8			X						
		BP Minerals Aust P/L		16889	85	Percussion	9			X						
		BP Minerals Aust P/L		17421	86	RAB	35			X						
						Soil	105			X						
		Hillmin Gold Mines P/L		20096	87	RC	27			X						
81	3139	Amoco Minerals Aust Co	3266/2	19486	83	Auger	315	X		X					X	
						Rock Chip	63	X		X					X	
82	3139	Amoco Minerals Aust Co	3266/4	15898	84	Percussion	5	X	X	X					X	
		Amoco Minerals Aust Co		17155	84	RAB	23	X		X					X	
									X							
						Rock Chip	4	X		X					X	
									X							
		BHP Minerals Ltd		18736	86	RAB	54			X						
									X							
														X	X	X
		BHP Minerals Ltd		21647	87	Deflation Lag	39			X						
									X							
						RC	74			X						
									X							
														X	X	X
		BHP Minerals Ltd	3266/6	19315	86	Deflation Lag	20		X	X						
83	3138	Technomin Aust NL	3088	21697	87	Rock Chip	56			X						
									X							
		Julia Mines NL		29461	89	Soil	889			X						
									X							
84	3139	Aust Anglo American Ltd	3040/1	11633	82	RC	32			X						
85	3038	Aust Anglo American Ltd	3040/2	11923	83	RC	19			X						
		Aust Anglo American Ltd		12972	83	RC	13			X						
86	3139	Freeport of Aust Inc	3033	11606	82	Rock Chip	16			X						
								X								
						Stream Sed	63			X						
								X								
87	3138	Esso Expl Aust Inc	2990/1	11163	82	Rock Chip	234			X						
									X							
								X				X	X		X	
88	3138	Aberfoyle Expl P/L	2990/2	14412	84	RC	9			X						
						Rock Chip	40			X						
								X	X		X					
		Aberfoyle Expl P/L		18734	86	RC	9			X						
		Jones Mining Ltd		22465	88	RC	17			X						

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
												AAS	Genalysis	Y	Depth: 0-4m
												AAS	Genalysis		Depth: 0-4m
	X	X	X				X					AAS	Analabs	Y	Not all for Au
										X		Colourimetry	Analabs		
	X	X	X				X					AAS	Analabs		Not all for Au
										X		Colourimetry	Analabs		
												AAS	BP Minerals		Shallow pit sampling
												AAS	BP Minerals	Y	Depth: 0-2m
												AAS	BP Minerals	Y	
												ICP	BP Minerals		
												AAS	Genalysis	Y	Depth: 0-4m
			X								X				Depth: 0.5-4m
			X								X				
			X								X			Y	Depth: 0-1m, Selected samples only
		X	X								X	AAS		Y	Depth: 0-4m
												ICP - MS			
		X	X								X	AAS			
												ICP - MS			
												FA		Y	Depth: 0-2m
												XRF			
												AAS			
												FA	Comlabs	Y	Surface
												XRF	Comlabs		
												FA	Comlabs		Depth: 0-2m
												AAS / XRF	Comlabs		
												AAS	Comlabs		
												FA	AAL		
												AAS	AAL		
													Kal Assay Labs		Not all for As
												AAS	Kal Assay Labs		
												AAS	Amdel	Y	Depth: 0-1m
												AAS	Amdel		Depth: 0-1m
												AAS	Amdel		Depth: 0-1m
												FA	Pilbara Labs		
												AAS	Pilbara Labs		
												FA	Pilbara Labs		
												AAS	Pilbara Labs		
												FA	Analabs	Y	
												Colourimetry	Analabs		
							X					XRF	Analabs		
		X	X								X	AAS	Analabs		
														Y	Depth: 0-3m
												FA	Classic Labs		Selected samples only
										X			Amdel		
												Gravimetry	Classic Labs	Y	Depth: 0-1m
												FA	SGS	Y	Depth: 0-1m

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
89	2939	CRA Expl P/L	2903	10675	82	Rock Chip	40	X	X	X			X	X	X	
	3039															
90	3039	BHP Minerals Ltd	2799	10020	81	Vacuum	19	X		X						
							9	X		X						
91	3038	US Steel International Inc	2670	9273	73	Rock Chip	31						X	X	X	
	3039															
		US Steel International Inc		9278	73	Auger	179								X	
						R Percussion	129								X	
		US Steel International Inc		9279	73	Rock Chip	218								X	
				& 9280		Soil	2 460								X	
92	2939	Aust Consolidated Minerals Ltd	2612	8936	79	RC	68									
							10									
93	3139	Chevron Expl Co	2531/2	9296	80	Rock Chip	100	X		X					X	
		Chevron Expl Co		10207	81	R Percussion	5	X							X	
94	2939	International Nickel Aust Ltd	2479/1	9782	80	Percussion	6								X	
		International Nickel Aust Ltd		9783	81	Auger	16						X		X	
		Shell Company Aust Ltd		12347	83	Ironstone	6			X						
								X					X	X	X	
		Shell Company Aust Ltd		12979	83	Ironstone	74	X		X			X	X	X	X
									X		X	X				
						Rock Chip	31			X						
								X					X	X	X	
						Stream Sed	51	X		X					X	
95	3139	Penzoil of Aust Ltd	2387	8101	78	Rock Chip	45	X		X	X			X	X	
				& 8102												
96	3138	Australis Mining NL	2336	7991	78	Auger	32									
97	3139	Abminco NL	2301	7897	78	Ironstone	121	X							X	
98	3038	International Nickel Aust Ltd	2110	7530	78	Ironstone	70								X	
						Rock Chip	115								X	
99	3138	Asarco Aust Ltd	2067/2	32706	90	Deflation Lag	1 580			X						
		Asarco Aust Ltd		32707	90	Deflation Lag	173			X						
		Asarco Aust Ltd		36429	92	Deflation Lag	400			X						
		Asarco Aust Ltd		32705	91	Deflation Lag	171			X						
						Soil	143			X						
100	3139	Jimberlana Minerals NL	2044	7046	77	Gossan Float	53	X							X	
101	3139	Asarco Aust Ltd	2017	6989	77	Rock Chip	137								X	
								X	X	X				X		
						Stream Sed	22							X	X	
							130		X						X	
							108		X						X	
102	3039	Uranerz Aust P/L	1994	7331	77	Auger	17									
							19									

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
X	X	X	X								X		Analabs		Not all for Co
															Depth: 0-1m
															Depth: 1-2m
X		X	X								X				
		X												Y	Depth: 0-4m
		X													Depth: 0-1m
		X												Y	
		X													Depth: 0.1-0.15m
								X				Fluorimetry	Mining & Agri Labs	Y	Depth: 0-2m
									X			AAS	Mining & Agri Labs		
								X				Fluorimetry	Mining & Agri Labs		Depth: 0-4m
									X			AAS	Mining & Agri Labs		
X		X	X				X				X	AAS	Pilbara Labs	Y	Not all for Au
X		X	X								X	AAS	Genalysis	Y	Depth: 0-1m
		X									X	AAS	Analabs	Y	Depth: 0-2m
		X									X	AAS	Analabs	Y	Depth: 0-2m
				X	X							FA / AAS	Comlabs		Also for Ir by FA / AAS
X		X	X								X	AAS	Comlabs		
X	X	X	X	X	X						X	AAS	Comlabs		Also for Cd by AAS
						X	X					XRF	Comlabs		Also for Tl by XRF
				X	X							FA / AAS	Comlabs		Also for Ir by FA / AAS
X		X	X								X	AAS	Comlabs		Also for Mg by AAS
													Amdel		
X		X	X								X				
								X							Depth: 0-1.3m
			X								X	AAS			
		X									X				
		X									X		Analabs		
															Fraction: -7+2mm
												ETA	Analabs		Fraction: -7+2mm
												ETA			Fraction: -7+2mm
												ETA	Analabs		Fraction: -7+2mm
												ETA	Analabs		Fraction: +2mm, -2mm
X			X				X				X				
			X								X				
		X													Not all for Ag, As, Au, Cr & Ni
			X								X				Not all for Cr
			X								X				
		X	X								X				Duplicates of above
								X							Depth: 0-1m, Also for Th (not all)
								X							Depth: 1-4m, Also for Th (not all)

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
103	3139	Shell Minerals Expl	1912	6605	75	Rock Chip	73						X		X	
						Soil	460								X	
		Shell Minerals Expl		6606	76	Soil	438								X	
							931								X	
104	3039	Cliffs International Inc	1848/1	9245	79	Soil	1 350								X	
				& 9325												
		Cliffs International Inc		9944	81	RAB	104			X						
105	3038	Cliffs International Inc	1848/4	9246	79	Diamond	6						X	X	X	
				& 9326		Soil	2 400							X	X	
		Cliffs International Inc		16751	85	RC	36			X						
106	2939	Esso Aust Ltd	1840	6976	77	RC	45									
107	3138	Aust Selection P/L	1789	6055	75	Percussion	6								X	
						Rock Chip	6								X	
						Soil	640								X	
108	2939	Great Boulder Mines Ltd	1776	5984	75	Soil	700								X	
109	3138	Newmont P/L	1765/2	7534	78	RAB	44	X							X	
						Rock Chip	50	X							X	
110	3139	Esso Aust Ltd	1676	5992	75	Percussion	2								X	
						RAB	3	X							X	
						Rock Chip	50	X							X	
111	3138	Samin Ltd	1633	5333	74	Gossan	112	X							X	
				& 5334		Rock Chip	218	X							X	
112	3039	Falconbridge Aust P/L	1518/1	5441	74	Soil	1 248							X	X	
				& 5442												
113	2938	Falconbridge Aust P/L	1517	5290	74	Soil	4 261							X	X	
	2939			to 5292												
114	3139	Western Mining Corp Ltd	1472	4393	73	Vacuum	32						X	X	X	
		Western Mining Corp Ltd		7476	78	Percussion	32						X	X	X	X
115	3038	Samedan of Aust	1447	4196	72	Costeaning	129							X	X	
				4197		Percussion	7								X	
116	2939	Asarco Aust Ltd	1323	4736	73	Rock Chip	58								X	
	3039						93	X		X			X	X	X	
		Asarco Aust Ltd		4736	74	Percussion	13							X	X	
117	3139	CRA Expl P/L	1252	4536	73	Gossan	500								X	
		CRA Expl P/L		5428	74	Gossan	20								X	
						Soil	177								X	
		CRA Expl P/L		6040	74	Rock Chip	96	X					X		X	
							19						X		X	

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
		X	X								X		MGV Labs		
											X				
X											X				
X											X	AAS			
		X	X								X		Labtech		Sampled below 0.05m
													Analabs		
		X									X		Analabs / Labtech	Y	Depth: 0-2m
		X									X		Labtech		Sampled below 0.08m
														Y	Depth: 0-1m
								X				Colourimetry		Y	Depth: 0-3m
		X									X			Y	Depth: 0-2m
		X									X				
		X									X				
			X								X				
		X	X								X	AAS	Geomin	Y	Depth: 0-4m, Not all for Ni
			X								X	AAS	Geomin		
							X					Colourimetry	Geomin		
		X	X								X	AAS	Analabs		Depth: 0-2m
		X	X								X	AAS	Analabs		Depth: 0-2m
		X	X								X	AAS	Analabs		
			X								X	AAS	Analabs		Channels: 1-2m
X		X	X								X	AAS	Analabs		Not all for Mn
		X									X		Wheeler Lab		
		X									X	AAS		Y	Depth: 0.15m
		X									X	AAS	Western Mining	Y	Depth: 0-1.5m
		X	X								X	AAS	Western Mining	Y	Depth: 0-1.5m
		X									X	AAS	Geomin	Y	Depth: 2m, Length: 1.5m
		X									X	AAS	Geomin		Depth: 0-1.5m
		X									X	AAS	Associated Labs		
		X	X								X	AAS	Associated Labs		Not all for Ag, Au & Co
		X									X			Y	Depth: 0-4m
											X			Y	
											X			Y	
											X				
X		X	X								X				Also for Se
		X	X								X				Also for major oxides by XRF

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
118	2939	Electrolytic Zinc Co	1172	3607	72	Percussion	213	X							X	
						Rock Chip	11								X	
						Vacuum	11	X					X		X	
119	3138	CRA Expl P/L	1156	3570	73	Auger	39							X	X	
		CRA Expl P/L		4552	74	Auger	40							X	X	
		CRA Expl P/L		6170	75	Percussion	41						X	X	X	
120	3139	Asarco Aust Ltd	1152/4	16109	78	Rock Chip	33	X							X	
121	3139	Asarco Aust Ltd	1152/2	8560	75	Rock Chip	29	X	X	X			X	X	X	
						Soil	73		X						X	
								X		X			X	X		
122	3139	Asarco Aust Ltd	1152/1	3542	73	Rock Chip	23								X	
						Stream Sed	65								X	
123	3038	Falconbridge Aust P/L	1146	4532	73	Ironstone	39							X	X	
		Falconbridge Aust P/L		5578	74	Percussion	76							X	X	
				& 5582												
124	2939	Kennecott Expl Aust P/L	866/2	5424	71	Rock Chip	45							X	X	
						Soil	836								X	
125	3139	Le Nickel Aust Expl P/L	851	2543	71	Rock Chip	517								X	
				& 2544									X	X		X
						Soil	864								X	
						Stream Sed	111								X	
126	2938	Le Nickel Aust Expl P/L	840	2520	71	Gossan	50						X		X	
						Soil	530						X		X	
127	3139	Le Nickel Aust Expl P/L	838	2518	71	Gossan	13						X		X	X
						Rock Chip	68								X	
						Soil	45								X	
128	3038	Le Nickel Aust Expl P/L	837	2517	71	Gossan	35						X		X	X
						Rock Chip	32		X				X	X	X	
129	3139	Le Nickel Aust Expl P/L	834	2514	71	Rock Chip	140								X	
						Soil	143								X	
130	2939	VC Court & VK Russell	664	2087	70	Rock Chip	10									X
				& 2088			40									X
131	3139	BHP Company Ltd	491	70	71	Auger	100								X	

Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
		X	X								X			Y	Depth: 0-1.5m
			X								X	AAS	Associated Labs		Channel samples
		X	X								X				Depth: 0-2m
		X									X			Y	Depth: 0-4m
X		X									X			Y	Depth: 0-3m
X		X									X	AAS		Y	Depth: 0-3m
			X								X	AAS	Analabs		
		X	X								X		Associated Labs		
			X								X		Associated Labs		
		X											Associated Labs		Not all for Ag, Au, Co, Cr & Ni
X		X									X				
X		X									X				Depth: 0-2m, Not all for Mn, S & Zn
		X									X				
		X									X		Geomin		
											X	AAS	MGV Labs		
		X	X									AAS	MGV Labs		Not all for Co, Cr, Fe, Ni & Pb
		X									X				
		X									X				
		X									X	AAS	Geomin		
		X													
		X									X		Geomin		
		X									X	AAS	Geomin		
		X									X				
		X									X		MGV Labs		
		X	X								X		MGV Labs		Not all for As, Cr & Pb
		X									X				
		X									X				
X															Also for Al, Si & Ti oxides, P & S
															Also for Fe, P & Si oxides, & S
			X								X				Single traverse, Depth: 0.15-0.25m

ID No.	Map Sheet	Company	M No.	A No.	Yr	Medium	No.	Ag	As	Au	Ba	Bi	Co	Cr	Cu	Fe
132	2939	CRA Expl P/L	171	1068	68	Soil	3 300						X	X	X	
	3038			to 1070												
	3039															
		CRA Expl P/L		1071	68	Auger	1 978							X	X	
				to 1074		Gossan	409						X	X	X	
						Soil	16 190							X	X	
		CRA Expl P/L		1934	71	Gossan	145	X					X	X	X	
						Percussion	15							X	X	
							24							X	X	
						Soil	231							X	X	
							150								X	
		CRA Expl P/L		2165	71	Gossan	101						X		X	
						Percussion	26						X	X	X	
						Soil	5 000								X	
		CRA Expl P/L		3571	73	Auger	11							X	X	
						Rock Chip	150						X	X	X	
		CRA Expl P/L		4482	73	Soil	1 271							X	X	
133	3038	CRA Expl P/L	162	1062	67	Auger	1 470						X	X	X	
	3039															
	3138	CRA Expl P/L		1013	69	Percussion	19							X	X	
		CRA Expl P/L		1014	69	Auger	5							X	X	
						Gossan	27								X	
		CRA Expl P/L		1012	70	Gossan	102						X	X	X	
		CRA Expl P/L		1930	71	Percussion	16							X	X	
						Soil	9 020								X	
134	3039	New Consol Gold Fields Aust Ltd	110	1622	67	Gossan	270								X	
		New Consol Gold Fields Aust Ltd		1623	69	Drilling	9								X	
						Gossan	20								X	

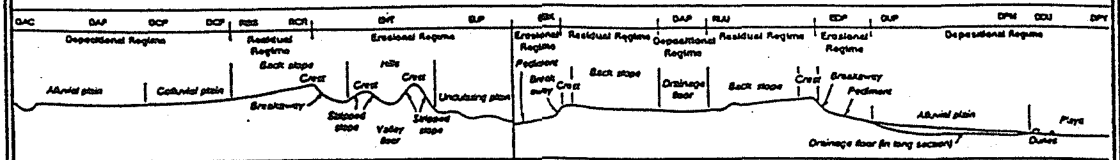
Mn	Mo	Ni	Pb	Pd	Pt	Sb	Sn	U	V	W	Zn	Method	Analyst	Deep Drill	Comment on Samples
		X	X								X		Broken Hill Labs		
		X									X			Y	Depth: 0-1m
		X	X								X				
		X									X				Depth: 0.2m
X		X	X								X			Y	Not all for Ag, Co, Cr, Mn & Pb
		X									X				Depth: 0-1.5m
		X									X				Depth: 0-1.5m
		X									X				
		X													Depth: 0.1-0.2m
X		X									X				Not all for Mn
X		X									X		Kaymin	Y	Depth: 0-1.5m, Not all for Co & Mn
		X											Amdel		
		X									X				Depth: 0-3m
X		X	X								X				Not all for Co, Mn & Pb
		X									X	AAS		Y	
		X													Depth: 0-1m
		X									X			Y	Depth: 0-1.5m, No 'real' loc of grid
		X									X			Y	Depth: 1-4m
		X									X				
		X	X								X			Y	
		X									X			Y	Depth: 0-1.5m
		X													
		X										AAS	Amdel	Y	
		X										AAS		Y	Depth: 0-1.5m
		X										AAS			

Appendix 3

Form used to record sample-site details

Sheet ________	Loc/n No________	GSWA No________	Date________
1:100K________	East________E	North________N	Sampler____

Landform | Sample Type: ☐Single point ☐Composite ☐Drainage ☐Laterite ☐Lag ☐Soil



Regolith Code ________

CLASTS

Duricrust	Non Lateritic	Lithic
☐ Lat Piso's / Nods	☐ Gossan fragments	☐ Saprolite fragments
☐ Frag's of duricrust	☐ Iron segregations	☐ Saprock fragments
☐ Ferrug. saprolite	☐ Ferrug lithic fragments	☐ Bedrock frag's
☐ Black ferrug. duricrust	☐ Brown ferrug granules	(See below for detailed
☐ Black piso/nod ferrug duricrust	☐ Black ferrug granules	description)

MATRIX

From Residual Lateritic Profile	From Saprock/Bedrock	From Alluvium
☐ Gravelly orange sandy clay	☐ Red clay	☐ Red clays
☐ Gravelly red/brn sandy clay	☐ Calcareous red clay	☐ Calcareous red clay
☐ Yell/brn sandy gravel	☐ Calcareous grey/brown clay	☐ Saline brown soil
☐ Gravelly yellow sand	☐ Cracking clays	☐ Saline calcareous earth
☐ Gravelly red sand	☐ Sandy soils ☐ Stony soils	☐ Cracking clays
	☐ Brown sandy soils	
From Colluvium	**From Aeolian**	**Stream Descrp Order - ____**
☐ Red clay	☐ Yellow sands	☐ single ☐ Incised
☐ Calcareous Red clay	☐ Red Sands	☐ Braided ☐ Broad
☐ Yellow sands ☐ Red Sands		Osize - ____% Usize - ____%
☐ Brown Sands		Size fr/n-______ Depth-______

Clasts at Site

☐ *Mafic* ☐ *Ultramafic* ☐ *Felsic* ☐ *Sediments* ☐ *Cherts* ☐ *BIF* ☐ *Qutz Blows* ☐ *Granite*

<u>REMARKS</u>

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Figures

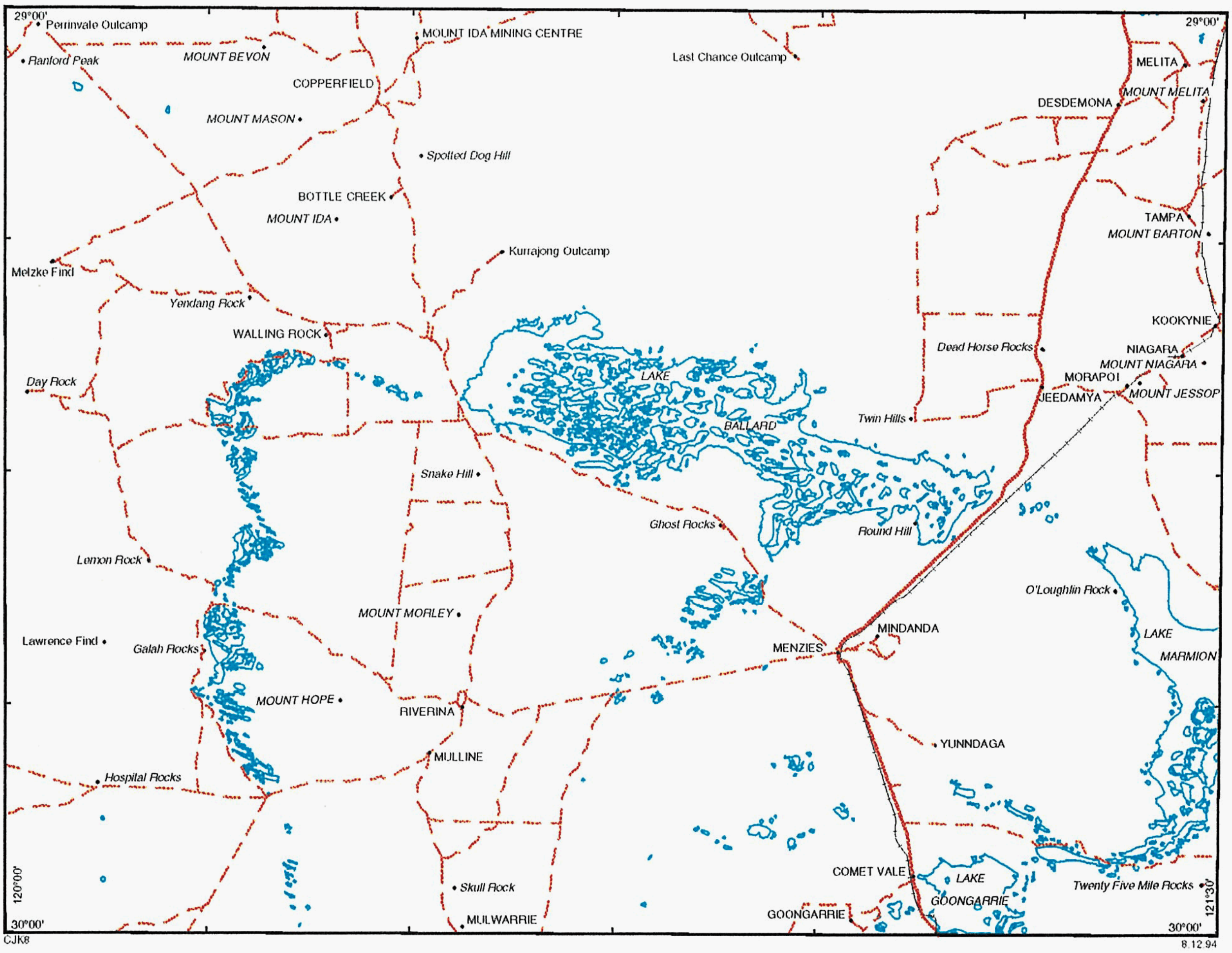
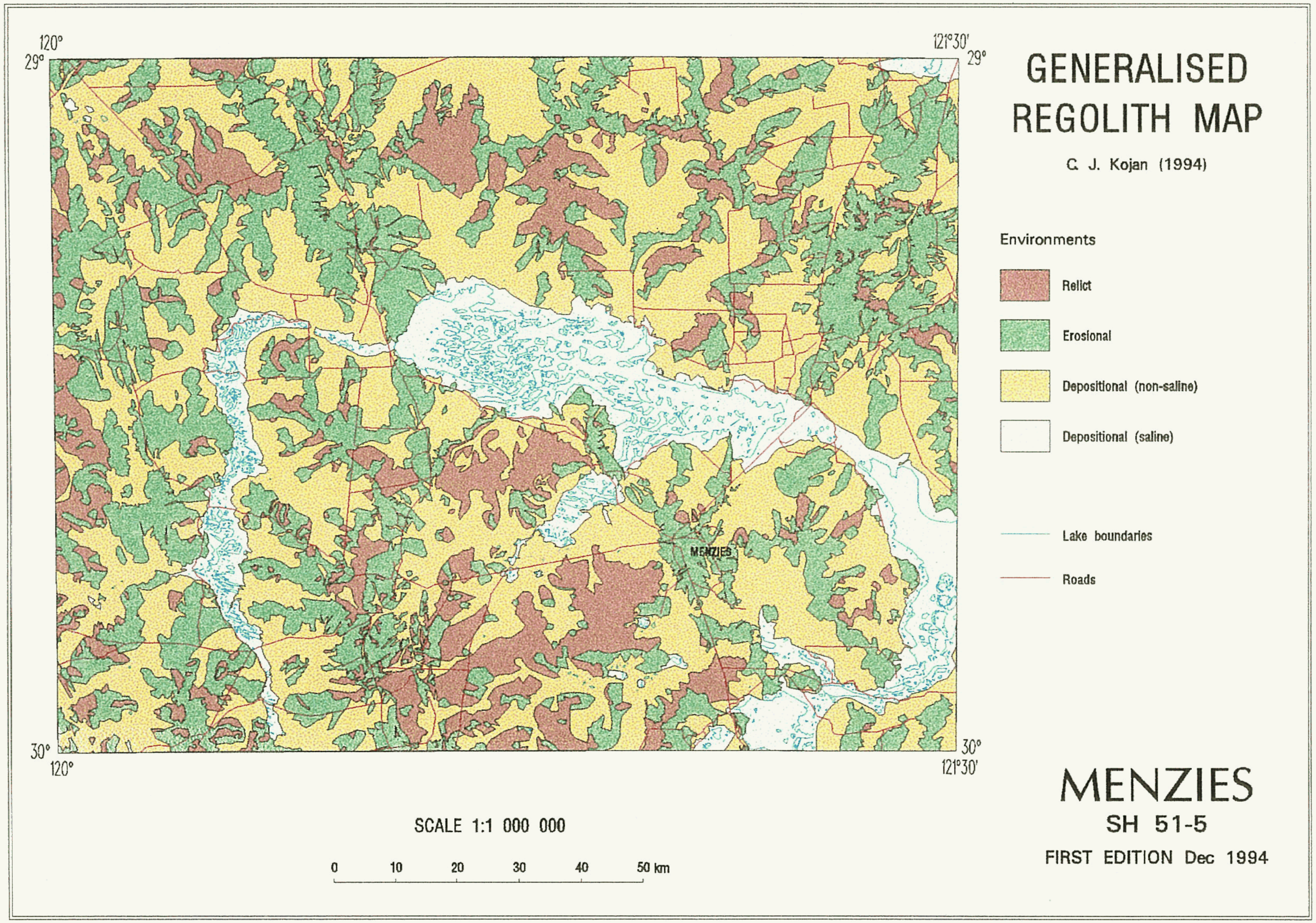


Figure 1. Locality plan



GENERALISED
REGOLITH MAP
C. J. Kojan (1994)
Environments
Relict
Erosional
Depositional (non-saline)
Depositional (saline)
Lake boundaries
Roads
120°
29°
121°30'
29°
30°
120°
30°
121°30'
MENZIES
SCALE 1:1 000 000
0
10
20
30
40
50 km
MENZIES
SH 51-5
FIRST EDITION Dec 1994

Figure 2.

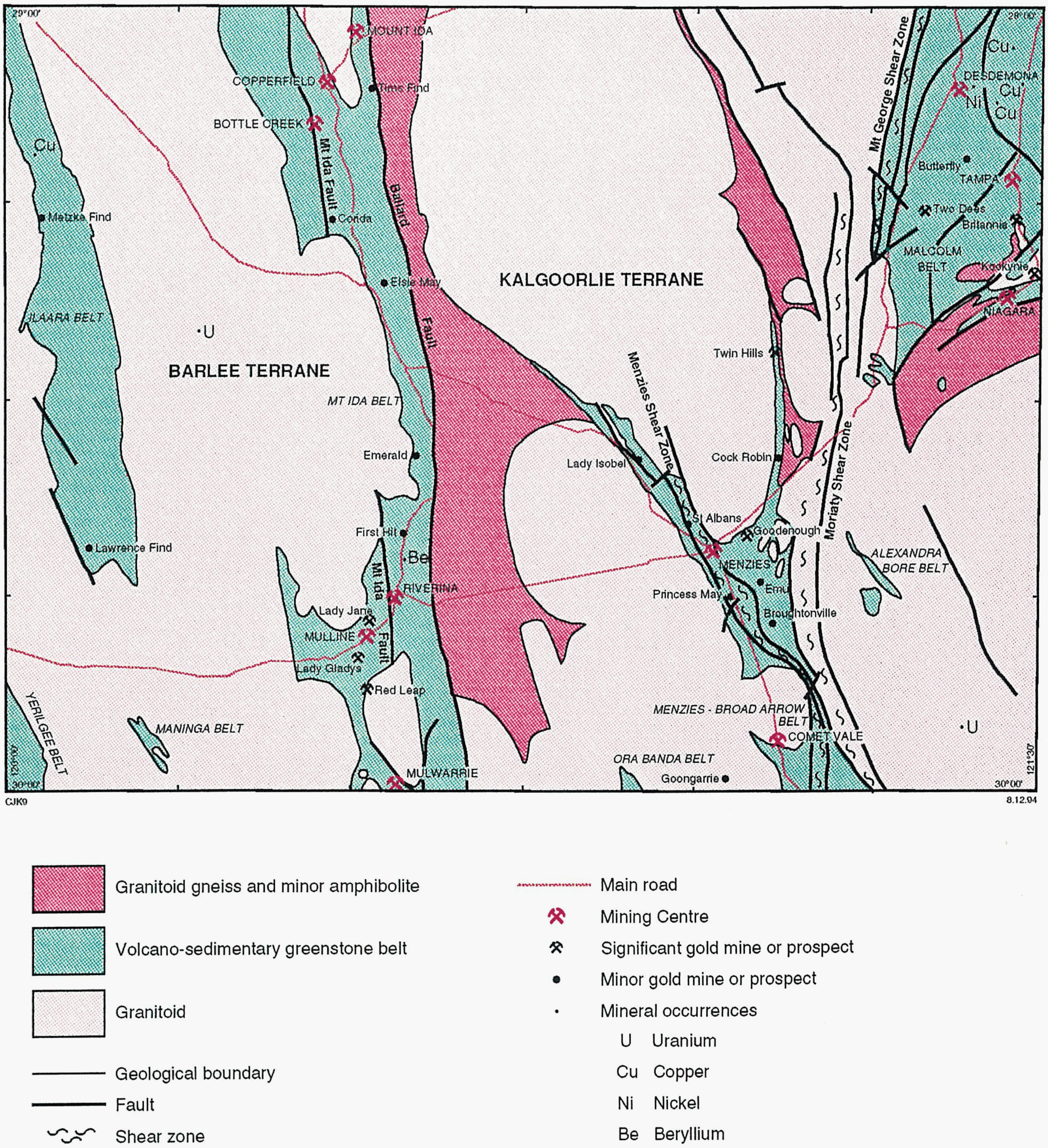
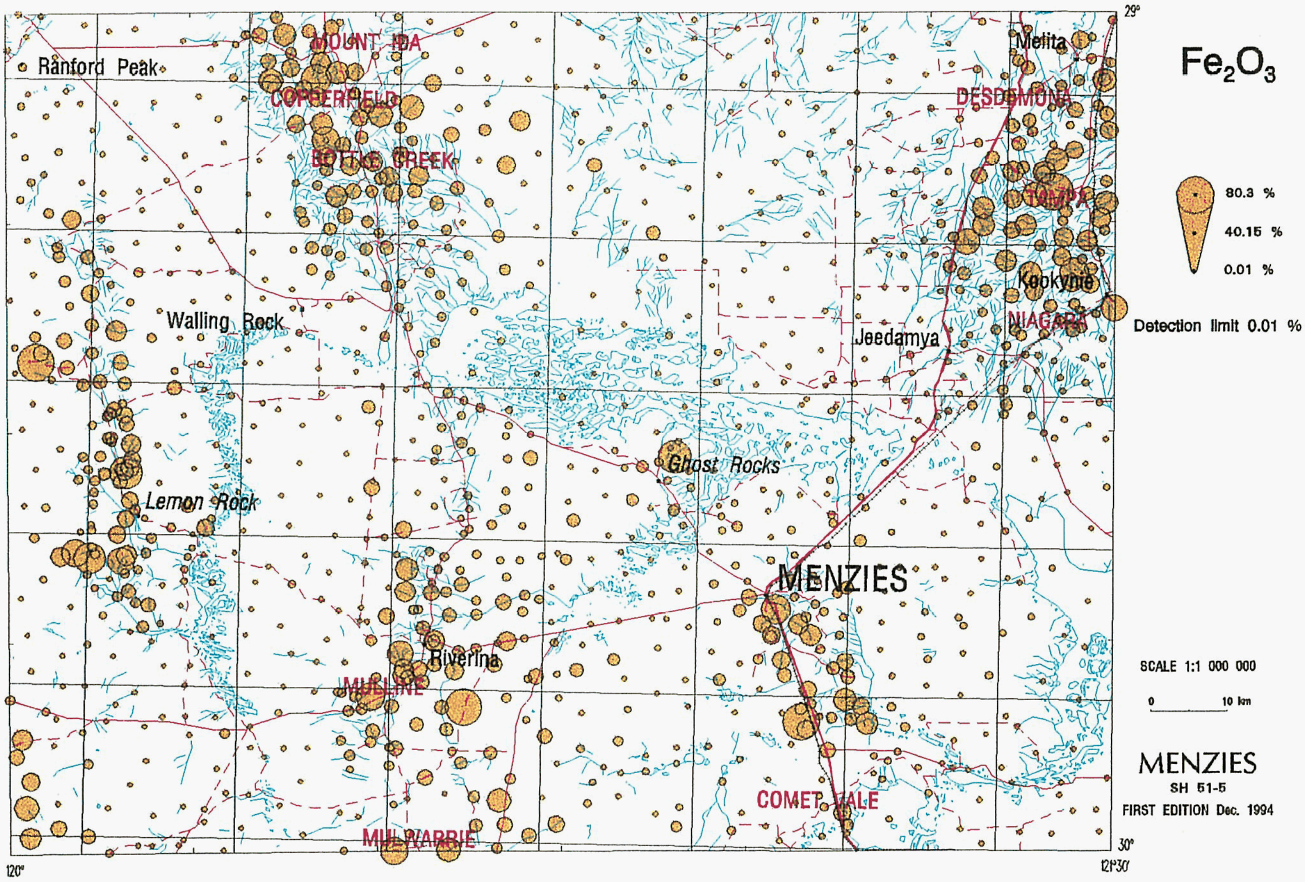


Figure 3. Geological interpretation with mining centres and mineral occurrences



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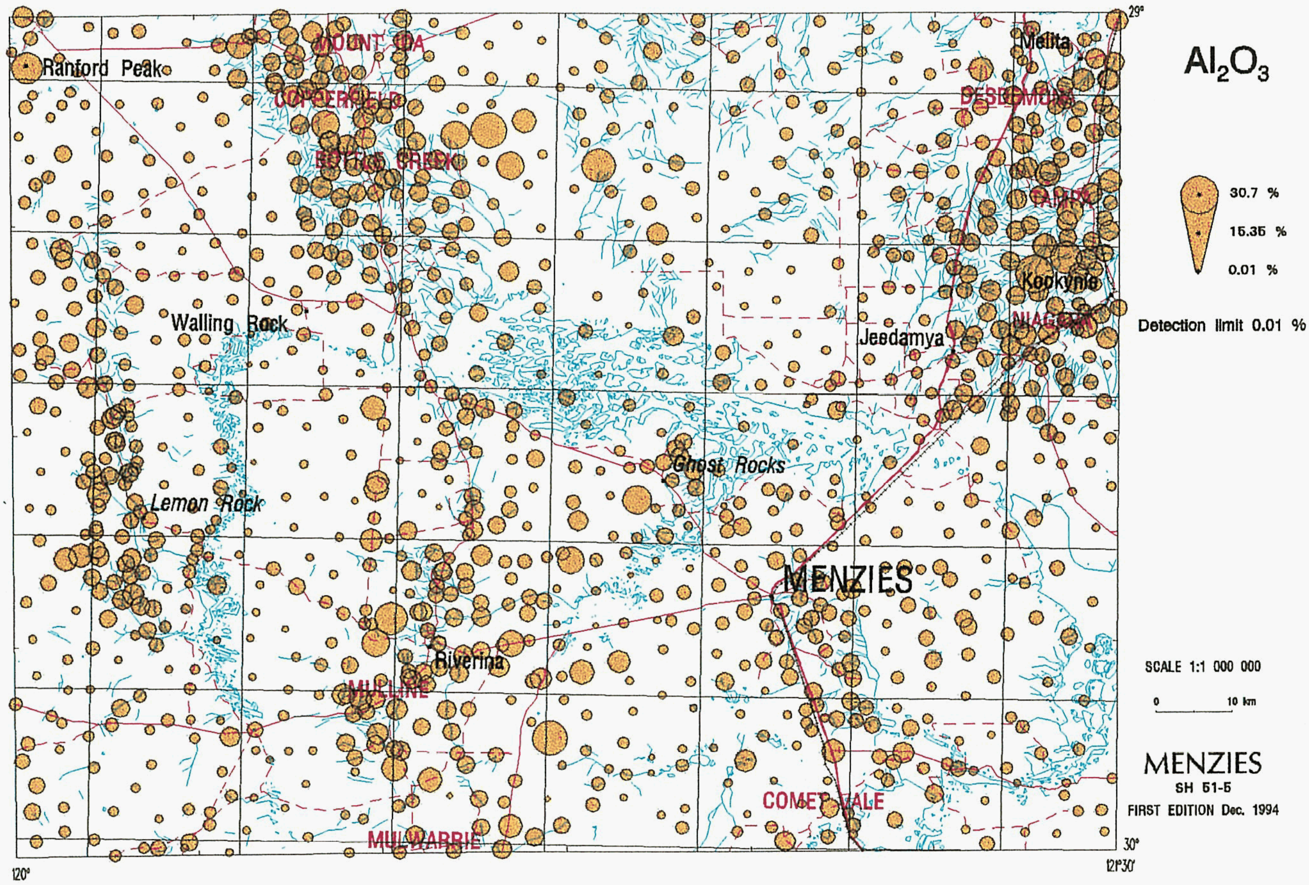

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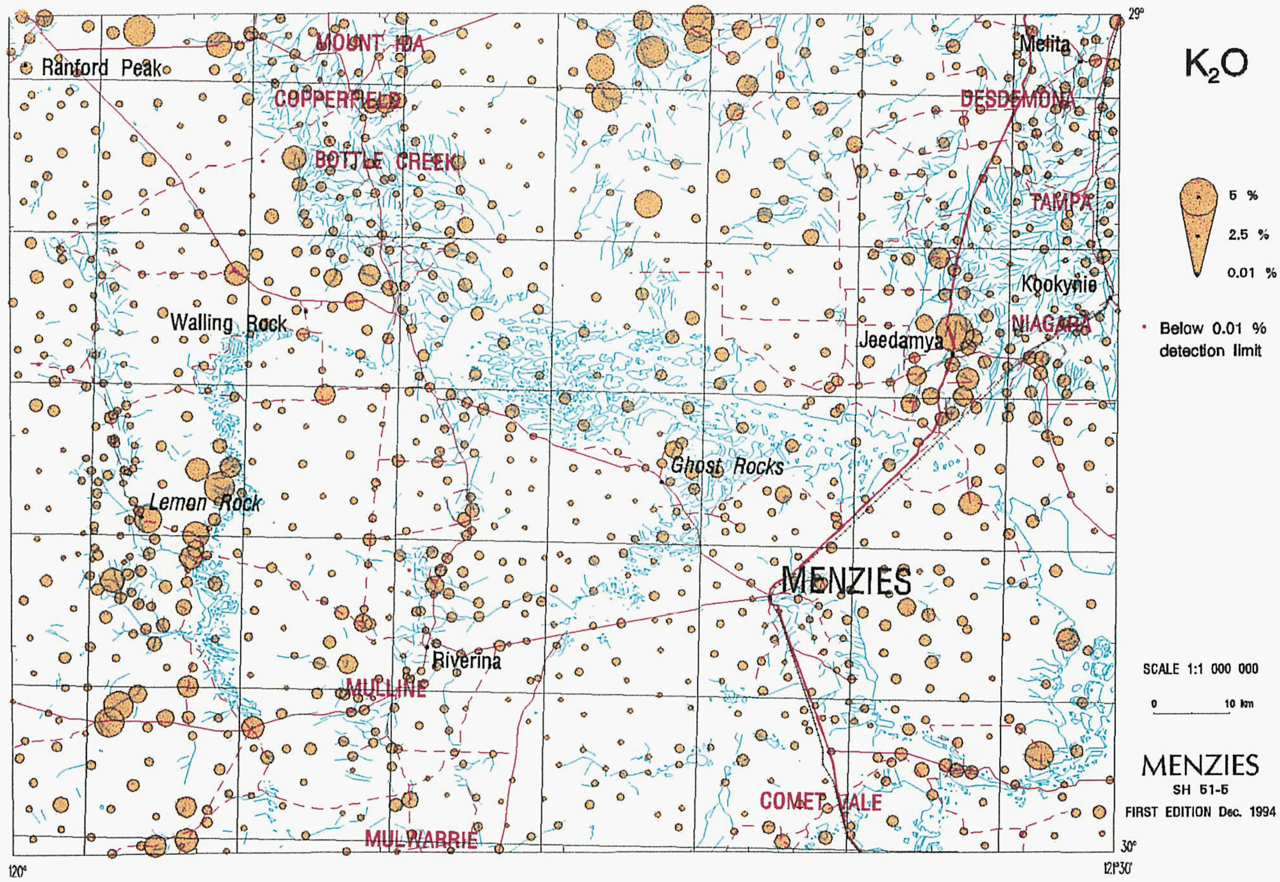

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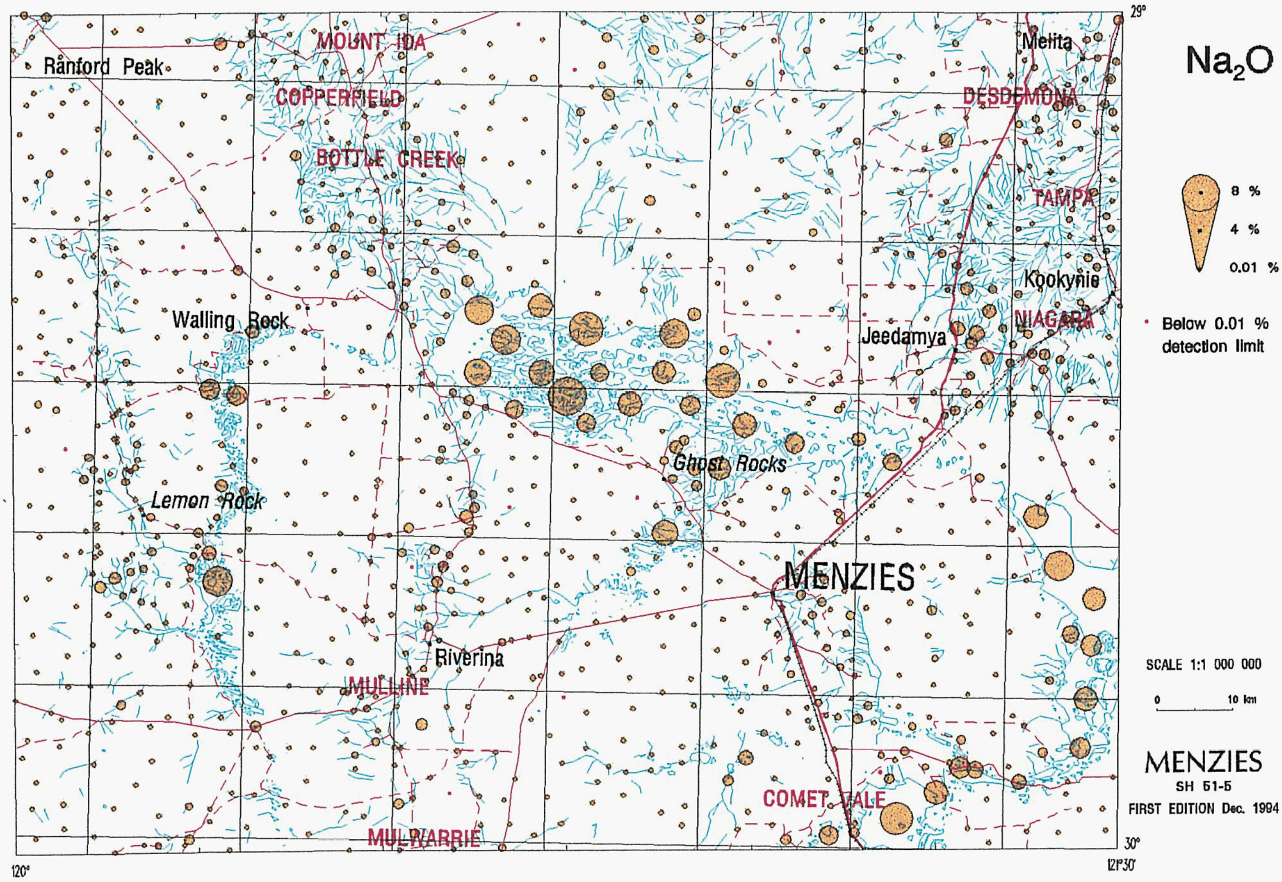

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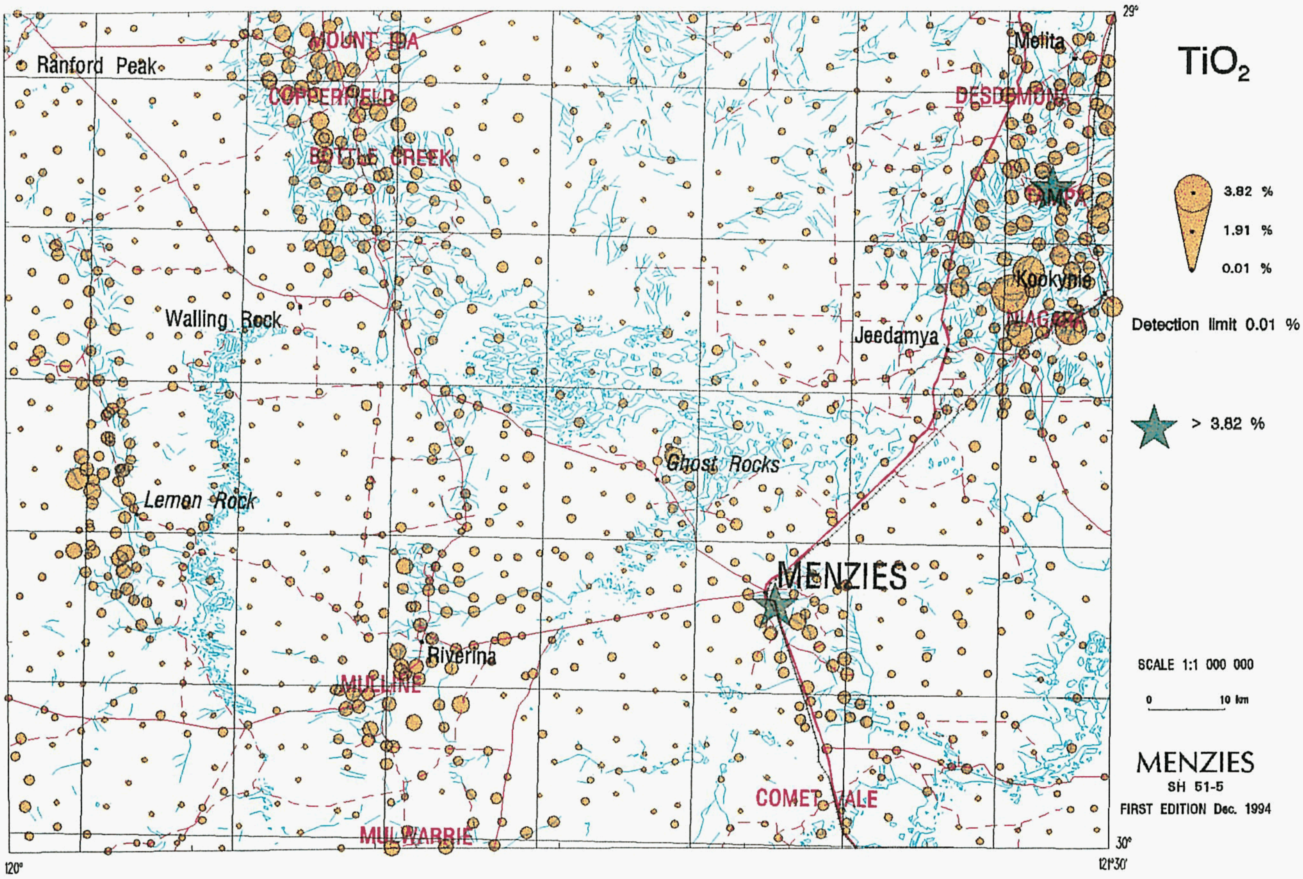
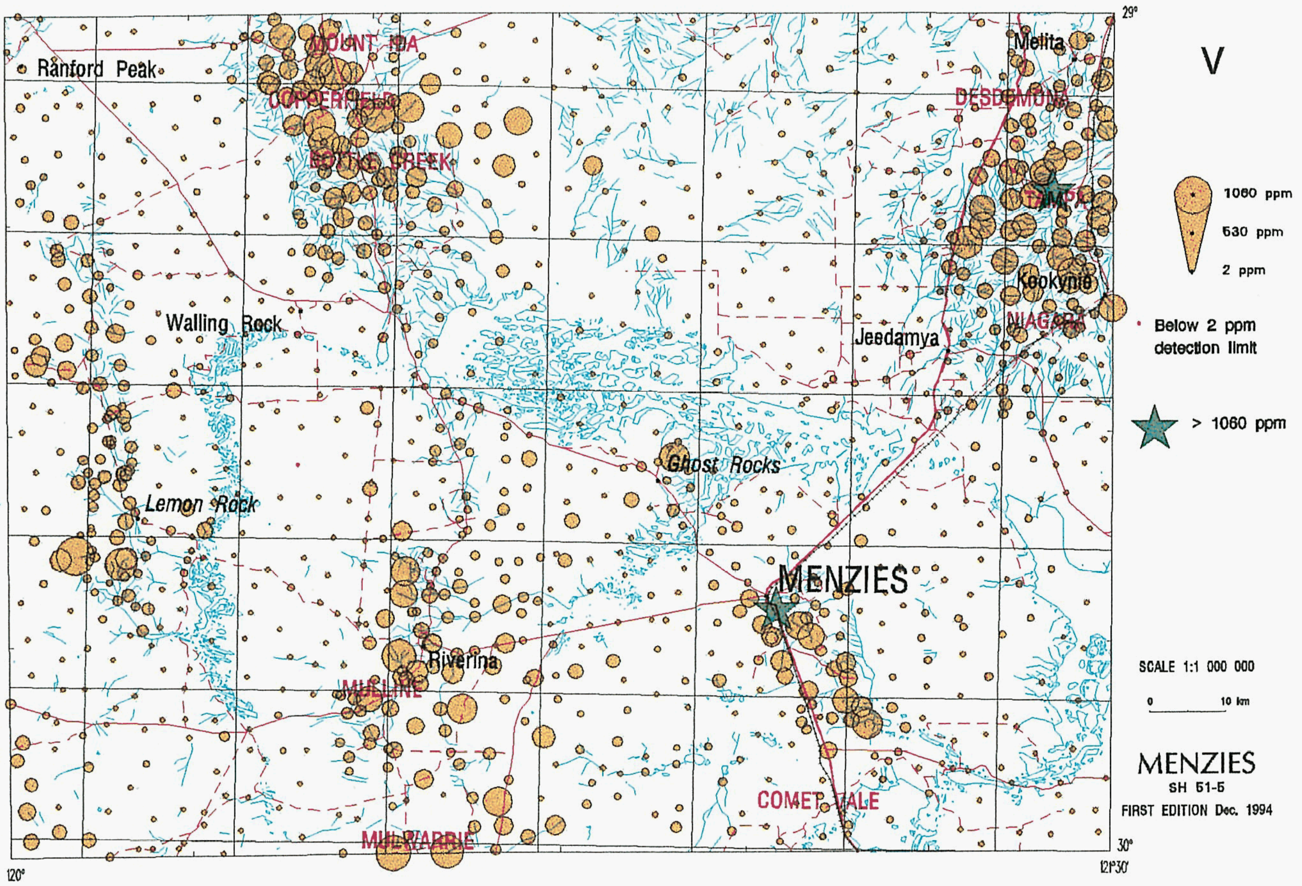


Figure 8.



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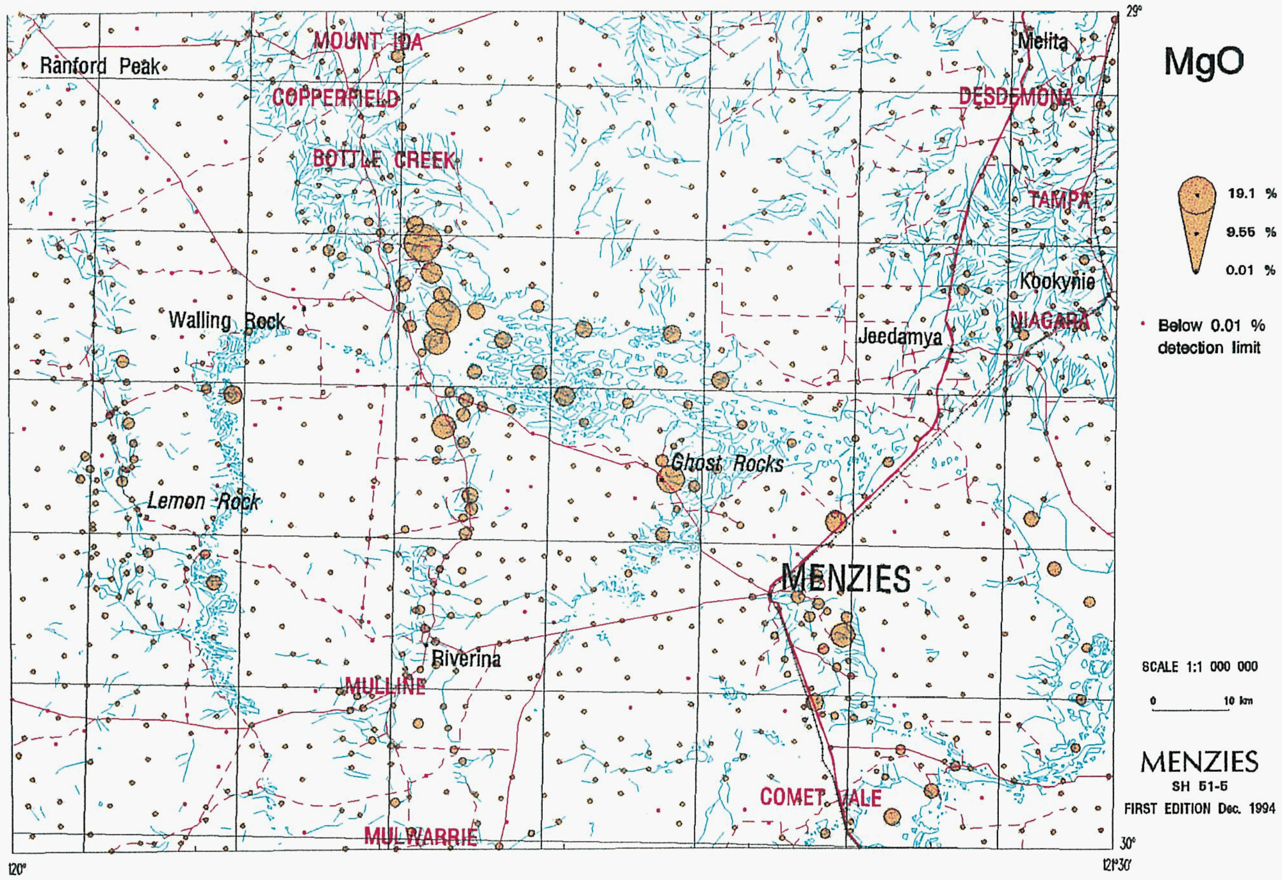

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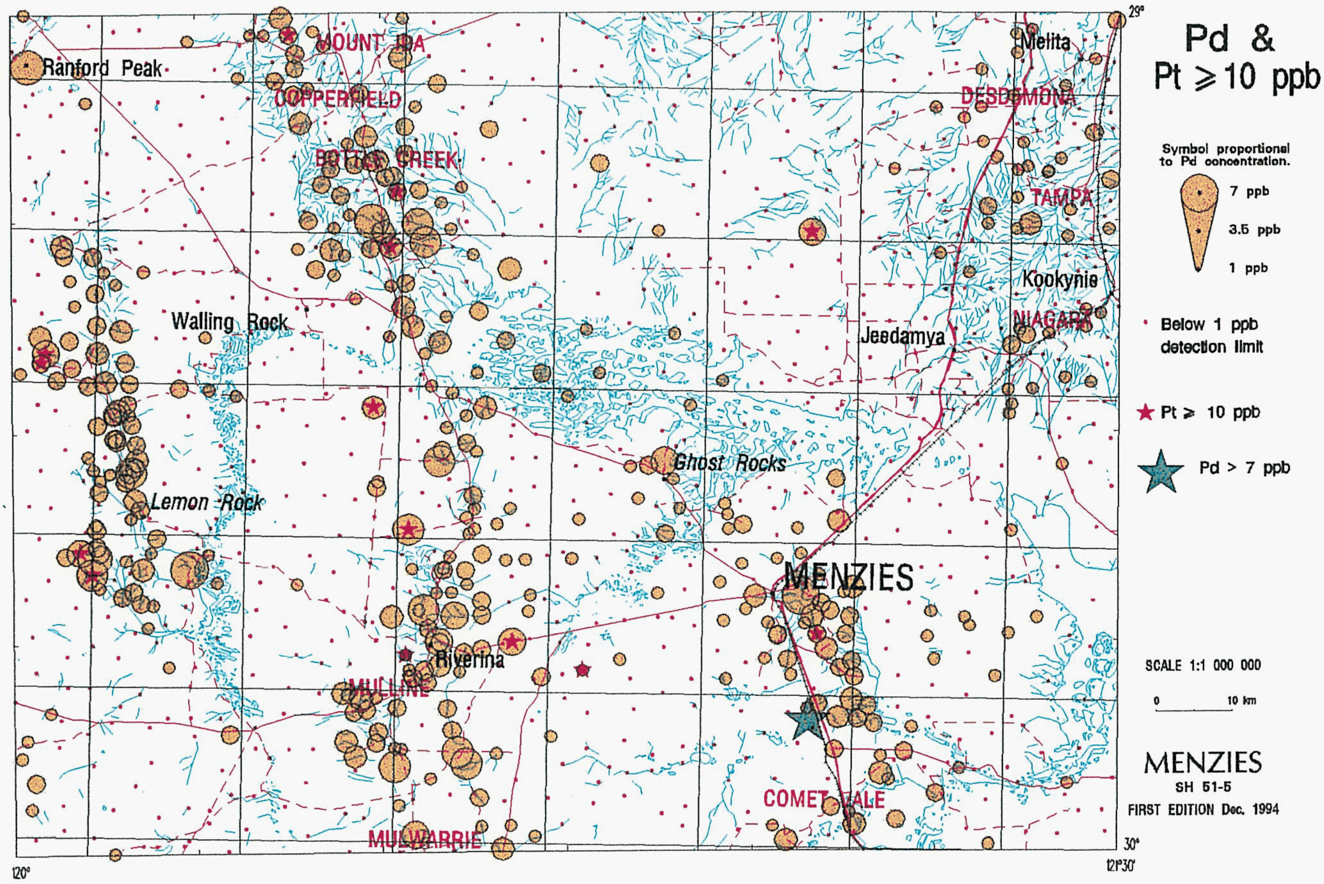

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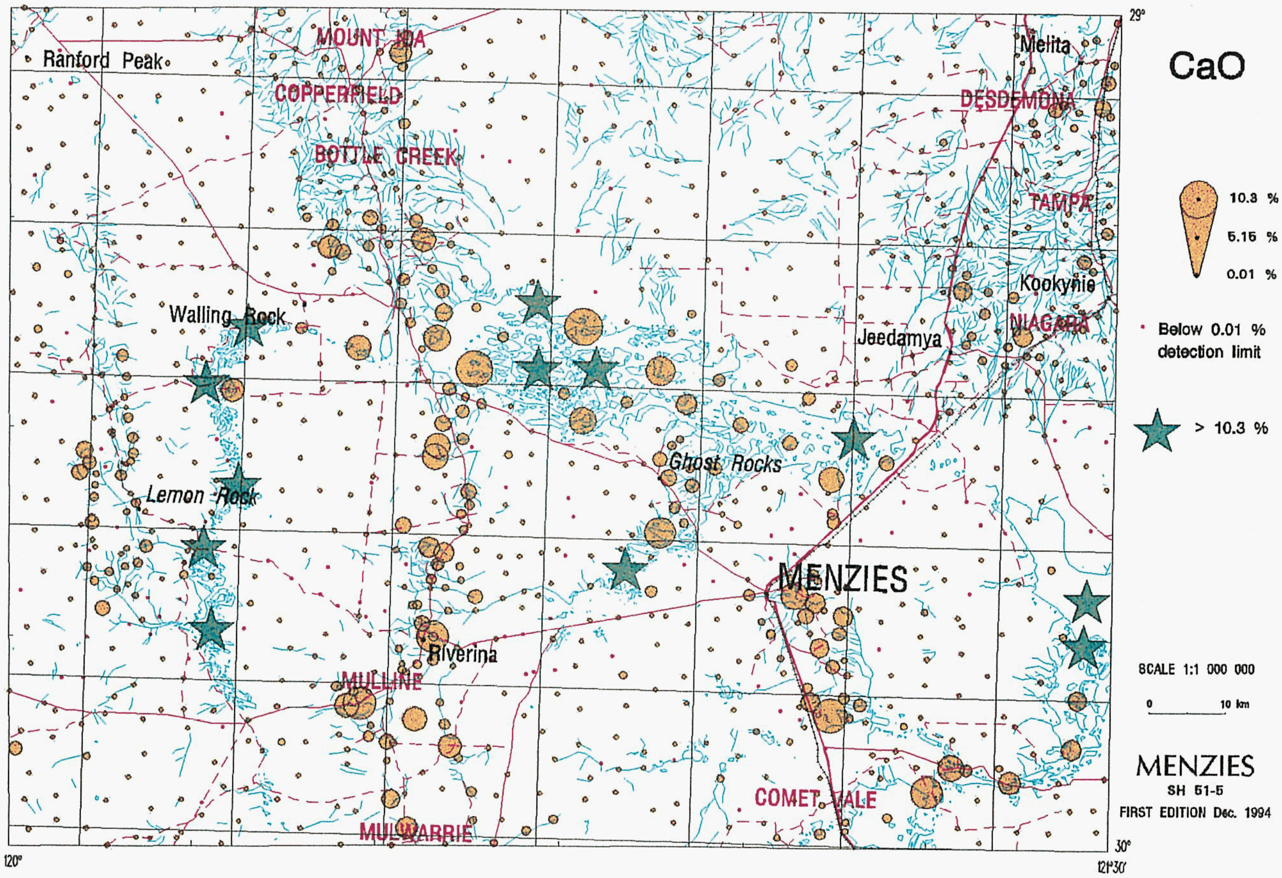

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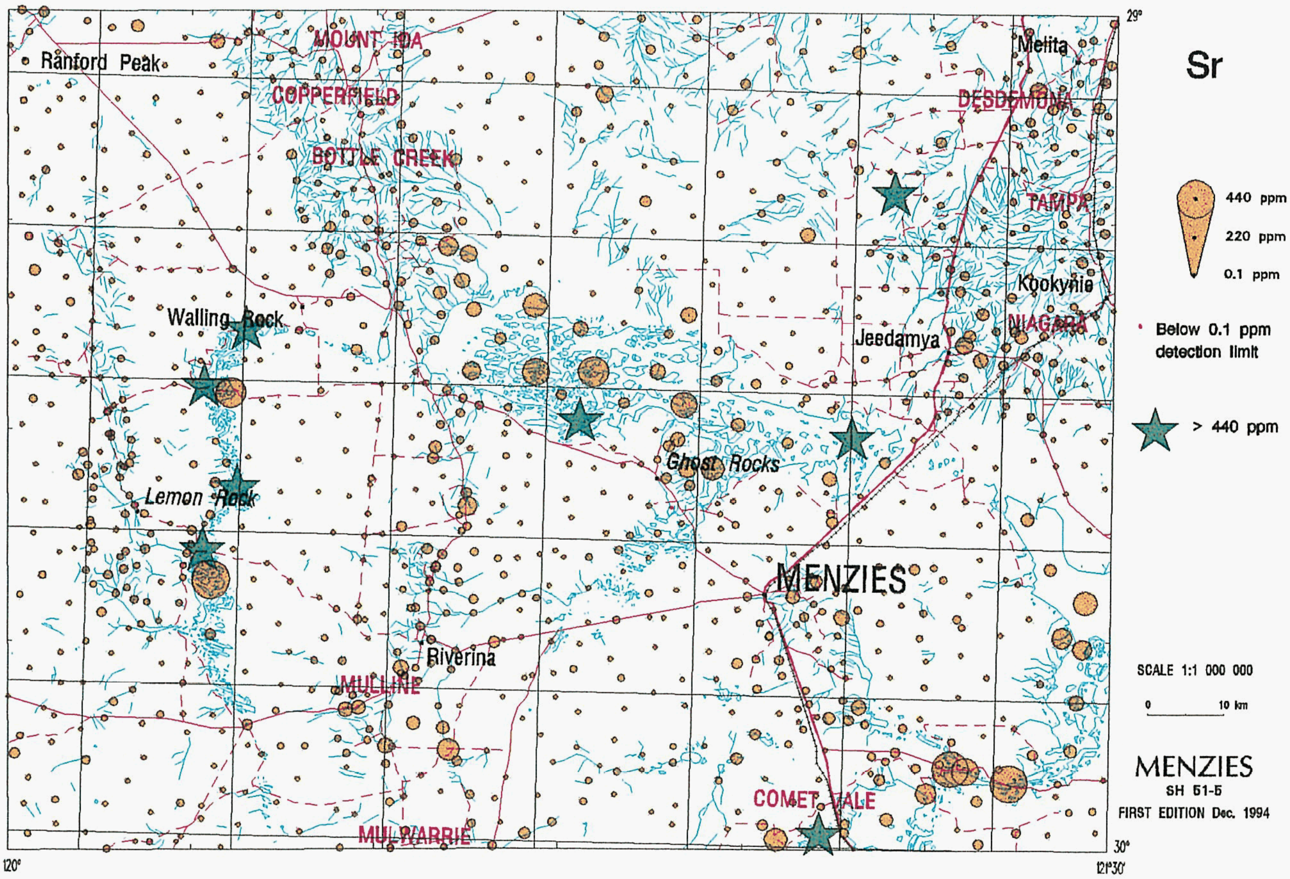

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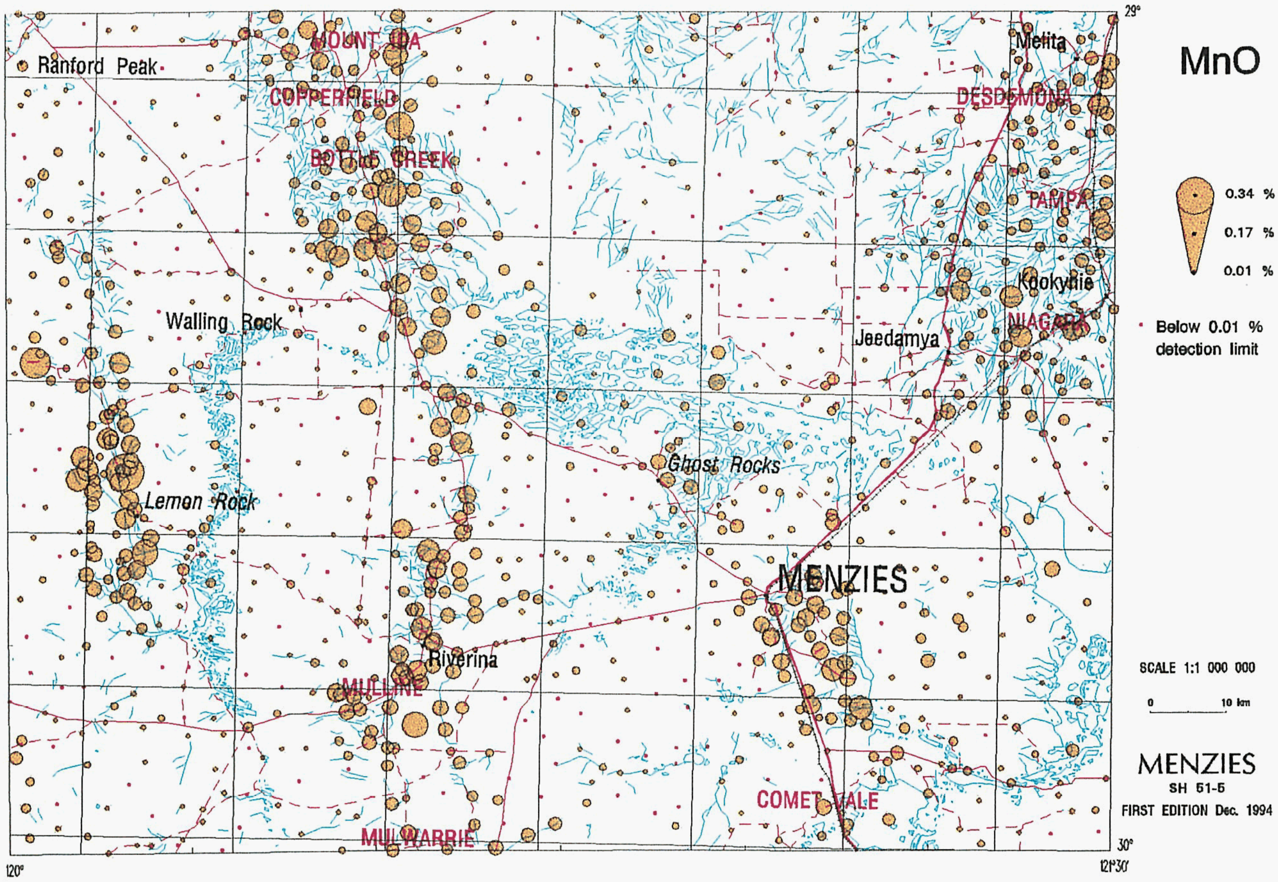

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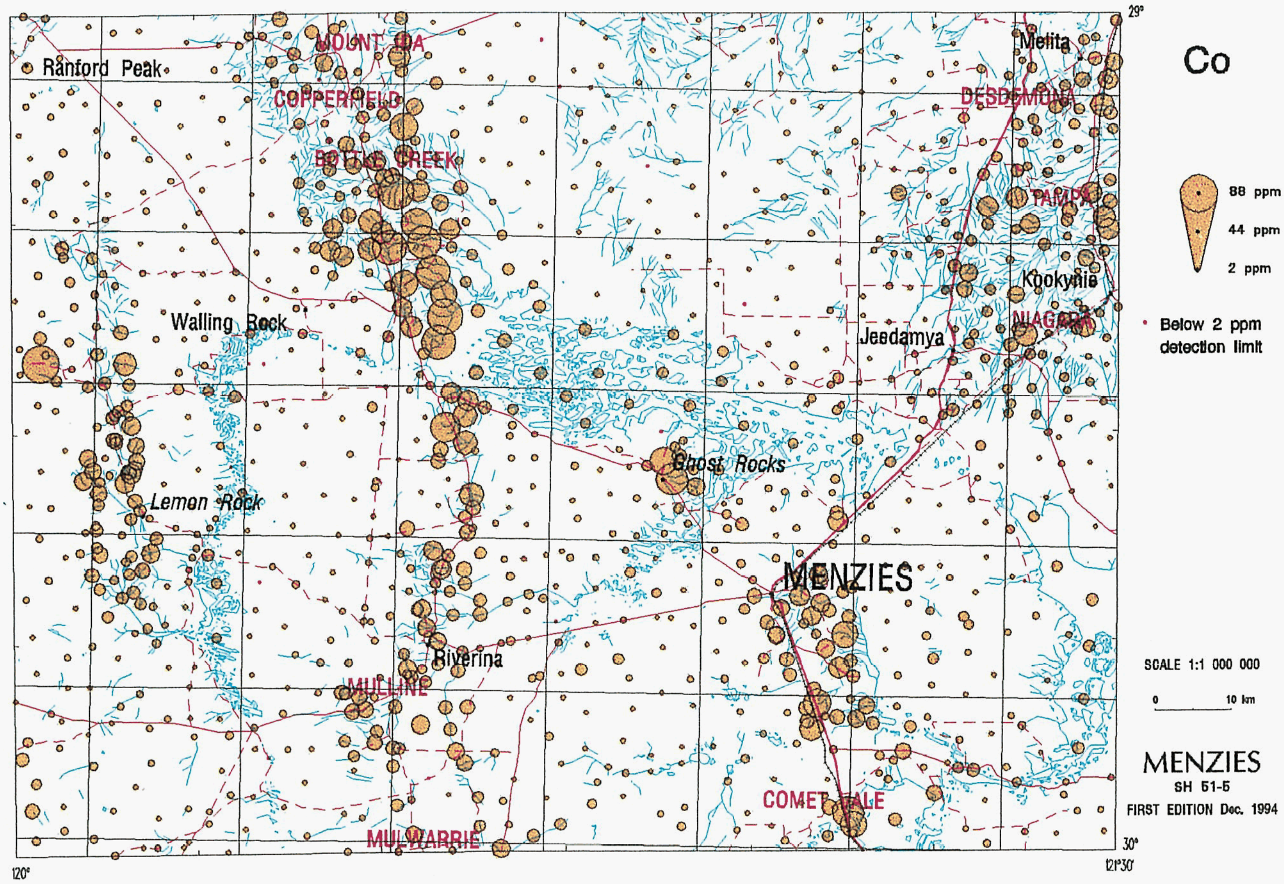

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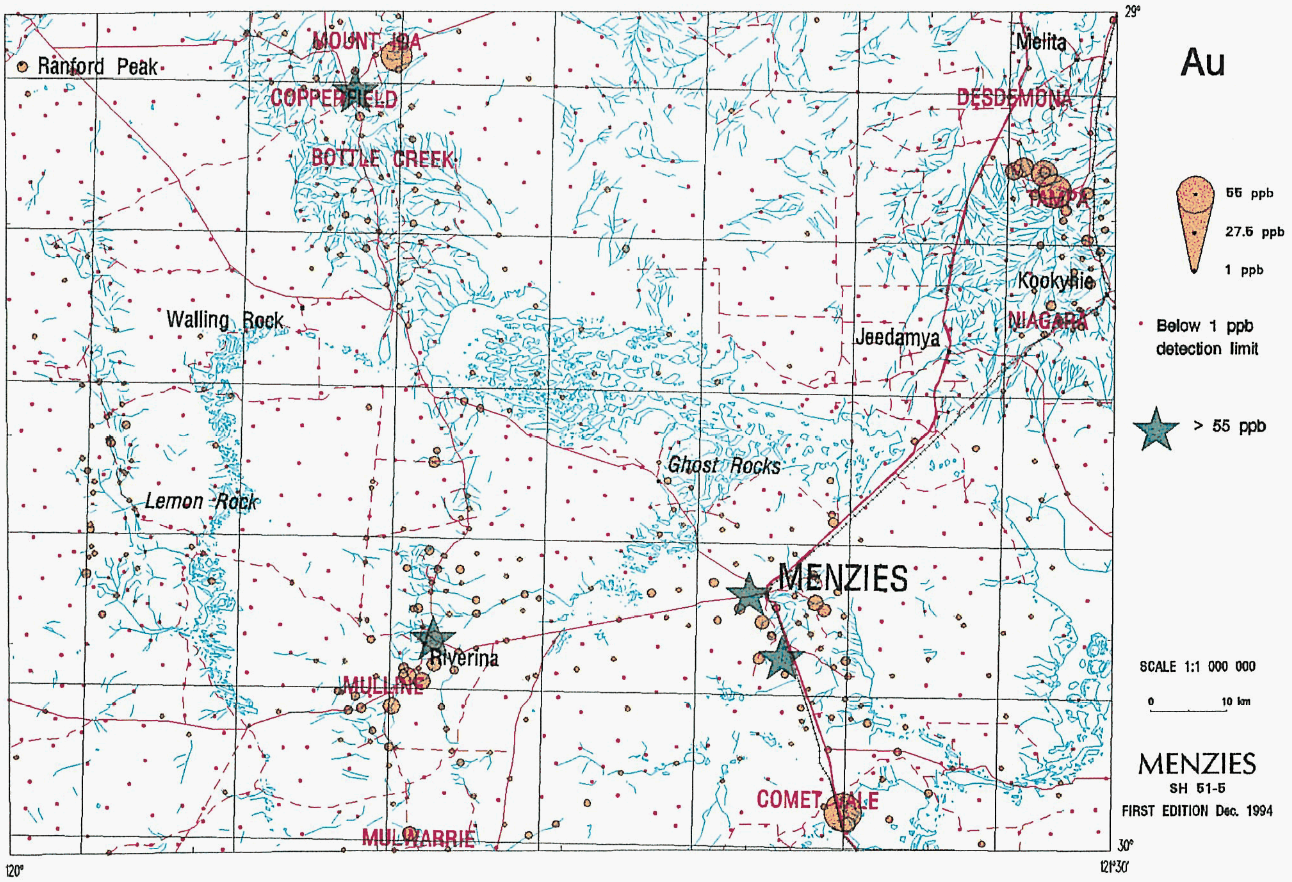

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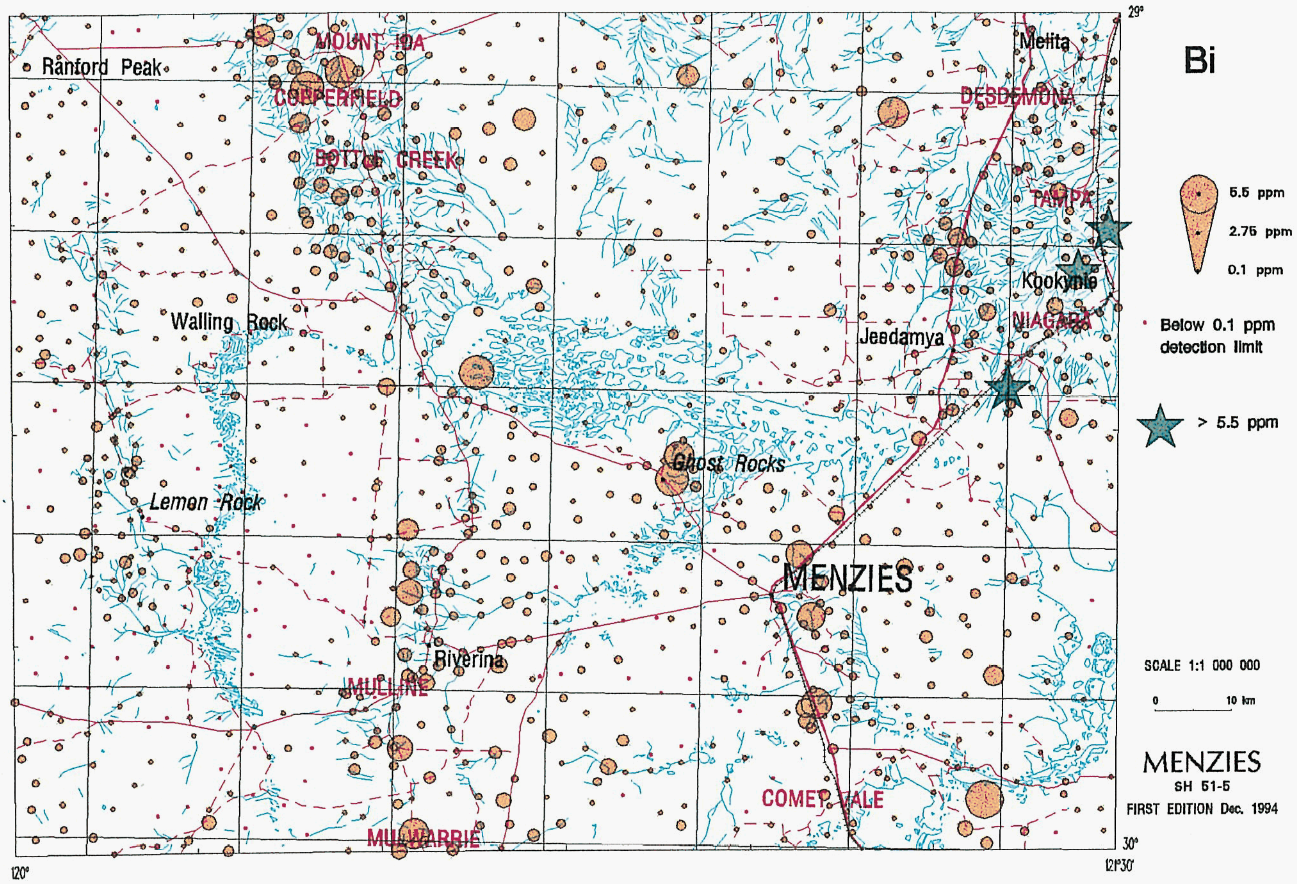

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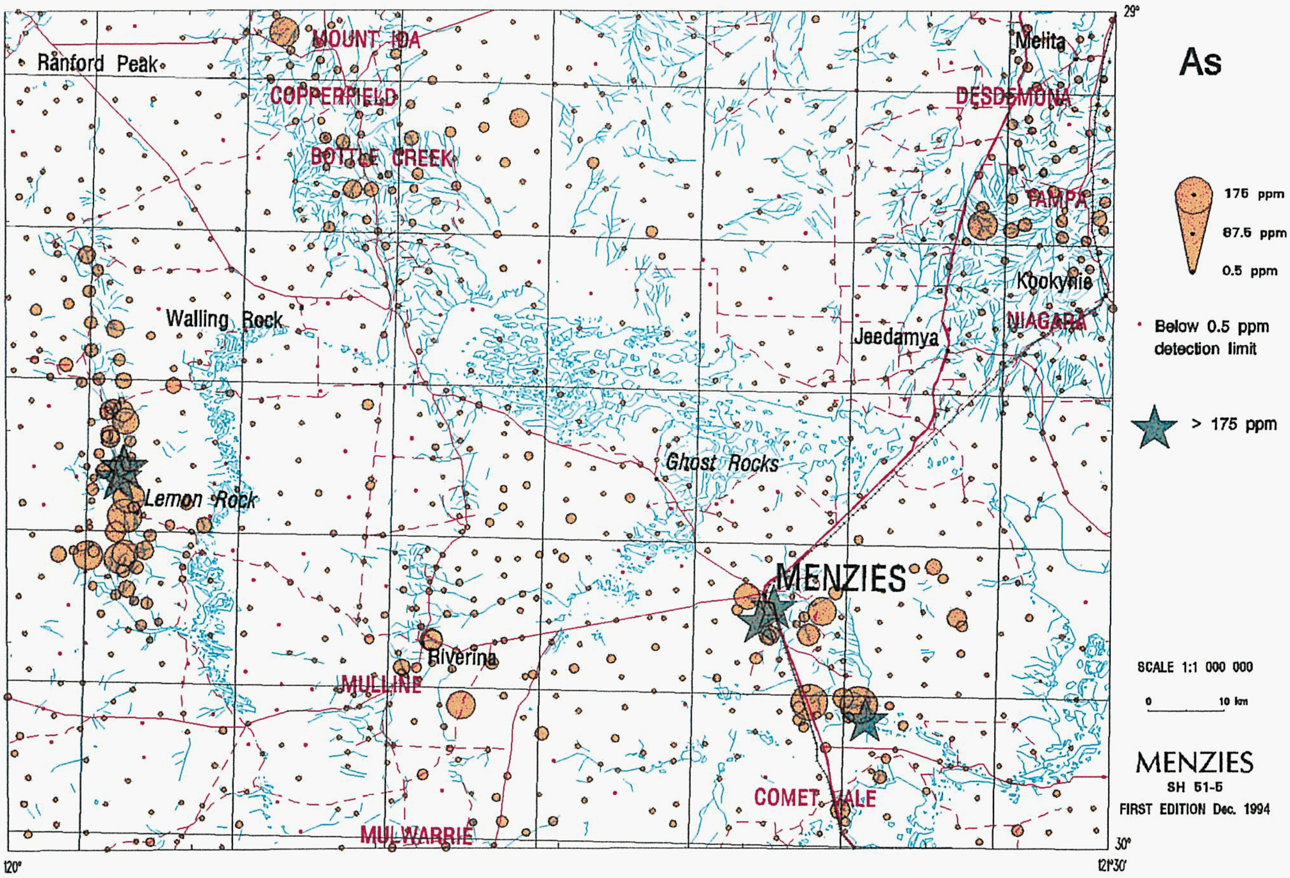

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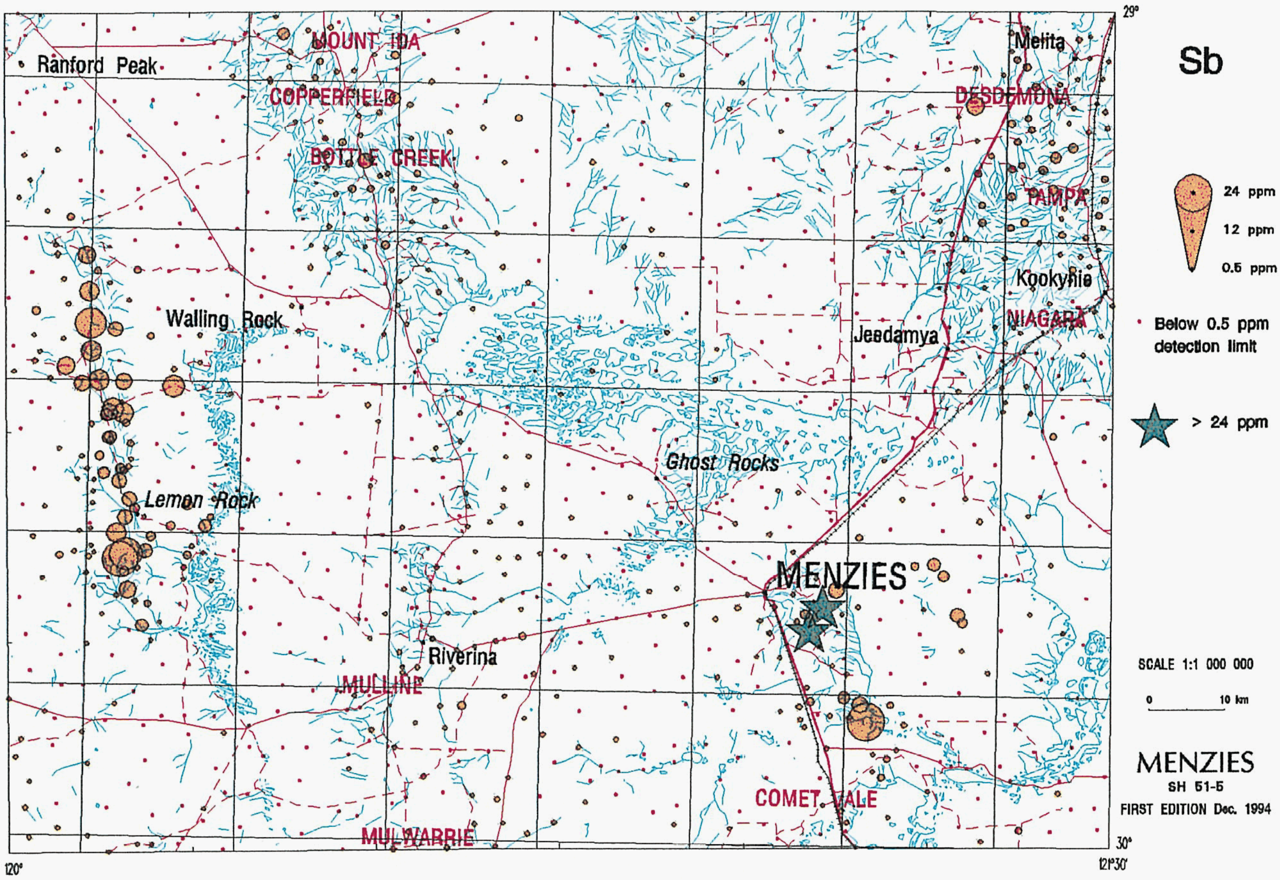

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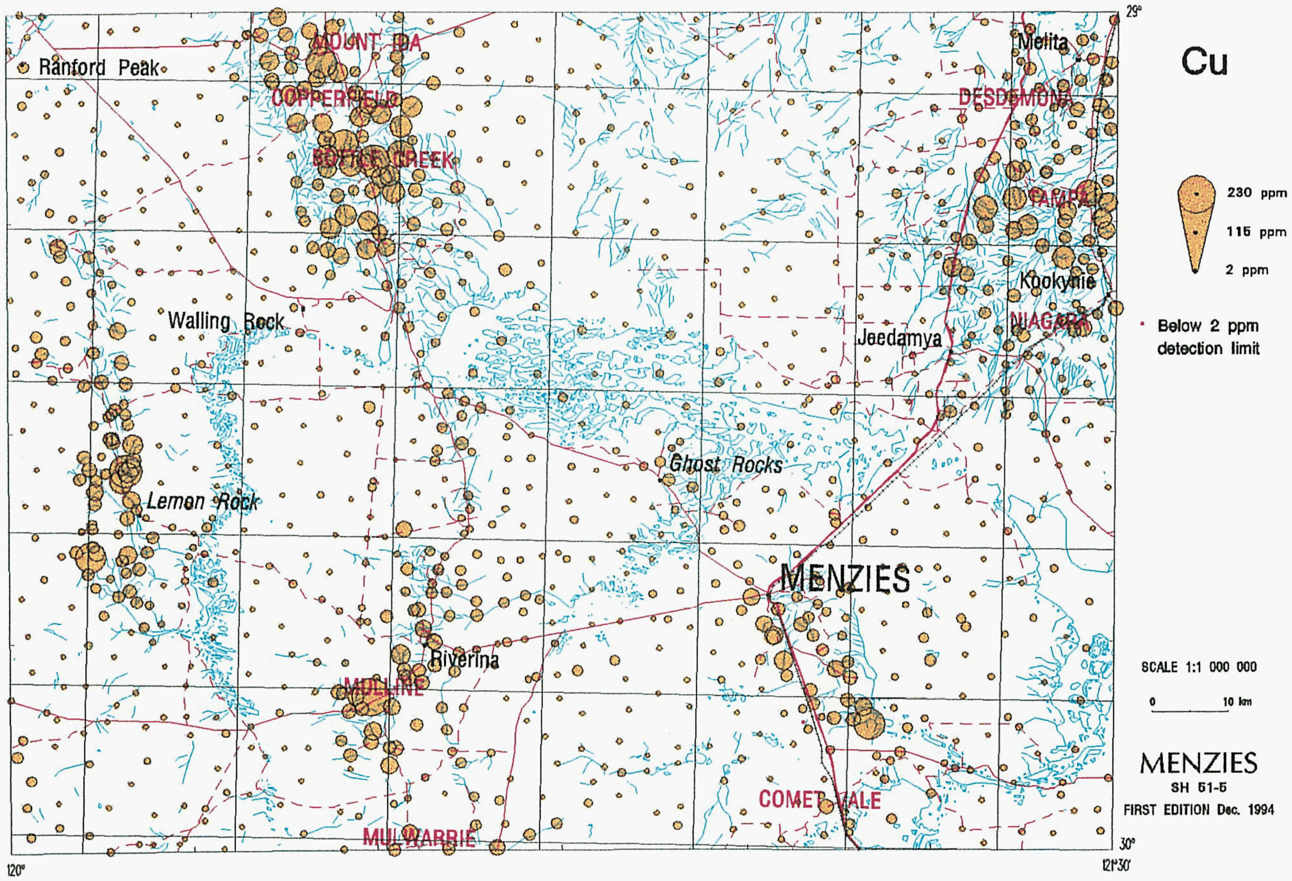

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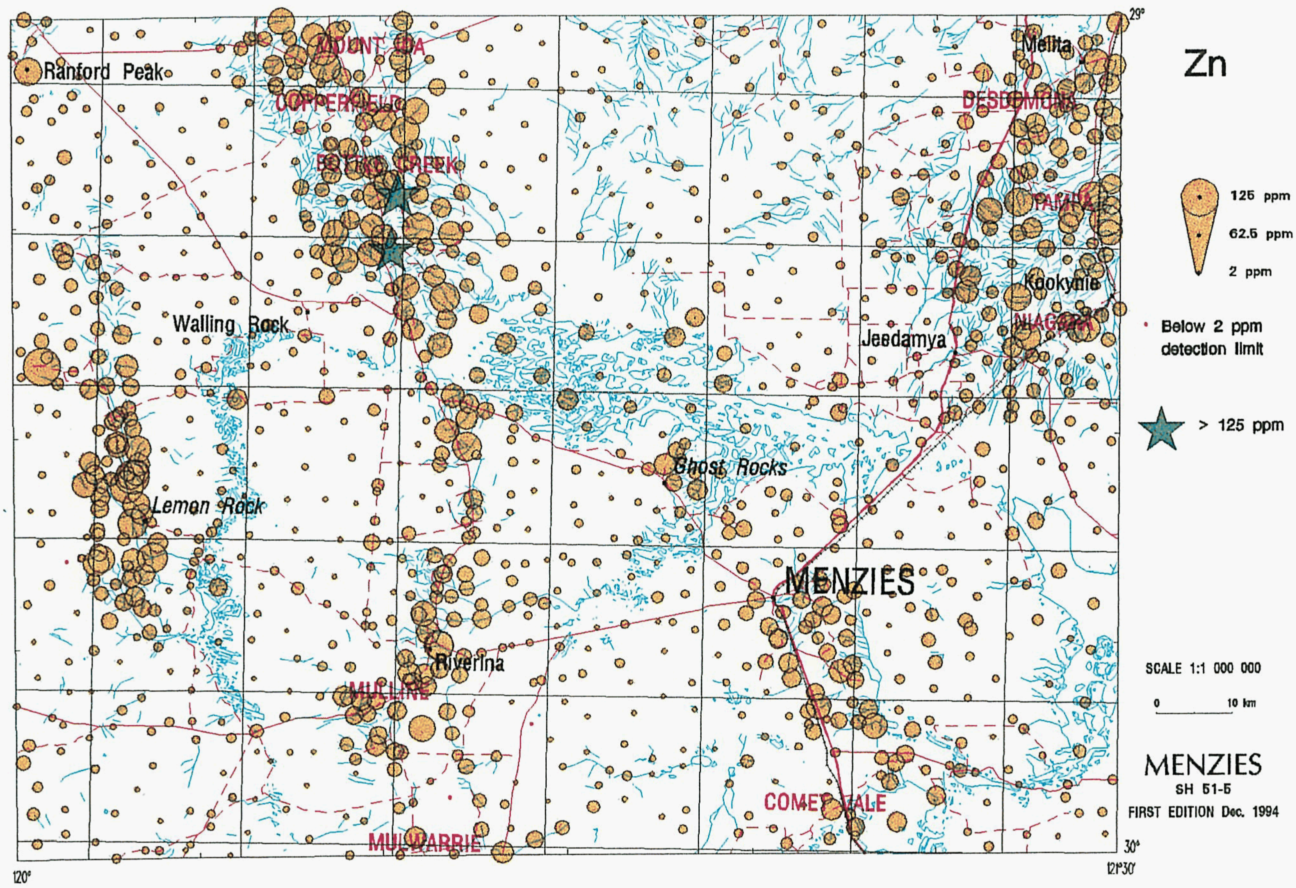

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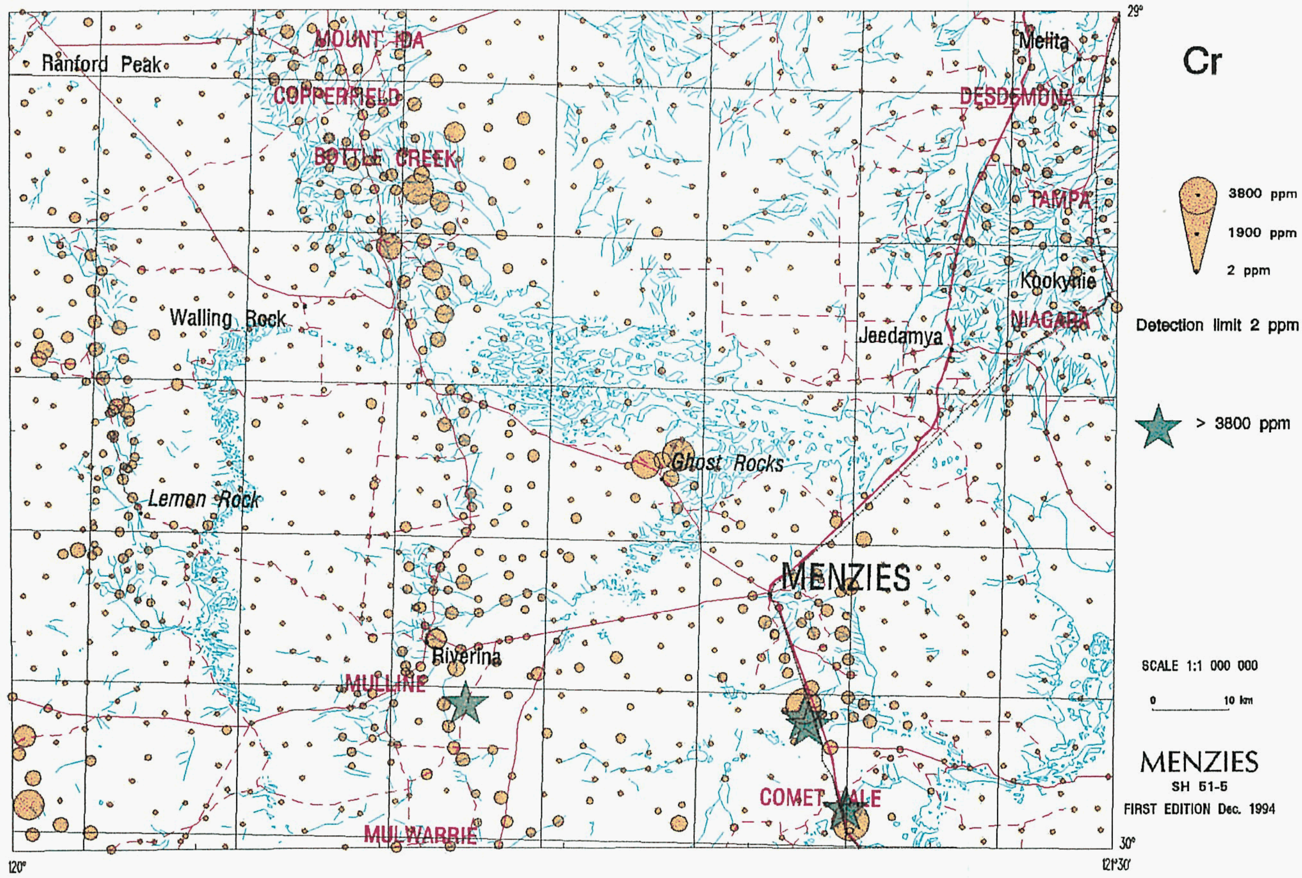

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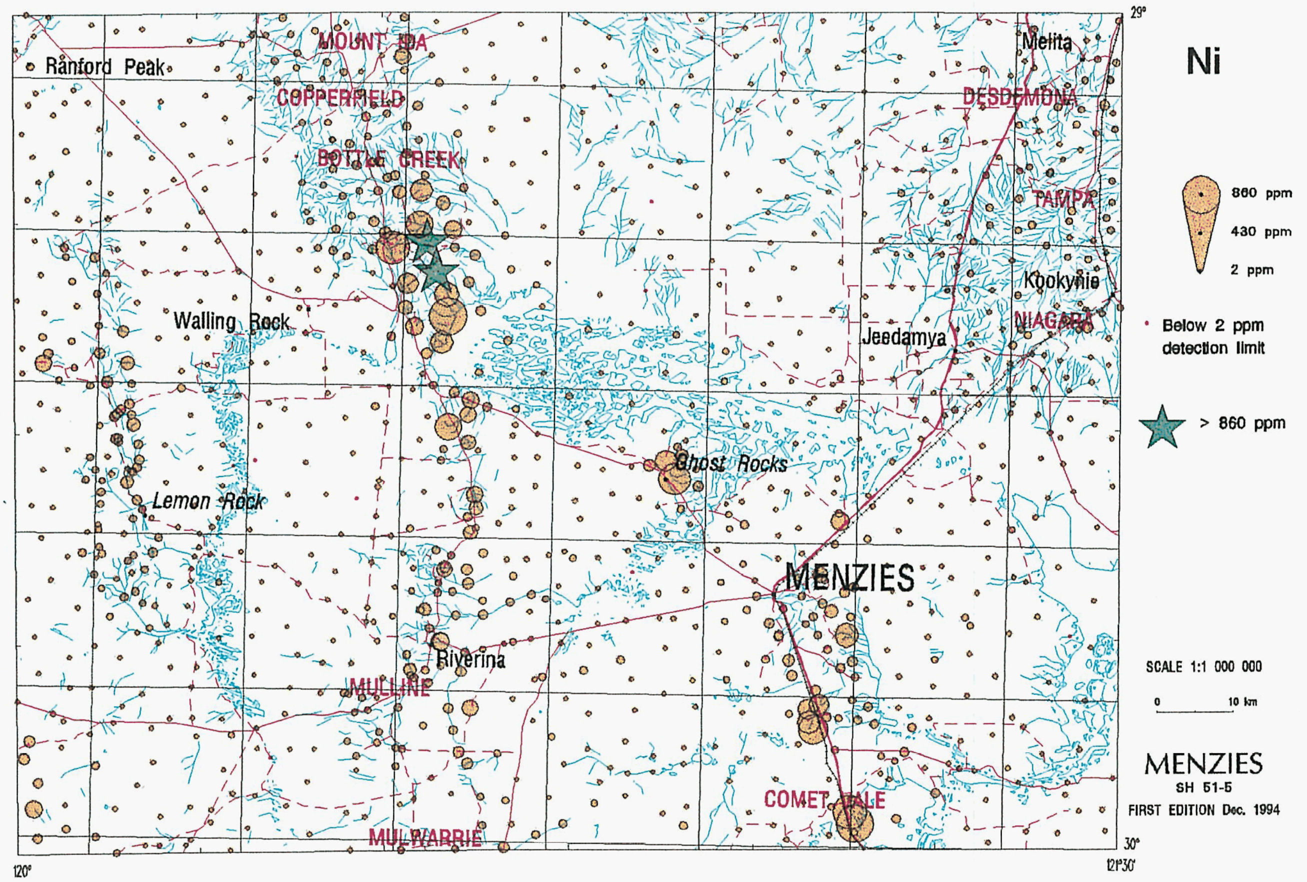

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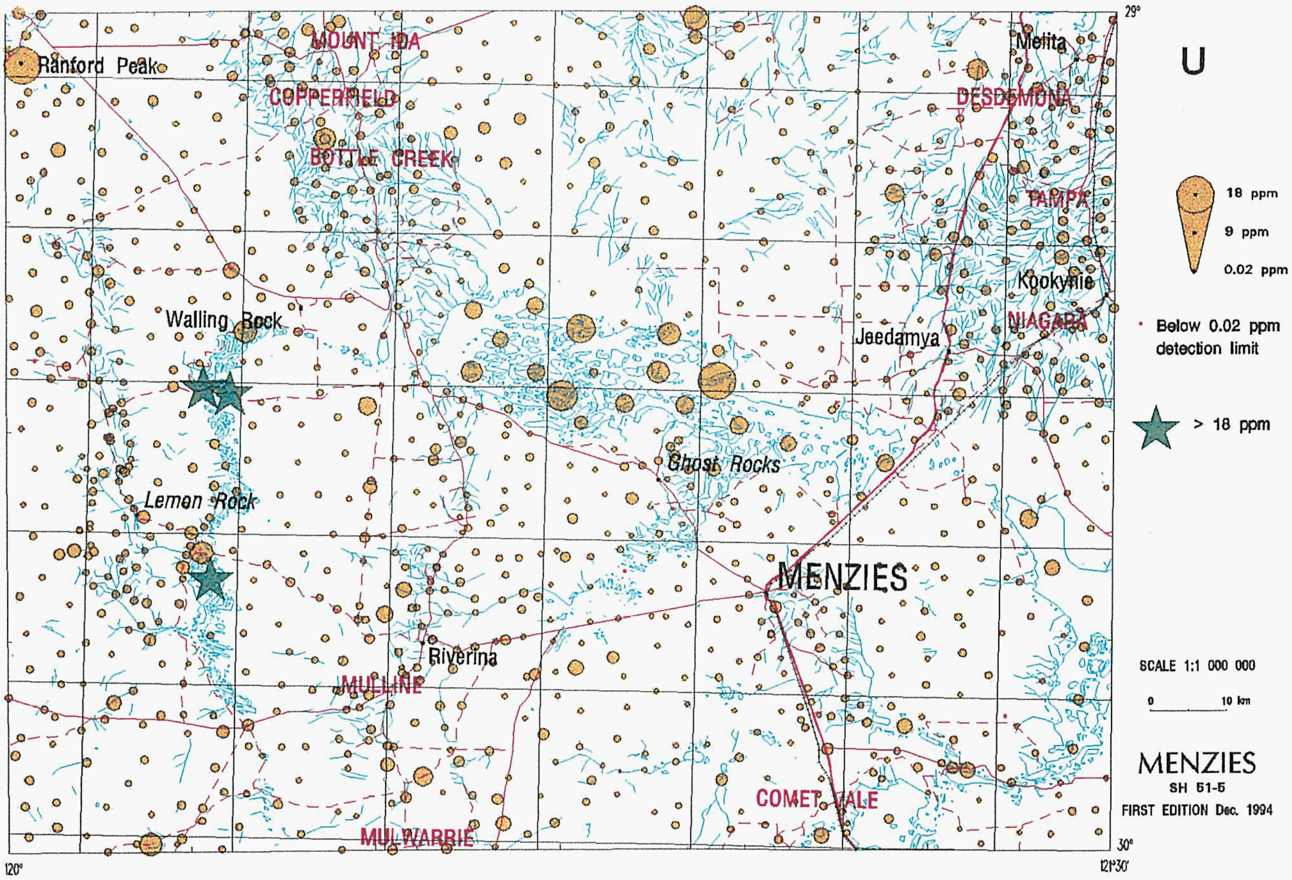

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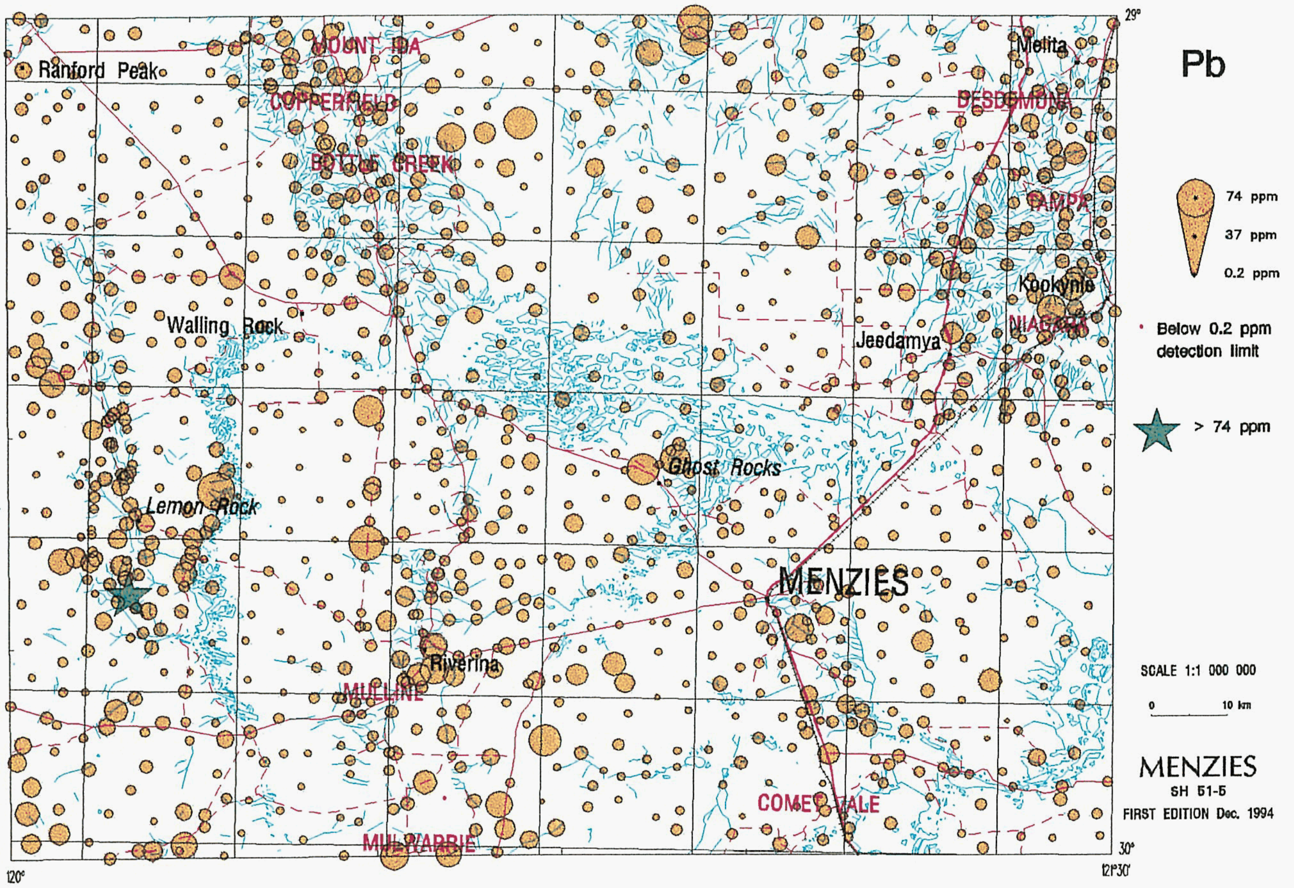

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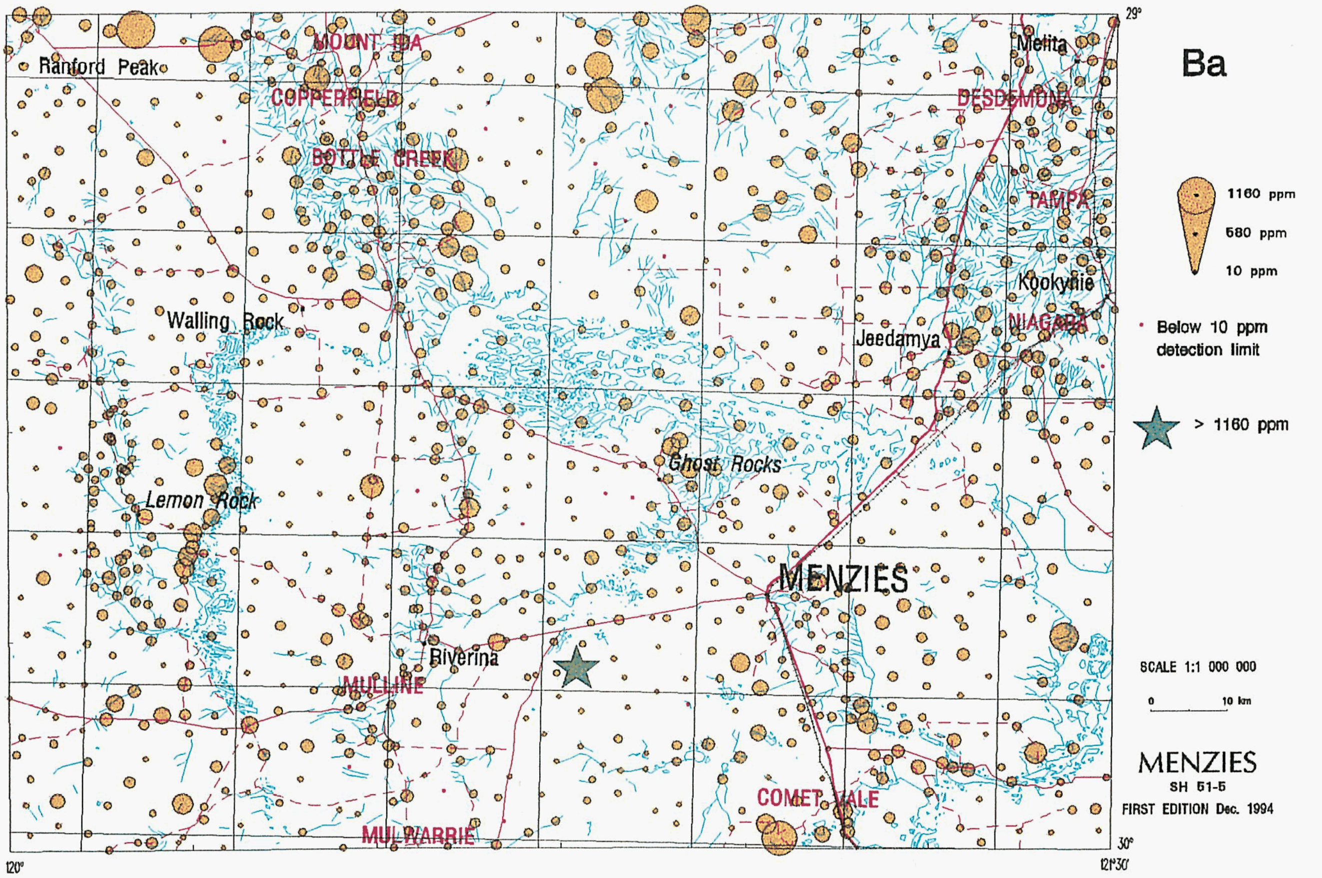

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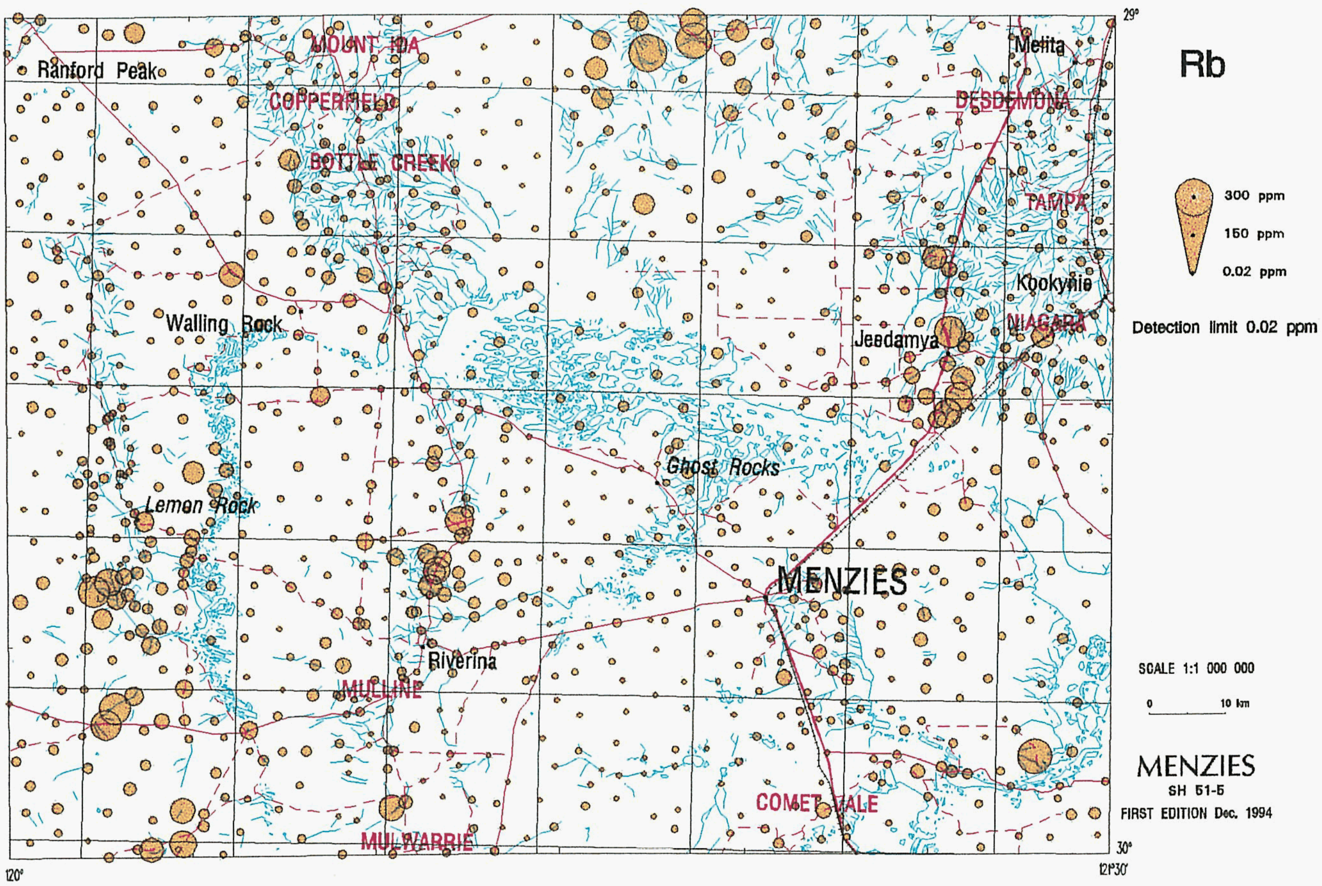

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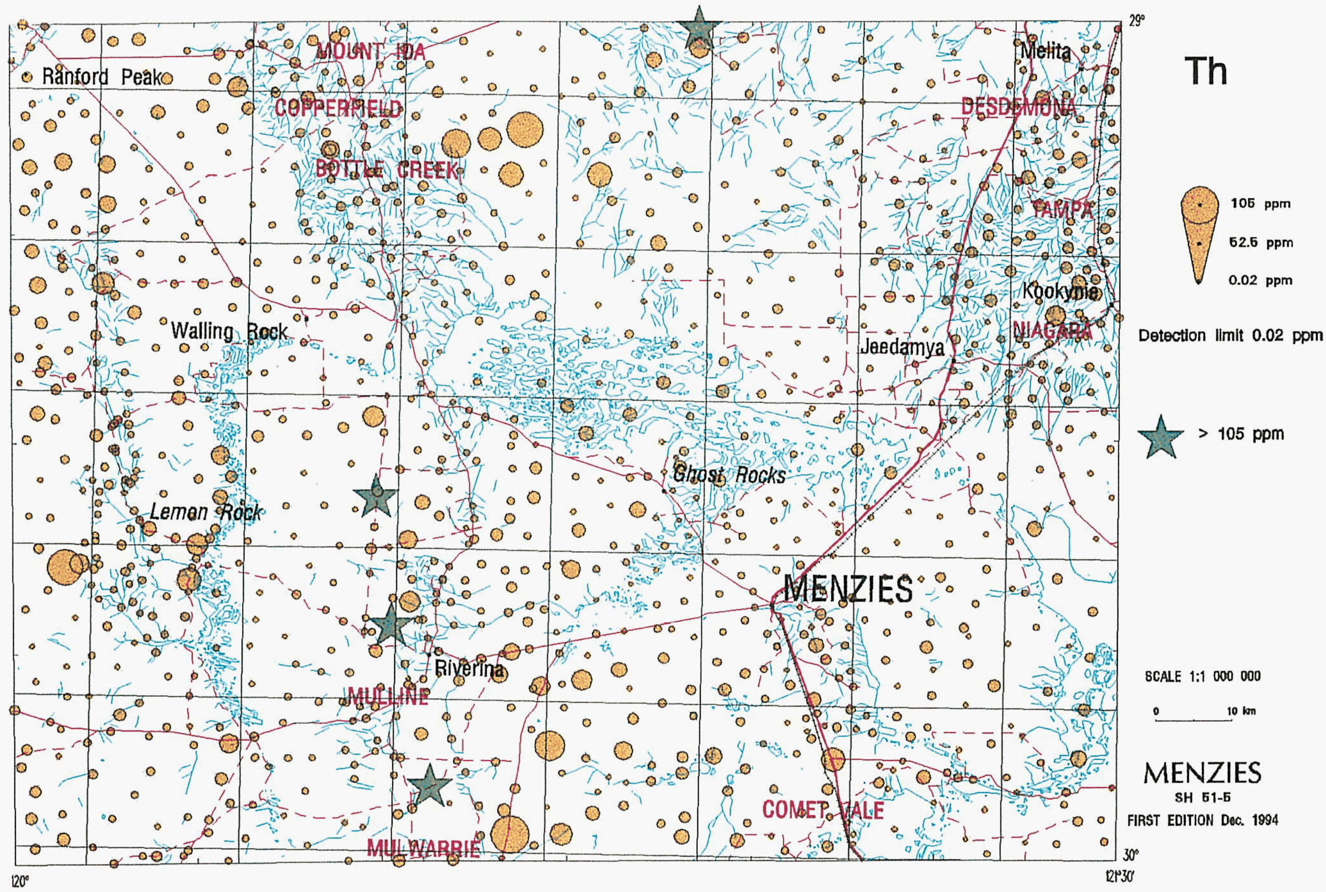

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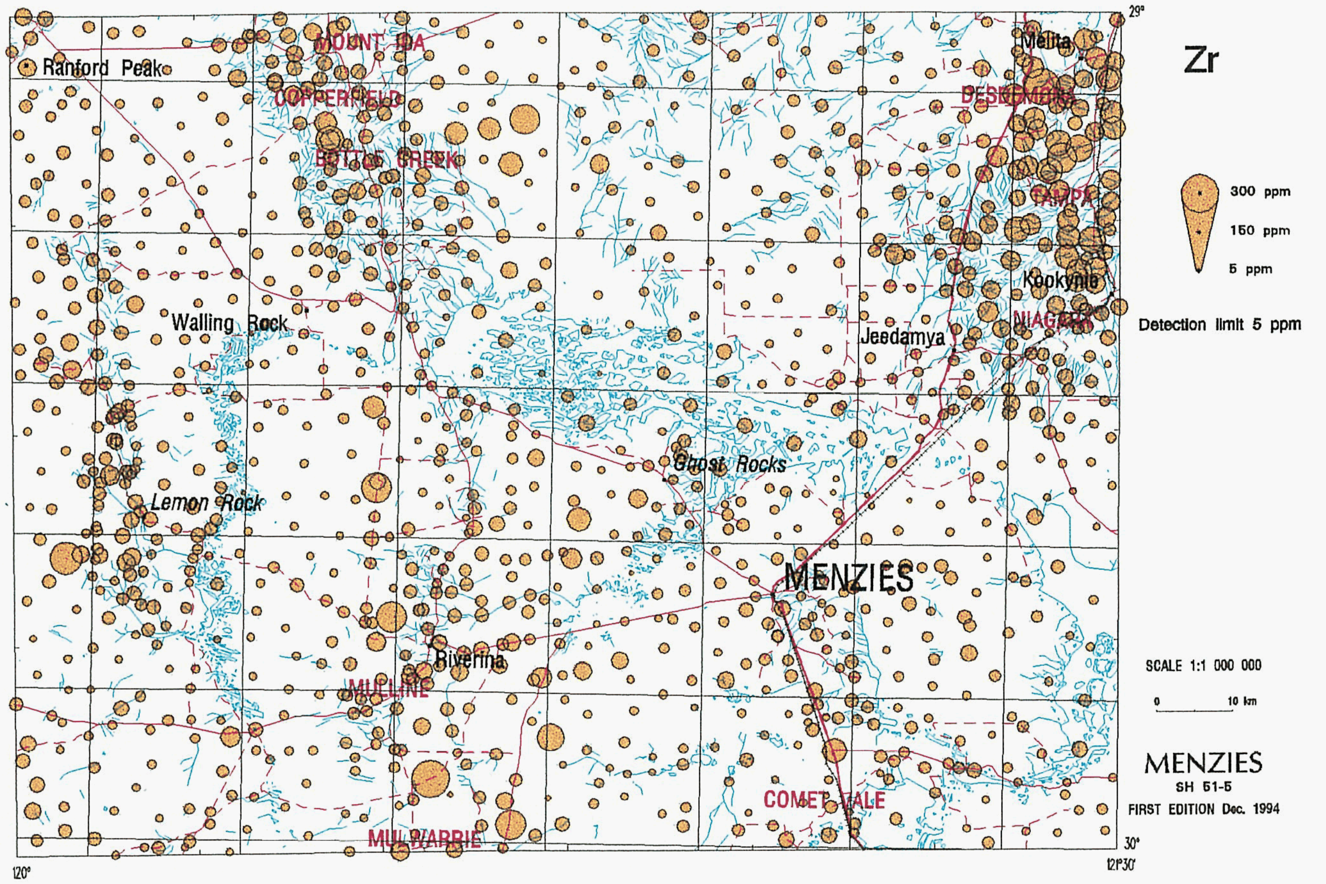

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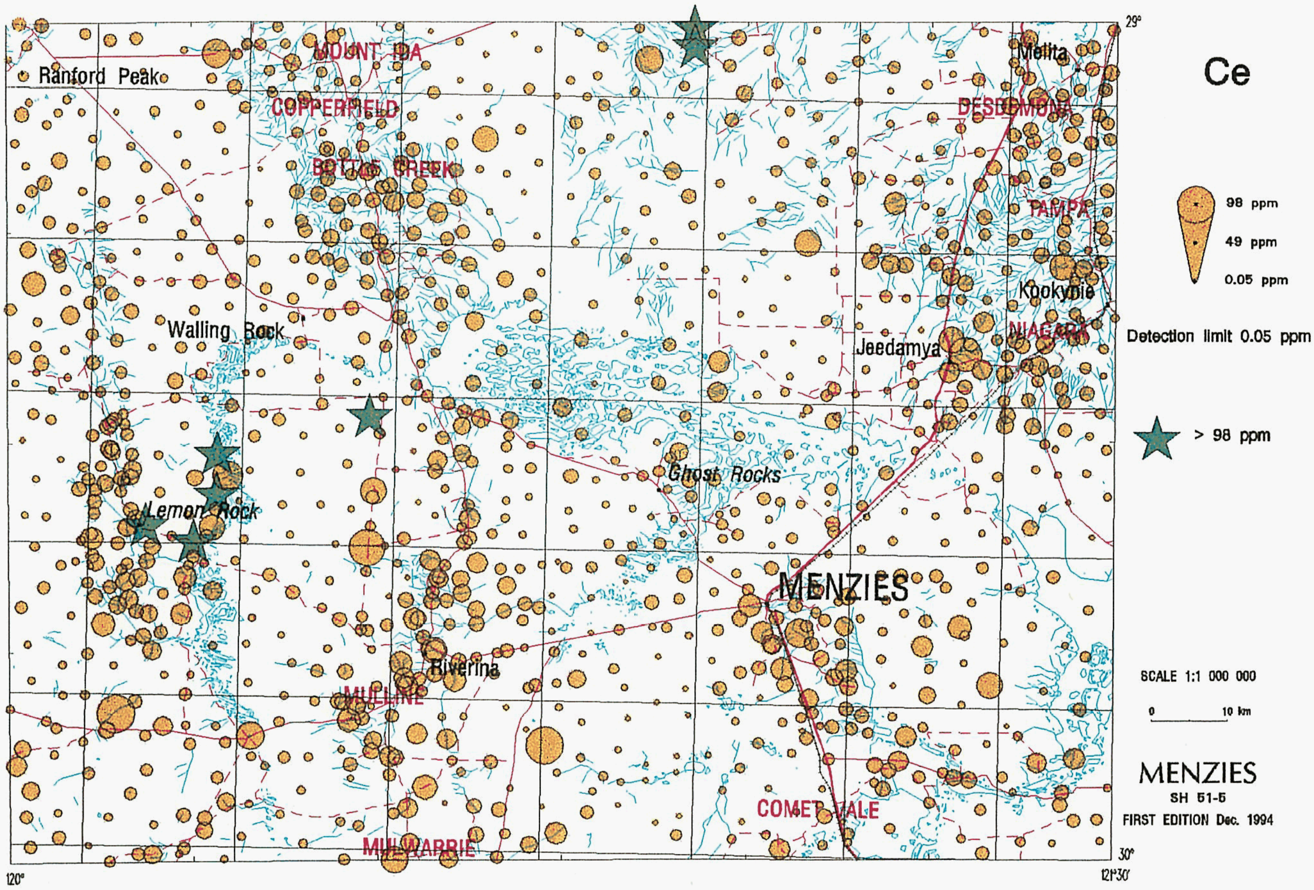

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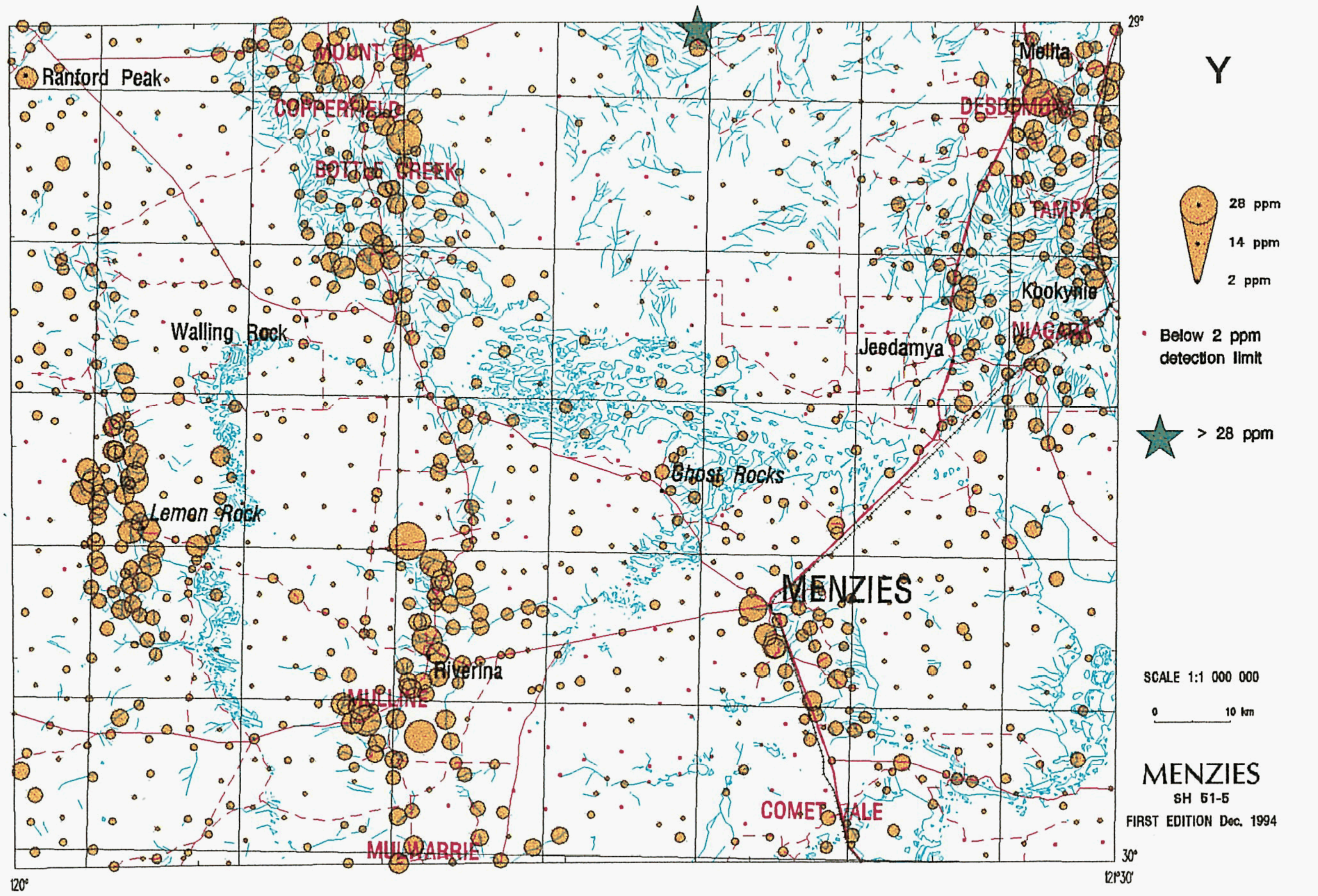

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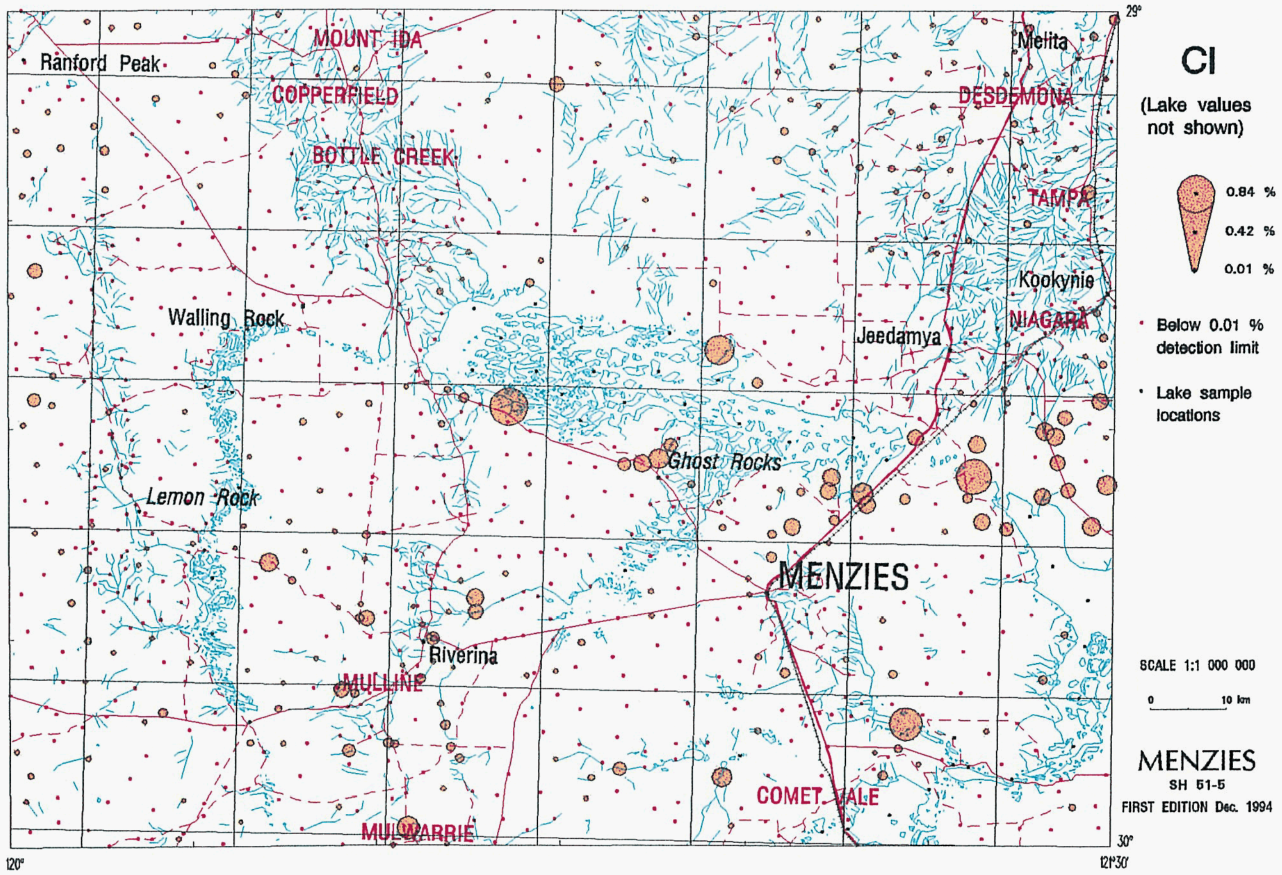

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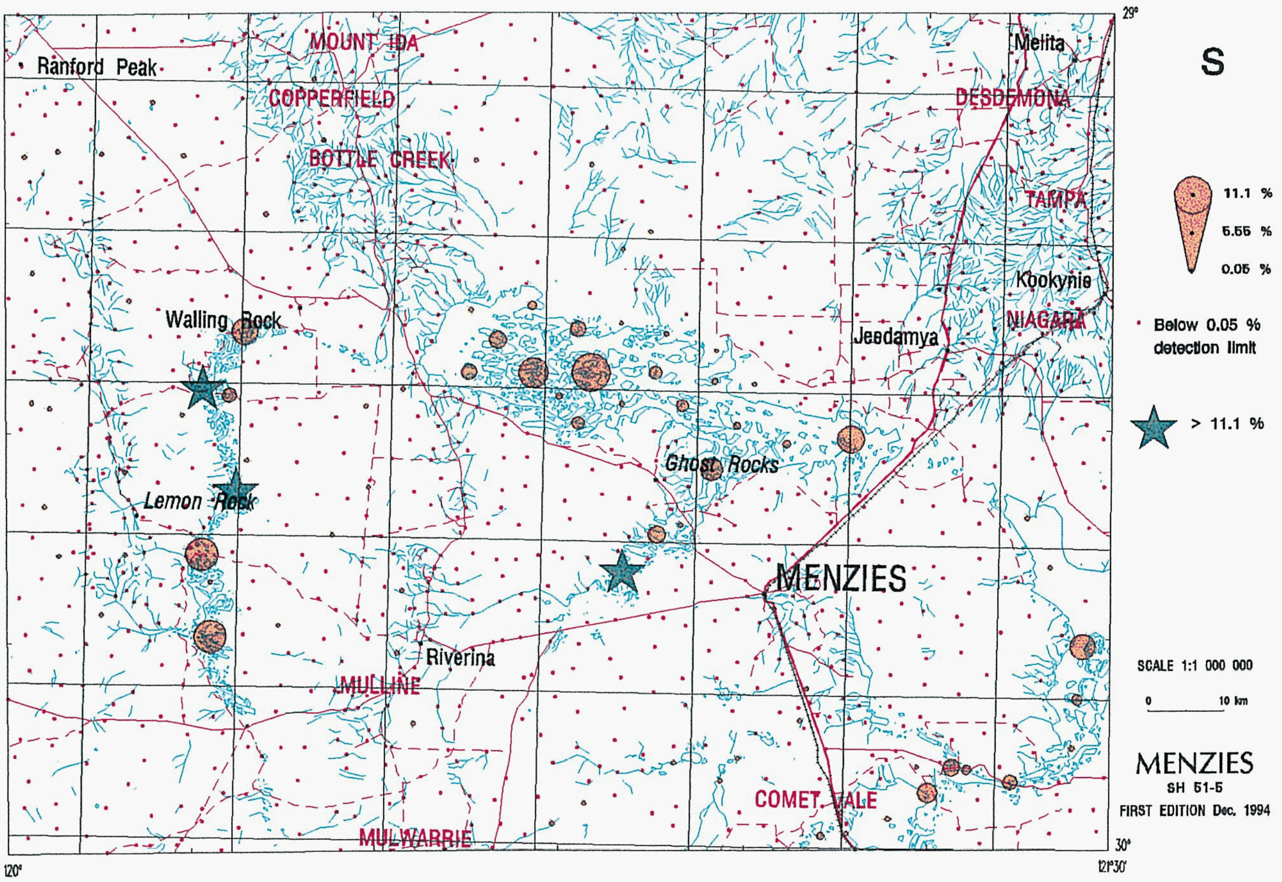

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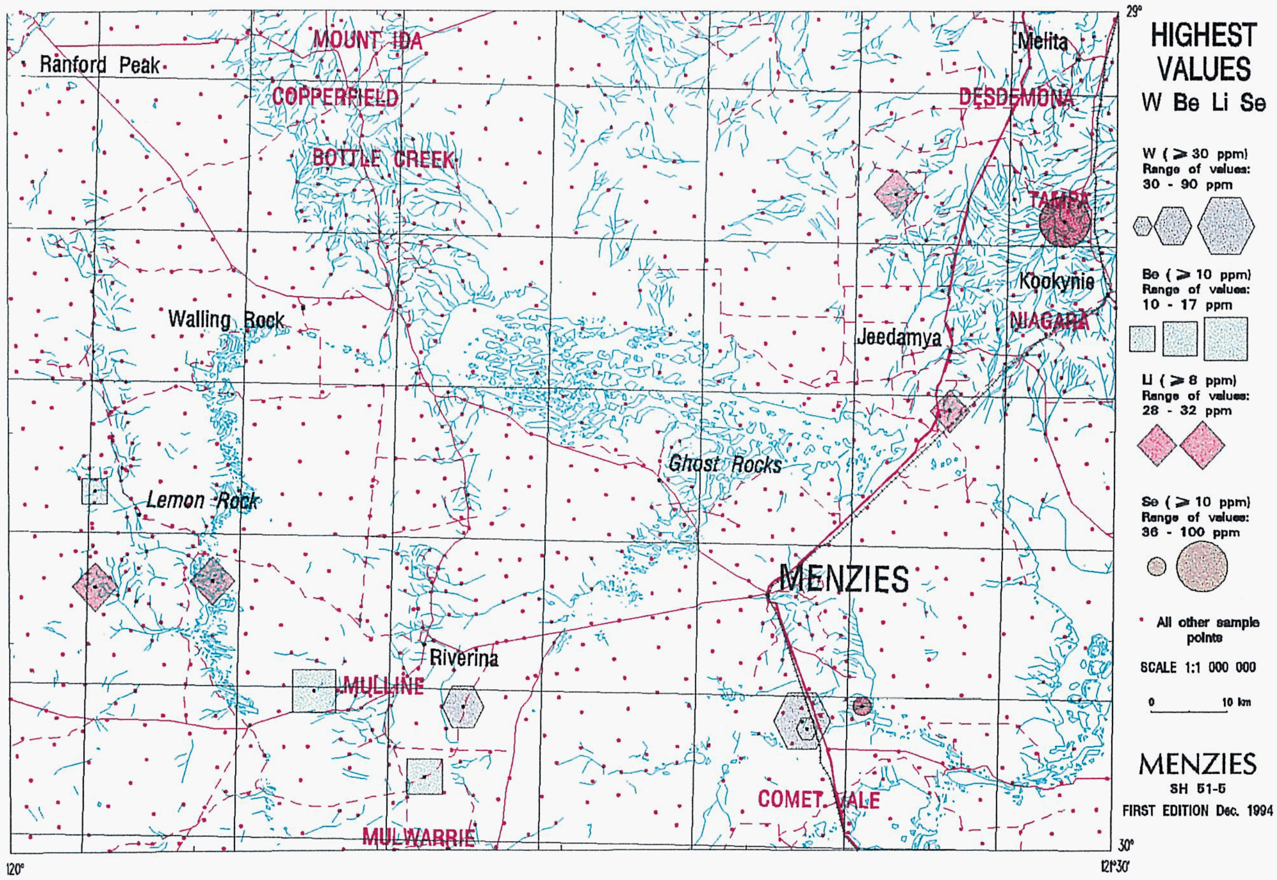

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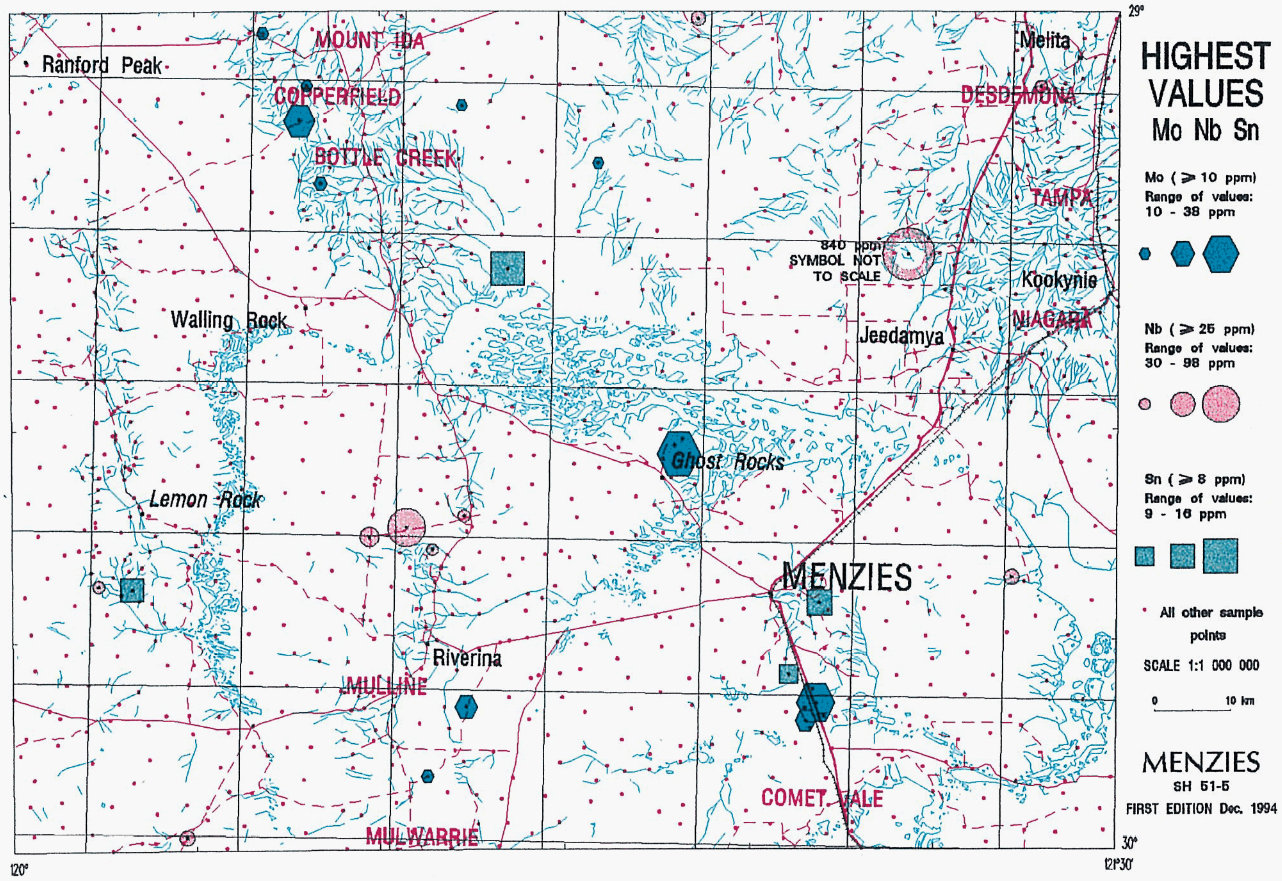

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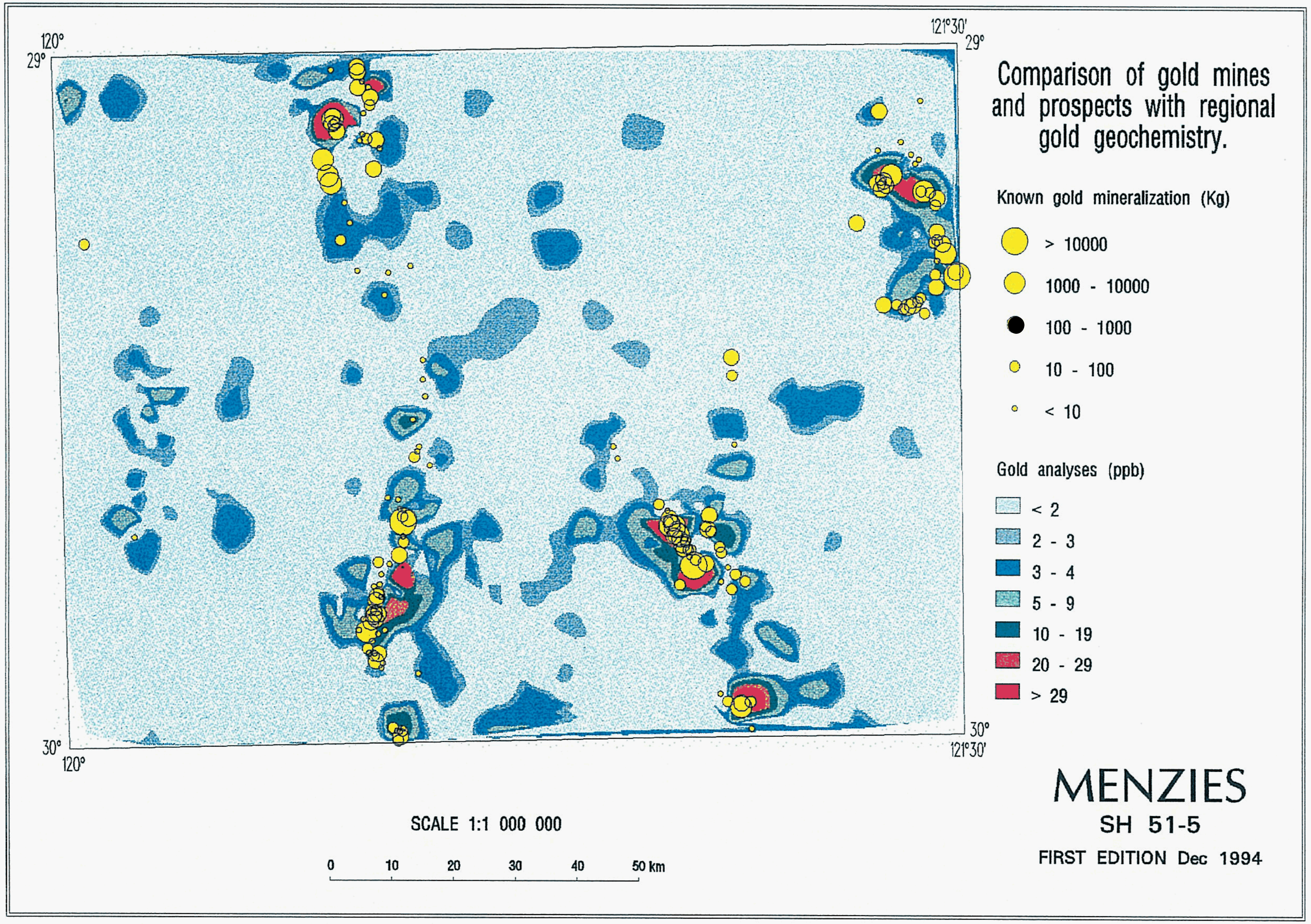


Comparison of gold mines and prospects with regional gold geochemistry.
Known gold mineralization (Kg)
> 10000
1000 - 10000
100 - 1000
10 - 100
< 10
Gold analyses (ppb)
< 2
2 - 3
3 - 4
5 - 9
10 - 19
20 - 29
> 29
120°
29°
121°30'
29°
30°
120°
30°
121°30'
SCALE 1:1 000 000
0
10
20
30
40
50 km
MENZIES
SH 51-5
FIRST EDITION Dec 1994

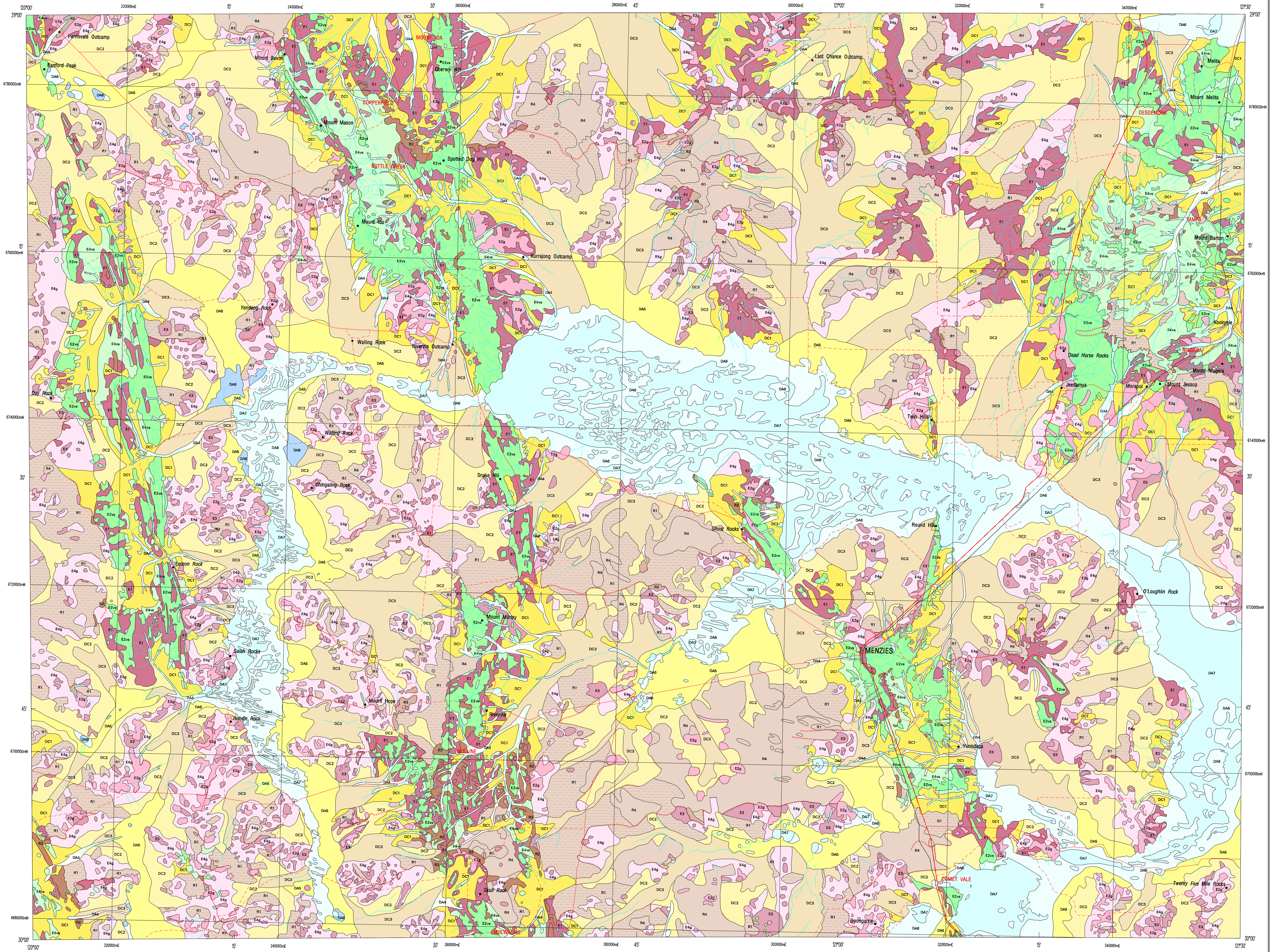
Figure 36.

1:250 000 REGOLITH MATERIALS SERIES

MENZIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-5



REFERENCE

RELICT REGIME

		CSIRO (1)	CSIRO (2)	AGSO
R1	Lateritic pisoliths and nodules with sand	LT1	R2	N040
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
E3	Residual sands and sandy clays developed over eroding mottled zone, saprolite, and bedrock	SS1 SS6	E2 E4g	--
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	Predominantly non-lithic ferruginous detritus (most clasts <10 mm), some magnetic, in a red sandy clay matrix in sheetwash areas; clasts may be absent	MI2, CS1 AS3	D4	SC05a SC05b

DOMINANTLY ALLUVIAL

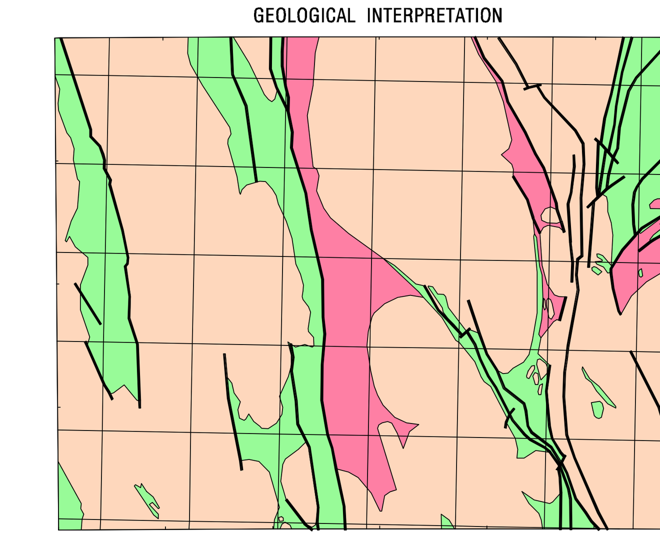
		CSIRO (1)	CSIRO (2)	AGSO
DA4	Gravelly sands and sandy clays of active alluvial channels with mixtures of lateritic, non-lateritic and variably altered lithic clasts	AS1 AS2	D1	SA01
DA5	Sand- or clay-rich alluvium on or adjacent to broad drainage floors with negligible detritus; calcrete nodules common	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
- Townsite — MENZIES
- Homestead
- Breakaway
- Watercourse, ephemeral
- Mining locality — MULLINE

GEOLOGICAL INTERPRETATION



- Granitoid rock
- Granitoid gneiss and strongly sheared granitoid rock; minor amphibolite
- Volcano-sedimentary greenstone belt
- Major fault

Geological interpretation after W.K. Witt (in prep.) and A.H. Hickman (in prep.)

INDEX TO ADJOINING SHEETS

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BARLEE SH 50-8	MENZIES SH 51-5	EDJUDINA SH 51-6
JACKSON SH 50-12	KALGOORLIE SH 51-9	KURNALPI SH 51-10

Edited by C. Strong and G. Loan

Cartography by: K. Smith, A. Rogers and D. Ladbrook of the Cartographic Services Branch, Surveys and Mapping Division, Department of Minerals and Energy, Western Australia

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 C.J. Kojan 1994

Field observations by: C.J. Kojan (GSWA), and J. Bradley, D. Ellis, B. McGraw, and G. Mehri (Geochemex)

The recommended reference for this map is: Kojan, C.J., 1994, Menzies, W.A. (prelim. ed.): Western Australia Geological Survey, 1:250 000 Regolith Materials Series

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

REGOLITH MATERIALS SERIES
MENZIES
SHEET SH 51-5 PRELIMINARY EDITION 1994

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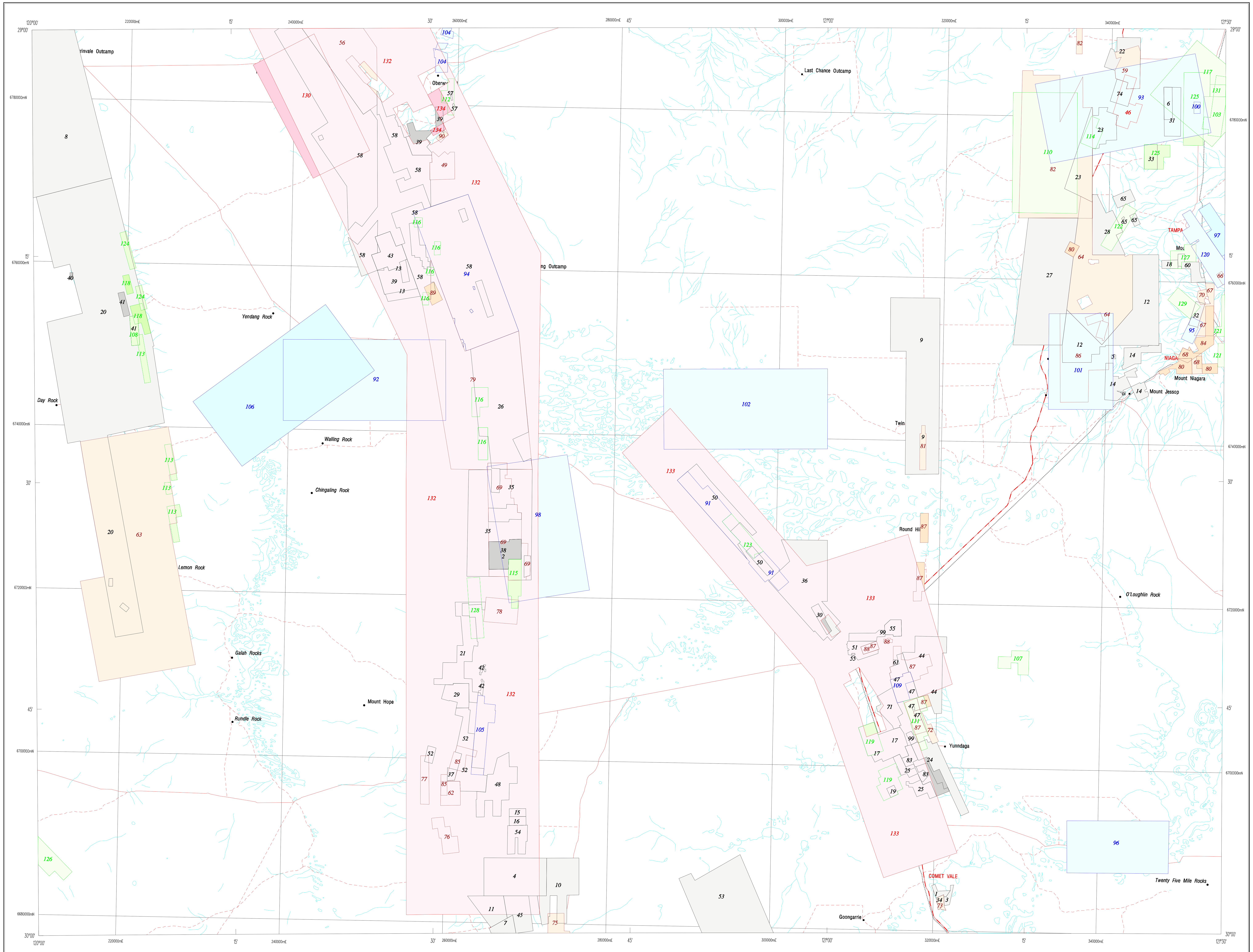
WARNING: Inks are water soluble and will fade with prolonged exposure to light



COMPANY PROJECTS WITH SURFACE GEOCHEMISTRY DATA IN OPEN FILE REPORTS (at June 1994)

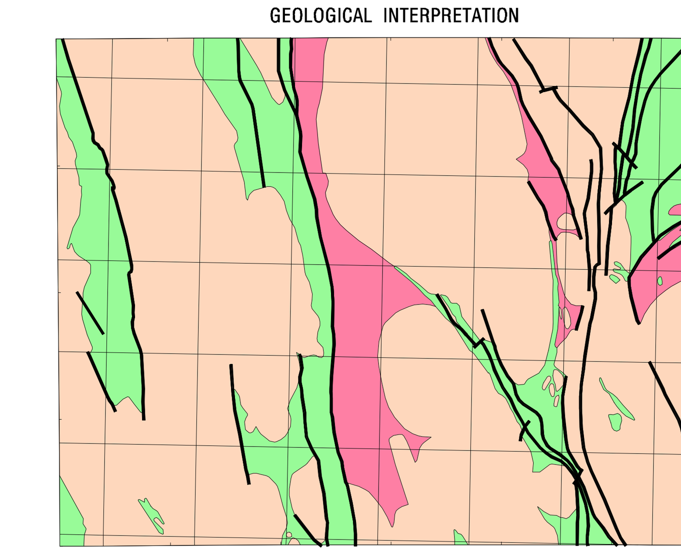
Project Commencement Period

- 1967 - 1970
- 1971 - 1975
- 1976 - 1980
- 1981 - 1985
- 1986 - 1992

Number within project area is a database ID number (See Appendix 2)

- Principal road
- Minor road
- Track
- Watercourse and lake boundaries
- Railway
- Locality
- Homestead
- MULLINE Mining locality

GEOLOGICAL INTERPRETATION



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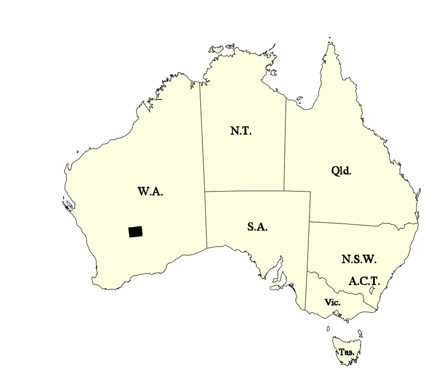

INDEX TO 1:100 000 MAP SHEETS WITHIN MENZIES 1:250 000

MT MASON 2939	BALLARD 3039	MELITA 3139
MULLINE 2938	RIVERINA 3038	MENZIES 3138

MENZIES

COMPANY PROJECTS WITH SURFACE GEOCHEMISTRY DATA IN OPEN FILE REPORTS (at June 1994)

PRELIMINARY EDITION December 1994

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Edited by C. Strong and G. Loan

Cartography by: A. Rogers, K. Smith and T. Lenane of the Cartographic Services Branch, Surveys and Mapping Division, Department of Minerals and Energy, Western Australia

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DEPARTMENT OF MINERALS AND ENERGY
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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

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Compiled by: J. Faulkner 1994

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

The recommended reference for this map is: Faulkner, J., 1994, Menzies, W.A. -- Company projects with surface geochemistry data in open file reports (prelim. ed.): Western Australia Geological Survey, Geochemical mapping of the Menzies 1:250 000 sheet, Plate 2.

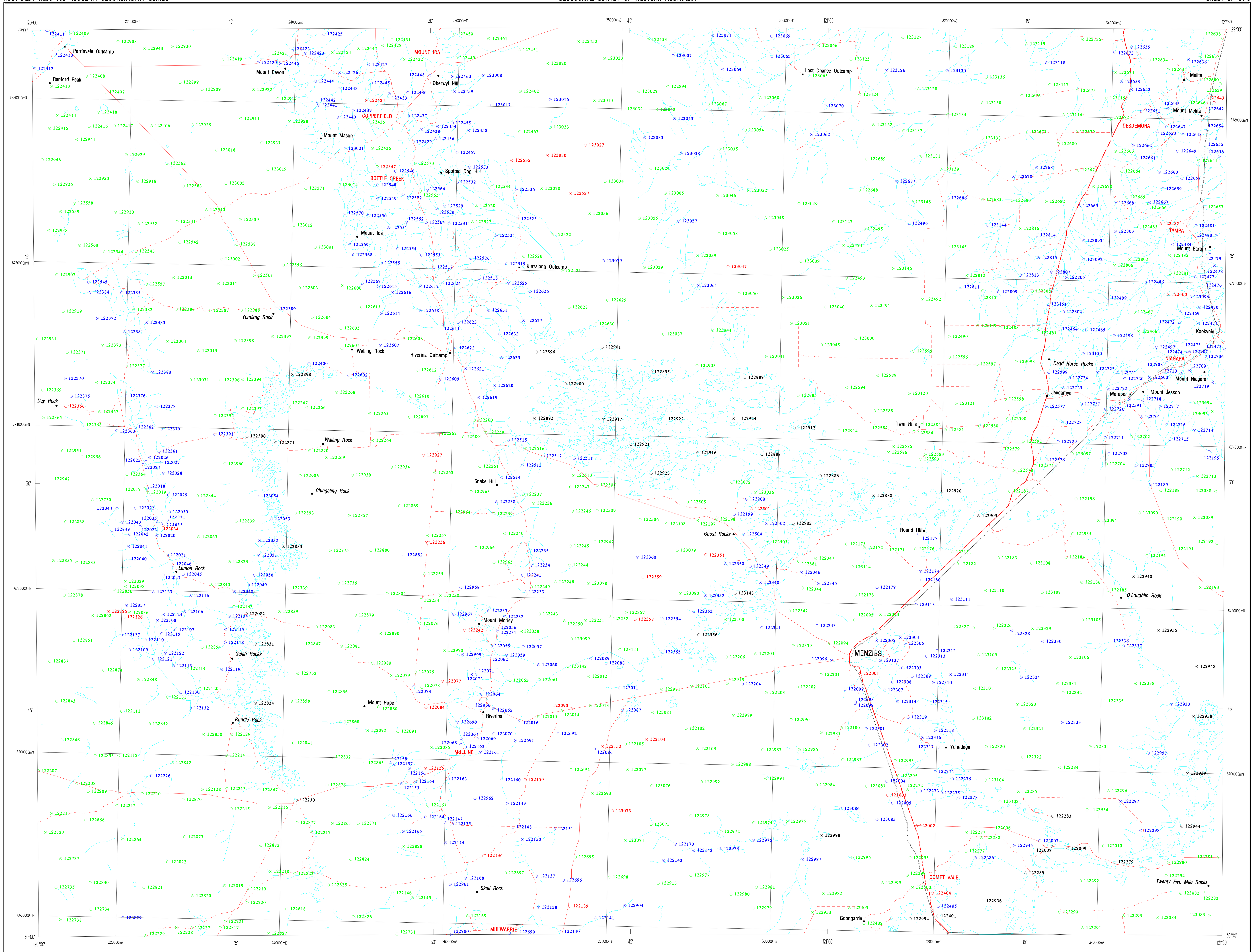
WARNING: Inks are water soluble and will fade with prolonged exposure to light

MENZIES

AUSTRALIA 1:250 000 REGOLITH GEOCHEMISTRY SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-5



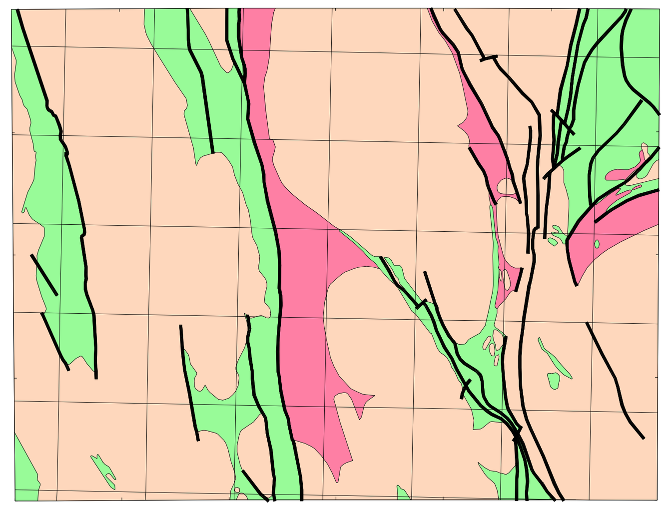
SAMPLE LOCATIONS

Sample point references

- Lake sample
- Laterite sample
- Soil sample
- Stream sample

- Principal road
- Minor road
- Track
- Watercourse and lake boundaries
- Railway
- Locality
- Homestead
- MULLINE Mining locality

GEOLOGICAL INTERPRETATION



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SAMPLE LOCATIONS

REGOLITH GEOCHEMISTRY SERIES

MENZIES

SH 51-5

FIRST EDITION December 1994

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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

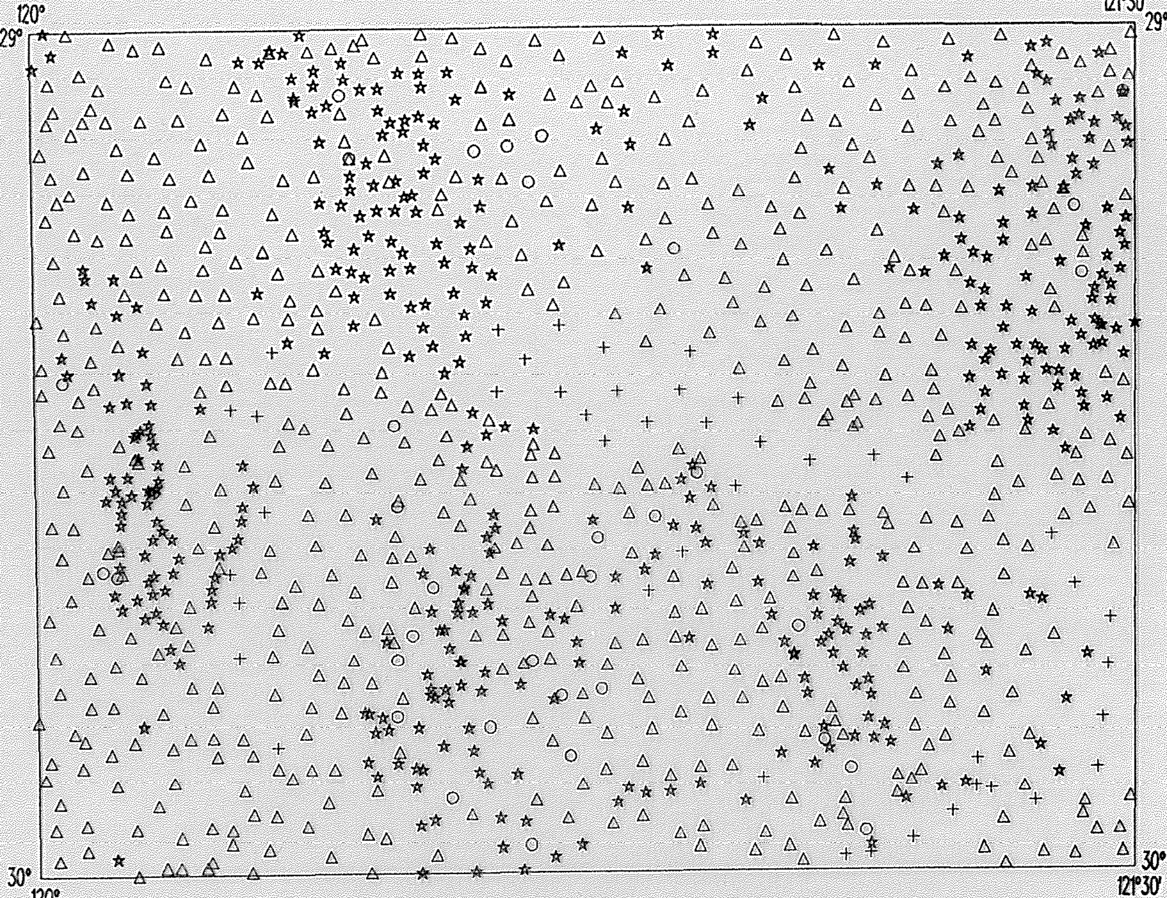
Sampling by: C. Kojan (GSWA) with assistance from J. Bradley, D. Ellis, B. McCrow and G. Mehri (Geochemex) 1994

Total sample sites: 1072; 413 stream sediment, 44 lake sediment, 580 soil, 35 laterite

Analyst: AMDEL Laboratories. Minimum sample size: 1.5 kg. Fraction of soil, stream sediment and lake sediment samples analysed: -2mm+0.45mm

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

SAMPLE LOCATIONS



SAMPLE TYPE

- ○ Laterite
- △ Soil
- + Lake
- ★ Stream

SCALE 1:1 000 000

0 10 20 30 40 50 km

MENZIES

SH 51-5

FIRST EDITION Dec 1994

PLATE 4

GEOLOGICAL INTERPRETATION

After W.K. Witt (in prep.) and A.H. Hickman (in prep.)

SCALE 1:1 000 000

0 10 20 30 40 50 km

MENZIES

SH 51-5

FIRST EDITION Dec 1994

PLATE 5