DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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AID TO THE BURMESE MINING INDUSTRY - EXCURSION GUIDE FOR INSPECTION OF GOLD PROSPECTS AND MINING OPERATIONS IN SOUTH AUSTRALIA

GEOLOGICAL SURVEY

by

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MINERAL RESOURCES SECTION

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DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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AID TO THE BURMESE MINING INDUSTRY - EXCURSION GUIDE FOR INSPECTION OF GOLD PROSPECTS AND MINING OPERATIONS IN SOUTH AUSTRALIA

INTRODUCTION

South Australian Department of Mines and Energy (SADME) welcome members of the Burmese mining industry to South Australia.

This excursion guide has been compiled to provide basic information on the history, geology, mining, mineral processing and exploration at mines and mineral prospects to be visited (see Fig. 1 for locations).

The main purpose is to demonstrate features of gold mineralisation within late Proterozoic strata of the Adelaide Geosyncline and other mineralisation at Olympic Dam, Tarcoola, Glenloth and Mount Gunson in the north of the State.

Although gold is widespread, South Australia has not been a major producer. Total recorded production for the State is about 22 million grams approximating 0.25% of the Australian total. Much of this output came from the alluvial fields at Echunga, Barossa and Teetulpa. Only the last of these three will be inspected. Significant reef production has come from Waukaringa, Mongolata, Nillinghoo, Tarcoola and Deloraine; all but the latter will be inspected.

<u>Addendum:</u>

This report contains the following changes from the guide used by the Burmese:

- Nillinghoo - revised geology text.
- Ajax gold mine - not inspected and therefore the text has not been included.
- Mount Gunson Copper Mine - substantial reduction of the text.

- Olympic Dam - text revised and updated.
- Moonta/Wallaroo Copper Mining Field - text not included as time did not permit inspection.
- Andamooka Opalfield - not visited due to weather conditions making the road impassable.

Data supplied by the operators are listed after the references at the end of each section.

An appraisal of the tour and recommendations for future tours are presented in Horn et.al. (1985).

Reference

Horn, C.M., Morris, B.J. and Olliver, J.G., 1985. Aid to the Burmese mining industry. Appraisal of 1985 Study Tour of gold geology, mining and metallurgy. S. Aust. Dept. Mines and Energy report 85/56 (closed file).

ITINERARY

BURMESE STUDY TOUR - 21-31 MAY 1985

STAGE 1:	17 Burmese	- Leader - 5 geologists - 4 engineers - 7 metallurgists
	4 SADME	- Olliver, Horn, Morris, Coates
	1 AMDEL	- Clayton
	1 Driver	- Dick Lang
Tuesday 21	8 am	- depart Adelaide
	10.30 am	- arrive Mongolata Byles underground gold mine, abandoned battery
	Lunch	- Burra
	pm	- brief look - Burra open cut abandoned copper mine
	3 pm	- Mount Grainger John Simnovec (leaseholder) Gold opencut and underground Woolford mobile treatment plant
	Night	- Waukaringa camp SADME - Townsend, Flintoft, Ewen on site.
Wednesday 22	Breakfast	- camp
	am	- Nillinghoo Harry Rademaker, Johnny Michaelevs (leaseholders) Ross Warner (caretaker)
	Lunch	- Waukaringa camp
	pm	- Waukaringa David Fairs (leaseholder) gold underground mine SADME diamond drill (Frank Costello, Driller) gold tailings gravity jigs, amalgamation
	Night	- Waukaringa camp
Thursday 23	Breakfast	- camp
	am	- Mannahill Mark Selga (leaseholder) gold underground diamond drill SADME surveyors (Harrison, Fradd)
	Lunch	- Mannahill
	pm	- Kings Bluff gold underground
	Night	- Old Willyama Motor Inn, Broken Hill
Friday 24	8 am	- North Broken Hill Ltd lead-zinc-silver geologists, mining engineers - underground metallurgists - treatment plant

	Lunch	- Broken Hill
	pm	- sight seeing - mineral museum etc. metallurgists inspected South Mine treatment plant
	Night	- Old Willyama Motor Inn
Saturday 25	am	- Wadnaminga Chris Johnston (leaseholder) underground gold mine gold tailings Wilfley table
	Lunch	- Mannahill
	pm	- Teetulpa Murray Raymond (leaseholder) alluvial gold sluice, nuggets
	Night	- Waukaringa camp
Sunday 26	Breakfast	- camp
	am	- Baratta Fred Hughes (leaseholder) gold-lead-zinc-silver open cut and underground crusher, gravity, amalgamation
	Lunch	- picnic
	pm	- Inspection Waukaringa drillcore
	Night	- Waukaringa camp

STAGE 2

Monday 27	Breakfast	- camp
	8 am	- depart
	10 am	- arrive Peterborough Battery Peter Talbot (SADME - Battery Manager) Party joined by Cave and Wilson (SADME)
	1 pm	- lunch Port Pirie
	2 pm	- BHAS lead-zinc smelter
	4 pm	- Return to Adelaide for 7 Burmese metallurgists, Clayton (AMDEL), Cave and Coates (SADME) Townsend, Flintoft, Ewen (SADME) in 2 Subarus, 1 Nissan - Remainder proceed northwards with bus and driver Burmese - leader + 9 Olliver, Horn, Morris and Wilson
	Night	- Acacia Ridge Motel, Port Augusta

STAGE 3 - New bus driver - Terry Carr

Tuesday 28	10.30 am	- arrive Mount Gunson John Davey (Manager, EMAC) opencut copper-silver crushing, grinding, flotation
	Lunch	- Mount Gunson canteen
	Night	- Olympic Dam

<u>Wednesday 29</u>	am	- Olympic Dam inspection WMC-BP joint venture underground copper-gold-uranium -silver pilot treatment plant diamond drills
	Lunch	- Olympic Dam canteen
	pm	- travel to Glendambo
	Night	- Glendambo Hotel-Motel
<u>Thursday 30</u>	8 am	- depart
	am	- Tarcoola Peter Philip-Harbutt (leaseholder) underground gold mine gold tailings old battery
	Lunch	- Tarcoola
	pm	- Glenloth Laurie Sice, Dean Knapp, Laurie Heylen, Yvonne and Norm Clark (leaseholders) underground gold mines ball mill 5-head battery
	Night	- Glendambo Hotel-Motel
<u>Friday 31</u>	return to Adelaide. Lunch at Port Augusta.	

GEOLOGICAL FRAMEWORK OF SOUTH AUSTRALIA

Geology and tectonic setting of South Australia are outlined on Figure 2 and 3 and are briefly summarised as follows.

Precambrian crystalline basement rocks, although partly buried, extend over a significant portion of South Australia.

The west and central part of the State is occupied by the stable mass of the Gawler Platform which extends from Eyre Peninsula through the Gawler Ranges to the Musgrave Block in the northwest (Fig. 4). Along the eastern margin of this shield, generally undisturbed and flat-lying shallow water sediments are referred to as the Stuart Shelf.

East of this stable shelf, less stable Adelaide Geosyncline was downwarped and folded during Adelaidean and Lower Palaeozoic time. More than 15 000 metres of sediments were deposited in the geosyncline during Proterozoic times. The material was derived from the shield area to the west and deposited in relatively shallow water and included accumulations of glacial debris. Major stratigraphic and tectonic events during the Precambrian are shown on Fig. 5. Times and rock terms used in the Adelaide Geosyncline and adjoining areas are illustrated on Fig. 6.

Along the southeastern margin of the geosyncline, a deep trough developed from Kangaroo Island north to Kanmantoo and beyond, in which fine grained deep water sediments were deposited (Fig. 4). Distribution of Cambrian sediments is shown on Fig. 7.

In Palaeozoic times, the geosynclinal trough broke up with major folding and granitic intrusions. Erosion of these fold mountains continued until Permian times when a major ice age transported debris over a wide area. Sediments eroded from the mountains before the Permian are not preserved in South Australia.

Marine sediments of Permian age are present at depth in crustal troughs now evident as Great Artesian Basin, Murray Basin and Eucla Basin. Areas of Permian sedimentation in South Australia are shown on Fig. 8. These subsiding basins continued through the Mesozoic and Tertiary. Sedimentary basins of South Australia and areas of Tertiary sedimentation are shown on Figs. 9 and 10 respectively.

State maps at about 1:7 000 000 for total magnetic intensity, interpreted depths to magnetic basement, Bouguer gravity data and groundwater resources are attached as Figs. 11, 12, 13 and 14 respectively.

References

Ludbrook, N.H., 1980. A guide to the geology and mineral resources of South Australia. S. Aust. Dept. Mines and Energy Handbook No. 4.

Parkin, L.W. (Editor), 1969. Handbook of South Australia Geology. Geol. Surv. of S. Aust.

GOLD MINERALISATION

In South Australia, host rocks for most gold deposits are sediments of Precambrian age. Many of the gold occurrences in the northeast are confined to sandy sediments of Umberatana Group of Late Proterozoic age. Sedimentation is cyclic and associated with tillite as shown diagrammatically in Fig. 15.

Thickness varies from 3 650 m to 4 570 m in the Geosyncline but increases to over 6 000 m in the southeast and some eastern areas marginal to basement. Similar Precambrian tillitic deposits are recorded in Amadeus Basin of Central Australia, Kimberley area of Western Australia, and in the Congo and Zambia regions of Central Africa.

Auriferous reefs in South Australia generally are quartz veins or stockworks in fractured or faulted Precambrian sediments. Minor pyrite, arsenopyrite and chalcopyrite are present in the veins. Calcite and siderite are the main gangue minerals. Gold deposits appear to be structurally controlled

- near closure of anticlines or synclines
- related to flexures within regional folds.

A number of reefs are stratabound e.g. Waukaringa, Mannahill, Kings Bluff, Mount Grainger and Mongolata.

Gold is a common minor constituent of some base-metal deposits and was an important by-product at Wallaroo-Moonta and Kanmantoo copper mines.

At Glenloth in the west, gold occurs in quartz veins associated with diorite dykes in granite.

The sites to be visited in the North East are on either Fig. 16 - regional structure of ORROROO 1:250 000 map area or Fig. 17 generalized geology of the Olary Province.

MONGOLATA GOLDFIELD

Location

16 km northeast of Burra

History and Production

Worked between 1930 and 1954, this was the last goldfield discovered in South Australia. Production totalled more than 350 000 grams from about 7 750 tonnes of hand picked ore. Overall grade was 45 g/t.

A Government 10 head stamp battery treated ore on site between 1932 and 1954.

The biggest producing mines were

Byles	108 900 g
Takati	84 500 g
Curlew	56 500 g
Baldina	42 500 g
East View	18 800 g

Regional Geology

On the eastern margin of the Adelaide Geosyncline, relatively unaltered Pre-cambrian sediments are deformed by north-south trending folds and strike-slip faults. The goldfield is on the eastern margin of a northerly plunging syncline within glacial sediments of Umberatana Group. The eastern margin of the syncline is marked by a Tertiary fault scarp that separates the Adelaide Geosyncline from the extensive Tertiary plains of the Murray Basin to the east.

Site Geology

Country rock dips about 35°-65° to the west. Greenish calcareous shale (possibly Enorama Shale?) and flaser-bedded siltstone (possibly Tarcowie Siltstone?) are underlain by bedded, argillaceous, creamy-white, medium-grained, feldspathic sandstone and massive brownish medium grained feldspathic quartzite which in turn is underlain by banded slate.

The competent sandstone-quartzite unit was fractured during folding and faulting and subsequently invaded by gold-bearing quartz veins containing siderite and red-yellow iron oxide boxworks. Black manginiferous ironstone veins are also common. Iron oxides replace both pyrite and carbonate.

No alluvial gold has been found in unconsolidated clay and gravel of Recent to Pleistocene age to the east although values of 1-2 g/t Au have been recorded.

Gold Mineralization

Gold extends north-south for about 12 km (Fig. 18) in ironstone and to a lesser extent quartz veins, from 1-40 cm thick that invade fractures within the 10-15 m wide sandstone-quartzite unit. These ironstone and quartz veins have the same north-south strike as country rock but generally dip steeply east. Margins are often slick'n'sided. Stock works of veins are also developed, particularly at Byles' Mine. Gold has also been found as irregular patches in weathered slate and in easterly dipping quartz veins below quartzite at Curlew and Baldina Mines.

Gold has sparodic distribution in the oxidised zone making prospecting difficult. Rich patches of secondary gold have been found with specimens weighing up to 6 kg. The secondary nature of the gold and its patchiness plus the abundance of supergene iron oxide suggest that during leaching and oxidation gold has been remobilised from a primary source and enriched within the permeable sandstone-quartzite unit with some migration into the underlying slate. Possible primary sources of gold are

- deep igneous source with subsequent intrusion along faults and fractures with quartz and pyrite during regional metamorphism.

- fossil placer deposits within sandstone-quartzite unit.
- lateral secretion from surrounding shale and siltstone.

Mining Methods

Shafts were sunk from surface to intersect quartzite-sandstone unit at depth, then to drive both north and south along the unit with cross cuts to the east to expose the underlying weathered slate. Significant gold mineralization was open stoped. Often an adit was driven from the east to intersect the main shaft.

A plan of the 28 m level of Byles' Mine is attached (Fig. 19). A shaft was sunk on the site of the original gold find and subsequently an open cut was developed with stoping below on a stockwork of mineralized quartz veins within shattered quartzite. An adit was driven from the east to connect with the vertical shaft. A vertical 3 compartment shaft was developed from a chamber in the adit, west of the original shaft, to intersect the quartzite. Two compressors each producing 4.4 m^3 of free air per minute at 4.8 kPa were used to drive the winch and air drills.

Reference

Morris, B.J., 1975. The Mongolata goldfield. Mineral Resour. Review S. Aust., 142: 109-114.

BURRA COPPER DEPOSIT

History and Production

Burra Mine, 160 km north-northeast of Adelaide, was one of the earliest in South Australia and was mined between 1845 and 1877, mainly by underground methods. A recorded total of 238 413 tonnes of handpicked ore averaged 22% Cu. Total value was about 10 million pounds.

Hand picked ore was transported to Port Adelaide by bullock wagon and shipped from there to Swansea in Wales for refining to copper metal. To obviate the heavy transport costs, smelters were built at Burra in 1849.

In 1869, new smelters were constructed at Newcastle, N.S.W. as open cut operations were started in order to treat lower grade ore and recover high grade pillars. Despite this, it was realised by 1875 that open cut mining alone would not be viable and underground operations below the old levels recommenced.

High dewatering costs and depressed copper prices coupled with exhaustion of the high grade ore forced closure in 1877.

Apart from a small amount of tributing, the mine stayed dormant until 1961 when the Department of Mines began investigations. In 1969, Samin Ltd. was formed with open cut mining resuming in 1971. In 1978, the business and assets of the Company were purchased by Adelaide and Wallaroo Fertilizers Ltd. and the mine was worked until February 1981.

2.1 million tonnes of oxidised ore at 1.77% Cu were produced. Final pit depth was 106 m below surface and 4.8 million tonnes of dolomitic overburden were removed.

Before closure, 380 000 tonnes at 2.5% Cu were stockpiled and treatment of this stockpile was completed in 1983.

Approximately 50 000 tonnes of ore in the pit floor became inaccessible due to major slumping of a section of pit face.

Regional Geology

Burra Mine is situated in complexly folded Upper Proterozoic, Burra Group dolomite and limestone near the faulted axial region of a major, shallow north-plunging anticline.

The deposit is located at the point of flexure of a major north-northwest trending fault where two faults (Kingstons and Tinlines) branch off and trend north-west. Mineralization is contained between the two faults.

Mine Geology

Copper mineralization occurs within Skillogalee Dolomite interbedded dolomite, shale and siltstone and separated to the south by Kingstons Fault from diapiric material (Fig. 20). Host rock is strongly brecciated with mineralization contained within a pipe-like body of kaolinization and silicification.

Mineralization is epigenetic, migrating into prepared ground and infilling fractures. Main minerals are malachite, azurite with minor cuprite and chalcocite. Oxidation extends to at least 200 m deep and only primary sulphides are minor pyrite, chalcopyrite and bornite in quartz veins.

Feldspar porphyry uncovered near the bottom of pit which is considered to be an intrusive dyke contains 12-15% Cu as pyrite, chalcopyrite and bornite in thin veins.

Ore Treatment

A reducing roast in CO + H_2 atmosphere is followed by ammonia-ammonium carbonate leach. Final product is chemical grade copper oxide at plus 77% copper. Plant output of 14 tonnes of CuO per day is about 30% of western world's primary CuO production. About 80% is exported.

The plant presently processes copper cement from Tennant Creek, in the Northern Territory.

Major markets for cupric oxide are:

- trace element addition to fertilizers
- trace element addition to animal feed
- manufacture of copper sulphate
- manufacture of copper oxychloride
- colouring frits and glazes for the ceramic industry
- manufacture of copper chrome arsenate for use as wood preservative
- manufacture of copper carbonate

Reference

Wright, R.G., 1975. Burra copper deposit, South Australia. In Knight, C.L. (Ed.), Economic Geology of Australia and Papua New Guinea, Vol. 1 Metals Monograph 5, Australasian Inst. Min. Metall., Melbourne, pp 1039 - 1044.

MOUNT GRAINGER GOLDFIELD

Location

240 km north-northeast of Adelaide and 10 km north of Oodlawirra and the Barrier Highway to Broken Hill. The climate is semi-arid with an average rainfall of 327 mm at Peterborough 29 km to the southwest. Dense mallee scrub covers much of the area although to the north and west, particularly around the Dustholes line of workings, the land is more open shrubland with tussock grasses.

Regional Geology

Gold mineralisation is scattered around the nose of the Mount Grainger Anticline, a broad north trending anticlinal dome of Adelaide System rocks (Fig. 21). The Mount Grainger Anticline is overturned to the east and trends north-south within a northeasterly regional trend.

Oldest rocks are Callanna Beds of probable Willouran age in the core of the anticline. Rock types include dolomite, limestone, siltstone, sandstone, shale and minor volcanics.

Burra Group laminated siltstone and calcareous siltstone and shale of Saddleworth Formation are also exposed in the core of the anticline.

Appila Tillite disconformably overlies Burra Group sediments and is characterised by fractured, pale brown, poorly sorted basal sandstone, light brown to yellow silty and shaley tillite containing pebbles and boulders up to 1 m diameter and interbeds of quartzite and dolomite. Several cycles of deposition are evident with boulder tillite and sandstone beds separated by shale.

Tapley Hill Formation conformably overlies the tillite and its base is defined by 15-20 m of thinly laminated, carbonaceous and pyritic shale (Tindelpina Shale Member). Grey-green calcareous siltstone, shale and minor dolomite comprise the remainder.

Tarcowie Siltstone consisting of greywacke siltstone and phyllite which shows a marked wavy bedding overlies Tapley Hill Formation.

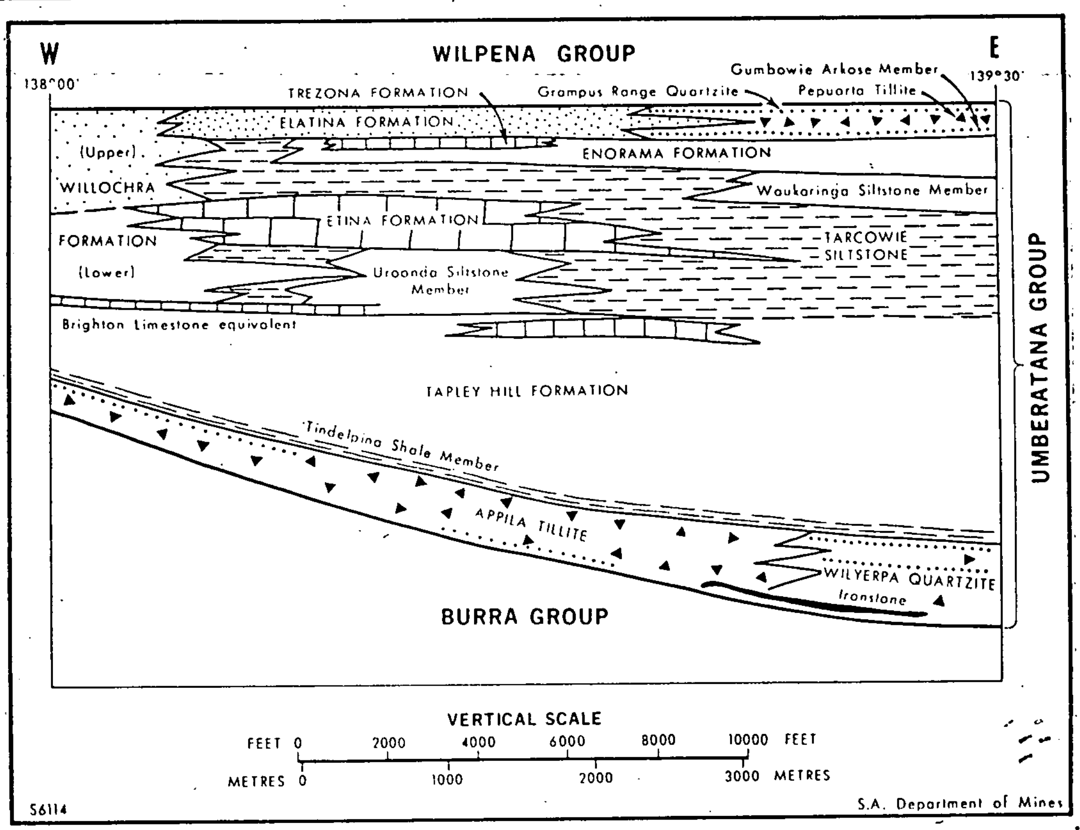
Well laminated green to grey-green calcareous shale and silty shale, Enorama Shale, overlies Tarcowie Siltstone.

Pepuarata Tillite principally feldspathic sandstone and shale, massive grey siltstone and greywacke containing erratics and dropstones crops out along Dustholes Range approximately 2 km west and north of Mount Grainger mine.

Gumbowie Arkose coarse-grained feldspathic sandstone 50-100 m thick with interbedded shale is the basal member of Pepuarta Tillite.

Grampus Quartzite medium grained grey to brown quartzite, grey siltstone with occasional erratics, off-white arkose and minor thin dolomite bands is at the top of Pepuarta Tillite.

The rock relationship diagram for Umberatana Group is as follows.



—Umberatana Group—rock relationship diagram.

The Mount Grainger Anticline is a concentric fold formed by flexural slip with an overturned eastern limb. Radial faulting around the nose of the fold has caused several major displacements. Most rocks are generally unmetamorphosed although poor foliation defined by flakes of chlorite and sericite indicate lower Greenschist Facies grade of metamorphism attributed to the Lower Palaeozoic Delamerian Orogeny.

Gold Mineralization

Gold occurs in quartz veins as fine free gold. Vein quartz is hydrothermal and fluid inclusion studies indicate medium temperatures from highly saline solutions. Associated minerals include chalcopyrite, pyrrhotite, micaceous hematite, siderite, sericite and kaolinite.

Most gold has come from the basal sandstone unit of Appila Tillite which has been prospected for about 2 km along strike. Joint-controlled stockwork quartz veins within sandstone contain low but consistent gold values. Other sandstone units within Tarcowie Siltstone have been prospected for gold (Aureous Line) and Gumbowie Arkose has produced gold from the Dustholes Line of workings. Small pits and shafts on fold-controlled quartz veins within Burra Group shale have produced minor gold.

History

Total recorded production is 5 024.28 tonnes which yielded 65 801.04 grams of gold bullion. Battery returns from the old mine battery are incomplete and ore treated is estimated at 10 000 tonnes of which 2 498 tonnes yielded 12 850.62 grams for grade of 5.14 g/t Au.

Gold was discovered in 1894. A shallow open cut (site of the entrance to the main underlie) exposed gold-bearing quartz stringers.

By March 1895, an underlay shaft from the original workings had been sunk to 16 m depth. From the 10 m level, a winze had been sunk 14 m following the hanging wall vein and associated quartz stringers.

Below the 10 m level, a zone of hydrothermal alteration was encountered and a large stope opened up (Fig. 22).

By 1900, numerous trenches and pits had been cut across the lode over a strike length of 300 m. A vertical shaft (old main shaft on Fig. 21) sunk to 45 m intersected the main stope.

A new main shaft was collared in 1900 and was sunk and timbered to 67 m (No. 2 level) with chambers cut at the 36 m (No. 1 level) and the 67 m levels. On the 36 m level, a cross cut was driven 33 m southeasterly to intersect the lode and provide access to and haulage from the main stope.

Crushing of ore from the mine at the site battery commenced in September 1901.

In June 1908, the main shaft was reported to be 75 m deep. From the No. 2 level (67 m), a winze had been sunk on the underlay to a depth of 38 m. Drives off this winze were made along strike of the arkose unit at the 21 m and 27 m levels, where reportedly rich ore was encountered. (Note - recent sampling of these drives assayed up to 27 g/t Au).

By 1911, the main shaft had been deepened to 101 m where a westerly cross cut was driven 15 m to intersect the lode which reportedly assayed 12.54 g/t Au.

Driving on the lode on No. 2 level began in 1912 and a small amount of ore was stoped off the level.

In 1964, a small company commenced cross cutting on No. 2 level supposedly to intersect North Medora and Jones Shaft workings, however, the cross cuts were both driven in the wrong direction and work ceased in 1965. Geological level plans of Mount Grainger gold mine are shown in Fig. 23.

Other workings in the area include North and South Medora shafts, Golden Junction and Jones shaft.

References

Binks, P.J., 1970. Mineral Exploration in the Mount Grainger Diapir Mineral Resour. Rev., S. Aust., 129: 167-177.

Brown, H.Y.L., 1908. Mount Grainger. Record of the Mines of South Australia (fourth edition) pp 250-251.

Fairburn, W.A. and Nixon, L.G.B., 1966. Mount Grainger Gold Mine. Min. Rev. Adelaide, 124: 5-33.

Jack, R., Lockhart, 1913. The Mount Grainger Goldfield. Geol. Surv. S. Aust. Rept. 2.

Morris, B.J., 1984. A Geological and Geochemical Survey of Part of the Mt. Grainger Anticline. S. Aust. Dept. Mines & Energy report 84/67 (unpublished).

NILLINGHOO GOLDFIELD

Introduction

approximately 65 km north of Yunta and 7 km east of the Yunta to Arkaroola road, recorded production is in excess of 120 000 grams of gold bullion from 8 000 tonnes of ore crushed.

History

Gold was discovered in January 1894 by Henry Kirkeek. Between 1894 and 1916, various companies mined open-cut and underground. The first ore was carted to Yunta and railed to Mount Torrens Government Battery for treatment. Subsequently, a five-head stamp battery was erected at the mine and crushing commenced on 4 May 1896. Scarcity of water made the operation of the battery erratic and expensive. Crushing ceased in 1897 and the battery was removed.

Mining recommenced in 1900 and ore was railed from Yunta to Peterborough for treatment at the Government Battery and Cyanide Works. A new ten head battery (part of the old Alma Extended plant at Waukaringa) was installed and operated up until 1914. Intermittent small-scale mining resumed about 1974 through to the present day with ore being processed at Peterborough.

Kirkeek's Treasure is the most significant mine with a recorded production of 119 314 grams from 7 051 tonnes of ore up to 1981.

Geology

Kirkeek's Treasure mine is situated on the northern limb of an east-west trending anticlinal domal structure near its eastern closure.

Burra group sediments occupy the core of the structure and are overlain by Yudnamutana Sub-group fluvioglacial sediments.

Mineralisation occurs within transgressive quartz-limonite-pyrite-hematite veins hosted by feldspathic quartzite.

Mineralised quartz veins have variable orientation and generally do not penetrate the less competent overlying and underlying siltstone.

In 1980, 3 diamond drillholes by C.R.A. Exploration Pty. Ltd. (1980) indicated the presence of a parasitic fold (see attached cross sections Fig. 24, 25 and 26).

Bedding dips 50° to the north with well preserved ripple marks and load casts.

Gold content of the veins is patchy, varying from 0.01 to 155 g/t Au. Gold is generally fine grained.

Diamond drillhole 80 KTD 2 intersected 16 m @ 1.0 g/t Au from 19 m to 35 m which included 1 m @ 4.45 g/t Au. Other holes failed to locate any significant mineralisation although the quartzite has a high background gold content ranging from 0.1-0.8 g/t Au.

Current Operations

Two miners are extracting ore for treatment at Peterborough State Battery.

Typical grades are as follows:

Parcel	Operator	Tonnes	Bullion (g) Recovered	Yield g/t Au	Tailings g/t Au	Extraction %
1544	J. Michaelevs	22	101.1	4.60	3.69	55.4
1559	H. Rademaker	15	130.6	8.71		-

N.B. Parcel 1559 included 248.8 g of amalgam from the operators own battery.

Assays for grab samples of the ore submitted to Peterborough gave the following results:

Parcel	Sample	g/t Au	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppm)	As (ppm)	Bi (ppm)
1544	A860/83	10.4	10	30	20	2	50	4
	A861/83	17.3	10	20	20	6	50	8
1559	A4625/83	4.4	Not analysed					

Exploration drilling to the east of the mine where the structure is concealed by calcrete and aeolian sand is searching for a small low grade orebody suitable to open cut.

Mining

Most ore has come from open cuts. The main cut is 90 m long, 6 m wide and 15 m deep.

References

Brown, H.Y.L., 1908. Nillinghoo Goldfield and Kirkeeks Treasure mine. Record of the Mines of South Australia. (fourth edition) pp 225-226 & 256.

Mayer, T.E., 1981. Final report, Mt. Victor E.L. 584 South Australia. CRAE Pty. Ltd. S. Aust. Dept. Mines and Energy open file Env. 3847 (unpublished).

WAUKARINGA GOLDFIELD

Waukaringa Goldfield was discovered by J. Watson, a shepherd, in 1873 and worked until 1894 producing over 45 000 ounces (1.4 tonnes) of gold mainly from Alma-Victoria Mine, the largest underground gold mine in the State with four underlay shafts, an 80 m vertical shaft and 1 800 m of drives.

Tailings dumps contain over 40 000 tonnes of 3 g/t Au and in underground workings reserves of 2 700 tonnes at 8.7 g/t Au remain in pillars of oxidised ore.

Other workings sampled at Waukaringa appear to have low potential with reported assays of <1 ppm gold.

Some tailings were retreated in 1889 by cyanidation which appears to be the most likely method of treatment for the remaining tailings as the gold is very fine grained and locked in composites and therefore unsuitable for gravity separation.

Source of gold is sedimentary, either deposited in traces as a paleoplacer in Cox Sandstone Member or as chemical deposit with pyrite and remobilised during folding of Waukaringa Syncline (Fig. 28). Cross folding in a southwesterly direction increased thickness and grade predominantly in Main Reef which dips at 30° and lies between Tapley Hill Formation and Cox Sandstone. Folding also may have upgraded lodes in the hanging wall in Alma Extended area.

The ore shoot and workings at Alma-Victoria are shown on Fig. 29 and a geological section through Alma Underlay Shaft on Fig. 30.

MANNAHILL GOLDFIELD

History

Gold was discovered about 12 km northwest of Mannahill late in 1885 and a battery was erected and commenced crushing in 1886. Production exceeds 155 500 grams of gold.

Geology

Stratiform gold mineralisation occurs in a series of conformable quartz bands within Waukaringa Siltstone Member of Tarcowie Siltstone (Umberatana Group of Sturtian age). Dip is south between 10°-30° on the northern flank of a major syncline (Fig. 31).

Ore comprises finely interbanded quartz, siderite and minor barite. Dark green chlorite marks the contact of the quartz vein with siltstone. Quartz veins contain abundant pyrite/arsenopyrite with minor chalcopyrite, pyrrhotite, and galena.

Within the workings, only the upper oxidised part of the veins has been mined. Primary mineralisation is only known from drillholes.

Westward Ho and Homeward Bound are the largest workings and were the main producers. At Homeward Bound, mining has been confined to the near-surface parts of an east-west orebody 800 m long. Intersections in two drillholes were

- HB 1 - 18.6 g/t Au over 20 cm at 37.7 m depth,
- HB 2 - 3.1 g/t Au over 20 cm at 35.6 m depth.

At Westward Ho, stratabound quartz-siderite has been followed for 1.5 km. Samples from the walls of the main stope indicate an average grade of 2.7 g/t Au over a thickness of 1.5 m although the recovered grade reported is 37.7 g/t Au. Drilling has intersected grades up to 20.6 g/t Au at a depth of 13.7 m.

Mining

A plan of Westward Ho mine is shown in Fig. 32.

At Westward Ho the main shaft is an underlay at about 20° to approximately 76 m deep. The last 21 m is below water level.

From the bottom of this shaft, a drive extends 15 m to the south east on lode.

A second inclined shaft 33 m east of the main shaft has also been sunk to water level on an incline of about 24°. These two shafts are connected by a drive at the 48 m level.

Stoping has been confined mainly to between the two inclined shafts with a minor amount west of the main shaft and east of the bottom of the No. 2 inclined shaft. Veinstone below water level consists mainly of iron and arsenical pyrite with quartz and minor ironstone. Samples from the bottom drive of the main shaft assayed 3 - 22 g/t Au.

At Homeward Bound, a main shaft has been excavated on the underlie to 76 m deep with shallower prospecting shafts on the underlie to depths of 10 - 20 m. Most of the ore has been stoped from the main shaft area.

Other workings at Mannahill Goldfield are Jacksons, Elsie May, Aurora Australis, Birthday and Royal Charlie.

Reference

Verwoerd, P.J., 1978. Final Report Exploration Licence 363, Mannahill. S. Aust. Dept. Mines and Energy open file Env. 3224 (unpublished).

KINGS BLUFF GOLDFIELD

Location

Outside counties within Far North Planning Area, 6 km west-northwest of Olary about 400 km from Adelaide on the Barrier Highway. The goldfield extends for 2 km^2 along a prominent quartzite ridge.

Geology

The goldfield occupies a narrow, 2 km long, hookshaped ridge chiefly composed of quartzite of Wilyerpa Formation, a unit in Yudnamutana Subgroup of Adelaidean age (Fig. 33). This ridge forms the western nose and southern limb of an easterly trending anticline. The quartzite is generally clean with traces of heavy minerals (mainly blackish specks of iron oxide after pyrite), and few narrow lenses of pebbles, which are subangular to subrounded and between 2-5 cm in diameter. There are three main fracture planes:

- southerly striking vertical plane
- moderately north-dipping plane
- moderately south-dipping plane.

Quartz veins are present in many fracture planes although major veins only occupy the vertical planes. In the underground workings, vertical planes are generally vuggy, filled with clay/kaolin and/or crystalline quartz. Brown (1908) reported that higher grade gold mineralisation was localised in these pug-quartz filled veins.

In the underground workings, declines follow the contact of quartzite with underlying shale and siltstone which dips southwards at 15° to 20°. Pebble lenses within the quartzite have southerly dips up to 40°.

History

Discovery in March 1887, followed the recovery of gold in the creek below the Bluff, and mining was sporadic until the early part of this century. Workings at the main Kings Bluff Mine have been described by Brown (1908). However, about 500 m to the southeast, numerous closely spaced short declines or adits and trenches were sunk along the length of the ridge (Fig. 35). The declines are between 8 and 85 m long; the ten longest being designated A to J. At declines E, H, I, and J additional development took place (see Fig. 34).

Total recorded production is about 967 tonnes of ore: treated for a recovery of about 31.57 kg of gold bullion. From the size of workings and dumps, only high-grade ore was selected for treatment.

Australian Gold and Uranium Pty Ltd, inspected the field in 1968 as part of their exploration program for EL 207. Anomalous gold values were obtained from some of the workings, but no further work was recommended (Lopes, 1969).

Conclusions

Gold mineralisation along fracture planes in quartzite beds of Wilyerpa Formation at the Kings Bluff Goldfield is patchy and localised in the vertical fractures. Some secondary dispersion may be present.

No significant base-metal anomalies were detected, and base metals do not appear to be indicators for gold.

Further, work is required to test the vertical quartz veins intersecting the underlying shale beds for Tarcoola-type preferential mineralisation in shale sandwiched between quartzite.

References

Brown, H.Y.L., 1908. Record of the Mines of South Australia, 4th Ed. Gov. Printer, Adelaide.

Campana, B. and King, D., 1958. Regional geology and mineral resources of the Olary Province. Bull. geol. Surv. S. Aust., 34.

Lopes, D., 1969. Report on exploration for year ending 30th June 1969, SML 207. Dept. Mines and Energy open file Env. 1116 (unpublished).

Martins, J.J., 1979. Results of underground sampling - Kings Bluff Goldfield. S. Aust. Dept. Mines and Energy report 78/101 (unpublished).

BROKEN HILL SILVER-LEAD-ZINC MINES

History

Broken Hill is 500 km northeast of Adelaide in the Barrier Ranges, New South Wales. The region was first explored by Charles Sturt in 1844, who took some samples which he later discarded.

First silver-lead ore was produced at Thackaringa, 30 km W.S.W. from Broken Hill in 1876 and in the following year from Silverton.

In September 1883, Charles Rasp, a boundary rider of Mt. Gipps Station, pegged black oxidised outcrop over part of the Broken Hill lode for silver and tin and in 1885, The Broken Hill Proprietary Company was formed and mined until 1939 when operations were sold.

Many companies have been involved at Broken Hill but the following are the main operators.

Mine	Company	Production Period
North	North Broken Hill Ltd	1885 - 1985 +
South	Broken Hill South Silver Mining Company	1885 - 1918
	Broken Hill South Ltd.	1918 - 1971
	Minerals Mining & Metallurgy	1971 - 1985+
Zinc	Zinc Corporation Ltd.	1905 - 1924 (Tailings)
	New Broken Hill Consolidated	1924 - 1985+
NBHC	New Broken Hill Consolidated	1943 - 1985+

+ denotes currently operating mine.

Mining

Production from Broken Hill lodes is mainly underground. However, Minerals, Mining and Metallurgy (MMM) mine oxidised lead-zinc ore from Blackwoods open cut on South Mine and North Broken Hill Ltd has developed an open cut on oxidised ore.

North Mine consists of drives from the main shaft with cross-cuts through the ore body and vertical connections (rises and winzes) between levels. Stoping is by horizontal cut and fill. Stope filling consists of coarse sand residue from the concentrating plant. Some of the stopes are mined by open stope methods with square sets of timber used for support where ground conditions are weak. There is only one haulage shaft, No. 3, which is elliptical, concrete lined and 9.5 m x 4.6 m, used for men, ore and ventilation. Bottom level is No. 36, 1 581 m in below the collar. No. 3 ventilation shaft is the main upcast shaft, 1 140 m deep, equipped with a 4.8 m diameter single-stage adjustable-pitch axial-flow fan which exhausts 16 000 m^3/minute. Virgin rock temperature on No. 36 level approximates 53° C.

Production

Production exceeds 150 million tonnes containing approximately 20% lead and zinc in a ratio of 2:1.

ie 20 million tonnes lead.
10 million tonnes zinc.

Silver production totals approximately 24 000 tonnes.

Total gold production is unknown but annual production since 1980 is in excess of 400 kg.

Proven reserves at Broken Hill in 1983/84 were;
NBHC - 22 million tonnes at 7% Pb, 12.5% Zn, 60 g/t Ag
North - 4 million tonnes at 13.1 Pb, 10.4% Zn, 20.7 g/t Ag

Probable reserves include another 7 million tonnes.

Geology

Lead-zinc-silver and gold mineralisation occurs in high grade metamorphic rocks of Early Proterozoic Willyama Complex comprising sillimanite - biotite - garnet schist and gneiss, granitic gneiss, pegmatite, amphibolite and minor banded iron formation. Later intrusives comprise plugs and dykes of leucogranite, mica granite (adamellite) pyroxenite, serpentinite and dolerite.

Structure (Fig. 35 and 36) and deformational history are complex and possible origins of the orebody are

- selective replacement of favourable beds by hydrothermal solutions,
- sedimentary, biosedimentary, volcanco-sedimentary (exhalative)
- syngenetic modified by deformation.

The most accepted current view is that the Broken Hill lode is an intensely deformed and metamorphosed stratiform deposit of submarine exhalative origin followed by hydrothermal alteration, especially silicification (Plimer 1984).

Treatment

Ore is milled and concentrated on site by flotation and lead concentrates are sent to BHAS at Port Pirie for smelting.

References

Braes, J.R., 1980. Lead Zinc concentration by New Broken Hill Consolidated Ltd., Broken Hill N.S. in Mining and Metallurgical Practices in Australasia. The Sir Maurice Mawby Memorial Volume Monograph 10. Australas. Inst. Min. Metall. Melbourne.

Hardwick, W.S., 1980. Lead-zinc ore concentration by the Zinc Corporation, Ltd Broken Hill NSW. in Monograph 10 (as above).

Koenig, K., 1983. Broken Hill, 100 years of mining N.S.W. Dept. Mines Res.

Plimer, I.R., 1984. The mineralogical history of the Broken Hill lode N.S.W.

Slattery, T.E., 1980. Lead-zinc ore concentration by North Broken Hill Ltd., Broken Hill, N.S.W. in Monograph 10 (as above).

Staff of North Broken Hill Ltd. 1980. Lead - zinc ore mining by North Broken Hill Ltd Broken Hill N.S.W. in Monograph 10 (as above).

Staff of Zinc Corp & N.B.H.C. Ltd., 1980. Lead-zinc ore mining by the Zinc Corp. Ltd and New Broken Hill Consolidated Ltd Broken Hill N.S.W. in Monograph 10 (as above).

Data Supplied by North Broken Hill Ltd.

- North Broken Hill Holdings, Limited, Annual Report 1983.
- The North Mine at Broken Hill - The first 100 years.
- In Touch (The House Magazine of the North Broken Hill Group of Companies), November 1983.
- North Broken Hill Limited. Summary of Company's Operations.

WADNAMINGA GOLDFIELD

Location

320 km north east of Adelaide and approximately 25 km south east of Mannahill.

Workings are located on a series of low sub-parallel south west-northeast trending ridges drained by numerous southeasterly trending ephemeral creeks.

History and Production

Since discovery in 1888, mining has been intermittent. During the past 5 years, small parcels of ore have been treated at Peterborough State Battery. Records show that in excess of 20 000 tonnes of ore with an average grade of 27 g/t Au have been treated from narrow quartz reefs which pinched out rapidly with depth. A small amount of lead ore has also been mined from Thunder Queen mine. New Milo, Virginia and Thunder Queen have been the most productive mines.

Mine	Tonnes	grams	Av. Grade (g/t Au)
New Milo	9 938	341 385	29
Virginia	8 827	140 354	16
Thunder Queen	1 795	42 825	24

Geology

Strike length is about 12 km in a northeasterly direction as shown on Fig. 37. Mines are situated on the northern limb of the Wadnaminga Anticlinorium. Oldest rocks are interbedded phyllite, dolomite and calcareous siltstone of Burra Group, striking 065° and dipping about 70° to the north.

Unconformably overlying Burra Group to the north and south is Appila Tillite, grey pebbly and bouldery sandy siltstone and pebbly quartzite, which marks the base of Umberatana Group. Granite and quartzite erratics are common in the upper parts. Some gold mineralisation has been encountered in tillite in Benda Range north of Virginia mine.

Anabama Granite, which outcrops sporadically over a length of 50 km parallel to regional strike to the south of the goldfield is the main igneous rock. Width reaches a maximum of 12 km. Biotite granite is the main rock type with lesser adamellite and tonalite.

There are two groups of workings:

- Northern Virginia - Milo - Great Eastern (Fig. 38).
- Southern Countess of Jersey-Victoria Tower - Oulinina Tower (Fig. 39).

The main veins of the former, were productive over a considerable extent and were stoped systematically.

The latter were small producers, with gold in rich pods usually where narrow northerly striking near vertical indicator quartz veins intersected the main quartz vein.

Detailed geology of the northern workings is shown on Fig. 38.

Dolomite, siltstone, phyllite predominate with a good marker bed of sandy dolomite with distinctive honeycomb outcrop.

These units are part of Belair Sub-Group, which is underlain by Saddleworth Formation Equivalent.

Top unit of Saddleworth Formation is marked by a band of silicified dark grey siltstone riddled with quartz veins and containing iron oxide pseudomorphs after pyrite. The rest is siltstone and phyllite.

The underlying unit consists of interbedded dark calcareous siltstone, coarse grained micaceous phyllite and sandy siltstone.

At the southern workings, massive dark mica-flecked dolomite is offset by several faults on which the mines are sited (Fig. 39).

Mineralisation

Auriferous quartz veins are not confined to one lithological unit although mainly in dark grey siltstone containing iron oxide cubic pseudomorphs after pyrite.

At Virginia-New Milo-Great Eastern, veins cut across country rock at a low angle striking about 080° and dipping 30° south. They are up to 2 m wide and appear to be filling tension gashes arranged in an en echelon pattern. The exception is North & South mine where the mineralized vein strikes 160° and dips 30° west.

Mineralized veins in the Victoria Tower group are similar except that dip is south-easterly at 15°-30°. Exception is Oulnina Tower where dip is north-westerly. Veins consists of quartz, brown iron oxides, hematite and gossan. Quartz is often laminated and cellular containing pyrite, galena and minor chalcopyrite.

Virginia

Outcrop has been worked along a west-south-westerly strike for 300 m (see Fig. 40).

The quartz - pyrite - galena - cerussite vein was very irregular varying from a few centimetres to 0.6 m thick.

New Milo

Two lodes crop out, the eastern for 100 m and the western for 112 m. Two shallow shafts to 10 m have been sunk on the underlie down the eastern lode. However there are no records of any mining.

Western lode has been open cut for 85 m. Three shafts (Water, Nutman's and Golden Point) have been sunk on the underlie at a dip of about 20° south (Fig. 42).

Water shaft is 90 m on the incline to water level but is reportedly another 30 m deeper.

Stoping has removed ore from the 30 m level up to surface on both sides of the shaft.

Nutman's shaft is 150 m on the incline but has not reached water. At the bottom, the lode has been driven westerly for 25 m. The lode is 15 cm wide and consists of quartz with pyrite, galena and iron oxides (Fig. 41).

Victoria Tower

Outcrop strikes north 60° west for 240 m. The main shaft has reached water at 102 m on the incline 30°. Total depth is reported at 136 m where the lode contains abundant pyrite. Based on the numerous drives and winzes and limited stoping (Fig. 42), mining has been confined to rich pockets associated with indicator veins.

References

Brown, H.Y.L., 1898. The Wadnaminga Goldfield Record of the Mines of South Australia.

Morris, B.J., 1975. Progress Report for the Six Monthly Period Ending 25th October, 1974 - Final Report, Exploration Licence 16. S. Aust. Dept. Mines report 75/39 (unpublished).

TEETULPA GOLDFIELD

History and Production

Teetulpa 30 km northwest of Mannahill, the richest alluvial field in the State, produced about 2 700 kg of gold including nuggets up to 2.49 kg. The field was discovered in 1886 by Thomas Brady and Thomas Smith who dug pieces of gold weighing about 47 g from cracks in slate in a gully now known as Brady's. The prospectors received a Government reward for the discovery. A large rush attracted over 7 000 people within two months. A township was established with stores and a hospital. By the end of 1888, alluvial mining had virtually ceased.

In 1887, over 200 reef claims were taken up but gold was not found in amounts comparable to the alluvial leads and by 1889, all mines had closed. There was minor activity in 1909-1911, 1913 and 1934.

Alluvial Workings

Many gold nuggets were encrusted with limestone and iron oxides that reduced specific gravity. Wet slucing and panning were the main methods of recovery but work was severely hampered by lack of water. Many prospectors simply laid out the wash on primitive tables and scraped through with knives searching for visible gold.

The field consists of several small valleys and their streams extending north from, or across, a series of headwater quartz reefs. The field extends 3 km north-south and is about 1 km wide (Fig. 43).

The main alluvial leads represent fossil valley stream bed accumulations slightly offset from the modern drainage. Gold was found in sandy wash near the bottom of the alluvial leads in erosional gutters and pockets in slate bedrock. Depth to the auriferous gravel varied from about 1 m in the beds of present drainages to 7 m on the sides of valleys.

Reef Workings

Gold occurs in quartz veins about 30 cm wide containing iron oxides after pyrite and siderite. Quartz veins cut Late Proterozoic Tapley Hill Formation slate near the nose of Waukaringa Syncline. There are 2 sets of quartz veins, east-west and a younger north-south set. Shafts were generally sunk at the intersection of the two quartz vein sets and mining followed the north-south veins. Production from quartz veins was small and low grade. Gold was fine grained in contrast to the high grade nuggety alluvial deposits.

BARRATTA SILVER-LEAD-GOLD FIELD

Location

320 km north-northeast of Adelaide in the central Flinders Ranges on Baratta Pastoral Station approximately 100 km from rail sidings at both Yunta and Carrieton. Moomba-Adelaide gas pipeline passes through the field centre.

History

Discovered in 1887 at Eukaby Hill, silver-bearing galena was mined from 3-4 years, abandoned for 30 years and further discoveries worked only in 1920 with spasmodic small scale mining to present.

Eukaby Hill and Saltbush Flat fields are operated by F.C. Hughes and Mineral Leases over Cross Crusader mine are held by G.S. Marshall.

Production totals over 300 tonnes lead, nearly 400 kg silver and approximately 20 000 g gold (700 oz).

Geology

Mineralisation occurs in quartz veins predominantly along bedding and crosscutting quartz veins which offset the first set. Host rock is calcareous siltstone, shale and quartzite of Tapley Hill Formation striking east-northeast dipping southeast at 30°-80° (Fig. 44).

Drilling, costeaning and sampling by private companies supplemented by later Departmental mapping and sampling in 1981, failed to find large scale silver-lead-zinc mineralisation but outlined deposits suitable for small scale operations. Further exploration is in progress.

Eukaby Hill - Saltbush Flat

Workings extend for 2.5 km and comprise an old 52 m deep shaft, 2 decline adits and many shallow pits down to 10 m.

Eukaby Hill and Saltbush Flat ore, which contain high gold values are blended. High grade galena is handpicked and shipped to Port Pirie for smelting. Ore is also crushed and milled on site, free gold recovered from an amalgam plate and the remaining concentrate sent to Port Pirie for smelting (see flowsheet on Table 1).

Cross Crusader

Extensive trenching and shafts to 20 m extend for 1.5 km. Recent ore has been won from a 25 m x 5 m pit 2.5 m deep.

Reference

Newton, A.W., Crettenden, P.P., Fradd, W.P., 1982. Baratta silver-lead field: - summary of mineral investigations and mining activity 1969-1981. S. Aust. Dept. Mines and Energy report 82/83 (unpublished).

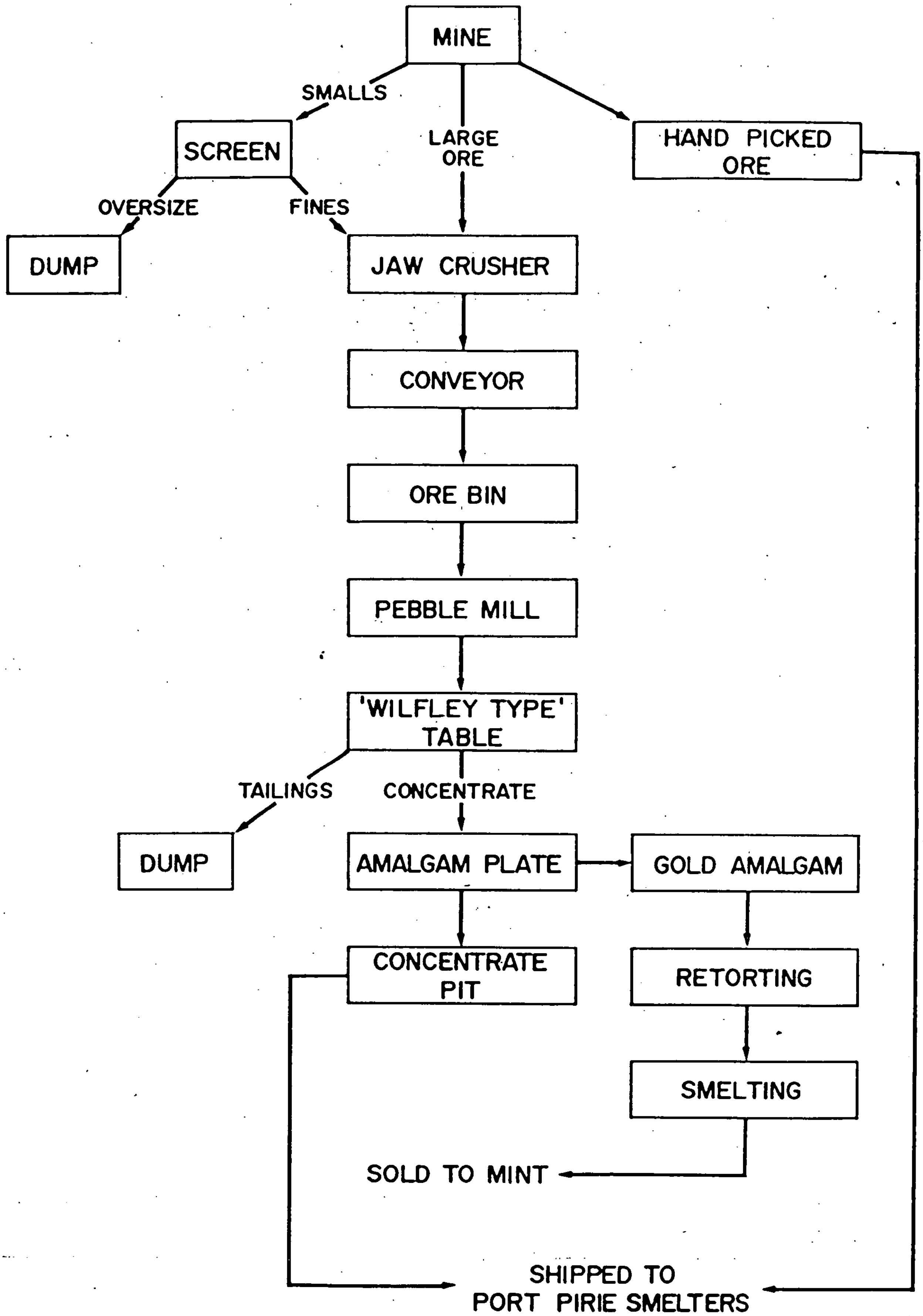


TABLE 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

BARATTA SILVER-LEAD FIELD

ORE TREATMENT FLOW CHART

COMPILED A.W.N.	C.D.O	DATE
DRAWN S.R.	SCALE —	
DATE 13/5/82	PLAN NUMBER S16287	
CHECKED		

2778

PETERBOROUGH STATE BATTERY

Peterborough Battery is located within section 440, hundred Yongala on the western side of the township of Peterborough approximately 210 km north of Adelaide.

Crushing and treatment of gold-bearing ore mainly from mines in the northeastern goldfields commenced in July 1897.

Ore is crushed by a ten head stamp battery and passed across mercury-coated copper amalgamation plates. Until June 1964, tailings with sufficient tonnage and grade were cyanided in three wrought-iron leaching vats capable of holding 25 tons, 12.25 tons, and 8 tons respectively. This practice has now been discontinued and tailings are stockpiled on site.

Figure 45, a simplified flow sheet, does not show new strake tables at the end of the amalgamation plates prior to the tailings launder.

Production from the battery is summarised in the following table to Parcel 1598.

Period	Ore (tonnes)	Bullion Recovered (grams)			Yield
		AMALGAMATION	CYANIDATION	TOTAL	g/t
July 1897-Dec. 1902	2 889	49 190.71	12 402.87	61 593.58	21.32
Jan. 1903-Dec. 1955	12 079	-	-	364 387.17	30.17
Jan. 1956-Nov. 1984	2 990	38 566.35	-	38 566.35	12.90
	17 958	87 757.06	12 402.87	464 547.10	25.87

By May 1985, a total of 1 602 parcels had been treated.

Data supplied by SADME on site

- Metallurgy of Gold - (4 pages).
- Gravity Mills (Stamp Batteries) - (2 pages).

THE BROKEN HILL ASSOCIATED SMELTERS

Port Pirie was established as the seaport for the massive silver-lead-zinc ore bodies discovered at Broken Hill in 1883. At first, ore was carted by bullock wagon, and later by rail, to the wharf facilities, the first load arriving at the docks in August 1885.

The British Broken Hill Pty Ltd build smelters at Port Pirie to treat Broken Hill ore concentrates in 1889. In the same year, The Broken Hill Proprietary Co. Ltd (BHP) constructed a lead refinery adjacent to the smelters to treat bullion produced on-site at its mine. BHP was the largest of the eight Broken Hill producers, and aquired the British Smelters in 1892; the BHP smelting operations were subsequently transferred to Port Pirie. Local supplies of flux for the smelters were obtained from ironstone deposits at Iron Knob.

The ore mined at Broken Hill from 1885 was mainly lead carbonate and sulphate, suitable for direct smelting. However, with deepening of the mines at the turn of the century, lead tnd zinc sulphide ores became dominant. As these had to be roasted before the metals could be extracted by smelting, BHP installed a sintering plant at Port Pirie. The other Broken Hil producers, with no smelting or refining facilities, had to be satisfied with overseas sales of ore concentrates.

A zinc smelter was built by BHP in 1906 to treat the large amounts of sphalerite being recieved. Two years elapsed before the plant operated efficiently, but it was closed in 1921 as a non-economic venture.

The First World War had a great impact on the smelters. BHP, with dwindling ore reserves, had ceased to be the largest Broken Hill producer and was considering a chnageover to iron ore smelting and steel manufacture elsewhere in Australia. The other mines lost their European markets because of trade embargoes, and a partial shutdown at Broken Hill looked likely. The solution was for a co-operative to take over the Port Pirie smelters and treat all Broken Hill ore. The Broken Hill Associated Smelters Pty Ltd (BHAS) was formulated with this capacity in 1915 from three shareholding supply companies including BHP.

The facilities were expanded to handle the extra ore concentrate input, and within a few years the company was the world's largest lead producer, and still operates the world's largest lead smelter and refinery. BHP, which sold its BHAS interest in 1925, continued to send concentrates to the smelters until its mine closed in 1939.

BHAS research department has introduced many innovaltions to lead smelting, the best known being the de-silvering kettle which enables silver and gold to be extracted continuously from molten lead bullion.

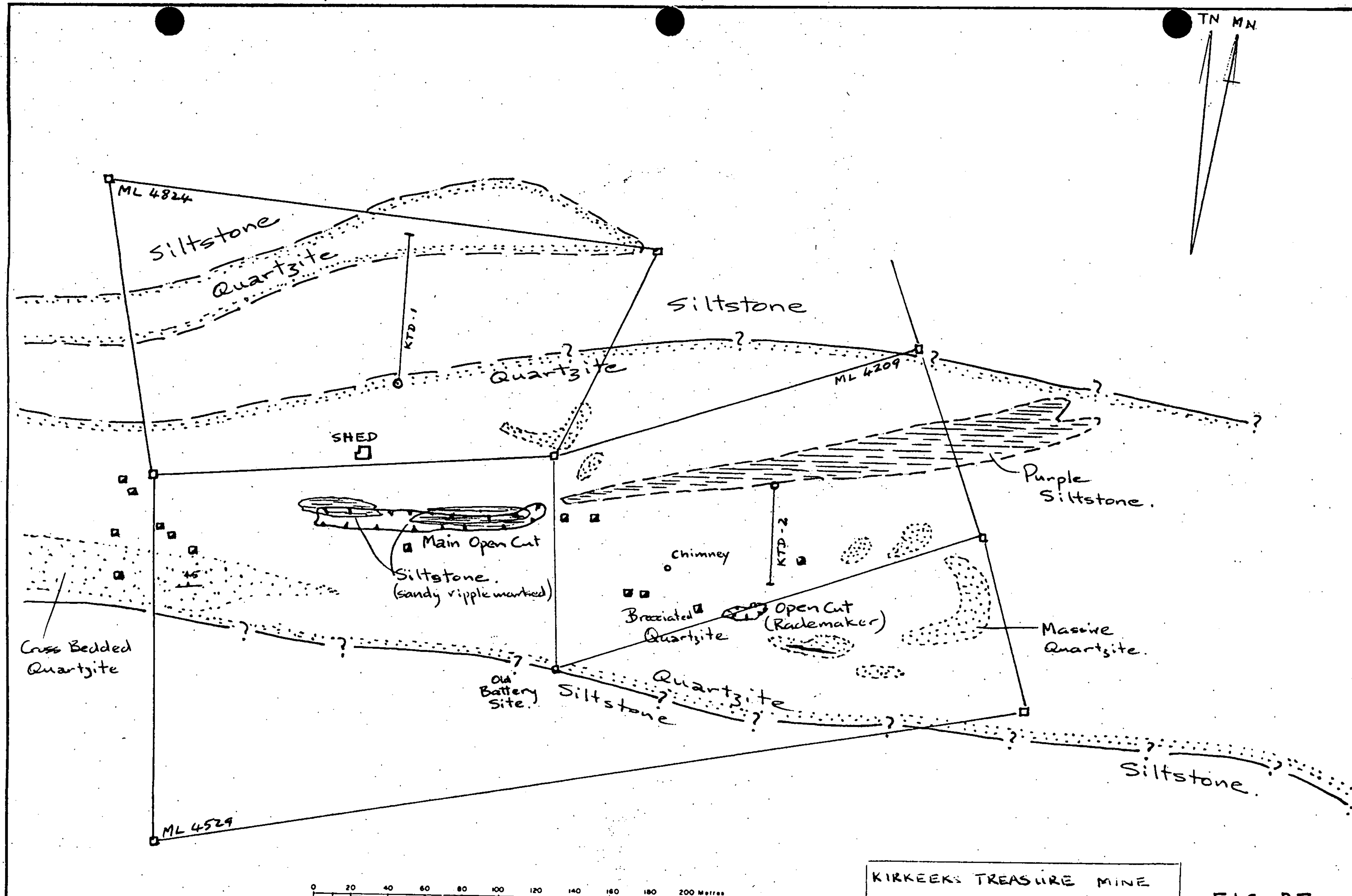
In 1967, a plant was commissioned to extract and refine zinc metal from lead blast furnace slag and the six million tonnes of granulated slag accumulated from decades of smelting. Approximately hald of the old slag dump had been reprecossed to the end of 1981.

Annual smelter production capacity is now 250 000 tonnes of lead, 280 tonnes of silver, and 45 000 tonnes of zinc. Nearly 75 000 tonnes of sulphuric acid are recovered from sinter gases each year for sale to fertilizer manufacturers. Cadmium, copper matte, gold and lead alloys are important by-products.

Recent production figures for BHAS (owned 70% by Australian Mining and Smelting Ltd and 30% by North Broken Hill Holdings Ltd) are:

		1982	1983
lead	(t)	238 865	211 223
zinc	(t)	39 659	42 065
silver	(kg)	244 025	221 020

A $100 million upgrading of the lead smelter using the Russian Kivcet process is being considered. Insertion of this process would replace the outdated mixing plant, sintering plant and blast furnace, provide more economical throughput of concentrates and improve sulphur recovery through a closed blast furnace-to-acid plant circuit.



KIRKEEKS TREASURE MINE

SKETCH GEOLOGY

FIG 27

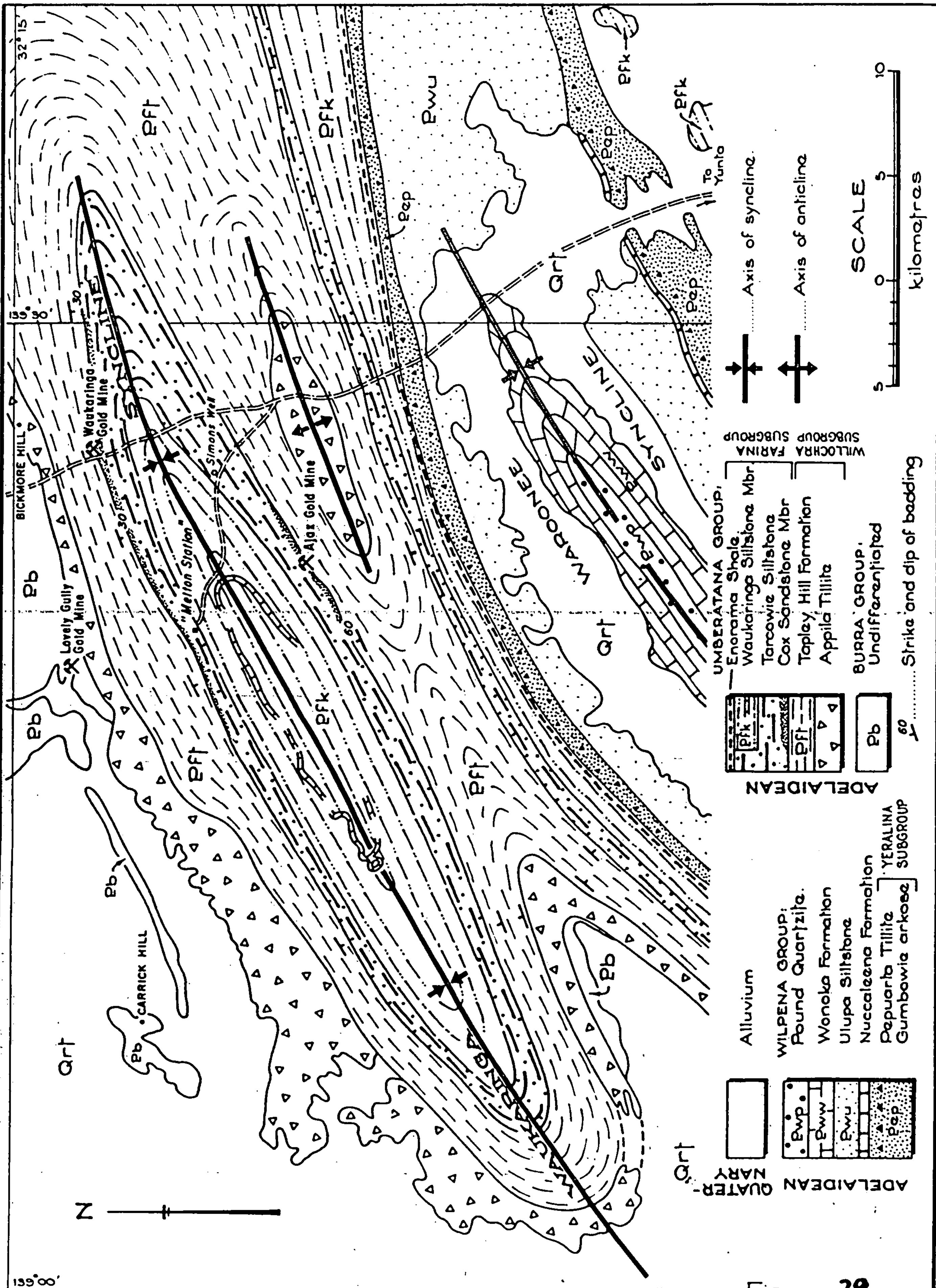


Figure 28

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED I.J.T.	
WAUKARINGA GOLDFIELD	DRAWN M.R.	SCALE 1:250,000
REGIONAL GEOLOGICAL PLAN	Sept. '84	PLAN NUMBER S 17928

3G1G

WAUKARINGA GOLDFIELD

SIMPLIFIED GEOLOGY AND WORKINGS

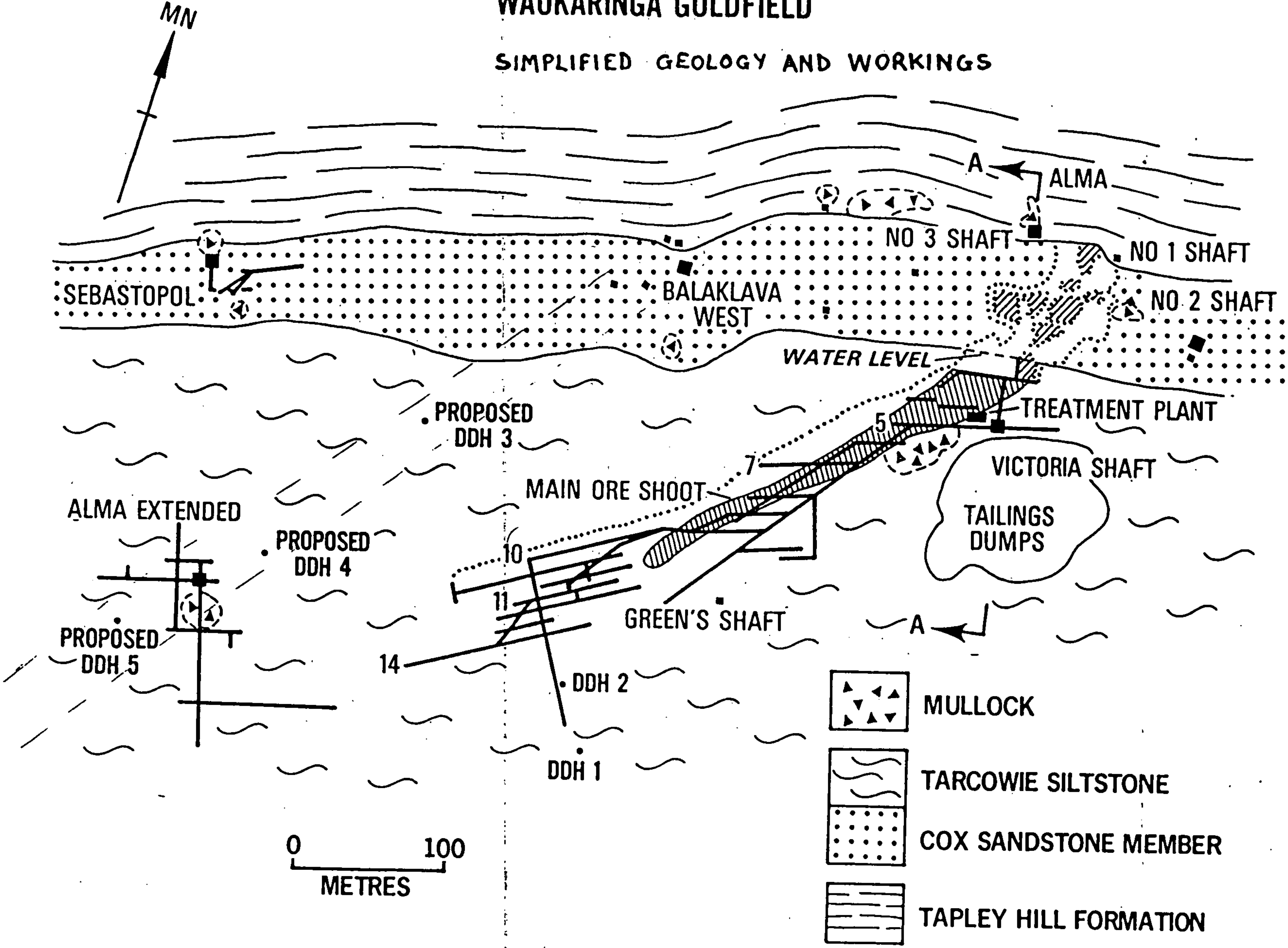


FIG. 29

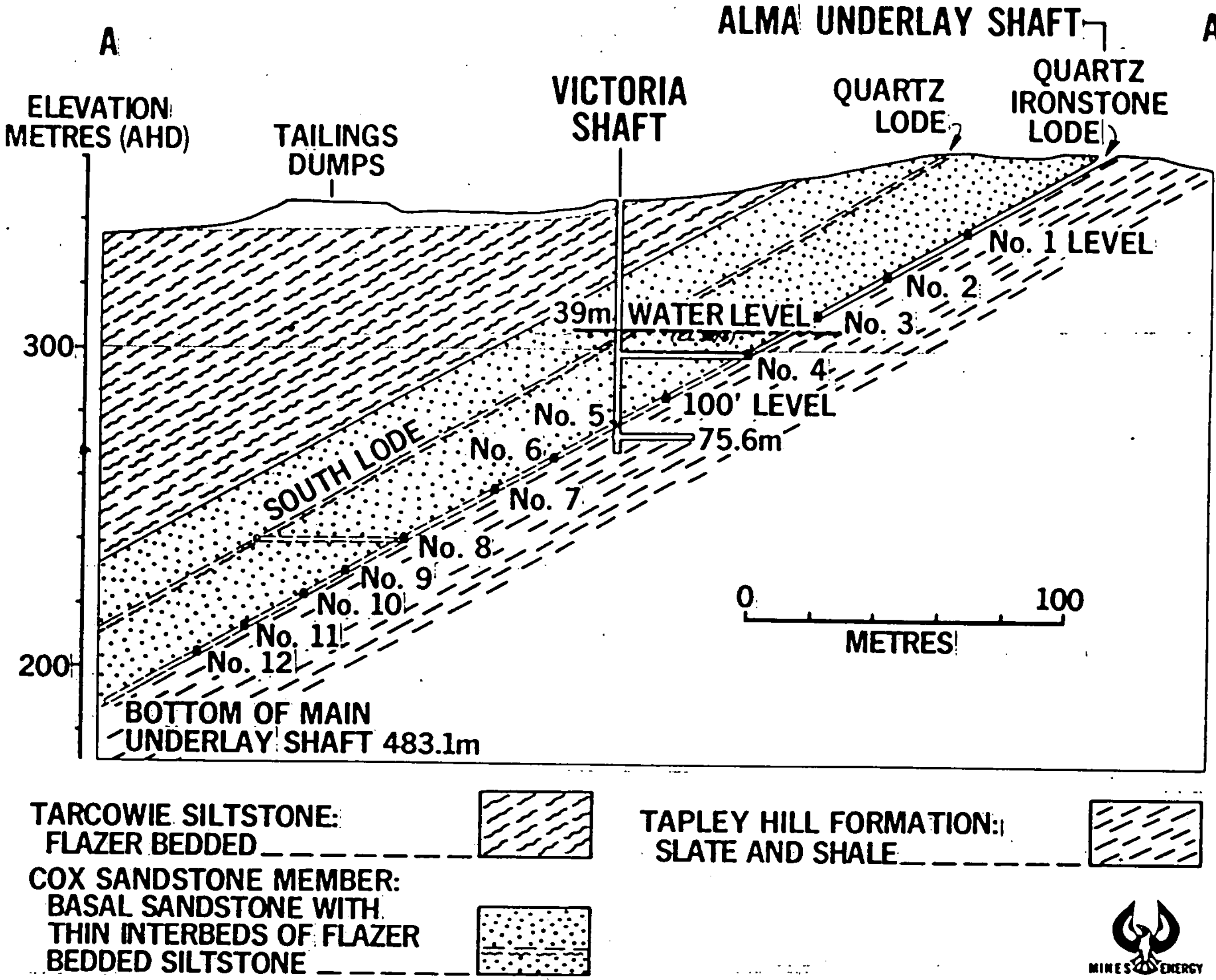

A
ALMA UNDERLAY SHAFT
A
ELEVATION METRES (AHD)
TAILINGS DUMPS
VICTORIA SHAFT
QUARTZ LODE
QUARTZ IRONSTONE LODE
No. 1 LEVEL
No. 2
39m WATER LEVEL
No. 3
300
No. 4
100' LEVEL
No. 5
75.6m
No. 6
SOUTH LODE
No. 7
No. 8
No. 9
No. 10
No. 11
No. 12
200
0
100
METRES
BOTTOM OF MAIN UNDERLAY SHAFT 483.1m
TARCOWIE SILTSTONE: FLAZER BEDDED
COX SANDSTONE MEMBER: BASAL SANDSTONE WITH THIN INTERBEDS OF FLAZER BEDDED SILTSTONE
TAPLEY HILL FORMATION: SLATE AND SHALE
MINES ENERGY

FIG 30

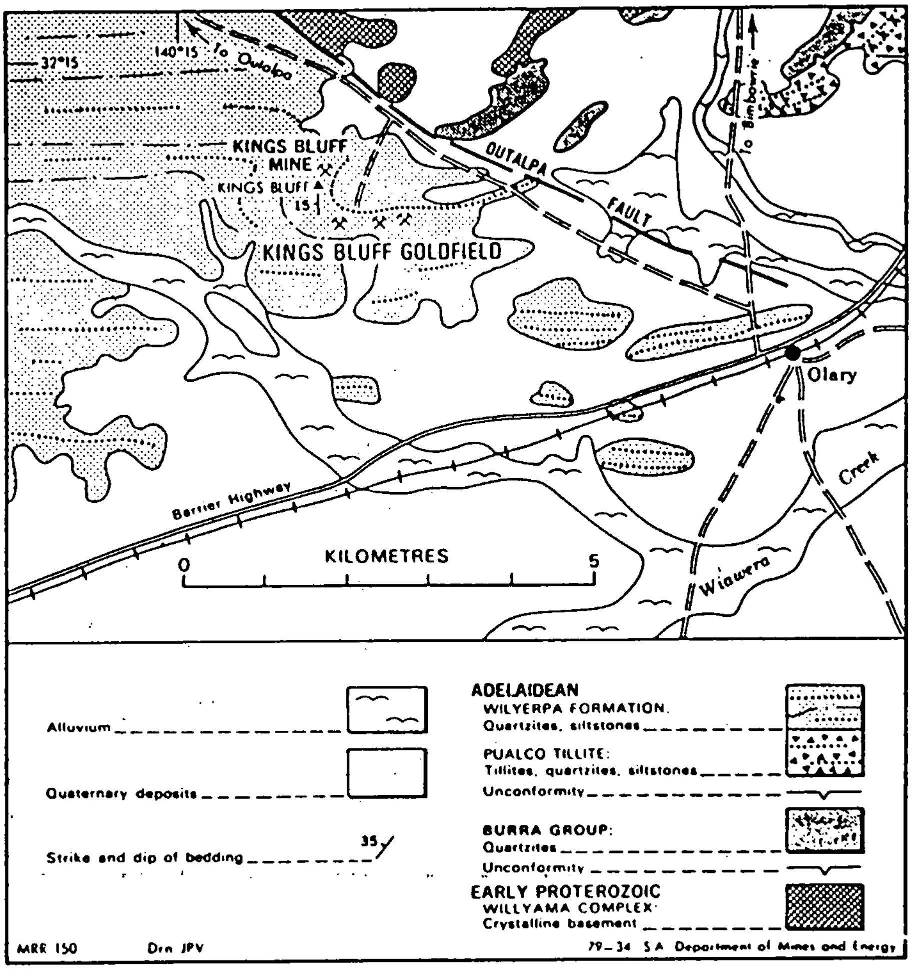


Fig. 1 Generalised geological plan—Kings Bluff Goldfield.

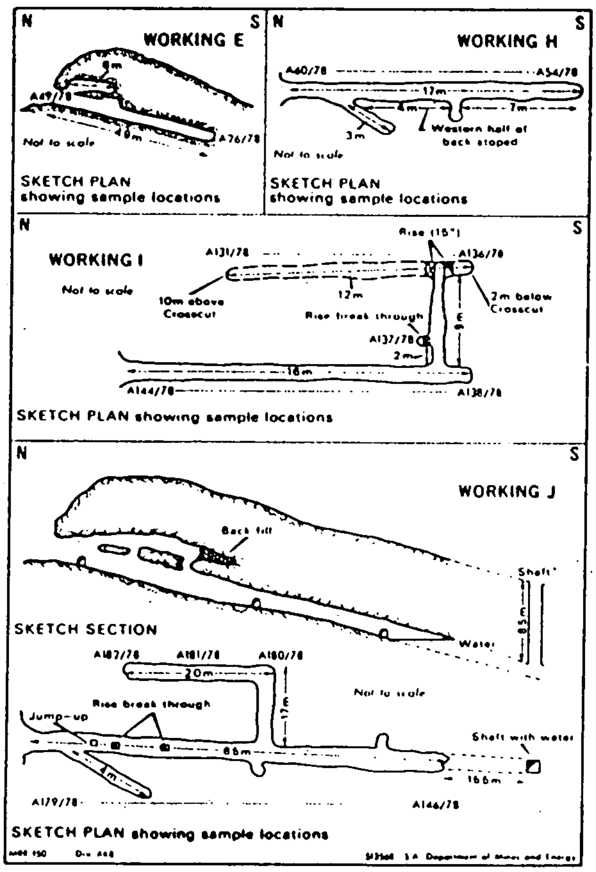


Fig. 3 Sketch plans and sections of workings—Kings Bluff Goldfield.

FIG. 33

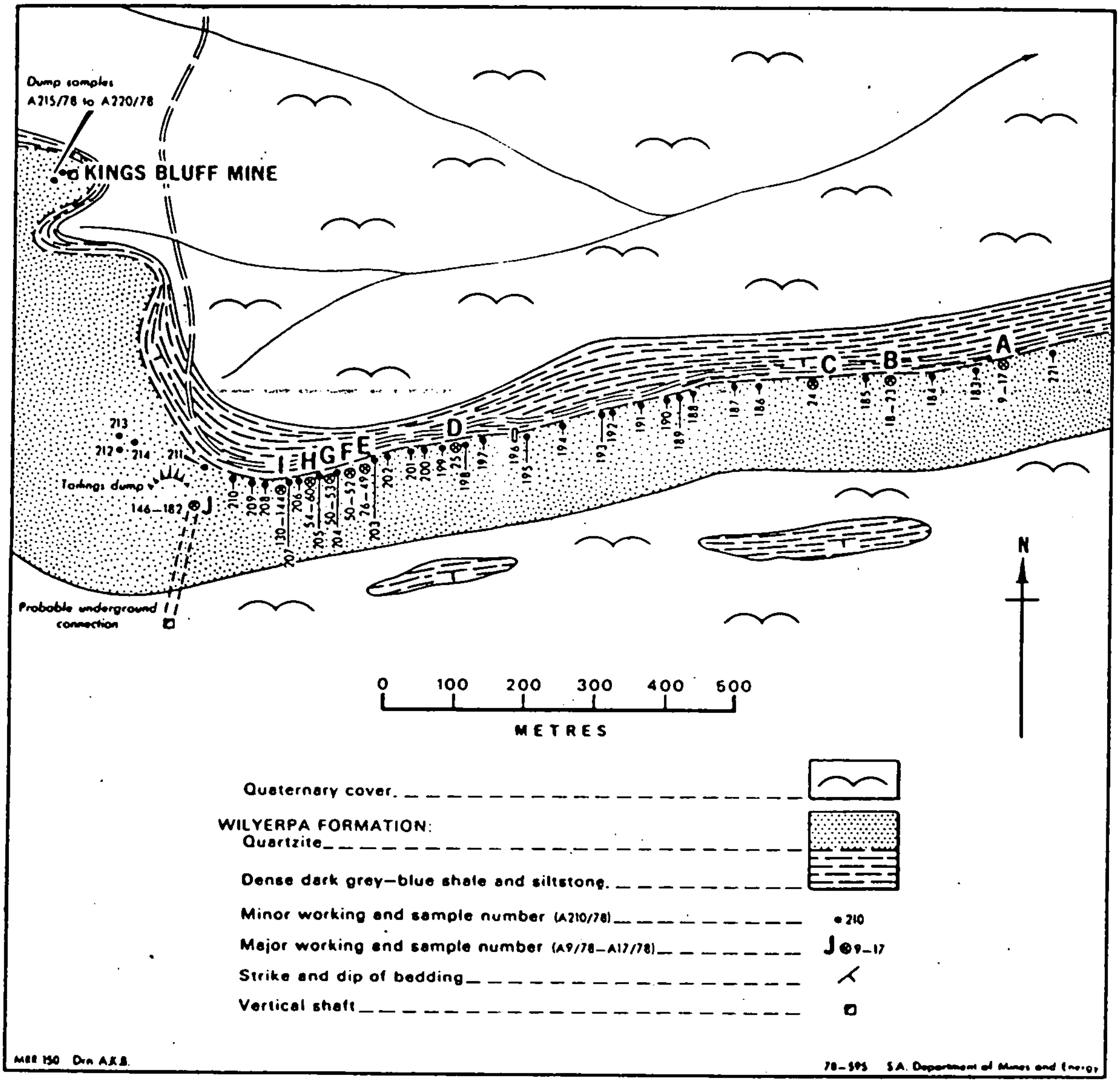
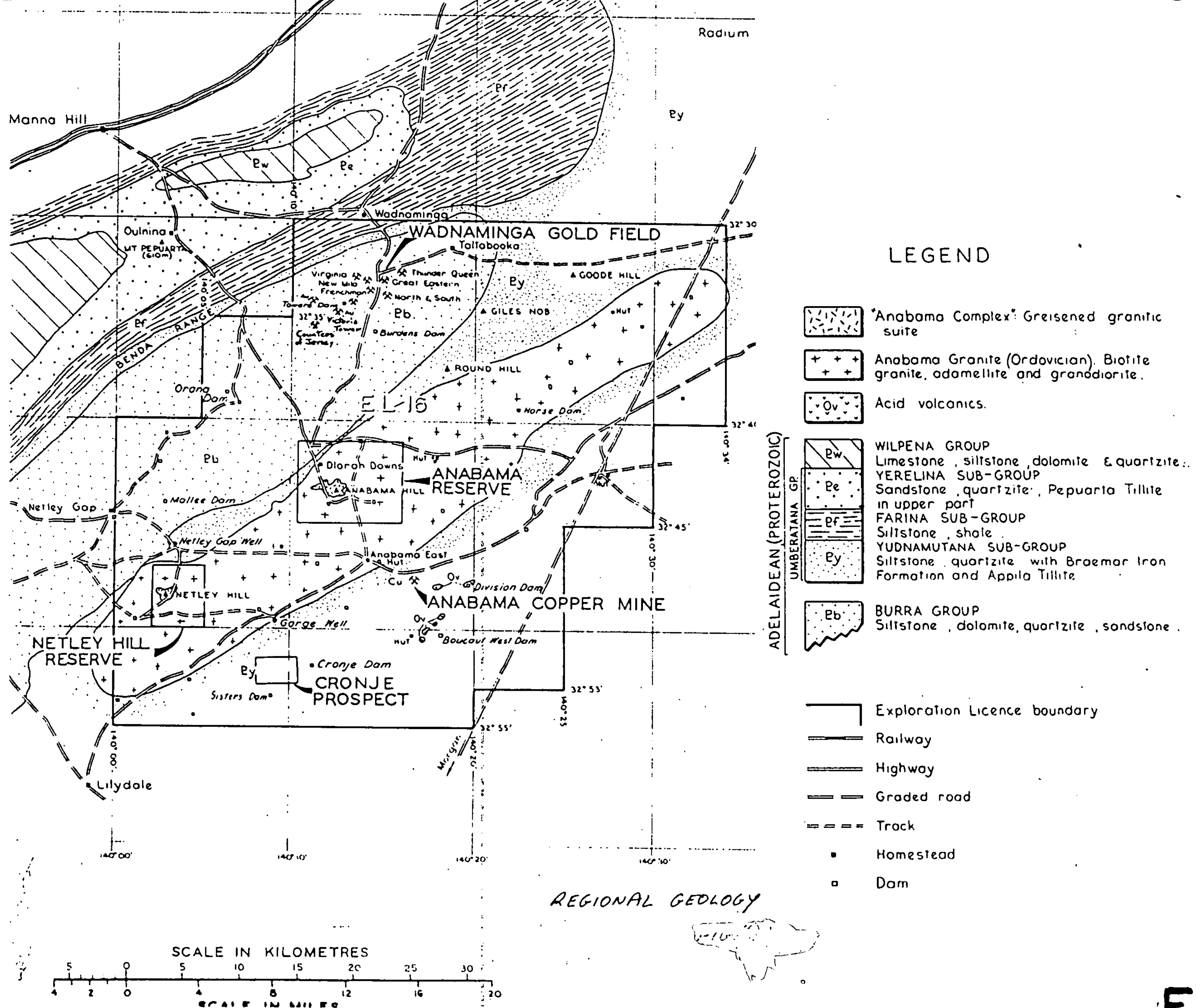


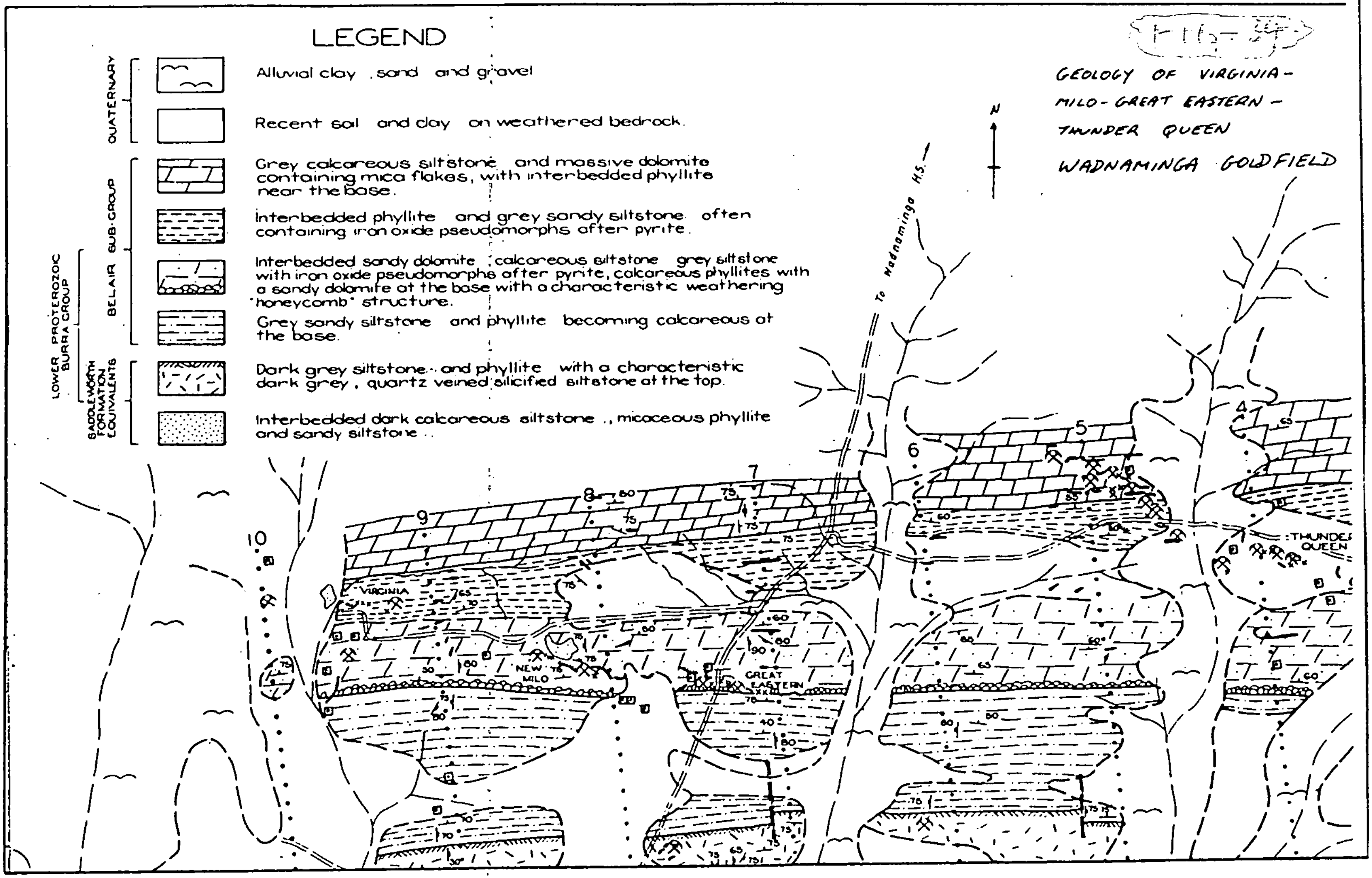
Fig. 2 Sample location plan.

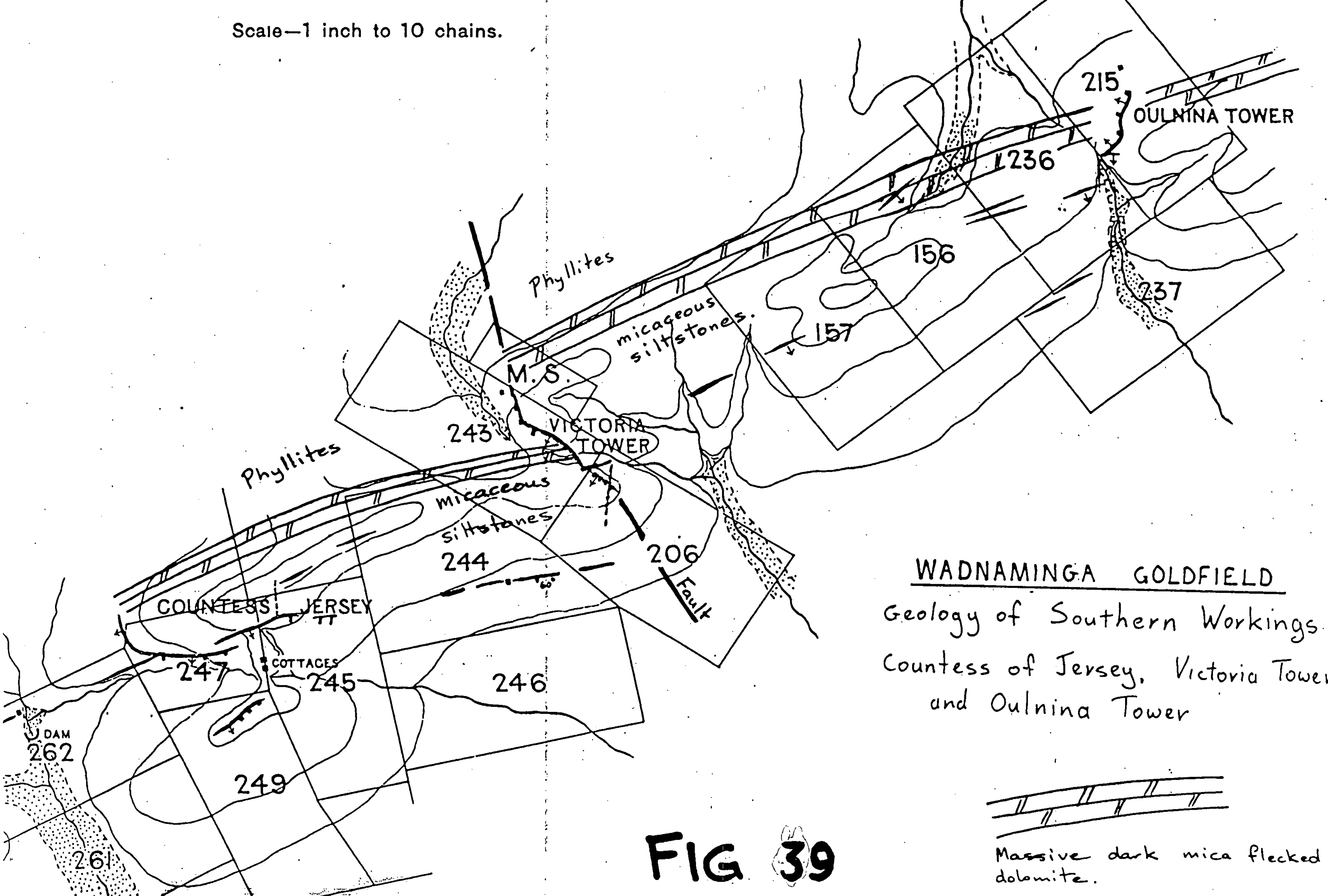
Fig. 34



REGIONAL GEOLOGY

FIG 37


LEGEND
QUATERNARY
Alluvial clay, sand and gravel
Recent soil and clay on weathered bedrock.
LOWER PROTEROZOIC BURRA GROUP
BELAIR SUB-GROUP
Grey calcareous siltstone and massive dolomite containing mica flakes, with interbedded phyllite near the base.
Interbedded phyllite and grey sandy siltstone often containing iron oxide pseudomorphs after pyrite.
Interbedded sandy dolomite, calcareous siltstone, grey siltstone with iron oxide pseudomorphs after pyrite, calcareous phyllites with a sandy dolomite at the base with a characteristic weathering "honeycomb" structure.
Grey sandy siltstone and phyllite becoming calcareous at the base.
SADDLEWORTH FORMATION EQUIVALENTS
Dark grey siltstone and phyllite with a characteristic dark grey, quartz veined silicified siltstone at the top.
Interbedded dark calcareous siltstone, micaceous phyllite and sandy siltstone.
GEOLOGY OF VIRGINIA - MILO - GREAT EASTERN - THUNDER QUEEN
WADNAMINGA GOLDFIELD
N
To Wadnaminga H.S.
VIRGINIA
NEW MILO
GREAT EASTERN
THUNDER QUEEN
10
9
8
7
6
5
4

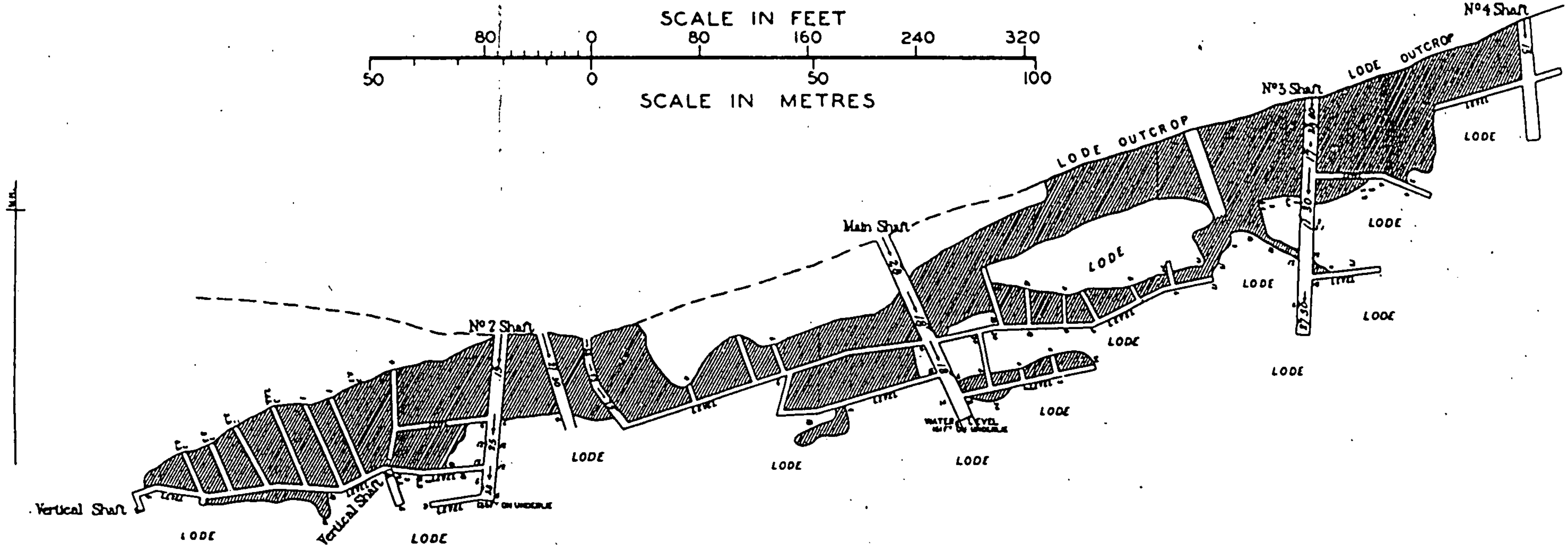


Scale—1 inch to 10 chains.
215
OULNINA TOWER
236
156
237
157
Phyllites
micaceous siltstones.
M.S.
VICTORIA TOWER
243
Phyllites
micaceous siltstones
244
206
Fault
COUNTESS JERSEY
COTTACES
247
245
246
DAM
262
249
261
WADNAMINGA GOLDFIELD
Geology of Southern Workings
Countess of Jersey, Victoria Tower and Oulnina Tower
Massive dark mica flecked dolomite.

FIG 39

VIRGINIA MINE.

Plan of Workings.



REFERENCE.

Portions of Lode Stoped.

Dips of Lodes.

The figures in Red denote the number of veins in the lode when divided. Those in black the thickness of the veins in inches.

FIG 40

NEW MILO MINE.

Plan of Workings and Section through Nutman's Shaft and Water Shaft.

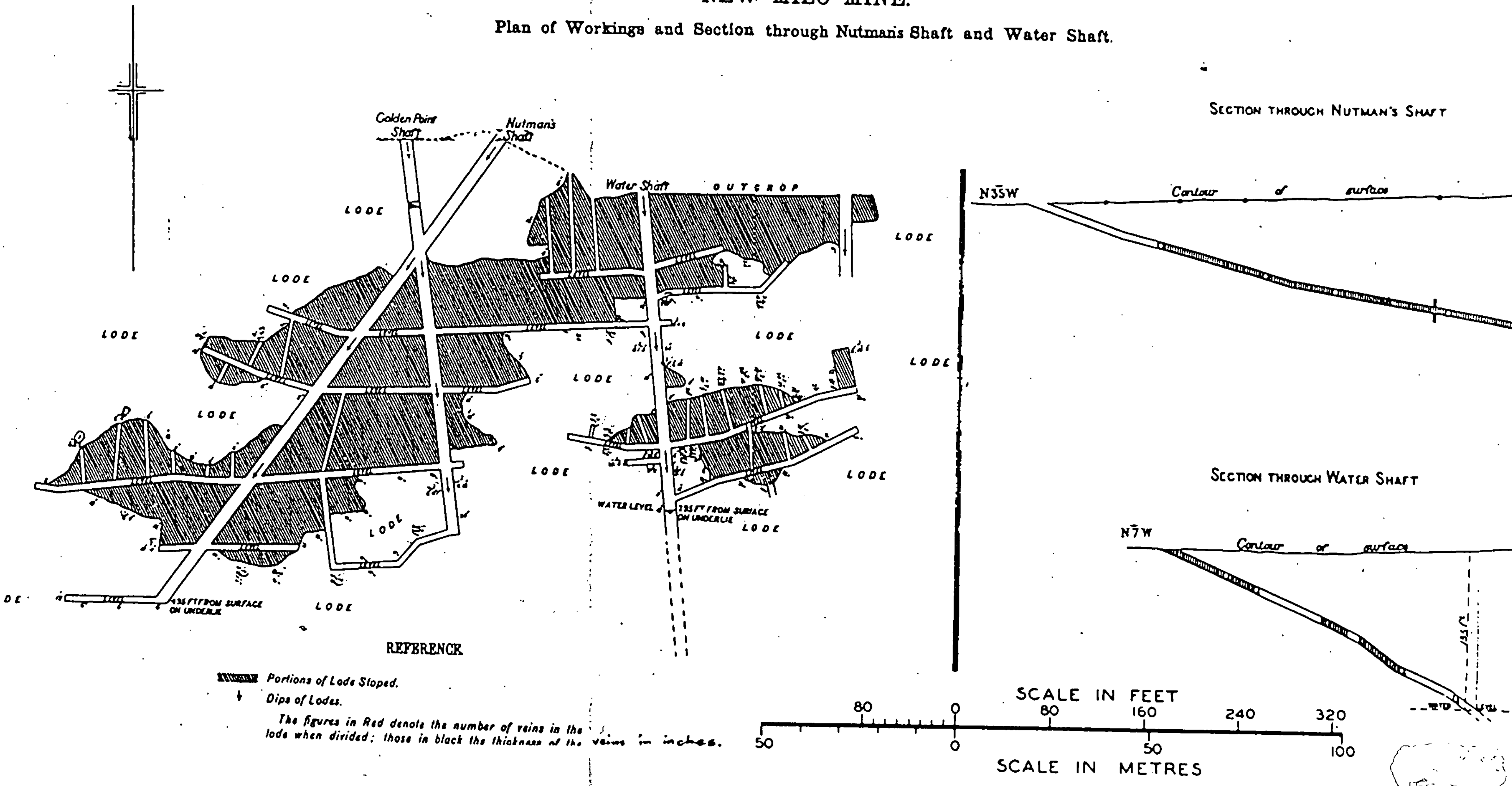


FIG 41

VICTORIA TOWER MINE.

Plan of Workings and Section through Main Shaft.

Scale—1 inch to 80 feet.

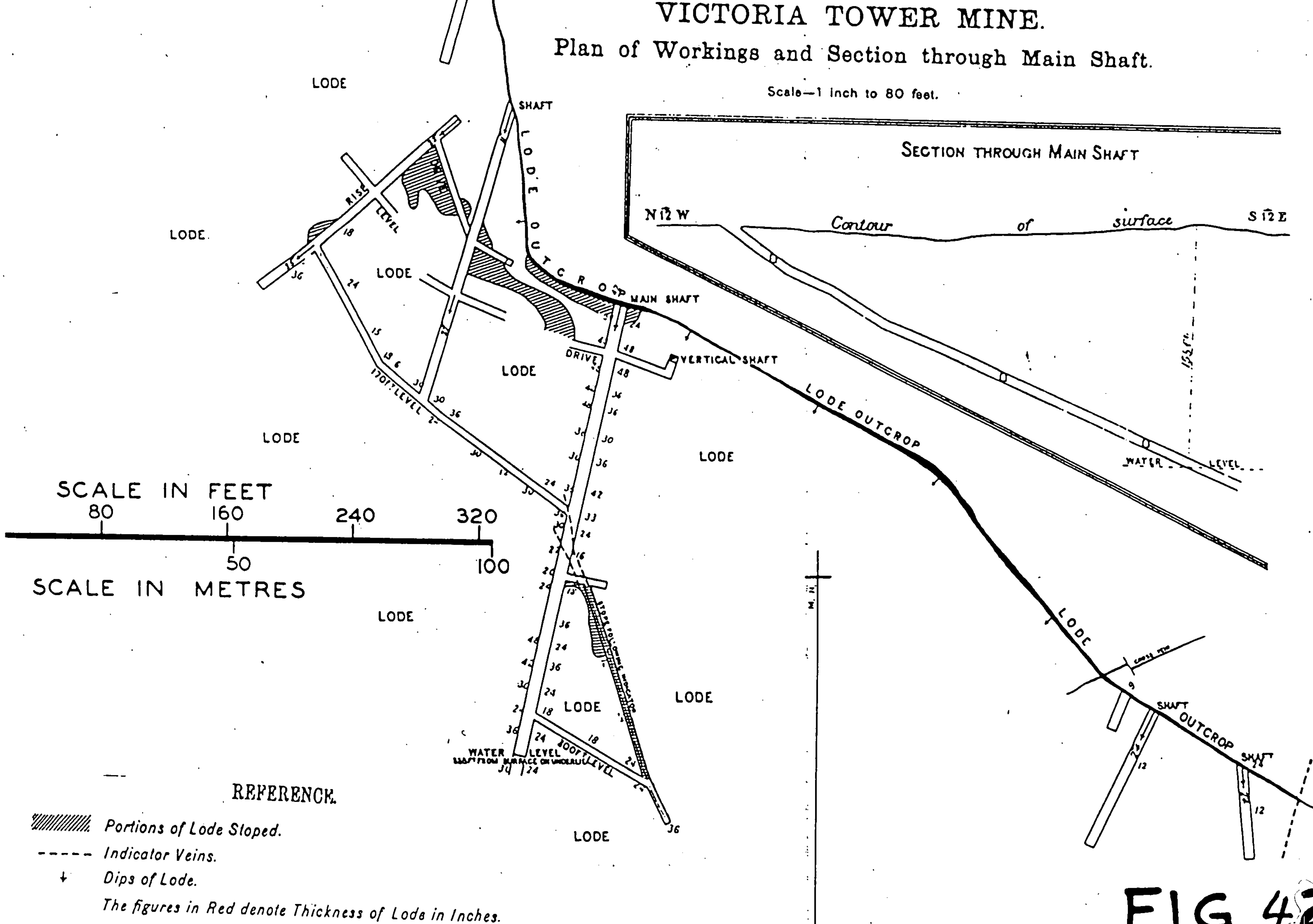


FIG. 42

TEETULPA GOLDFIELD

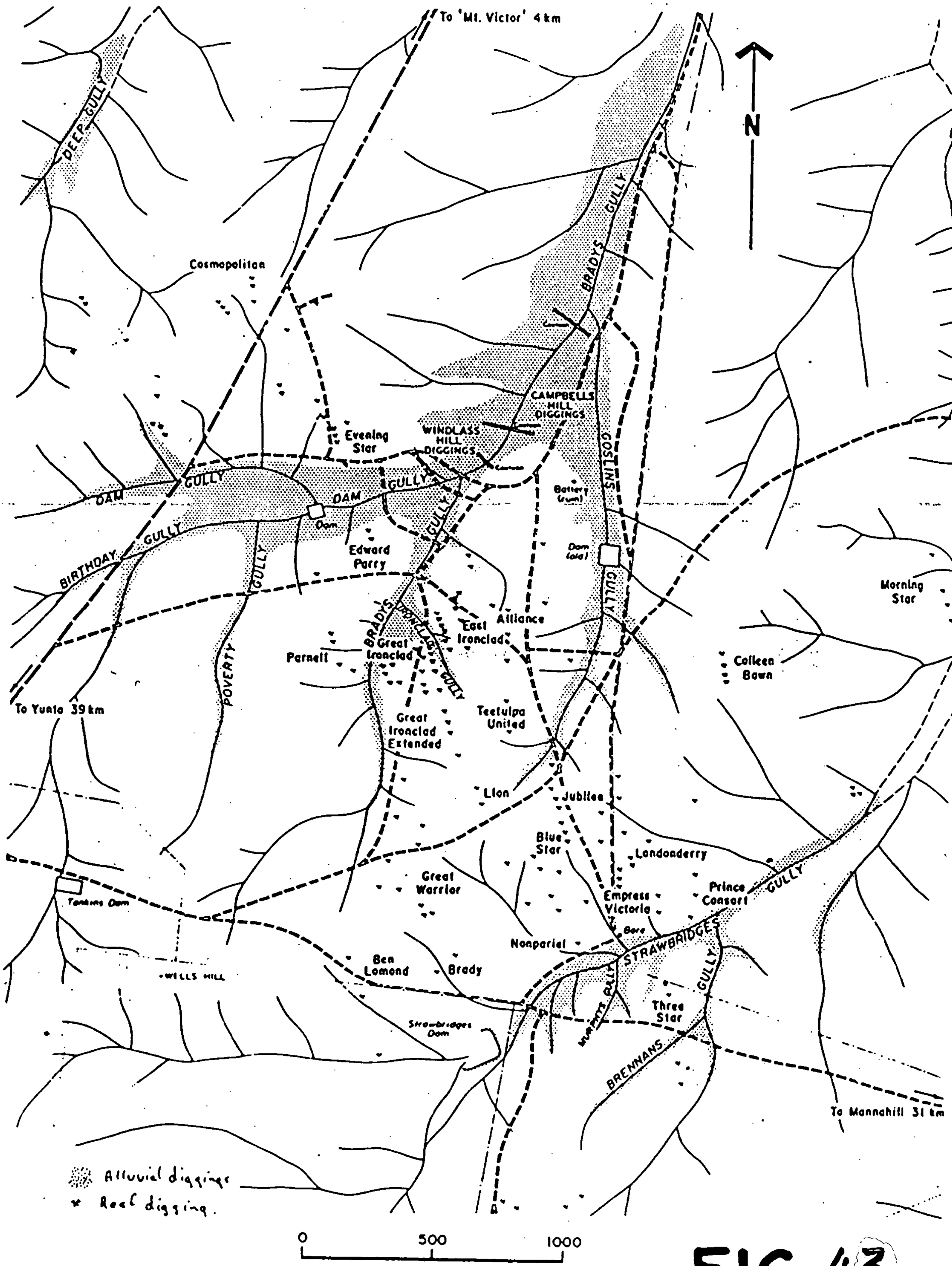


FIG. 43

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

FIG 44

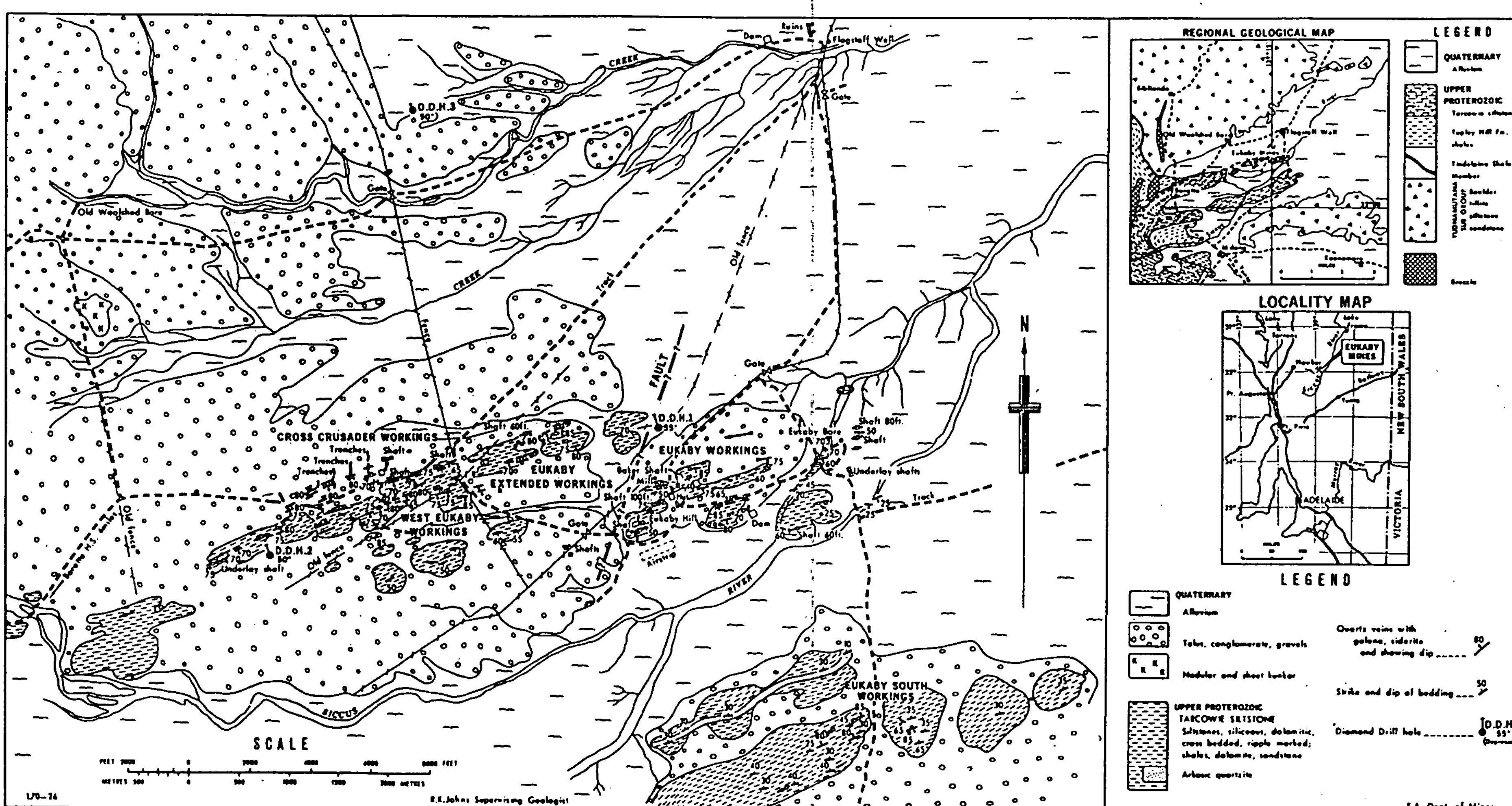


FIG. 1—GEOLOGICAL PLAN OF THE BARATTA (EUKABY, CRUSADER) SILVER-LEAD FIELD

DEPARTMENT OF MINES AND ENERGY
PETERBOROUGH GOVERNMENT BATTERY

FLOW SHEET FOR OPERATIONS AT BATTERY

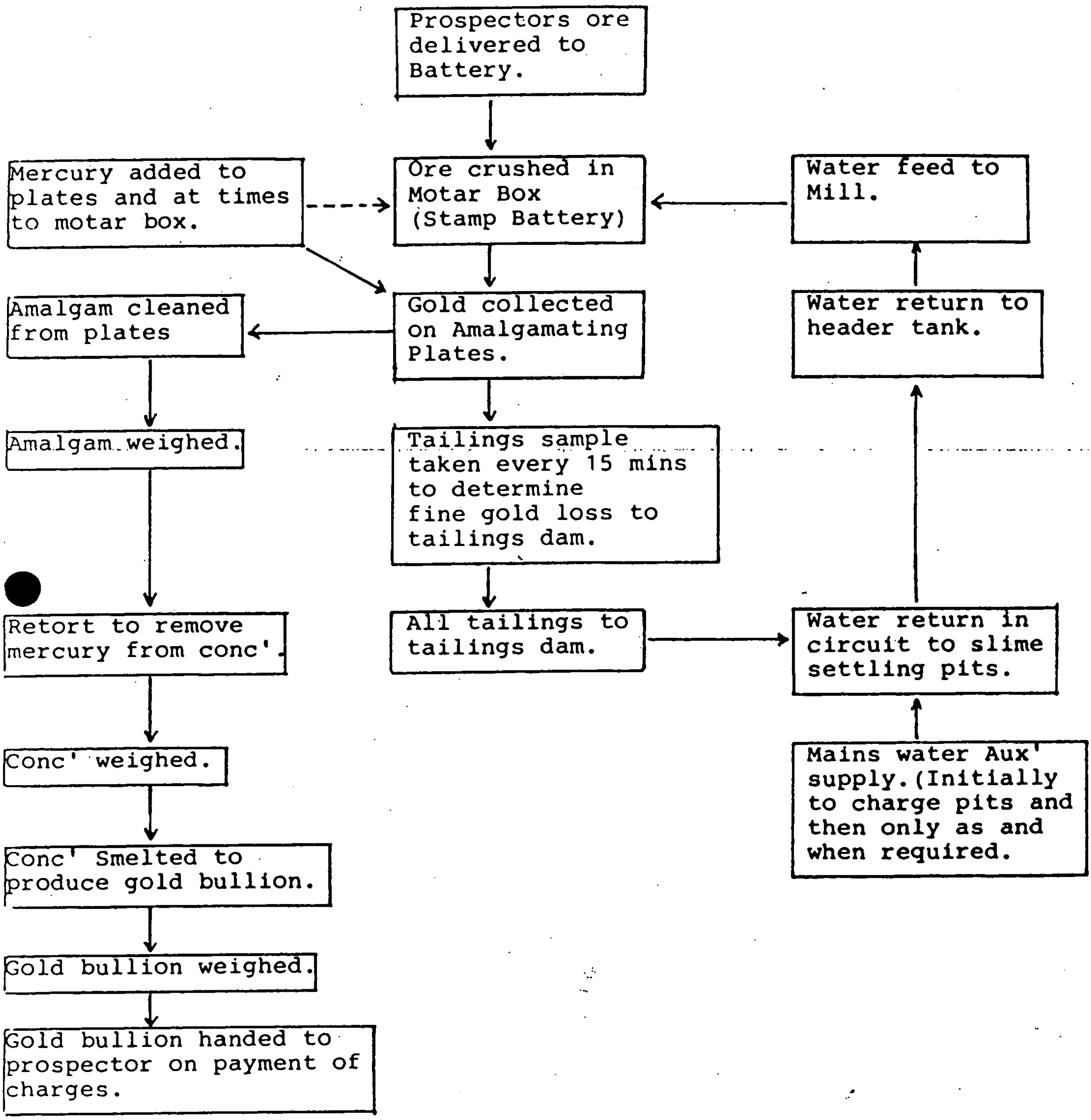
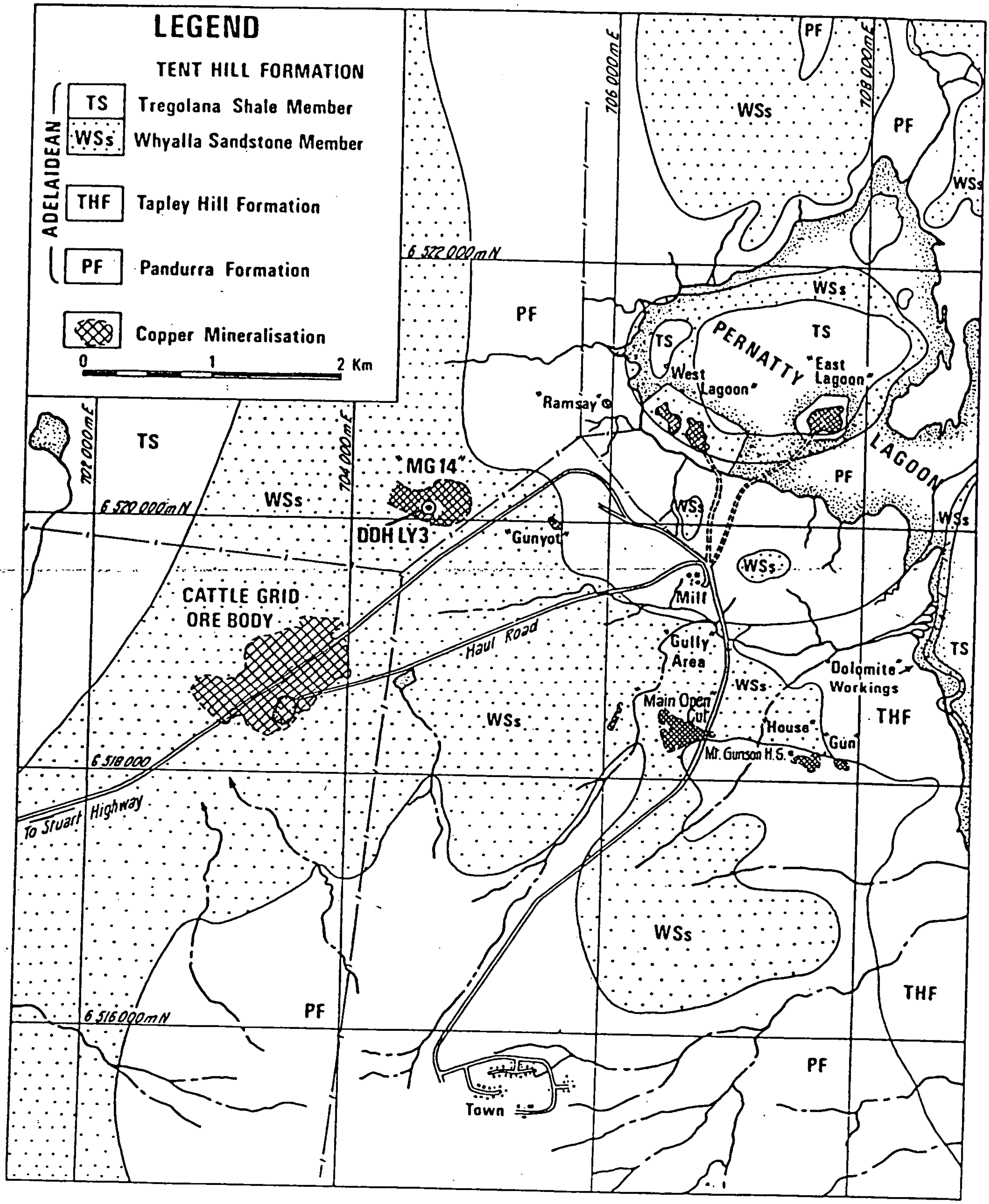


FIG. 45



LOCATION PLAN SHOWING MINERALISATION & GEOLOGY
CATTLE GRID - PERNATTY LAGOON AREA

FIG 46

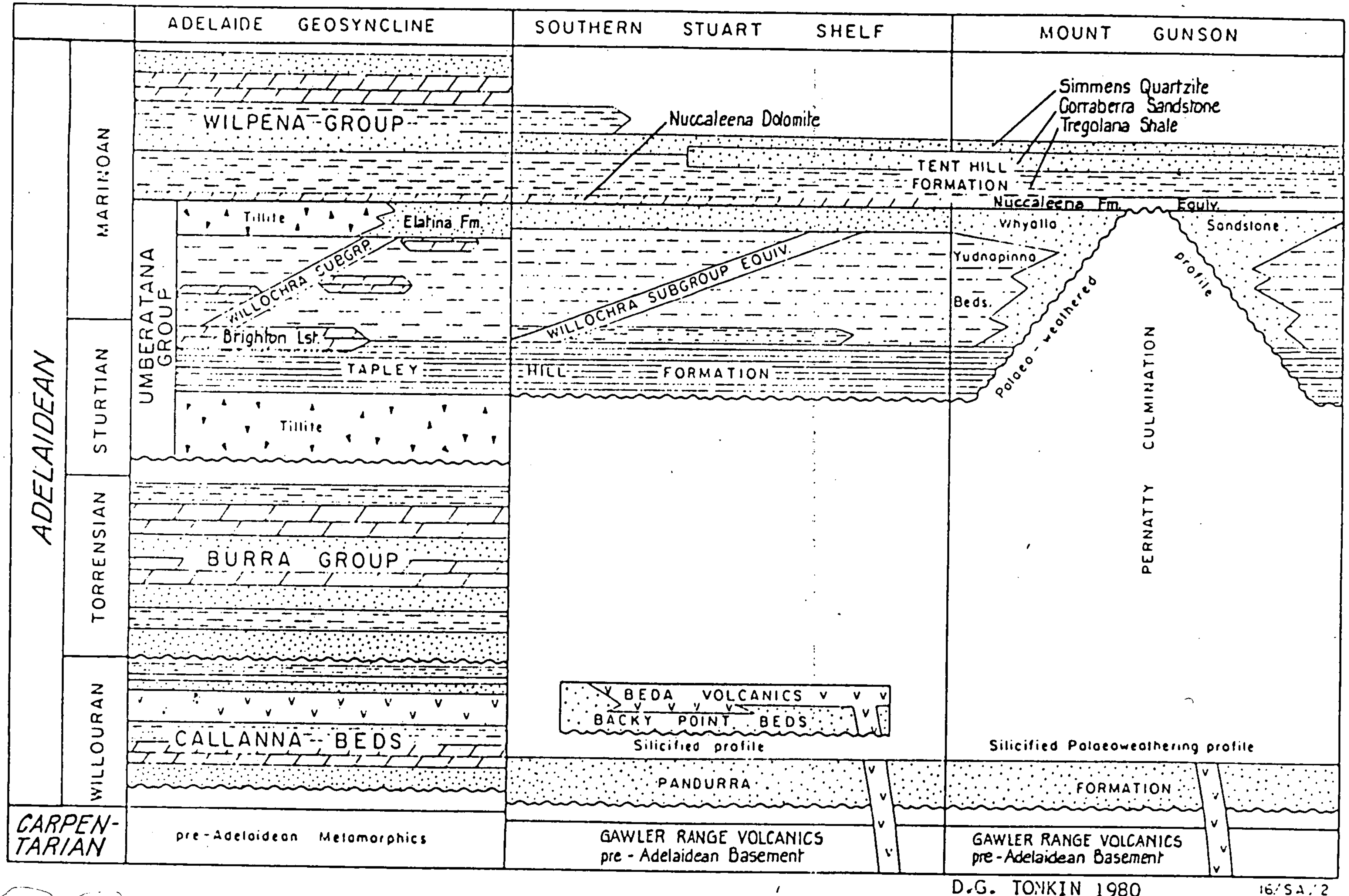
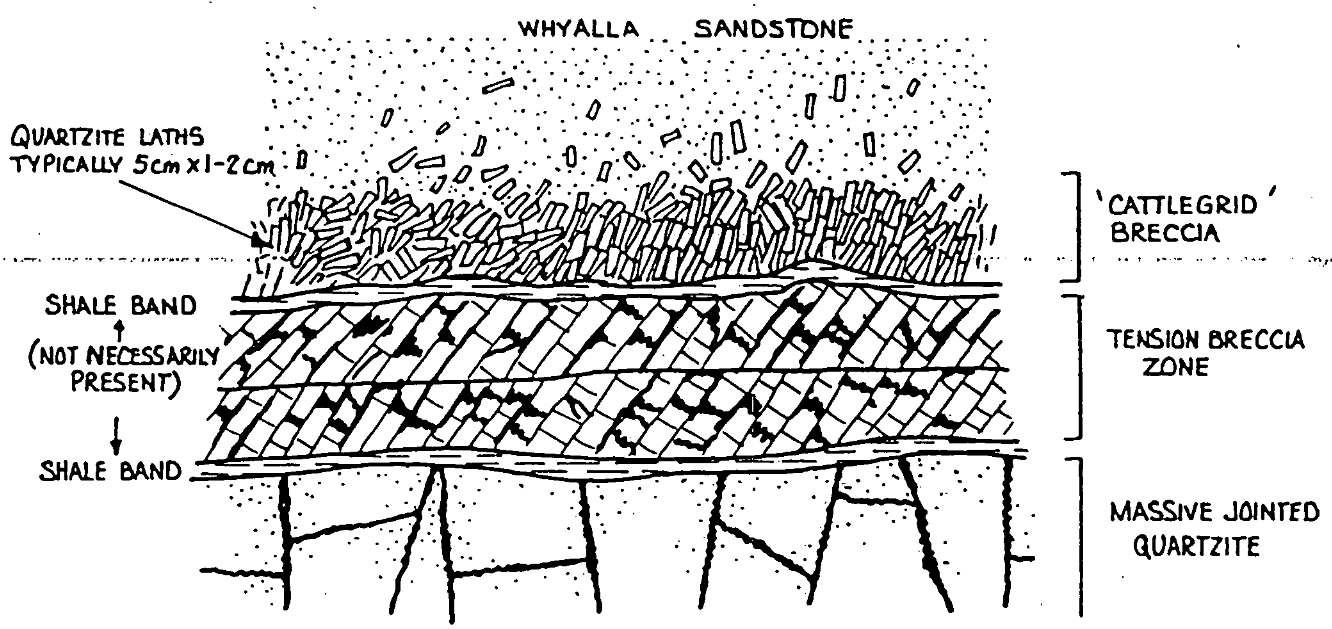


FIG 47

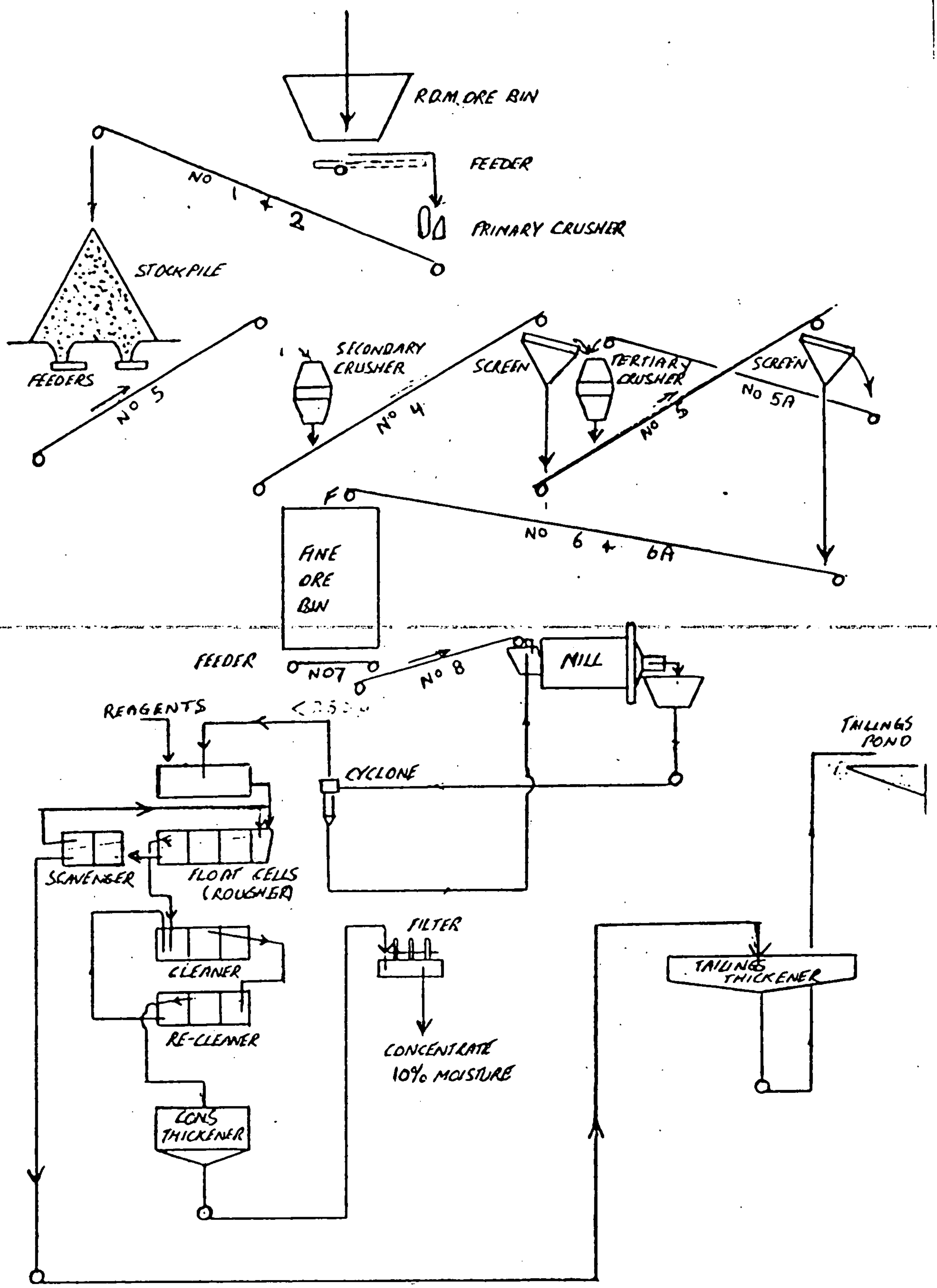
STRATIGRAPHIC COLUMNS - STUART SHELF & ADELAIDE GEOSYNCLINE



GOVEY 1979

IDEALISED ORE SECTION, SHOWING RELATIONSHIP OF CATTLEGRID BRECCIA, TENSION BRECCIA AND MASSIVE JOINTED QUARTZITE

Fig. 48



DIAGRAMMATIC FLOW SHEET
MT. GUNSON CONCENTRATOR.

FIG. 49

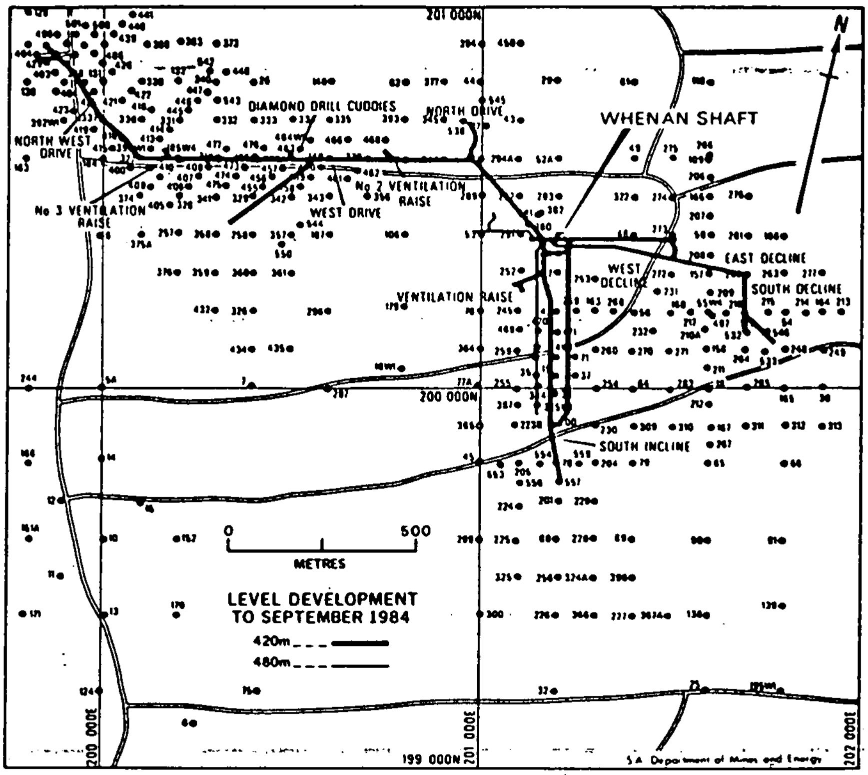


TABLE 1. Typical Cu-U Mineralized Drill Hole Intersections

Drill hole	Interval (m)	Thickness (m)	Cu (%)	U_3O_8 (kg/metric ton)	Au (g/metric ton)
RD1	353–391	38	1.05	0.40	
RD10	348–518	170	2.12	0.59	
RD19	422–436	14	2.00	trace	15.4
	684–758	74	3.04	0.45	
RD20	369–580	211	2.10	0.80	
RD24	343–649	306	1.00	0.20	
	811–1003	192	0.60	0.16	
	1003–1128	125	1.10	0.33	
RD39	368–414	146	3.25	0.68	

Location of drill holes indicated in Figure 3

OLYMPIC DAM
LEVEL DEVELOPMENT
1984

Fig. 50

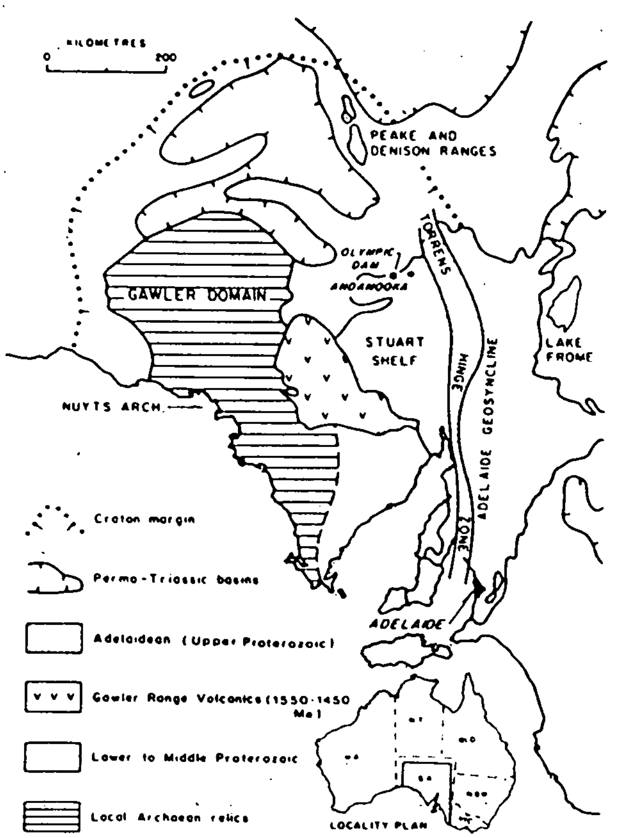


FIG. 1. Geologic map of the southern part of South Australia showing the main lithologic and tectonic features and the location of the Olympic Dam deposit.

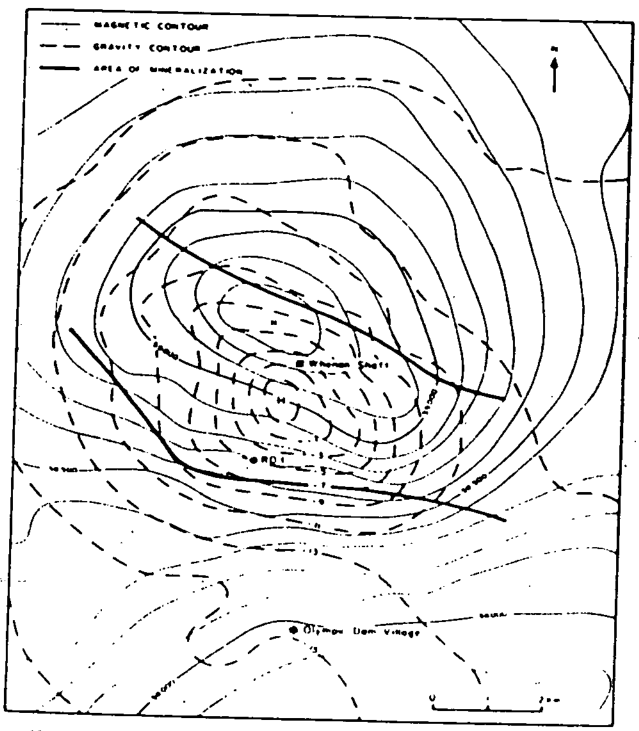


FIG. 2. Positive gravity and magnetic anomalies associated with the Olympic Dam deposit. Magnetic contours in nanoteslas; gravity in milliGals; H = center of anomaly; RD1 = discovery drill hole.

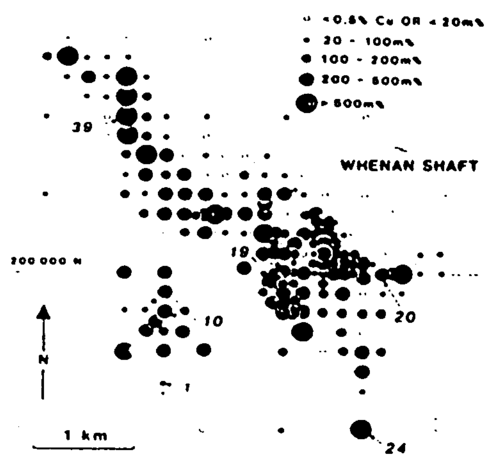


FIG. 3. Location of diamond drill holes showing greater than 0.5 percent copper intersections. See Table 1 for intersection in numbered drill holes.

OLYMPIC DAM

Geologic Map
Regional gravity and
Magnetic Anomalies
Drillhole Intersections

FIG 51

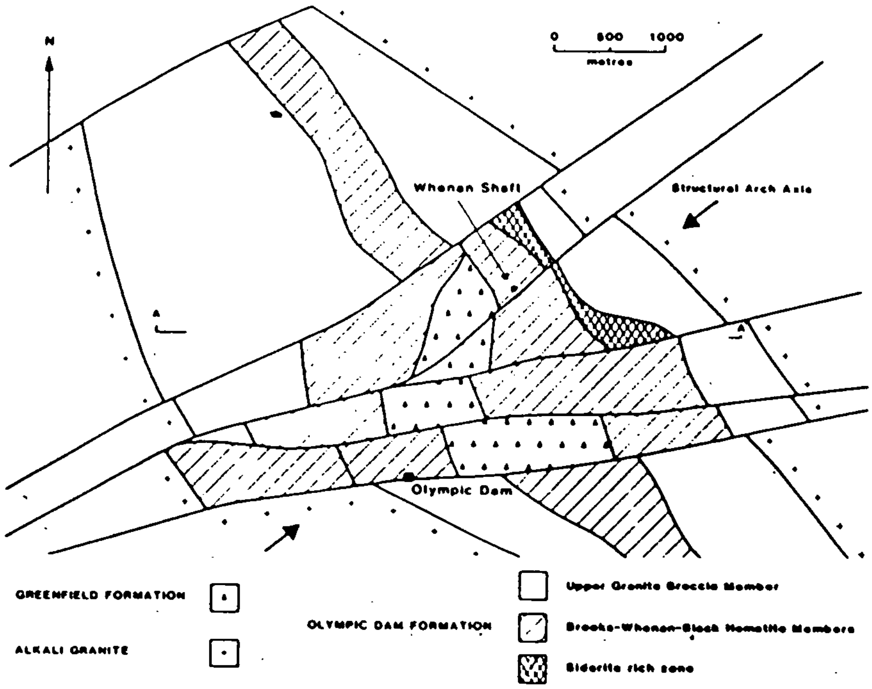


FIG. 5. Generalized geologic plan of the Olympic Dam deposit at the −450-m. level.

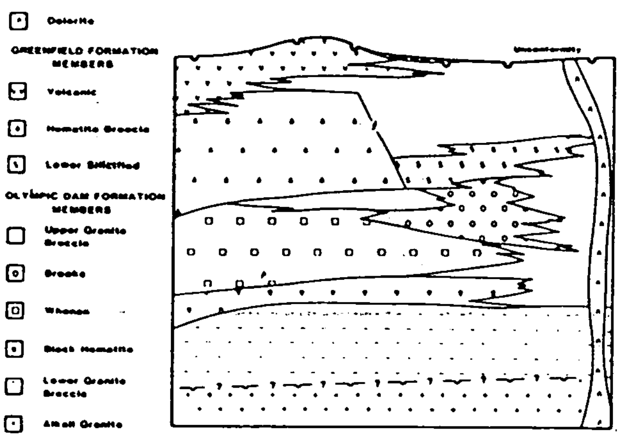


FIG. 4. Diagrammatic composite stratigraphic section of pre-Adelaidean units. Lithologies are summarized in Table 2. Approximate vertical extent is 1,500 to 2,000 m.

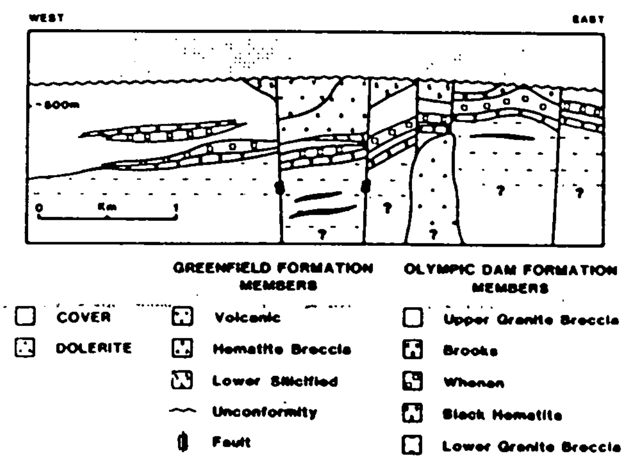


FIG. 6. East-west cross section of the Olympic Dam deposit at 200,000 N (A–A' in Fig. 5).

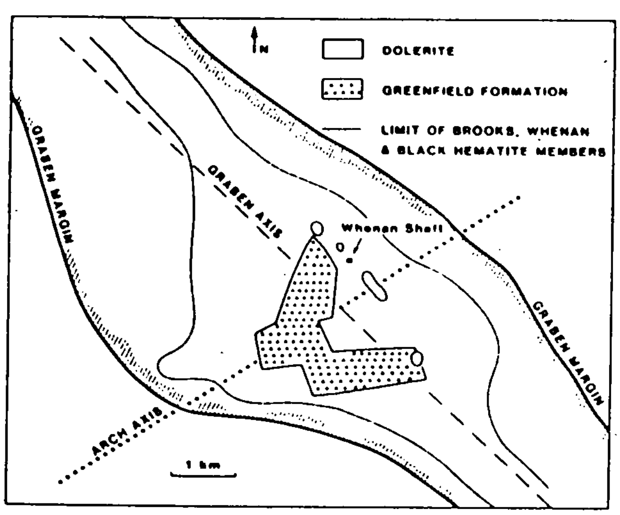


FIG. 10. Plan showing main structural elements of the Olympic Dam graben.

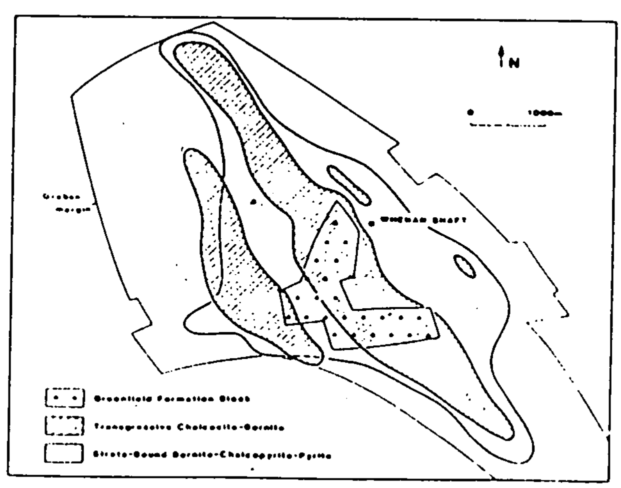


FIG. 11. Plan of the distribution of sulfide mineralization types

FIG 52

SILVER PRODUCTION

Silver content in concentrate shipped for period 1974-1982.

	Metal content kg
1974	602.66
1975	4 267.71
1976	3 543.32
1977	6 206.68
1978	4 820.19
1979	5 651.01
1980	4 250.44
1981	7 522.54
1982	4 551.85
1983	6 362.0
1984	3 630.0
TOTAL	51 408.40

References

Dawson, R.D., 1980. Silver recovery at The Broken Hill Associated Smelters Pty Ltd, Port Pirie, South Australia. In: Woodcock, J.T. (Ed.), Mining and Metallurgical Practices in Australasia, Monograph Series No. 10. Australas. Inst. Min. Metall., Melbourne, pp. 248-250.

Hart, D.H., 1980. Zinc production at The Broken Hill Associated Smelters Pty Ltd, Port Pirie, South Australia. In: Woodcock, J.T. (Ed.), Mining and Metallurgical Practices in Australia, Monograph Series No. 10. Australas. Inst. Min. Metall., Melbourne, pp. 250-254.

Pelton, L.A.H., 1980. Lead smelting and refining at The Broken Hill Associated Smelters Pty Ltd, Port Pirie, South Australia. In: Woodcock, J.T. (Ed.), Mining and Metallurgical Practices in Australia, Monograph Series No. 10. Australas. Inst. Min. Metall., Melbourne, pp. 232-237.

South Australian Department of Mines and Energy, 1984. BHAS Pty Ltd, Port Pirie. Miner. Ind. Q., S. Aust. Dept. Mines and Energy, 33:p.22 and 34:p.22.

Data Supplied by B.H.A.S. The Lead & zinc industry - Port Pirie, South Australia new edition, September, 1982.

MOUNT GUNSON MINES

INTRODUCTION

A small, in terms of production, open pit copper mine and concentrator is operated at Mount Gunson approximately 400 km north-northwest of Adelaide.

The present operation which began in August 1974 is a revival of an operation which commenced in 1969, but is now based on a new deposit of ore. Many of the facilities at the site were provided for the 1969-70 operation and have been modified and expanded as necessary.

Ore containing about 2% Cu as sulphide is mined at the rate of about 700 000 tonnes per annum and milled to produce a concentrate containing 43% Cu with minor amounts of silver, zinc, lead, bismuth and cobalt. Concentrate is trucked to Whyalla daily for shipment to Japan.

BRIEF HISTORY OF AREA AS A COPPER PROVINCE

Mount Gunson copper deposits were discovered in 1875.

Small parcels of high grade ore were mined and despatched for treatment over a 10 year period.

A reverberatory furnace was erected at Mount Gunson in 1905 and a chloridising leach plant in 1916, neither operated successfully due to silicious nature of the ore.

Between 1937 and 1943, The Zinc Corporation Limited, mined 31 000 tonnes of ore with an average grade of 3.5% Cu, on behalf of The Broken Hill Associated Smelters at Port Pirie. Work was discontinued when the minimum grade of 2.5% Cu could no longer be maintained by open cut mining.

During the years 1964-65, Jervois Sulphates (N.T.) Limited unsuccessfully attempted to produce copper sulphate by leaching.

Austminex Pty. Limtied carried out an extensive exploration program between 1966 and 1968 and indicated a reserve potential of 3 million tonnes of better than 1% Cu ore, suitable for open pit mining and flotation concentrating.

In 1969, the joint venture of Pacminex and United Uranium (Mount Gunson Mines Pty. Limited) purchased the rights and title to the deposit from Austminex and began construction of on site facilities. Reserves proved inadequate to warrant continued operations when world copper prices fell in 1971 and the plant closed down in December of that year.

Following closure, Pacminex Pty. Limited (the exploration and mining subsidiary of CSR Limited) outlined a new area of copper - lead-zinc mineralisation known as the Cattlegrid Area. Core drilling, sampling, mineralogical and metallurgical testing established the area (at 1% Cu cut off) as containing more than 4 million tonnes averaging 2.4% Cu.

In addition, drilling proved sufficient underground water to increase the capacity of the mill and allow the building of a small village to accommodate all employees at Mount Gunson.

These two factors, coupled with an upturn in the world copper price and the fact that mill and associated facilities already existed were compelling reasons to mine this new orebody.

The mining operation is currently operated by a Joint Venture arrangement between McMahon Constructions Pty. Ltd., and EMECO Australia Pty. Ltd. Remnant orebodies at Cattlegrid are being mined prior to closure in 1986.

GEOLOGY

Cattlegrid orebody is a concealed sandstone-hosted sulphide copper deposit with economically significant silver content. Located in the semi arid upper north of South Australia, the deposit lies within the upper Proterozoic, Adelaidean sedimentary sequence deposited on the Stuart Shelf (Fig. 46).

Adelaidean stratigraphy in the Cattlegrid area (Fig. 47) includes thick basal red-bed Pandurra Formation, hematitic, gritty sandstone which displays liesegang banding and silicification to depths of [illegible] 150 m. Pandurra Formation is overlain with major disconformity by Whyalla Sandstone - well sorted lithic quartz arenite with well rounded medium to coarse sand grains and clay matrix. In nearby areas, a major intervening unit, Tapley Hill Formation is developed. This unit consists predominantly of marine mudstone and dolostone, much of which was deposited in shallow water, including lagoonal environments.

Adelaidean rocks are underlain by early to middle Proterozoic rocks of the Gawler Craton. These 'basement' rocks comprise thick sequences of volcanics, including acid, intermediate and basic types. Cattlegrid orebody is situated at least 600 m above these pre-Adelaidean volcanics.

Lineaments, evident on aerial photographs, satellite imagery and aeromagnetic contour maps, are evidence of deep seated fractures and faults which have influenced the Adelaidean rocks in the Mount Gunson area. Movement along such structures is considered to have formed the structural high known as the Pernatty Culmination, on the western flank of which lies the Cattlegrid deposit.

Cattlegrid mineralisation is hosted primarily by a localised closely fractured and brecciated zone about the disconformity between Pandurra Formation and Whyalla Sandstone. Mineralisation extends downwards into massive Pandurra Formation as local fracture fillings, and upwards into disturbed basal Whyalla Sandstone as interstitial cement and inter-breccia fill. Whyalla Sandstone penetrates brecciated Pandurra Formation whilst Pandurra Formation breccia is also intercalated with basal Whyalla Sandstone (Fig. 48).

The breccia zone is now considered as part of a palaeoweathering profile of palaeopermafrost origin. Extensive frost wedging and perhaps salt wedging, especially in the uppermost cross bedded Pandurra Formation is believed to be the principal agent of brecciation. Deformation structures within the breccia were probably the result of frost heave and frost thrust. Sand wedges (downwards penetration of Whyalla Sandstone) provide firm evidence of a periglacial permafrost environment which persisted during deposition of basal Whyalla Sandstone.

Cattlegrid orebody is crescent shaped in plan with northeasterly elongation. Higher grade zones of mineralisation display northeasterly and northwesterly elongation which correspond with the strike of sets of penetrative, steep dipping fractures and faults in the orebody and footwall. Normal and reverse faults with small vertical displacement and associated brecciation of adjacent rock host narrow zones of high grade mineralisation to at least 20 m below the pit floor. Deep drilling has intersected 'Cattlegrid ore' veinlets approximately 120 m below the mine floor.

The orebody is a sub-horizontal, tabular shaped zone within a more extensive mineralised zone. Average thickness of the orebody is approximately 4.5 m and average depth to the top of ore is about 36 m. Average strip ratio (waste:ore) is 9.2:1.

Feasibility study in-situ ore reserves were estimated at 4.6 million dry tonnes with grade 2.44% Cu and 13 ppm Ag. The ore was also estimated to contain 0.47% Zn, 0.18% Pb, 0.06% Co and about 300 ppm Bi. Allowance for dilution resulted in mineable reserves of 5.6 million dry tonnes with grade 2.07% Cu.

As at 31 December 1982, ore mined plus mineable ore reserves totalled 6.37 million dry tonnes with average grade 1.9% Cu. 5.02 million dry tonnes with grade 1.93% Cu were mined and treated to 31 December 1982.

Minerals at Cattlegrid are pyrite, marcasite, arseniferous pyrite, carrollite, sphalerite, chalcopyrite, bornite, sulphur-rich bornite, digenite, djurleite, chalcocite, galena, wittichenite and native bismuth.

Mineralogical zoning is distinct. Three zone types are recognised:

- chalcopyrite-concentrated in the central portion and extending outside the orebody to the northwest.
- bornite - flank chalcopyrite zones.
- chalcocite zones (the last formed) rim bornite zone in the northeastern, southwestern and southeastern parts of the orebody.

The source of the copper at Cattlegrid is considered to be the Pre-Adelaidean volcanic basement. Fluids which circulated in and leached this basement were tapped by deep seated fractures and introduced either directly upwards into the host breccia at Cattlegrid, or into fluids circulating through adjacent Adelaidean basin areas which have subsequently migrated up-dip to the site of mineralisation.

MINING

Copper ore is extracted by open cut at the rate of approximately 700 000 tonnes per year, and is transported 3 km to the mill by 32 tonne dump trucks.

About 7 million tonnes of sandy overburden is removed each year.

An important feature of the mining operation is the rehabilitation and revegetation of areas disturbed to an acceptable state for grazing.

The main mining equipment is listed below:

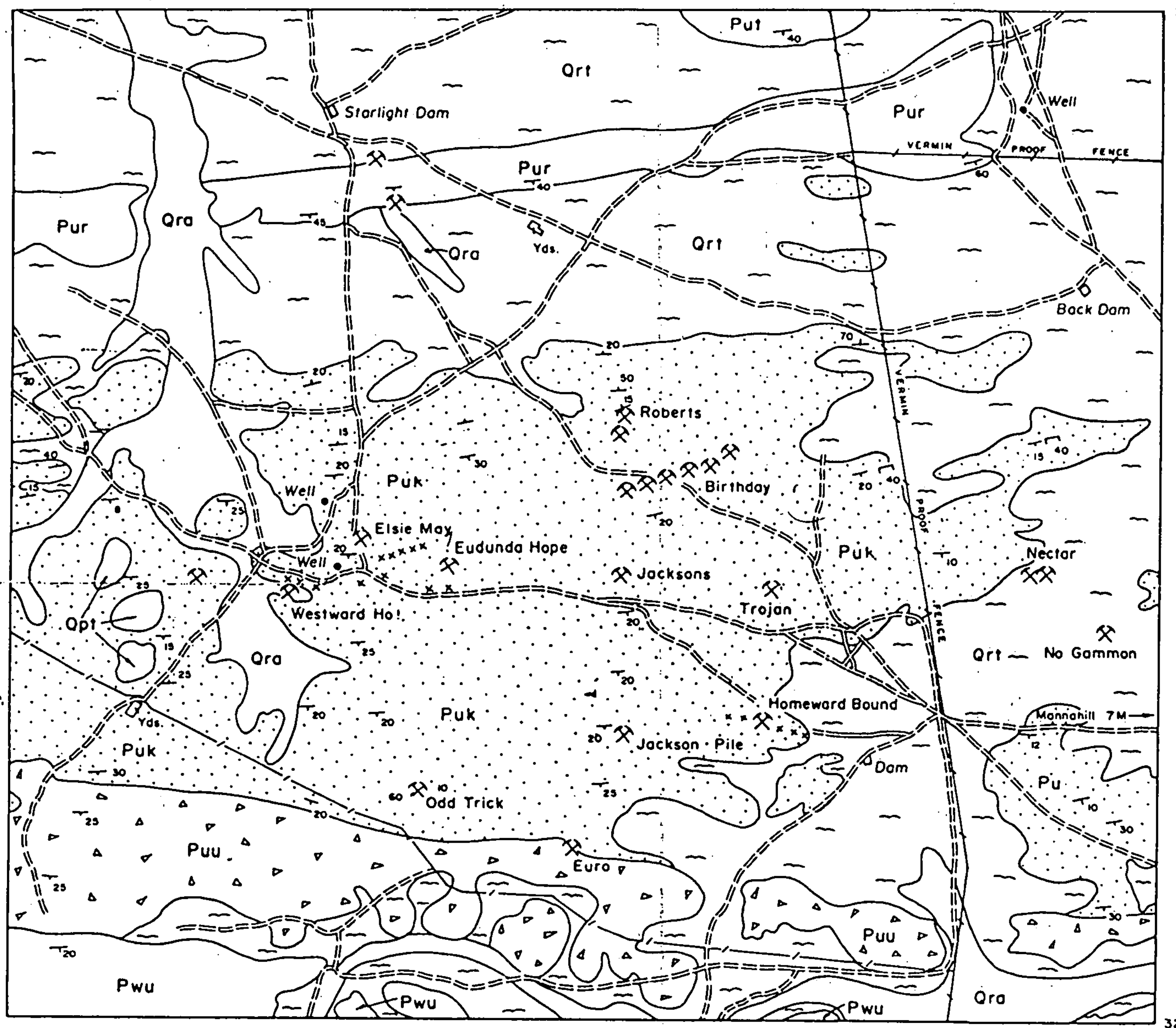
Bulldozers	-	1 Caterpillar DeK with tilt blade and Hyd. Ripper
		1 Caterpillar D9H with tilt blade and Hydr. Ripper
		1 Caterpillar D9L with tilt blade and Hydr. Ripper
Scrapers	-	2 Caterpillar 633D Elevating Scrapers 26 m^3
Drills	-	2 Gardner Denver ATD 3100A Airtrack, PR66 drifters
		1 Atlas Copco ROC 601-03 150B Airtrack
		1 RDC 16A Gardner Denver Rotary Drill
		1 Atlas Copco Rotamec 1700 Rotary Drill
Loaders	-	5 Caterpillar 988B Wheel Loader, 5.3 m 3 Bucket
		1 Caterpillar 950 Wheel Loader, 3 m 3 Bucket
Trucks	-	8 Caterpillar 769B Rear Dump, 32 tonnes
		2 Caterpillar 769C Rear Dump, 32 tonnes
Graders	-	2 Caterpillar 140G Motor Grader
Ancillary	-	3 Gardner Denver Sp 1050 Compressors
		1 Compair 275C compressor
		1 Trailer mounted ANFO mixer
		1 Chamberlain Agricultural Tractor
		3 Warman DHH3/2 Slurry pump powered by diesel engines
		1 Case Backhoe/Hydraulic rock hammer

MILLING

Figure 49 provides a diagrammatic flow sheet. Ore is crushed and milled and then subjected to flotation to remove mineral-bearing particles which are washed, thickened (by removing water) and finally filtered to produce about 30 000 tonnes per year of concentrate with 43% Cu and about 8% water. Waste material is pumped to a tailings dam, from which water is extracted and returned to the mill for re-use.

Main milling equipment is listed below:

Truck Hopper	- 150 Tonnes
Apron Feeder	- Link Belt Malco SG 414 S/No.920
Primary Crusher	- Vickers Ruwolt, single toggle, 1070mm x 760 mm
No. 1 Belt	- 760mm x 102000mm - 32 hp
No. 2 Belt	- 610mm x 134000mm - 30 hp
Coarse Ore Stockpile	- 10 000 Tonnes
No. 3 Belt	- 760mm x 132000mm - 20.5 hp
Secondary Crusher	- 1370mm x Standard Symons
No. 4 Belt	- 610mm x 68000mm - 15 hp
Tertiary Screen	- Single Deck. Linkbelt CA lyte Malco CA 1515 S/No.919
Tertiary Crusher	- 1220mm Shorthead Symons
No. 5 Belt	- 610mm x 85000mm - 20 hp
Recycle Screen	- Single Deck Linkbelt CB lyte 1718 S/No.1302 2.1m x 5.5m
No. 5A Belt	- 610mm x 10800mm - 10 hp
No. 6A Belt	- 760mm x 32000mm - 10 hp
No. 6 Belt	- 610mm x 87000mm - 20 hp
Fine Ore Bin	- 1 000 Tonnes
No. 7 Belt	- 760mm x 22000mm - 15 hp
No. 8 Belt	- 610mm x 42000mm - 7.5 hp
Ball Mill	- Goninan 4570mm x 3200mm - 900 hp
Cyclones	- 2 only 510mm Krebbs
Flotation	-
Rougher	- 8 cells x 30.48m 3 30DR - Denver
Scavenger	- 8 Cells " " " "
Cleaner	- 4 Cells x 10.67m 3 18SD - Denver
Re-cleaner	- 2 Cells " " " "
Concentrate Thickener	- 7300mm Goodwin Denver



MANNAHILL GOLDFIELD

REGIONAL GEOLOGY

LEGEND

QUATERNARY	RECENT	Qra	Alluvium of present creek and flood plains.
	PLEISTONE	Qrt	Alluvium and colluvium of slopes and plains above present creek beds.
		Qpt	Older gravels formed at higher surface level.
UPPER PROTEROZOIC (ADELAIDEAN)	MARINOAN	Pwu	ULUPA SILTSTONE: Thick greenish siltstone underlain by quartzite with dolomite underbeds.
	STURTIAN ?	Puu	PEPUARTA TILLITE: Includes siltstone, quartzite, tillite and arkose.
		Puk	WAUKARINGA SILTSTONE: Blue grey finely laminated siltstone with gold mineralization in places.
		Pur	TARCOWIE SILTSTONE: Sandy siltstone, fawn or green-grey.
		Put	TAPLEY HILL FORMATION: Blue-grey, siltstone with pyritic shale at base.

30 BEDDING

45 CLEAVAGE

GOLD MINE WITH LINE OF WORKINGS

TRACK

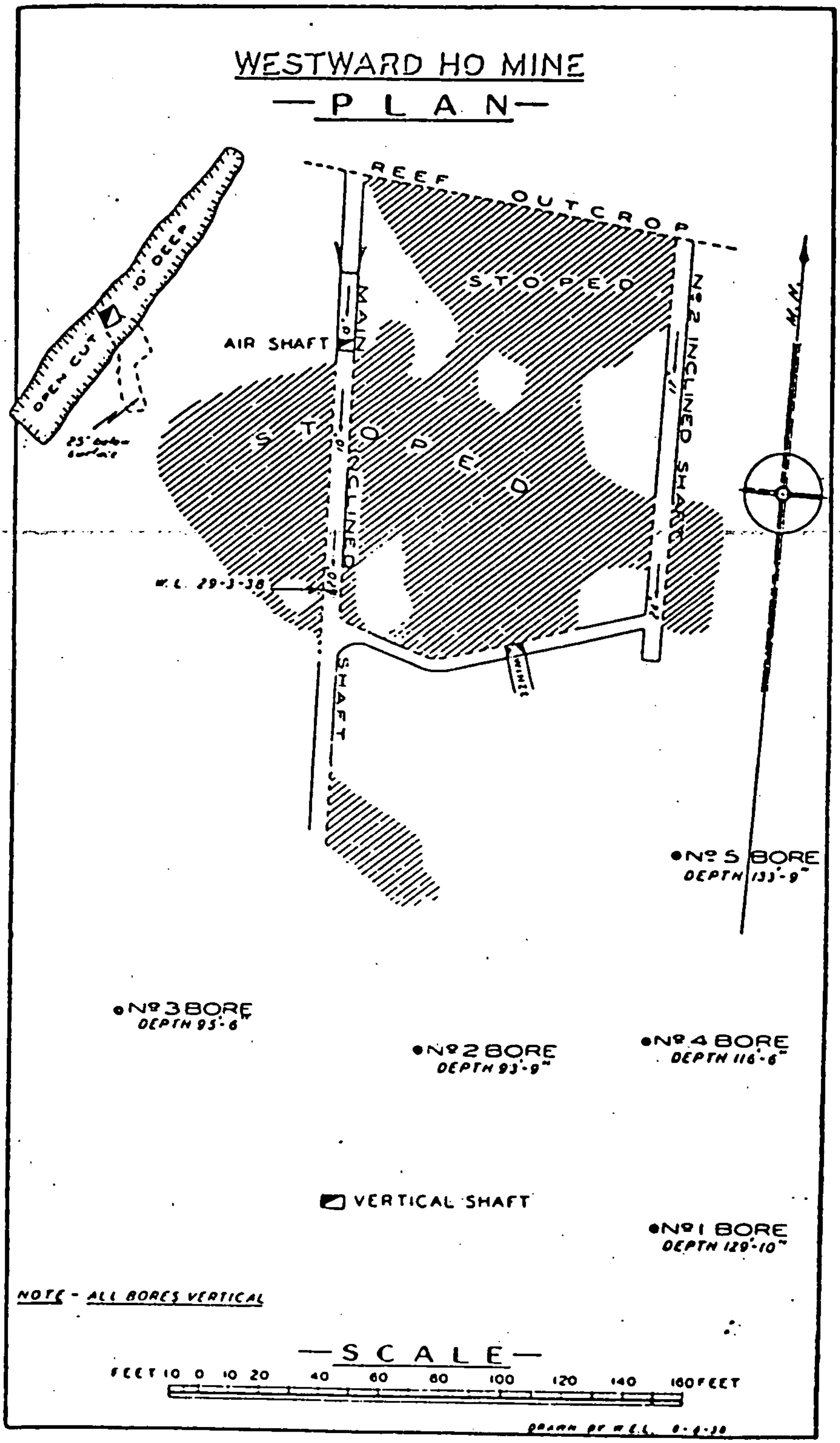
SCALE

60 0 60 120 180 240

CHAINS

RECEIVED 25 FEB 1972 DEPT. OF MINES SECURITY 1833

FIG. 31



WESTWARD HO MINE
— P L A N —
REEF OUTCROP
STOPED
STOPED
MAIN INCLINED SHAFT
No 2 INCLINED SHAFT
AIR SHAFT
OPEN CUT 10' DEEP
W.L. 29-3-38
WINZE
M.N.
No 5 BORE
DEPTH 133'-9"
No 3 BORE
DEPTH 95'-6"
No 2 BORE
DEPTH 93'-9"
No 4 BORE
DEPTH 116'-6"
VERTICAL SHAFT
No 1 BORE
DEPTH 129'-10"
NOTE - ALL BORES VERTICAL
— S C A L E —
FEET 10 0 10 20 40 60 80 100 120 140 160 FEET

FIG. 32

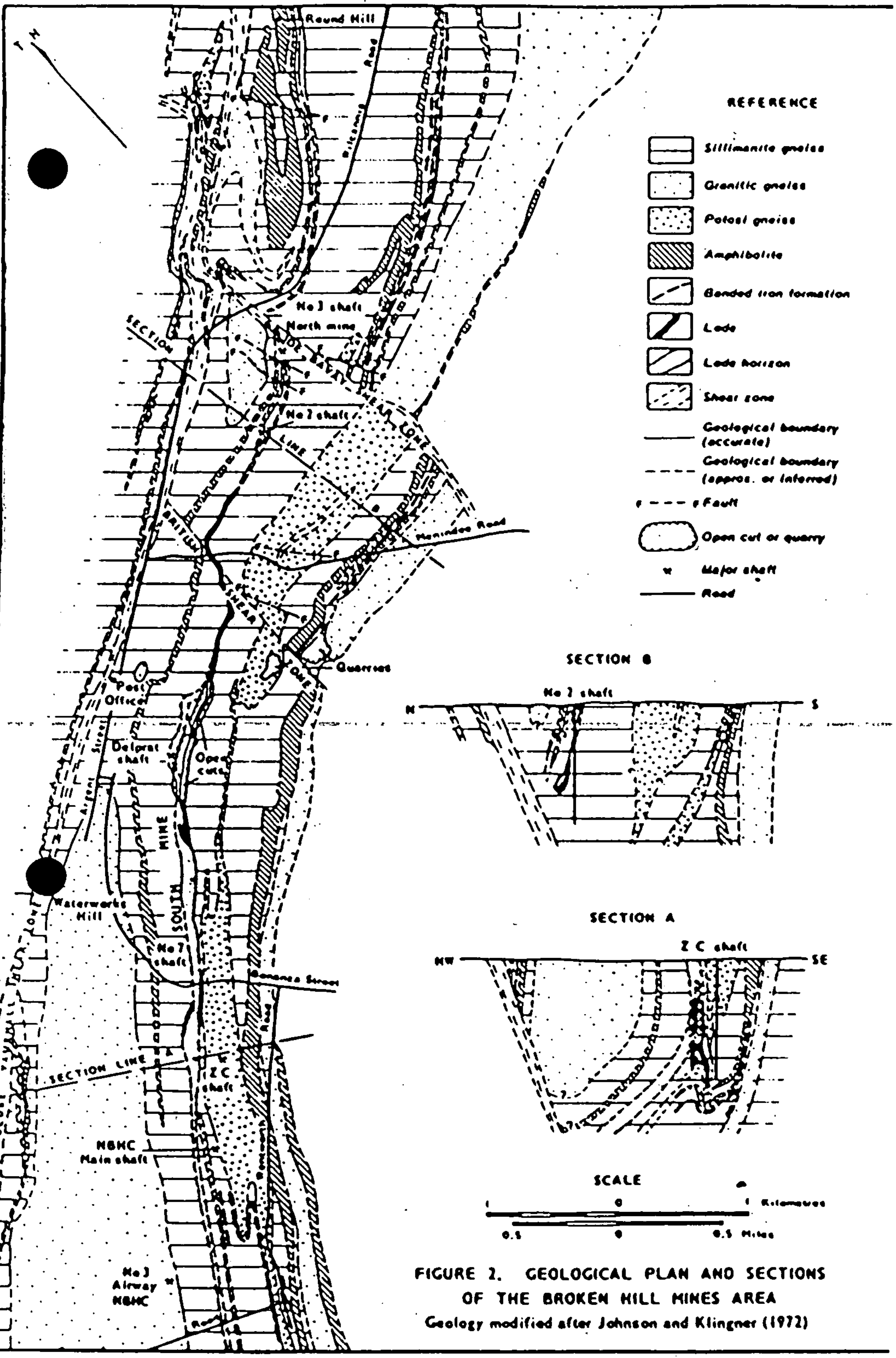


FIGURE 2. GEOLOGICAL PLAN AND SECTIONS OF THE BROKEN HILL MINES AREA
Geology modified after Johnson and Klingner (1972)

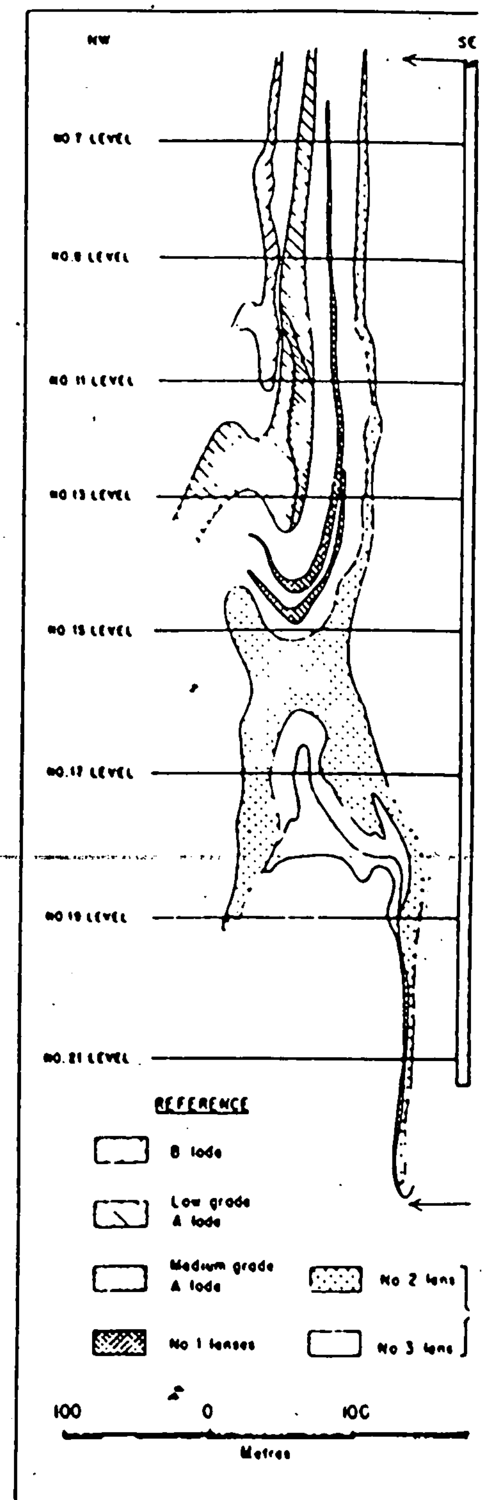
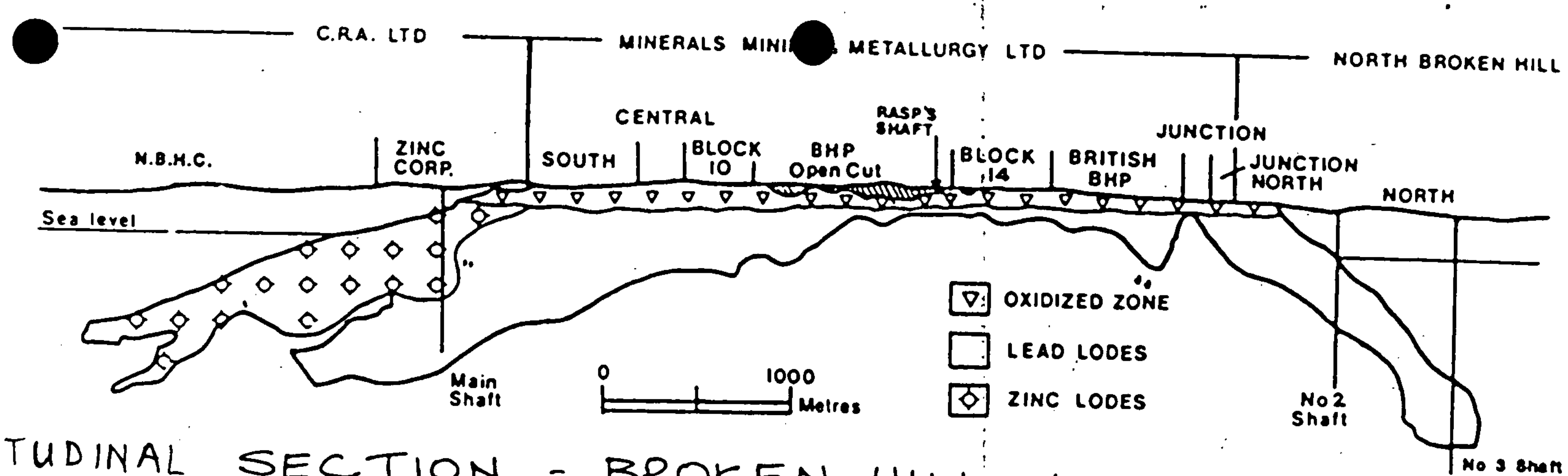


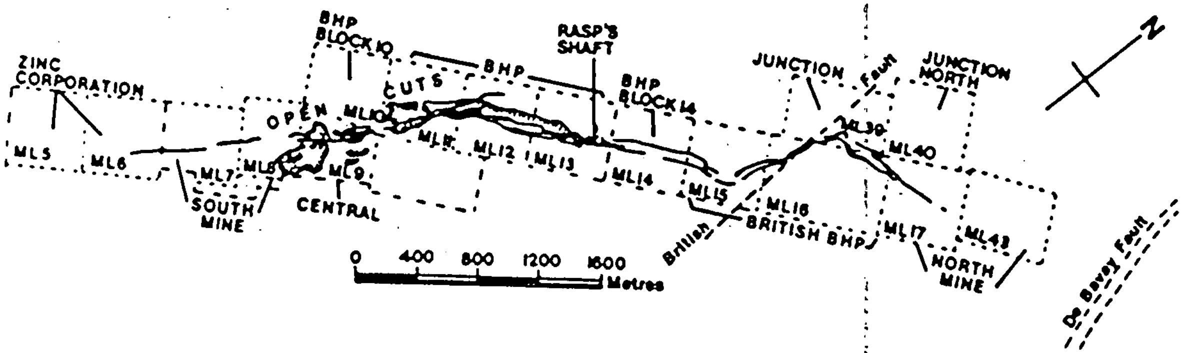
FIGURE 3 CROSS SECTION THROUGH THE BROKEN HILL LODE, ZINC CORPORATION MINE

Fig. 35



LONGITUDINAL SECTION - BROKEN HILL LODE

BROKEN HILL MINES 1920, SHOWING MINE LEASES, OUTCROP AND OPEN CUTS.



BROKEN HILL MINES 1980, SHOWING MINE LEASES, OUTCROP AND OPEN CUTS

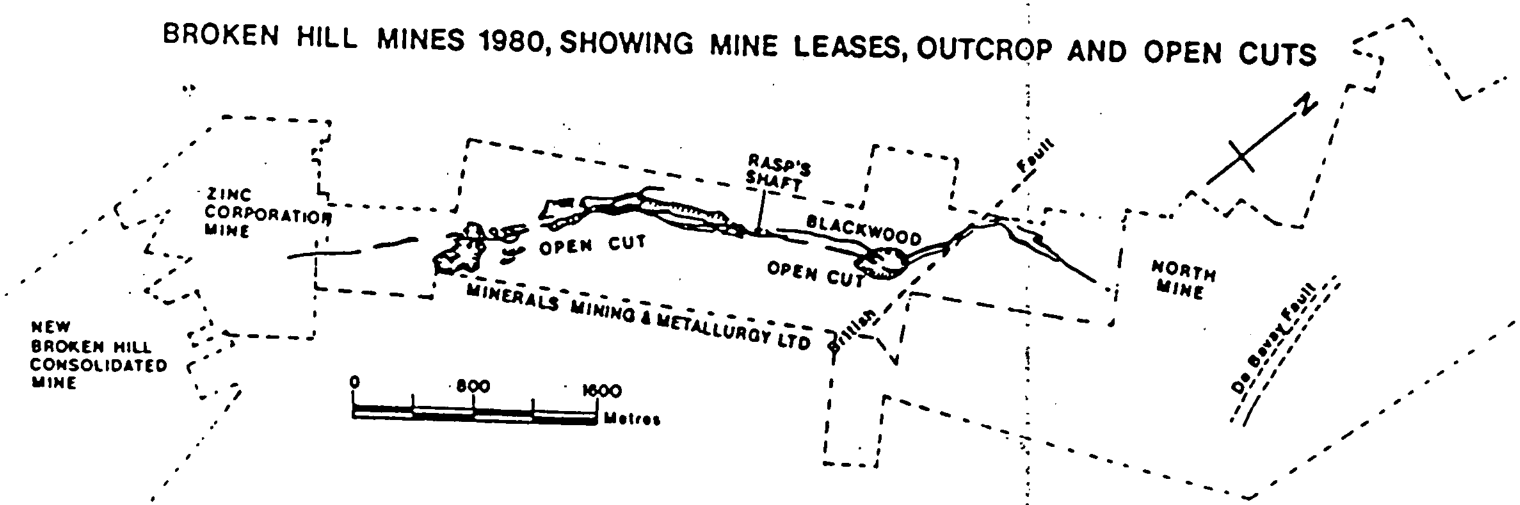


Fig. 36

Disc Filter	- 2 only 3 Disc Dorr Oliver (1200mm dia)
Tailings Thickener	- 1 only 27000mm Goodwin Denver Fixed Rate
	- 1 only 27000mm Dorr Oliver Cable Torque

AMENITIES

Total population of Mount Gunson, including children is approximately 300.

Employees at Mount Gunson are housed on site. Single personnel live in quarters situated approximately 1 km from the mill area. Rooms are air-conditioned with messing and recreational facilities provided at a nominal rent.

Married personnel reside in a small village approximately 5 km from the mill area. Houses are provided for married staff and key wages personnel.

Amenities in the Town Centre complex include a bar, small shop, swimming pool, tennis courts and regular cinema screenings. Primary schooling is provided on site by the South Australian Department of Education. High school students travel by company transport to Woomera each day.

Reference

CSR Limited, 1983. Geology of the Cattlegrid Mine, 1972-1983. S. Aust. Dept. Mines and Energy open file Env. 5429 (unpublished).

OLYMPIC DAM COPPER-URANIUM-GOLD DEPOSIT

Introduction

Olympic Dam copper-uranium-gold deposit on Roxby Downs Pastoral Station, 650 km north-northwest of Adelaide and 25 km west of the opal mining town of Andamooka (Fig. 1), appears to be a new type of strata-bound sediment-hosted ore deposit. The deposit contains at least 2 000 million tonnes of mineralized material with an average grade of 1.6% Cu, 0.06% U_3O_8, and 0.6 g/t Au. Areal extent exceeds 20 km^2 with vertical thicknesses of mineralization up to 350 m.

The terrain has low relief dominated by stable, linear, east-west sand dunes which overlie a gibber-strewn plain with occasional clay pans (Graetz and Tongway, 1980). These landforms are developed on a flat-lying succession of late Proterozoic to Cambrian sediments that blanket the area and postdate the deposits by hundreds of millions of years.

History of Exploration

Exploration for copper in South Australia by Western Mining Corporation Ltd. (WMC) began in 1957 and was concentrated mainly around the old mines in the Moonta-Wallaroo area on Yorke Peninsula. Although this first phase was unsuccessful, attention was again focussed on South Australia in 1972 following research from 1969 to 1971 which related the formation of strata-bound copper deposits to solutions that had acquired copper during oxidative alteration of basalt (Haynes, 1972). After a year of literature study and reconnaissance, several favourable areas, including the Stuart Shelf, were selected for testing. On the Stuart Shelf, regional gravity and magnetic data from surveys by the Commonwealth Bureau of Mineral Resources and SADME suggested the possibility of basalt at depth. The interpretation of gravity and magnetic anomalies as well as lineament mapping resulted in the selection of specific target areas, including the Olympic Dam area (Fig. 2). In 1974, stratigraphic holes were selected on two of the targets to test for the presence of favourable host rocks in the late Proterozoic cover sequence and source rocks in the basement.

The first hole at Olympic Dam, RD1 was completed in July 1975 after intersecting 38 m of 1.05% Cu in the basement at 353 m. This encouraging, although uneconomic, mineralization led to the drilling of a pattern of holes. The first two, RD3 and RD4, were barren, RD5 and RD8 intersected additional mineralization containing 1% Cu, RD6 and RD7 were barren, and RD9 low grade. Then, RD10 intersected 170 m of 2.1% Cu and over 0.5 kg/t U_3O_8.

Detailed assessment commenced in 1979 as a joint venture between Roxby Mining Corporation Pty. Ltd a wholly owned subsidiary of WMC, BP Australia Ltd., and BP Petroleum Development Ltd. The Manager is Roxby Management Services Pty Ltd (RMS), a wholly owned subsidiary of WMC. Intensive vertical diamond drilling over an area in excess of 25 km^2 has resulted in a success rate of over 80 percent mineralized drill holes

(Fig. 3, Table 1). Whenan exploration shaft has enabled underground exploration to proceed on at least two levels from October 1982. All observations, interpretations, and speculations presented in this paper are on data from diamond drilling.

The discovery of Olympic Dam was an example of co-operative effort between all levels of management and geoscientists in the exploration division of Western Mining Corporation (Haynes, 1979).

The gravity anomaly attributed to a shallow basement of basaltic rocks is now known to result from the dense hematite-rich breccia associated with the mineralization. The magnetic anomaly is still mainly unexplained and presumably results from a large magnetic body beyond the current depth of drilling. Host rocks for the type of strata-bound copper deposit predicted in the original concept do not occur in the area, and mineralization is confined to rocks beneath the late Proterozoic sedimentary sequences.

Geology and Mineralization

The deposit occurs in the basement beneath 350 m of unmineralized, flat-lying Adelaidean (late Proterozoic) to Cambrian sediments in the Stuart shelf region of South Australia. Host rocks are unmetamorphosed and are probably younger than 1 580 m.y. The deposit is spatially related to coincident gravity and magnetic anomalies and the intersection of west-northwest- and north-northwest-trending lineaments.

Proterozoic sediments comprising the local basement sequence are predominantly sedimentary breccia ranging from matrix-poor granite breccia to matrix-rich polymict breccia containing clasts of a variety of rock types. This sequence is over 1 km thick and has been divided into two main units - Olympic Dam Formation and Greenfield Formation. Olympic Dam Formation has five members, three of which are matrix-rich. Greenfield Formation has three members, the lower two being very hematite-rich whereas the upper has a significant volcanic component. Pervasive hematite, chlorite, and sericite alteration of varying intensity affects all the basement sequence. The rock unit below Olympic Dam Formation is assumed to be granite equivalent to that outside the known area of mineralization. Dolerite dikes, plugs, and sills intrude basement rocks but not the flat-lying cover sediments. Localizing structure for the sequence hosting the deposit is a northwest-trending trough or graben which is arched about a northeast axis. Arching parallel to the long axis of the graben also occurs in some areas. Strike-slip and dip-slip faults occur both parallel to, and at a high angle to, the long axis of the graben. Greenfield Formation is preserved in downfaulted blocks in the crest of the structural arch. Two types of copper sulfide mineralization have been defined - a strata-bound type and a younger transgressive type both with uranium, rare earths, gold, and silver.

Strata-bound bornite (chalcocite)-chalcopyrite-pyrite mineralization occurs in the hematite matrix-rich members of Olympic Dam Formation. Most of the sulfides are present in the breccia matrix as uniform disseminations, but massive sulfide clasts up to 5 cm across are also present. Vertical zoning of sulfides is consistent from a sulfur-rich, copper-poor assemblage - pyrite (chalcopyrite) - at the base to a copper-rich, sulfur-poor assemblage - bornite (chalcocite) - at the top. There is no evidence of supergene enrichment. Lateral zoning of sulfides is not obvious, but there is a distinct siderite-rich zone along the northeastern edge of the deposit in which pyrite is the predominant sulfide. A zone of intense chlorite alteration is developed at the base of the strata-bound mineralization. Transgressive chalcocite-bornite mineralization overlies the strata-bound type and is confined to a northwest-trending linear zone over 6 km long and up to 700 m wide in the centre of the graben. Massive sulfide clasts, veins, rims on clasts, and cavity fillings are present with chalcocite-bornite being complexly intergrown in all cases. Sericite-quartz or chlorite alteration halos are developed around sulfide veins.

In both types of mineralization, hematite, quartz, sericite, and fluorite are the main gangue constituents with lesser amounts of chlorite, siderite, barite, and rutile. Uraninite, with lesser coffinite and brannerite, is very fine grained and occurs in a variety of forms. Two rare earth minerals, bastnaesite and florencite, occur in, and adjacent to, sulfide mineralized zones.

A detailed genetic model has not been developed. Graben fill sediments were deposited in an arid subaerial environment during rifting or strike-slip faulting. Strata-bound sulfide mineralization is syngenetic or syndiagenetic and is probably related to local volcanism. Younger transgressive mineralization is epigenetic and was introduced into favourable structural zones. Uranium and rare earths were deposited during and after the sulfide mineralizing phase.

The deposit is a very unusual example of sediment-hosted mineralization. Most unusual features are the association of copper, uranium, rare earths, and gold; the association of reduced sulfur species such as chalcocite and bornite with high hematite concentrations; and the occurrence of strata-bound copper and uranium minerals in sedimentary rocks deposited in a very high energy environment.

A composite stratigraphic section of the basement units is illustrated in Figure 4. Figures 5 and 6 outline their broad distribution in plan at the -450 m level and in section at 200 000 N. Lithology of the stratigraphic units is summarized in Table 2 and the typical mineralogy of Olympic Dam Formation members is shown in Table 3.

Development

Whenan Shaft has been sunk to 500 m and several horizontal and inclined drives have been developed from the 420 m and 480 m levels. Whenan Shaft, named after the driller who drilled the discovery hole, measures 6.5 m x 3.5 m and is equipped to hoist rock and to transport personnel and materials.

WMC advised the following progress in its Quarterly Report for 12 weeks ended 19 June 1984.

> From Whenan Shaft, a new record of 354m of 6 x 4.5m development driving was created for the last four week period of the financial year. Development and underground drilling continued in copper/uranium ore-zones from the 420 m level to the south of the shaft, development and underground drilling proceeded from the

420 and 480 m levels into a portion of the Olympic Dam ore deposit which showed gold values in surface drilling.

Two development headings have been started parallel to the south incline, one on the 420 m level, the other on the 480 m level where another northwest drive has also been started. This work will allow underground development to continue while an extensive diamond ring-drilling programme is carried out northwest of the No. 3 ventilation raise, utilising five drilling rigs.

Surface exploration was completed during the previous quarter with the final four diamond-drillholes in the detailed evaluation programme of ore zones near Whenan Shaft. In total, 480 diamond-drillholes from surface have been completed at Olympic Dam.

	12 weeks 28/3/84-19/6/84	52 weeks 22/6/83-19/6/84	52 weeks 23/6/82-21/6/83
Exploration drilling(m)			
- surface diamond drilling	0	8 862	42 380
- surface percussion drilling	1 652	7 712	41 592
- underground diamond drilling	15 539	34 572	6 041
Mine Development(m)			
- raise drilling	0	826	342
- other development	888	3 624	1 430

Construction of a Sirosmelt facility for on-site smelting of copper concentrates is 90 per cent complete. Production of up to 50 t of copper concentrate per week at the pilot plant is being maintained. Shipment has been made of three parcels of copper concentrate totalling 500 t to Outokumpu Oy of Finland for independent tests at that company's testing facility at Pori in Finland. Slag from the overseas testing and containing all of the U_3O_8 in the concentrate will be returned to Olympic Dam for further leach tests.

TABLE 2. Olympic Dam Stratigraphy

Age	Unit	Thickness (maximum)	Lithology
Cambrian	Andamooka Limestone	60 m	Massive, locally bedded limestone.
	Wilpena Group		
Upper Proterozoic	Arcoona Quartzite	200 m	White and red massive and cross bedded sandstone.
	Corraberra Sandstone	20 m	Red, massive, and cross bedded sandstone.
	Tregolana Shale	200 m	Thinly laminated red and green shale.
		Unconformity	
	Greenfield Formation		
Middle Proterozoic(?)	Volcanic Member	250 m	Interbedded altered felsic volcanics, volcanic breccia, conglomerate, and banded iron-formation.
	Hematite Breccia Member	500 m	Hematite-rich breccia with thin interbeds of polymict breccia and hematite siltstone; veined by silica and barite.
	Lowered Silicified Member	275 m	Strongly hematized and silicified polymict breccia dominated by quartz, hematite, and altered volcanics.
	Olympic Dam Formation		
Middle Proterozoic(?)	Upper Granite Breccia Member	1 000 m	Granite breccia and weakly polymict granite breccia, matrix-poor; sericite and hematite altered; chalcocite-bornite mineralized zones.
	Brooks Member	300 m	Polymict breccia with a variety of clast types, sericitized felsic volcanic clasts diagnostic, discrete felsic volcanic lenses; variable matrix of brown and black hematite; reworked clasts of underlying members; variably mineralized with bornite (chalcocite) and chalcopyrite; siderite clasts locally abundant.
	Whenan Member	350 m	Polymict breccia, red and black hematite clasts and matrices; cyclic zones of matrix-rich and matrix-poor breccia; bedded and graded units common; strongly mineralized with bornite-chalcopyrite (pyrite).
	Black Hematite Member	150 m	Black hematite-dominated breccia both as clast and matrix; specular hematite, chlorite, and siderite in matrix; porous, often vuggy; pyrite (chalcopyrite) mineralized.
	Lower Granite Breccia	800 m+	Granite breccia with thin polymict breccia lenses often containing distinctive chlorite-altered volcanic clasts; chlorite-altered contact with above member and granophyre clasts.

TABLE 3. Olympic Dam Formation: Typical Modal Mineralogy

Member	Quartz	Sericite	Hematite	Siderite	Fluorite	Barite	Chlorite	K-feldspar	Total sulfides
Upper Granite Breccia	65	10	10		tr			15	
Brooks	40	20	25		2	tr			10
Brooks[1]	45	10	15	15	3	tr			12
Whenan	15	15	45		5	tr	5		15
Whenan[1]	20	5	30	30	5	tr			10
Black Hematite	10		70	3	2	tr	5		10
Black Hematite[1]	10		50	30	2	tr	3		5
Lower Granite Breccia	25	10	20	5	2		35		
Lower Granite Breccia[1,2]	50	10	5	5			5	25	

tr = less than 1%

[1] From carbonate-rich zone;
[2] from chloride-altered zone below Black Hematite Member;
averages of at least 20 samples in each case
Semiquantitative XRD analysis by S. Kermarec, Western Mining Corp. Ltd., Kalgoorlie.

WMC advised the following progress in its Quarterly Report for the 12 weeks ended 11 September 1984:

> Underground drilling was completed in the development to the northwest of Whenan Shaft. Other drilling was reduced to seven rig shifts per day. A small surface programme of evaluation drilling commenced.
>
> The pilot plant at Olympic Dam continued to test bulk samples received from underground development. The production and shipment of 500 t of copper concentrate to Finland for pilot scale smelting tests was completed. About 200 t of concentrate were smelted during the quarter; resultant slag will be processed for recovery of uranium that occurs in copper concentrate produced by conventional flotation. Matte and blister containing 70 and 98 percent copper, respectively, were produced in the Sirosmelt Furnace.
>
> From Whenan Shaft, a new record for a four week period of 356 m of development driving was set.
>
> On the surface, 650 m south of Whenan Shaft, preparations were made for the fourth drilled 3 m diameter ventilation raise; the Arcoona Quartzite was grouted to reduce inflow of saline water.

In July 1984, RMS retained Fluor (Australia) Pty. Ltd., to prepare a Technical Study on development at Olympic Dam.

Mining

The mine plan envisaged in the Study comprises a staged development initially producing 1 Mtpa copper/uranium ore, 0.5 Mtpa gold ore and approximately 0.5 Mtpa development waste during the first three years of operations. This production rate approaches the hoisting capacity of the existing 6.5m x 3.5m Whenan Shaft (currently at the 500 m level) after some upgrading work has been completed. The near-capacity demands on Whenan Shaft will necessitate construction of a decline prior to commencement of production to provide services and equipment access.

As a result of decreasing ore grades, production of copper/uranium ore will be increased from Year 4 to 2 Mtpa to maintain the planned level of U_3O_8 production. The necessary additional hoisting facilities required for this increased rate of ore production will be provided by the construction of a second shaft (No. 2 Shaft).

Three mining methods will be used: sublevel open stoping, post-pillar and cut-and-fill. These conventional methods, coupled with the use of mobile equipment, provide a basis for high productivity mining. The mining plan is designed to minimise cost and to achieve efficiency in development drilling, blasting, extraction and, where applicable, underground filling. The underground exploration development (which presently totals 7 km) has been on a scale which will allow heavy diesel mobile production equipment to be used.

Metallurgical Processing

The Olympic Dam deposit contains two distinct ore types for the purposes of metallurgical processing:

- copper/uranium ore (containing small amounts of gold and silver)
- gold ore (with variable copper and minor uranium contents).

These two ore types will be processed through separate facilities as follows:

Copper/Uranium Ore

- Concentrator - for recovery of a copper flotation concentrate
- Hydrometallurgical plant - for extraction of uranium from flotation tailings and copper concentrate
- Smelter - for the treatment of copper flotation concentrate to produce an upgraded copper product.

Gold Ore

- Gold plant - for production of gold bullion and copper/gold concentrate by a combination of flotation, gravity concentration and cyanidation processes.

- Copper/Uranium Plant

A principal objective for the initial Project is the production of approximately 2000 tpa U_3O_8 in the form of yellowcake. In order to achieve this, the treatment facilities will require a two-stage development. During the first three years of operation the treatment facilities will comprise one module which will process 1 Mtpa ore. A second module capable of processing a further 1 Mtpa ore will be brought into operation in Year 4.

Concentrator

The major stages in the proposed concentrator operations are:

- primary crushing of ore, hoisting from underground, followed by fine grinding and classification
- production of copper concentrate by conventional flotation methods.

Hydrometallurgical Plant

The hydrometallurgical plant will include all the facilities for the extraction and recovery of uranium as yellowcake from both the flotation tailings and the copper concentrate.

The major process stages are as follows:

- the uranium passing into the copper concentrate will be removed in an acid leaching circuit. After filtration and washing, the copper concentrate will be repulped and refloated in a two stage cleaner circuit. The final concentrate grade will vary between 52 and 60 per cent copper
- thickened flotation tailings from the primary flotation circuit will be leached for the extraction of uranium in a separate acid leaching circuit
- the pregnant solutions from both the copper concentrate and tailings leach circuits will be combined and clarified

- soluble copper present in pregnant liquor will be removed by solvent extraction and recovered as cathode copper by electrowinning
- uranium will be extracted and concentrated in a separate solvent extraction circuit and precipitated from the strip solution as ammonium diuranate. This product will be calcined to produce commercial grade uranium oxide (yellowcake).

Smelter

If a decision is taken to upgrade the copper flotation concentrate to either matte or blister copper, an electric smelting furnace will be installed at Olympic Dam. The smelter operation would be designed from start-up to accommodate the increased production rate of 2 Mtpa ore during Year 4 of the nitial project.

. Gold Plant

The gold plant considered in the Study will be capable of treating 500 000 tpa ore with an average grade of 5.0 g/t Au and 0.4% Cu. This plant will commence operation about mid-1987.

During the first year of production a copper/gold flotation concentrate will be produced for sale. After the first year, this flotation concentrate will be combined with the copper concentrate recovered from the copper/uranium ore and delivered to the copper smelter if the smelting route for copper is adopted. Gold remaining in the flotation tailings will be recovered by cyanidation using the carbon-in-leach method, followed by electrowinning. Some gold will also be recovered by gravity concentration and, after amalgamation, will be smelted with the electrowon gold to produce gold bullion.

Annual production of gold (in bullion) from the gold plant will average about 1 250 kg for at least the first four years. The remainder of the gold from both the gold plant operations and treatment of copper/uranium ore will report in the final copper product, i.e. concentrate, matte or blister.

The proposed process flow diagram for treatment of Olympic Dam ore for the initial project is shown in Figure 53.

Roxby Downs Township

An important component of the Olympic Dam project will be the new town for up to 9 000 people which will be constructed by the Joint Venturers on commitment to the project. Exploratory operations to date have been based on the village of Olympic Dam which is 5 km south of the deposit and has accommodation for over 300; there are 16 houses and 50 caravans.

The town of Roxby Downs will be built 10 km south of the existing village in sandhill country at the turn-off to Olympic Dam on the Woomera to Andamooka road. Preliminary plans for the proposed town are being prepared by the Joint Venturers for discussion with representatives of the State Government and the future municipality. For planning purposes, the commitment to build is assumed to be mid-1985 although the final detailed feasibility study by Fluor (Australia) Ltd. has only recently commenced.

The town will be built by the Joint Venturers and, under the indenture agreement, the State will design and construct Government buildings and community services. Roads, footpaths, power, water and sewage disposal facilities will be provided by the Joint Venturers. The cost of their provision will be eventually recouped in the sale of allotments.

The town water supply will be drawn from the Great Artesian Basin and desalinated at Olympic Dam before reticulation. Electricity will be drawn from Woomera and, later, Port Augusta. The municipality will purchase power and water in bulk from the Joint Venturers for distribution through the town at prices related to those elsewhere in the State.

References

Graetz, R.D. and Tongway, D.J., 1980. Roxby Downs, South Australia: Environmental problems of mineral exploration: Perth, CSIRO, Div. Land Resources Management, Management Rept. 5:1-28.

Haynes, D.W., 1972. Geochemistry of altered basalts and associated copper deposits: Unpub. Ph.D. thesis, Canberra, Australian National Univ.

Haynes, D.W., 1979. Geological technology in mineral resources exploration: Aust. Acad. Tech. Sci., Invitation Symposium, 3rd, Adelaide, 1979, Preprint 2:75-95.

Roberts, D.E. and Hudson, G.R.T., 1983. The Olympic Dam Copper-Uranium-Gold Deposit, Roxby Downs, South Australia. Economic Geology 78:799-822.

South Australian Department of Mines and Energy, 1984. Olympic Dam Project. Miner. Ind. Q. S. Aust. Dept. Mines and Energy, 34:3-6, 35:3-6, 37:2-9 and 28:11-12.

TARCOOLA GOLDFIELD

History and Production

Alluvial gold was discovered at the eastern end of Tarcoola Hill in 1893 but leases were not pegged until 1900 near the Blocks and the Tarcoola Blocks Company was formed. Crushing of ore commenced at the Blocks battery on 16 May 1901 and to March 1912, 32 084 tonnes of ore were treated which yielded 1 385 225 g gold bullion.

By 1915, the main workings consisted of an underlie shaft 152 m deep and a 3 compartment 3.6 m by 1.2 m, vertical shaft to 107 m. Driving and cross cutting on the 33 m (No. 1) and 76 m (No. 2) levels exposed a number of gold bearing reefs, five of which were worked to No. 2 level. Development commenced on the 91 m (No. 3) level, driving Fabian, Western Branch and McKechnie reefs. Mining operations ceased in June 1918.

Between 1918 and 1947, there was very little activity. Dewatering and re-timbering of the main shaft was undertaken by Standard Mining Company in 1948 and 4 458 tonnes of ore mined yielded 227 366.58 g gold bullion.

Operations ceased in 1952 and again the field was virtually dormant until 1973 when Emperor Gold Mines Limited of Fiji dewatered the mine. Systematic surface and underground mapping and sampling suggested a potential of 58 000 tonnes of ore between No. 2 and No. 3 levels. However, drilling to confirm this potential was not carried out.

Since 1979, mining has been intermittent with 267 tonnes of ore yielding 5 858.9 g gold bullion (i.e. 21.94 g/t Au) until November 1984. Most production came from Sullivans Reef with 36 tonnes from Welcome Home.

Geology

Gold-bearing reefs crosscut interbedded quartzite and slate striking east-west and dipping 35°-50° to the south. Reefs are normal to the bedding and are apparently enriched at contact with carbonaceous slate.

Slate is quite black underground but bleached on the surface and is divided into four groups:

. No. 1 Slates - interbedded greenish calcareous slate and flaggy quartzite crop out south east of the mine.

. Front Slates - underlie No. 1 Slates and are separated by about 15 m of quartzite. Pyritic and carbonaceous and up to 25 m thick with interbedded quartzite. All important reefs have been enriched in Front Slates.

. Back Slates - Up to 25 m thick, pyritic and carbonaceous and have been stoped where cut by reefs. Approximately 45 m below Front Slates and separated by massive and flaggy micaceous quartzite.

. No. 4 Slates - lowest and up to 25 m thick. At surface, greyish and calcareous separated from Back Slates by about 35 m of quartzite.

Quartzite - varies from hard massive and vitreous to micaceous and platy with minor bands of carbonaceous slate. In places, the reefs have been mined within quartzite.

Igneous Rocks - approximately 120 m north of the workings, metasediments are in contact with granite, gneissic granite and adamellite. Dykes and sills in the workings are microdiorite and andesite, generally barren of metalliferous mineralisation.

Most mining has been on the reefs in an upthrust block or horst between two strike faults (see Fig. 55).

- Main fault (or slide) - a bedding fault, often very carbonaceous.
- Pug seam - Soft white fault gouge, slightly oblique to bedding and has caused a repetition of Front Slates south east of the mine with a displacement of 50 m.

Gold has been derived from hyrothermal solutions emanating from the cooling of intrusive granitic magma. Minor gold has been mined from the periphery of the granite and from the quartzite. However, enrichment is apparent where solutions were in contact with carbonaceous slate (Fig. 56). Gold is pale yellow, battery bullion, being about 700 fine. Associated metallic minerals include: galena, sphalerite, pyrite, chalcopyrite and arsenopyrite.

A typical analysis of the ore is as follows:

	Au	Cu	Pb	Zn	Ag	As	Cd	Fe	Ba
A 1187/84	19.0	50	420	220	11	60	11	1.00%	800

(results in ppm unless otherwise stated).

Quartz reefs strike approximately 330° and dip steeply to the east occupying fault fissures with xenoliths of slate and quartzite.

Tarcoola Blocks Gold Mine underground plan of No. 1 level (Fig. 57) shows the reefs between Pug Seam and Main Slide. Sullivans lode geological plan is shown in Fig. 58.

Sections illustrating stoping on Fabian, Western Branch, McKechnie and Sullivans reefs are shown on Figures 59, 60, 61 and 62. Figure 63 is a composite plan of Tarcoola Blocks Mine workings.

References

Ridgway, J.E. and Johns, R.K., 1948. Fabian (Tarcoola Blocks) Gold Mine. Min. Rev. Adelaide., 88: 170-194.

Ridgway, J.E., 1949. Tarcoola Goldfield - Gold Leases 1654 and 1666 - Tarcoola Blocks Mine. Min. Rev. Adelaide., 91: 117-129.

Martins, J.J., 1974. Final Report Tarcoola Project S. Aust. Emperor Mines Limited. S. Aust. Dept. Mines and Energy open file Env. 2506 (unpublished).

EAREA DAM GOLDFIELD

History

In 1899, Mr. Kingsmill found a rich specimen of gold bearing quartz in surface material near Earea Dam 35 km west of Kingoonya (Fig. 64). As a result, active prospecting commenced and Wilgena Enterprise Mine began operations shortly after. Within the next few years, eight other mines were worked. The principal mine was Wilgena Enterprise producing intermittently in 1900-1906, 1915 and 1932-1941. A total of 1 480 tonnes of ore were raised from thin quartz veins in granite and treated for a yield of 52 000 g gold (1 620 oz). Preseverance over the same periods produced 319 oz. from 316 tonnes of ore. Total production of the field is about 62 220 g (2 000 oz).

Cassiterite (tin oxide) was discovered in 1899 at South Lake in decomposed quartz veins and alluvial material surrounding the veins. No production of tin is recorded but several hundred kg of concentrate may have been recovered.

Geology

Wilgena Enterprise mine is sited on outcrop of magnetic iron ore and quartz in granite which is cut by dioritic dykes. The lode pinched from 1.2 m at the surface to 0.5 m at water level (32 m). The lode strikes north-south and dips about 45° east. The main shaft has been sunk to 30 m. Gold occurs in quartz and ironstone lode and in places in granite wall rock. At 12 m depth on the decline, levels have been driven north and south and most ore mined has come from above this level.

References

Brown, H.Y.L., 1908. Record of Mines of South Australia. (4th Edition) Govt. Printer, Adelaide.

GLENLOTH GOLDFIELD

Location - 30 km south of the abandoned town of Kingoonya and 60 km east southeast of Tarcoola, recorded production exceeds 320 000 g of gold bullion.

History

Gold was discovered in 1893 but there was little work before 1901, development being hampered by the small size of the deposits and the remoteness.

A five head stamp battery was erected by Glenloth Mining, Battery and Options Company N.L. in 1904 to treat local ore. A cyanide plant was later installed, subsidised by the South Australian Government. This plant was acquired by the Government in 1907 and crushing continued on a small scale until 1924. Highest production at the battery was in 1910 when 15 147 g of gold bullion were recovered. Total production from this battery is recorded as 3 463 tonnes for a recovery of 82 191 g of gold bullion.

Prospectors were attracted to the field during the early 1930's and ore was transported to the Tarcoola battery. In 1935 with the aid of a Commonwealth Government grant, a new battery and cyanide plant were constructed at Glenloth. Production ceased in 1954 and the plant is now derelict. This second battery treated 10 452 tonnes of ore yielding 197 523 g of gold bullion.

Since 1973, small parcels of ore have been extracted from Jay Jay, Fabian No. 3, Pioneer and Royal Tiger (Fig. 65) and treated at Peterborough Battery. At present there are numerous current mining tenements and the leaseholders are in the process of constructing plant to treat the ore on site.

Most of the workings are small and relatively shallow. Highest production was from Fabian No. 3 mine, which has yielded 103 090 g of gold bullion from 3 048.9 tonnes of ore (33.81 g/t Au).

Geology

The original Fabian No. 3 workings reportedly were excavated on ferruginous quartz vein outcrop containing visible gold, striking northwest and dipping steeply southwest within Glenloth Granite (Fig. 66 and 67). Five shafts were sunk on the line of lode. Deepest workings are the 38 m and 69 m levels in the Main shaft. Drives totalled 244 m on lodes 30 cm - 75 cm thick.

Below the zone of weathering at a depth of about 30 cm in the main shaft, lodes consist of quartz veins carrying patchy aggregates of pyrite and some galena, within fractured and sheared granite and granitic gneiss. Gold content is patchy and mining has been confined to stopes on mineralised shoots above the 38 m level. The lode is poorly defined below this level. Drives north and south at the 69 m level encountered only low-grade quartz lenses. Two diamond core holes drilled by S.A. Dept. of Mines in 1940 intersected thin barren quartz veins in partly sericitised and kaolinised granitic gneiss.

One sample over a quartz vein 20.32 cm wide contained 30 ppm Au. However, in other samples gold content was below the limit of detection (0.05 ppm Au). Some samples with higher gold values contained up to 120 ppm Cu, 250 ppm Zn, 12 ppm Mo, 1250 ppm Pb, 70 ppm Sn and 1.02% As.

The pattern of mineralisation in the other mines and prospects is similar to Fabian No. 3 (Heylen) mine. Most workings are on irregular and discontinuous quartz reefs which became pyritic in depth. The quartz bodies occupy shear zones in Glenloth Granite trending between NNW and NNE in a similar direction to the igneous dykes at Glenloth, with dips generally steeper than about 35°. Width varies from a few centimetres up to at least 3 m, but generally is less than about 1 m. In some shear zones, parallel quartz veins are separated by shattered and sheared host rock; in others there are intricate networks of irregular quartz veins and stringers which split and join.

References

Blissett, A.H., 1985. GAIRDNER, South Australia. Explanatory Notes 1:250 000 geological series Sheet SH/53-15. Geol. Surv. S. Aust.

Brown, H.Y.L., 1908. Glenloth Goldfield. Record of the Mines of South Australia (fourth edition) pp.311-315.

Mining Review, 1940. Government drilling operations. Min. Rev., Adelaide, 71:53-55.

Mining Review, 1940. Government drilling operations. Min. Rev., Adelaide, 72:30.

Santos Limited, 1982. Exploration Licence 752 - Glenloth - Final Relinquishment Report. S. Aust. Dept. Mines and Energy open file Env. 4005 Vol. I & II (unpublished).

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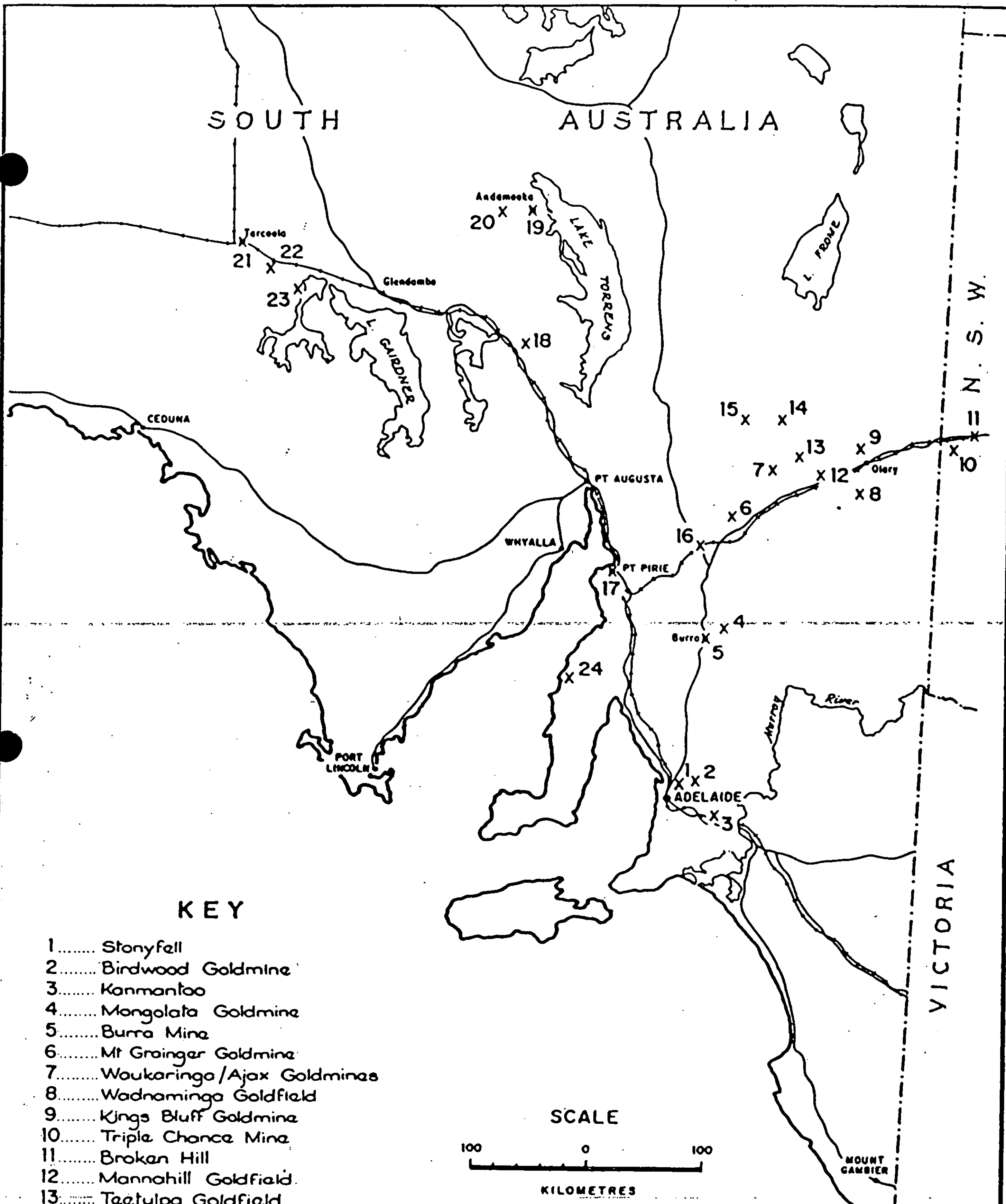


KEY

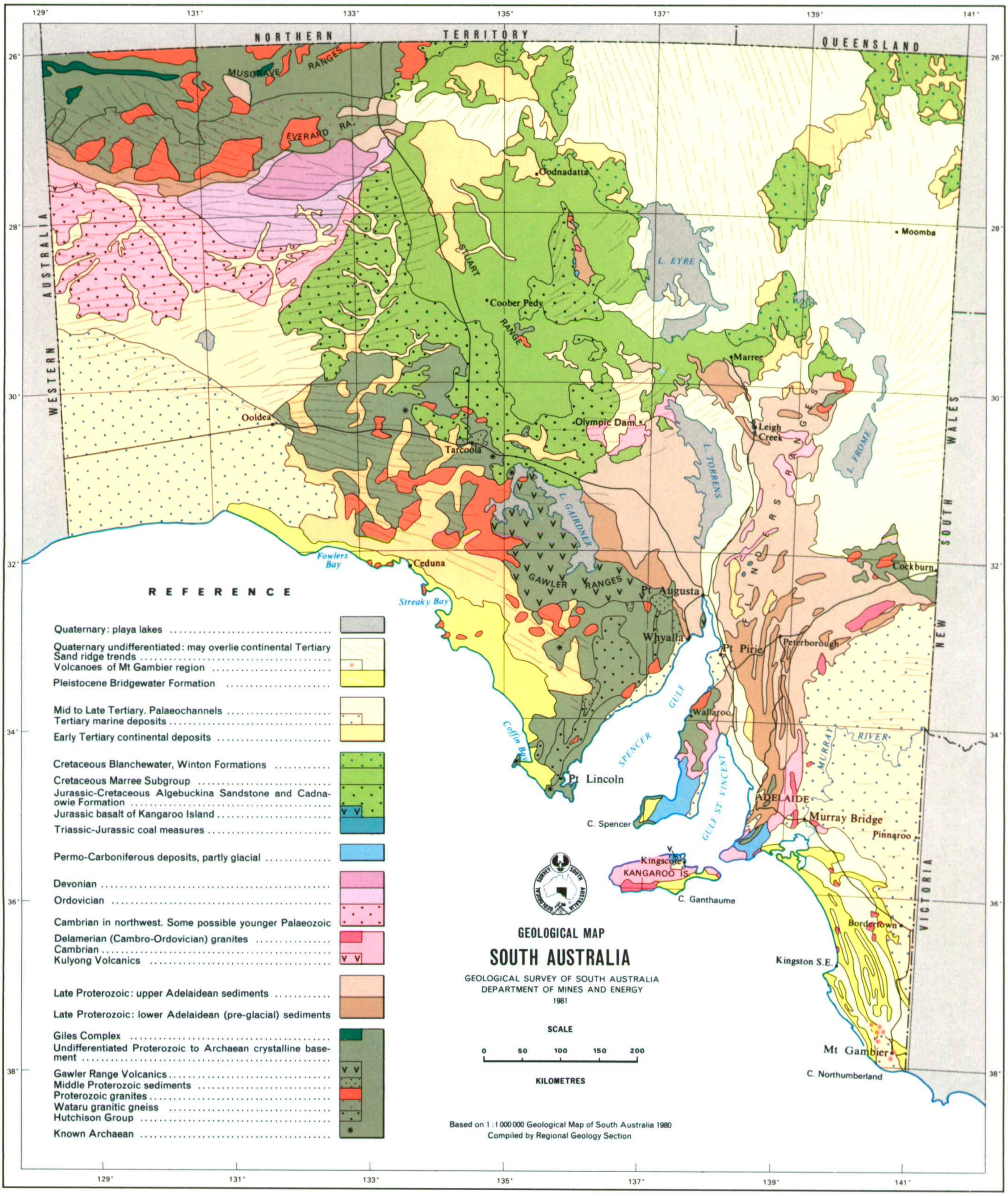
1........ Stonyfell
2........ Birdwood Goldmine
3........ Kanmantoo
4........ Mongolata Goldmine
5........ Burra Mine
6........ Mt Grainger Goldmine
7........ Waukaringa / Ajax Goldmines
8........ Wadnaminga Goldfield
9........ Kings Bluff Goldmine
10....... Triple Chance Mine
11....... Broken Hill
12....... Mannahill Goldfield
13....... Teetulpa Goldfield
14....... Nillinghoo Goldfield
15....... Baratta
16....... Peterborough Battery
17....... Port Pirie Smelters
18....... Mt Gunson Mine
19....... Andamooka
20....... Olympic Dam (Cu, Au, Ag, U)
21....... Tarcoola
22....... Earea Dam
23....... Glenloth
24....... Wallaroo / Moonta

LOCATION GUIDE TO BURMESE STUDY TOUR

Fig. 1

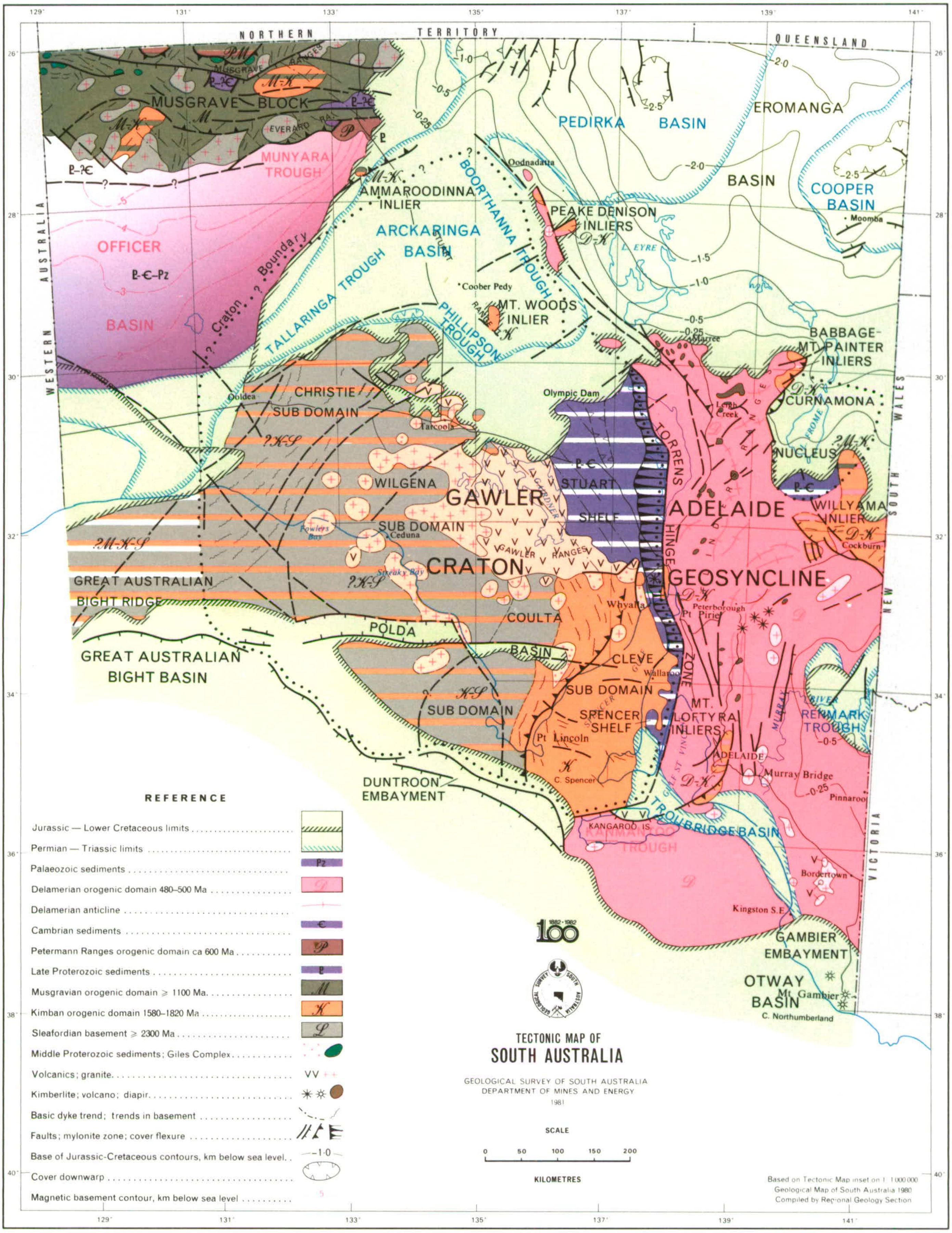
DEPARTMENT OF MINES & ENERGY – SOUTH AUSTRALIA

PLAN No. S 18101



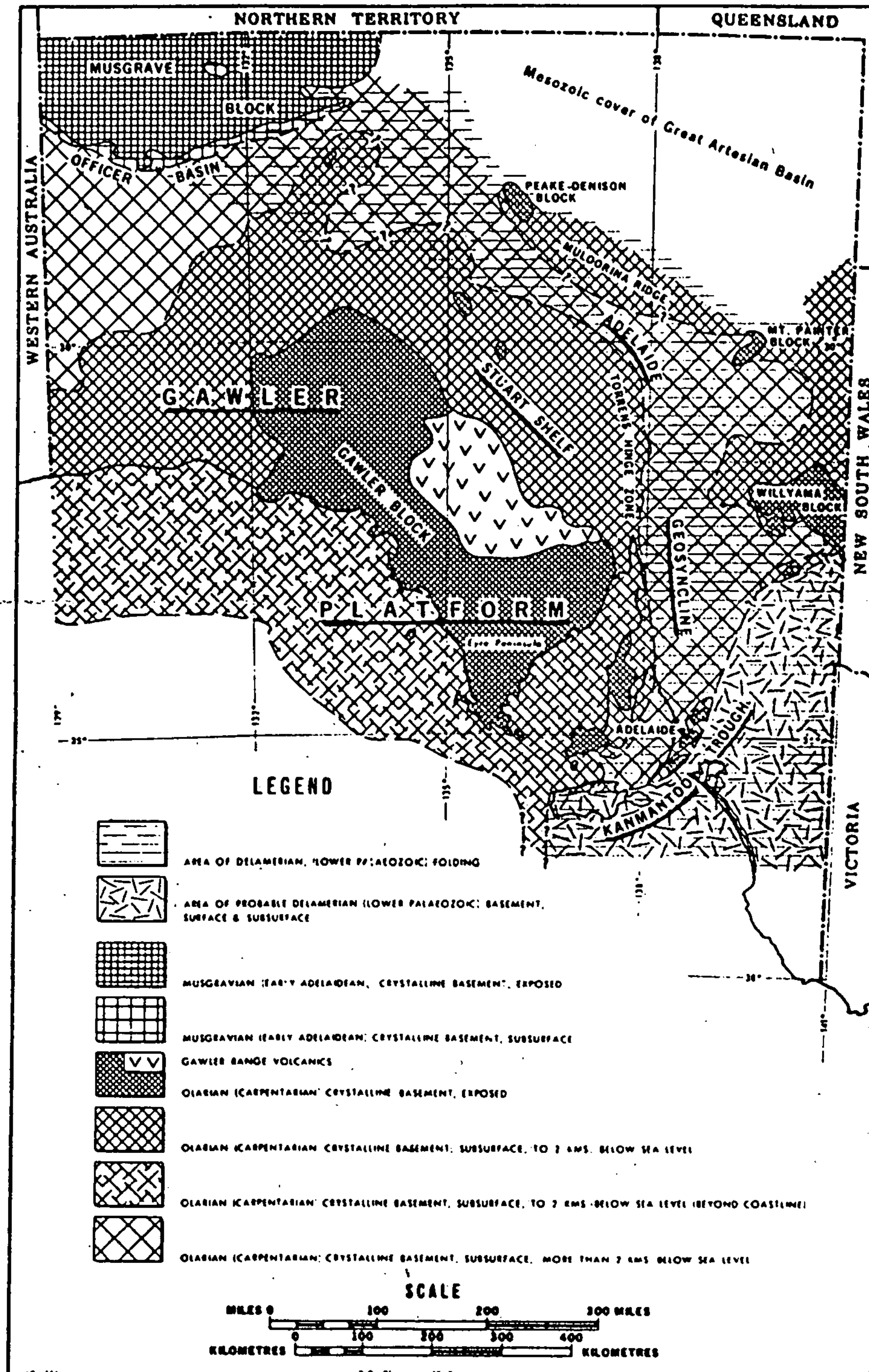
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
NEW SOUTH WALES
VICTORIA
MUSGRAVE RANGES
EVERARD RA.
Oodnadatta
STUART RANGE
Coober Pedy
L. EYRE
Moomba
Marree
Ooldea
Olympic Dam
Leigh Creek
Tarcoola
L. TORRENS
L. FROME
FLINDERS RANGES
L. GAIRDNER
Fowlers Bay
Ceduna
Streaky Bay
GAWLER RANGES
Pt Augusta
Whyalla
Pt Pirie
Peterborough
Cockburn
Wallaroo
Coffin Bay
SPENCER GULF
GULF ST VINCENT
MURRAY RIVER
Pt Lincoln
C. Spencer
ADELAIDE
Murray Bridge
Pinnaroo
Kingscote
KANGAROO IS.
C. Ganthaume
Bordertown
Kingston S.E.
Mt Gambier
C. Northumberland
REFERENCE
Quaternary: playa lakes
Quaternary undifferentiated: may overlie continental Tertiary
Sand ridge trends
Volcanoes of Mt Gambier region
Pleistocene Bridgewater Formation
Mid to Late Tertiary. Palaeochannels
Tertiary marine deposits
Early Tertiary continental deposits
Cretaceous Blanchewater, Winton Formations
Cretaceous Marree Subgroup
Jurassic-Cretaceous Algebuckina Sandstone and Cadna-owie Formation
Jurassic basalt of Kangaroo Island
Triassic-Jurassic coal measures
Permo-Carboniferous deposits, partly glacial
Devonian
Ordovician
Cambrian in northwest. Some possible younger Palaeozoic
Delamerian (Cambro-Ordovician) granites
Cambrian
Kulyong Volcanics
Late Proterozoic: upper Adelaidean sediments
Late Proterozoic: lower Adelaidean (pre-glacial) sediments
Giles Complex
Undifferentiated Proterozoic to Archaean crystalline basement
Gawler Range Volcanics
Middle Proterozoic sediments
Proterozoic granites
Wataru granitic gneiss
Hutchison Group
Known Archaean
GEOLOGICAL MAP
SOUTH AUSTRALIA
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES AND ENERGY
1981
SCALE
0 50 100 150 200
KILOMETRES
Based on 1:1 000 000 Geological Map of South Australia 1980
Compiled by Regional Geology Section

FIG 2



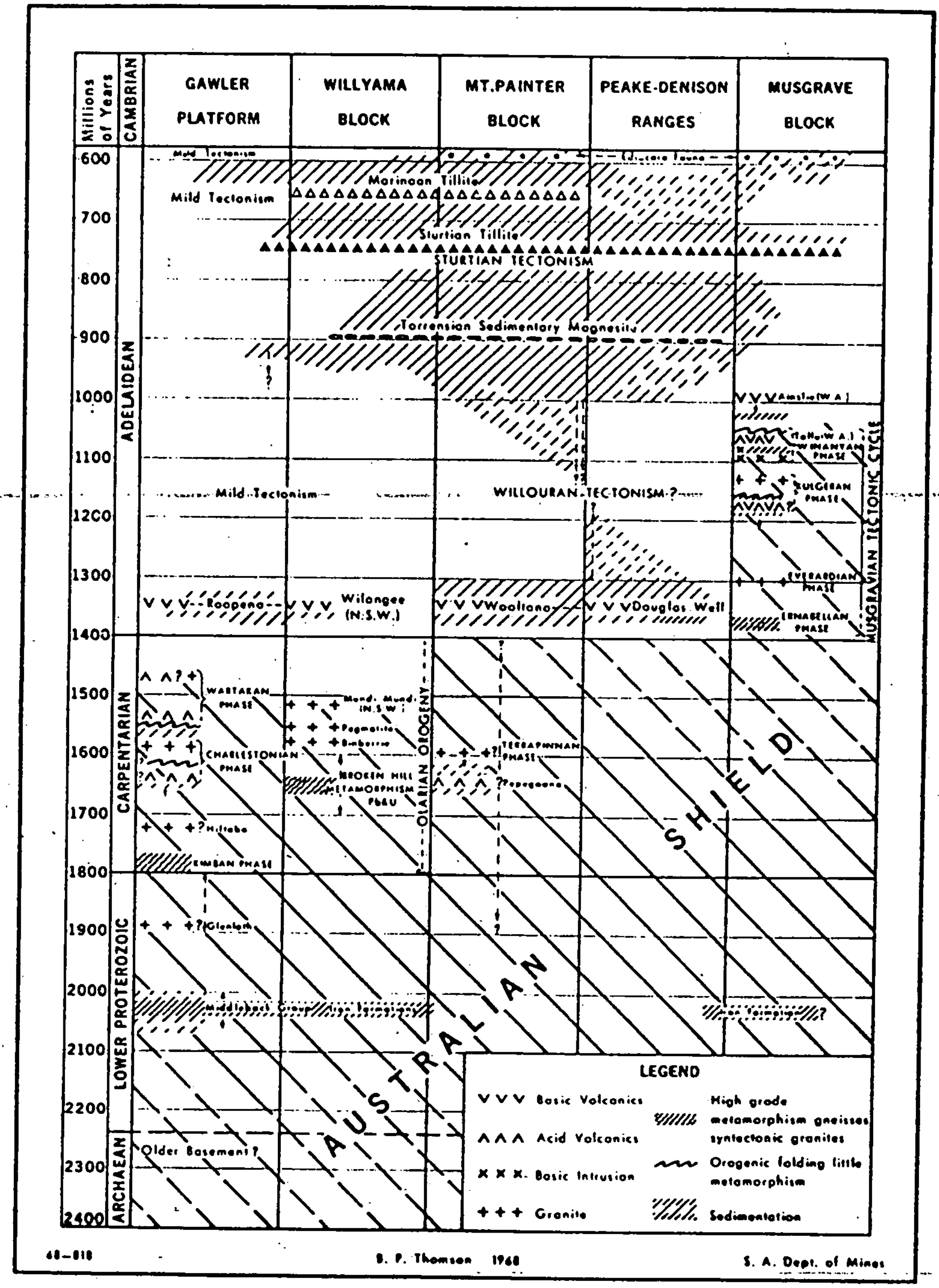
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
NEW SOUTH WALES
VICTORIA
MUSGRAVE BLOCK
MUSGRAVE RANGES
EVERARD RA.
MUNYARA TROUGH
OFFICER BASIN
Craton ? Boundary
AMMAROODINNA INLIER
ARCKARINGA BASIN
TALLARINGA TROUGH
BOORTHANNA TROUGH
PHILLIPSON TROUGH
PEDIRKA BASIN
EROMANGA BASIN
COOPER BASIN
Moomba
Oodnadatta
PEAKE DENISON INLIERS
L. EYRE
Coober Pedy
MT. WOODS INLIER
Marree
BABBAGE-MT. PAINTER INLIERS
CURNAMONA NUCLEUS
Olympic Dam
Leigh Creek
Ooldea
CHRISTIE SUB DOMAIN
Tarcoola
WILGENA SUB DOMAIN
GAWLER CRATON
Ceduna
Fowlers Bay
Streaky Bay
GAWLER RANGES
STUART SHELF
TORRENS HINGE ZONE
ADELAIDE GEOSYNCLINE
WILLYAMA INLIER
Cockburn
GREAT AUSTRALIAN BIGHT RIDGE
GREAT AUSTRALIAN BIGHT BASIN
POLDA BASIN
COULTA SUB DOMAIN
Whyalla
Pt Pirie
Peterborough
CLEVE SUB DOMAIN
Wallaroo
SPENCER SHELF
Pt Lincoln
C. Spencer
MT. LOFTY RA INLIERS
ADELAIDE
Murray Bridge
RENMARK TROUGH
Pinnaroo
DUNTROON EMBAYMENT
KANGAROO IS.
KANMANTOO TROUGH
TROUBRIDGE BASIN
Bordertown
Kingston S.E.
GAMBIER EMBAYMENT
OTWAY BASIN
Mt Gambier
C. Northumberland
REFERENCE
Jurassic — Lower Cretaceous limits
Permian — Triassic limits
Palaeozoic sediments
Delamerian orogenic domain 480–500 Ma
Delamerian anticline
Cambrian sediments
Petermann Ranges orogenic domain ca 600 Ma
Late Proterozoic sediments
Musgravian orogenic domain ≥ 1100 Ma
Kimban orogenic domain 1580–1820 Ma
Sleafordian basement ≥ 2300 Ma
Middle Proterozoic sediments; Giles Complex
Volcanics; granite
Kimberlite; volcano; diapir
Basic dyke trend; trends in basement
Faults; mylonite zone; cover flexure
Base of Jurassic-Cretaceous contours, km below sea level
Cover downwarp
Magnetic basement contour, km below sea level
100 1882-1982
TECTONIC MAP OF SOUTH AUSTRALIA
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES AND ENERGY
1981
SCALE
0 50 100 150 200
KILOMETRES
Based on Tectonic Map inset on 1:1 000 000
Geological Map of South Australia 1980
Compiled by Regional Geology Section

FIG 3



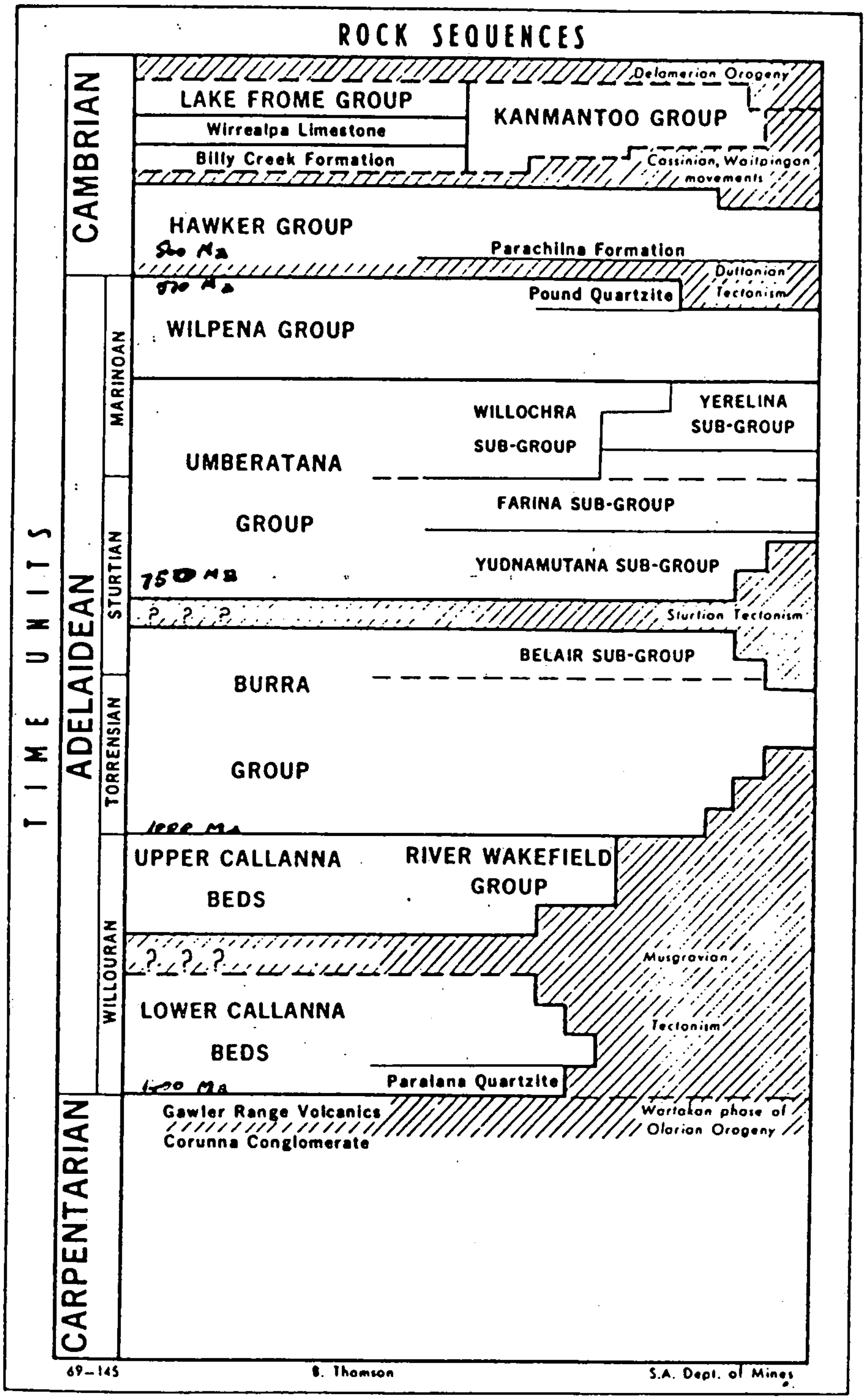
Major Structural Units of South Australia

FIG. 4



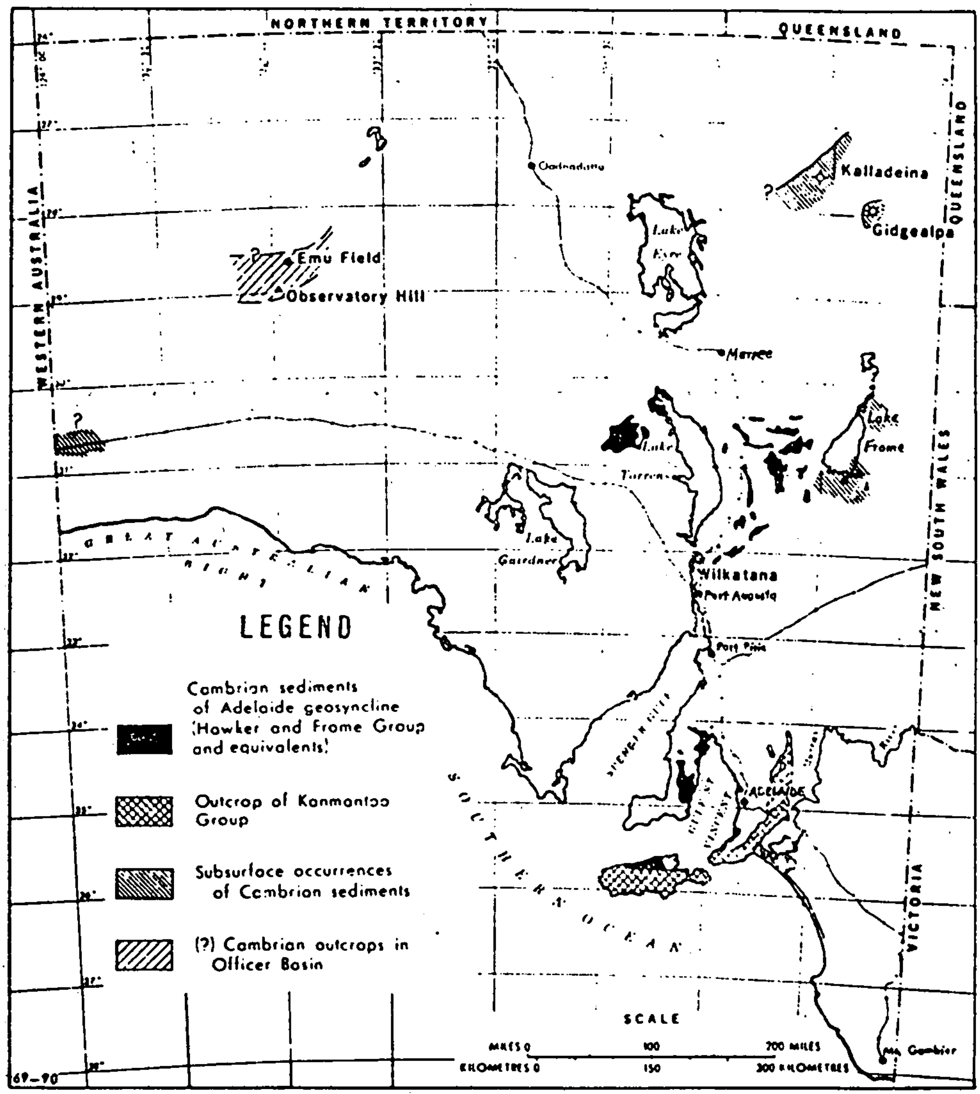
Major stratigraphic and tectonic events of the Precambrian.

FIG. 5



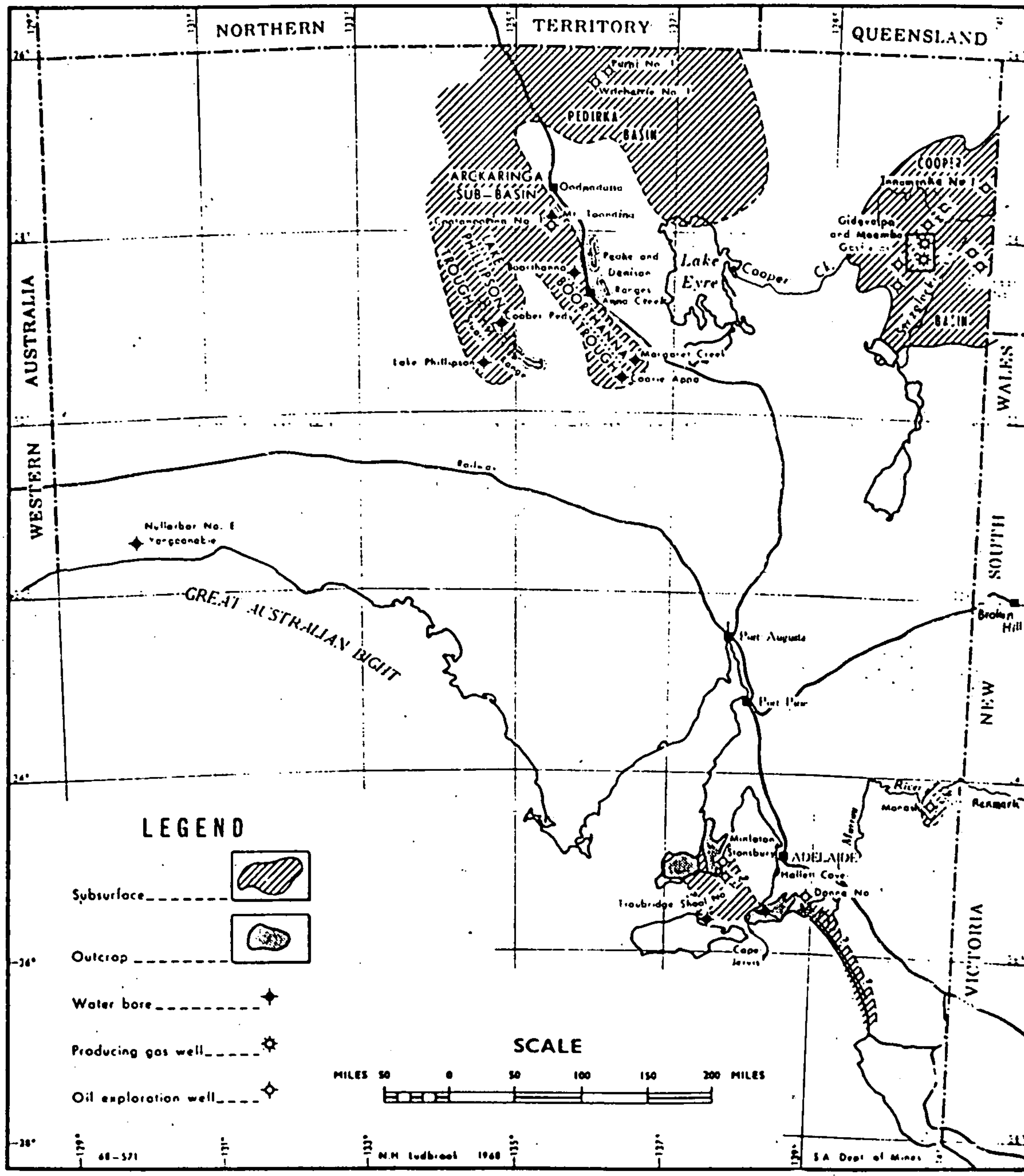
Time and rock terms used in the Adelaide Geosyncline and adjoining areas.

FIG. 6



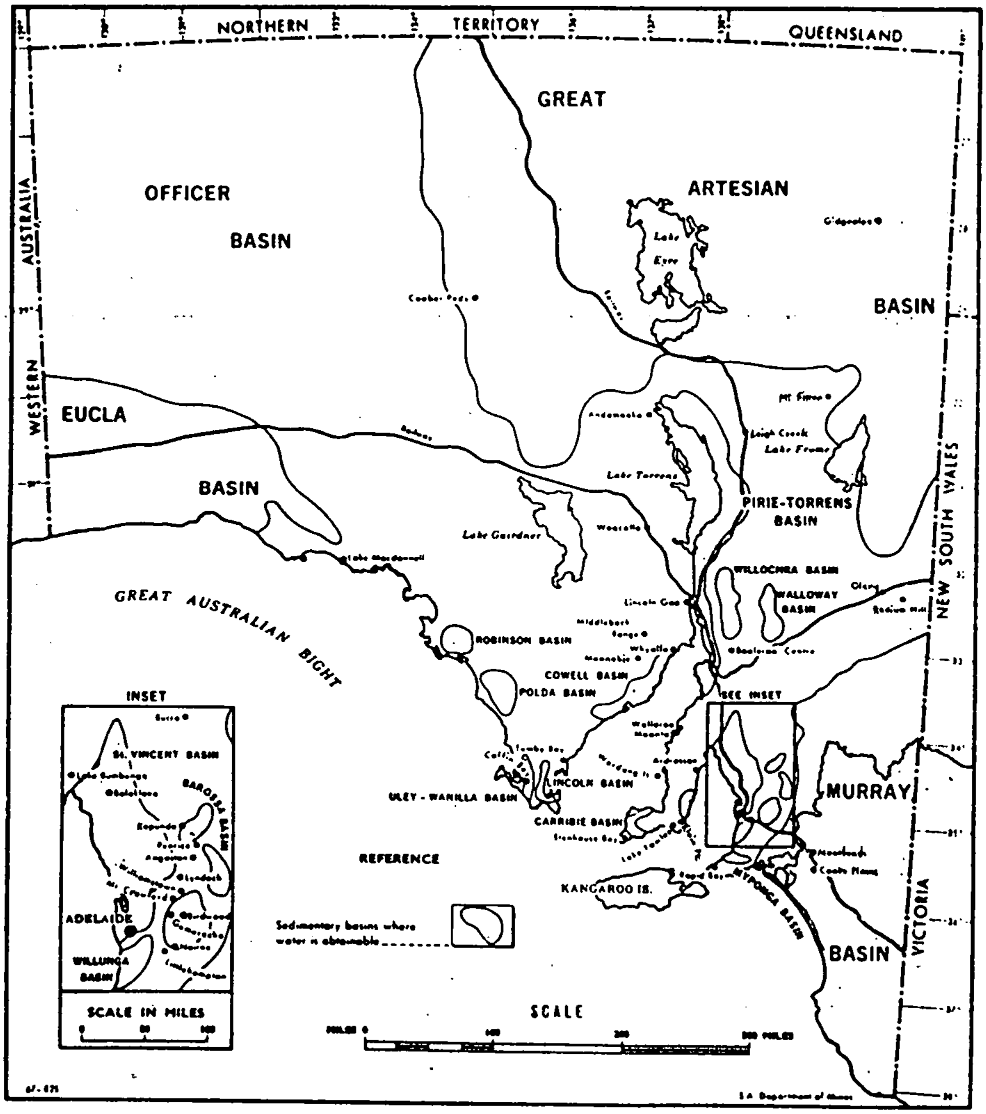
Distribution of Cambrian sediments in South Australia.

Fig. 7



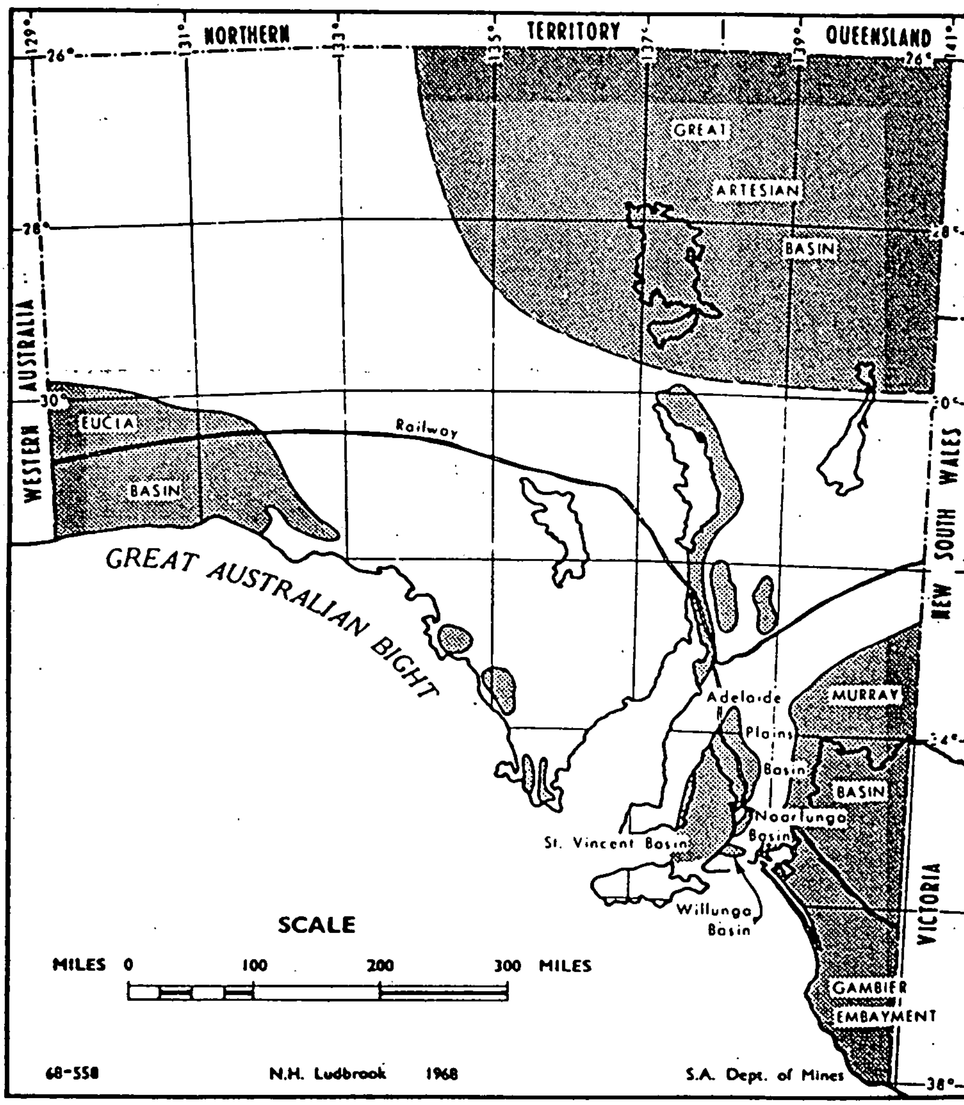
Areas of Permian sedimentation in South Australia.

Fig. 8



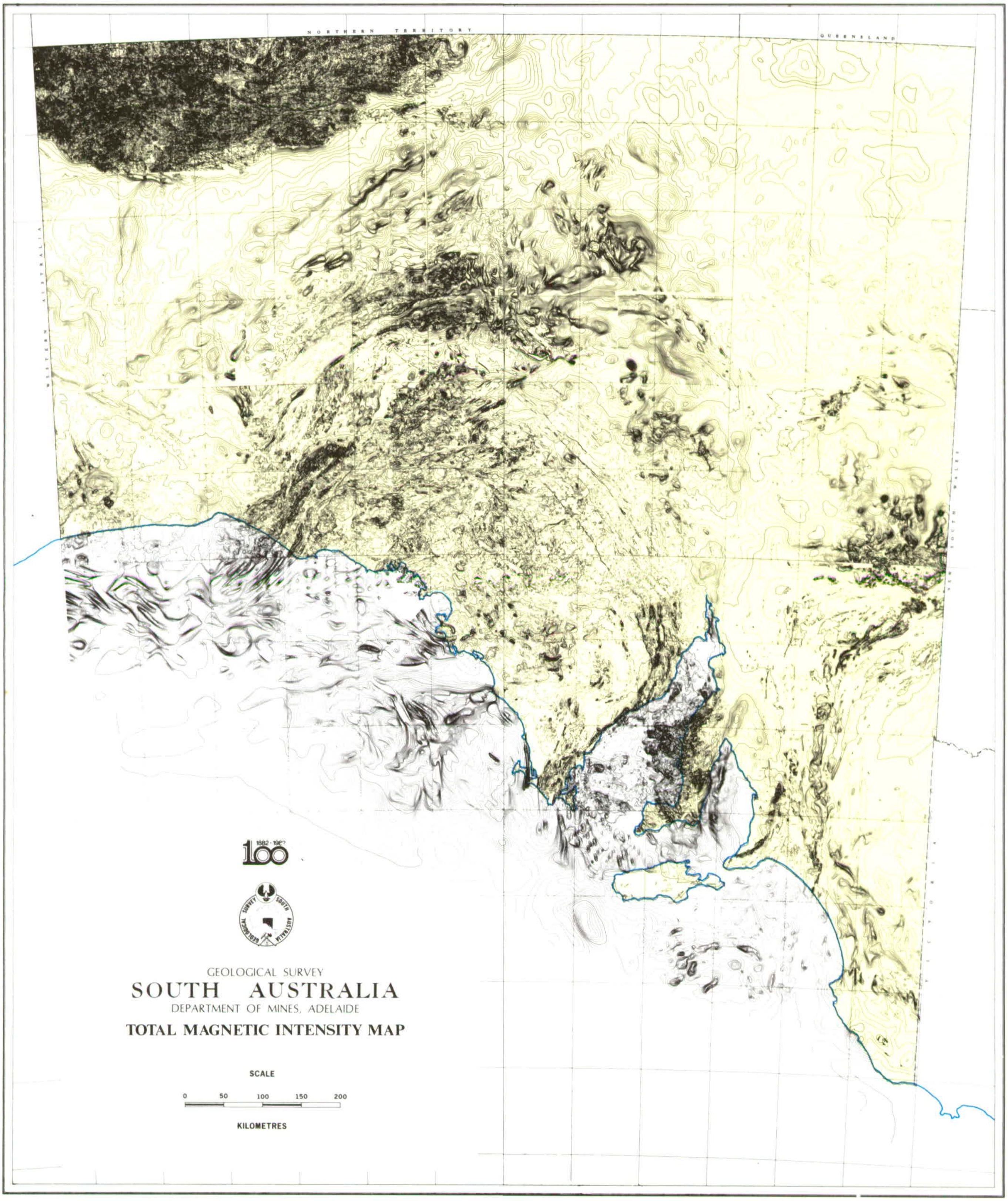
Sedimentary basins of South Australia.

Fig. 9



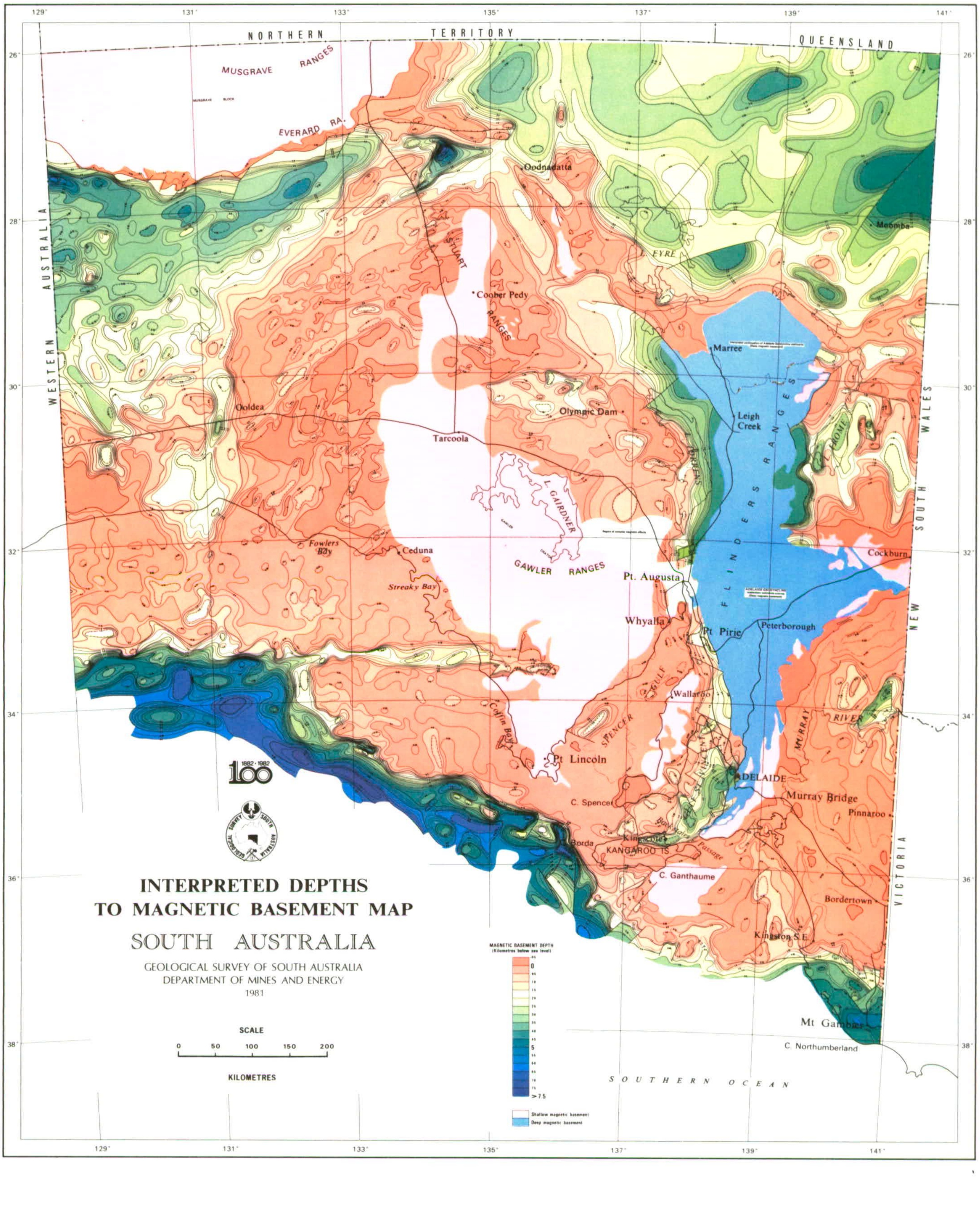
Areas of Tertiary sedimentation in South Australia.

Fig. 10



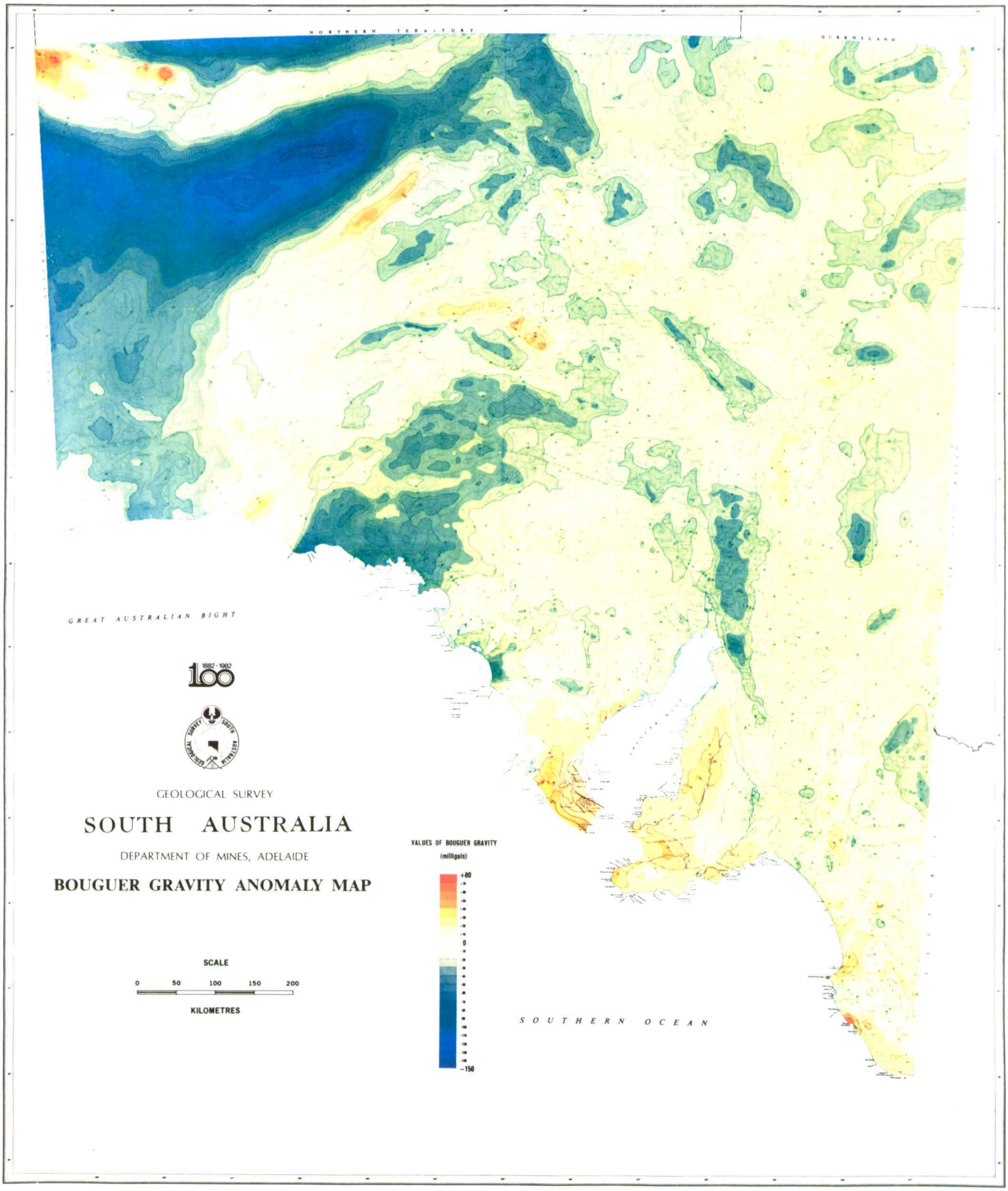
D.J.Woolman, Government Printer.

Fig. 11



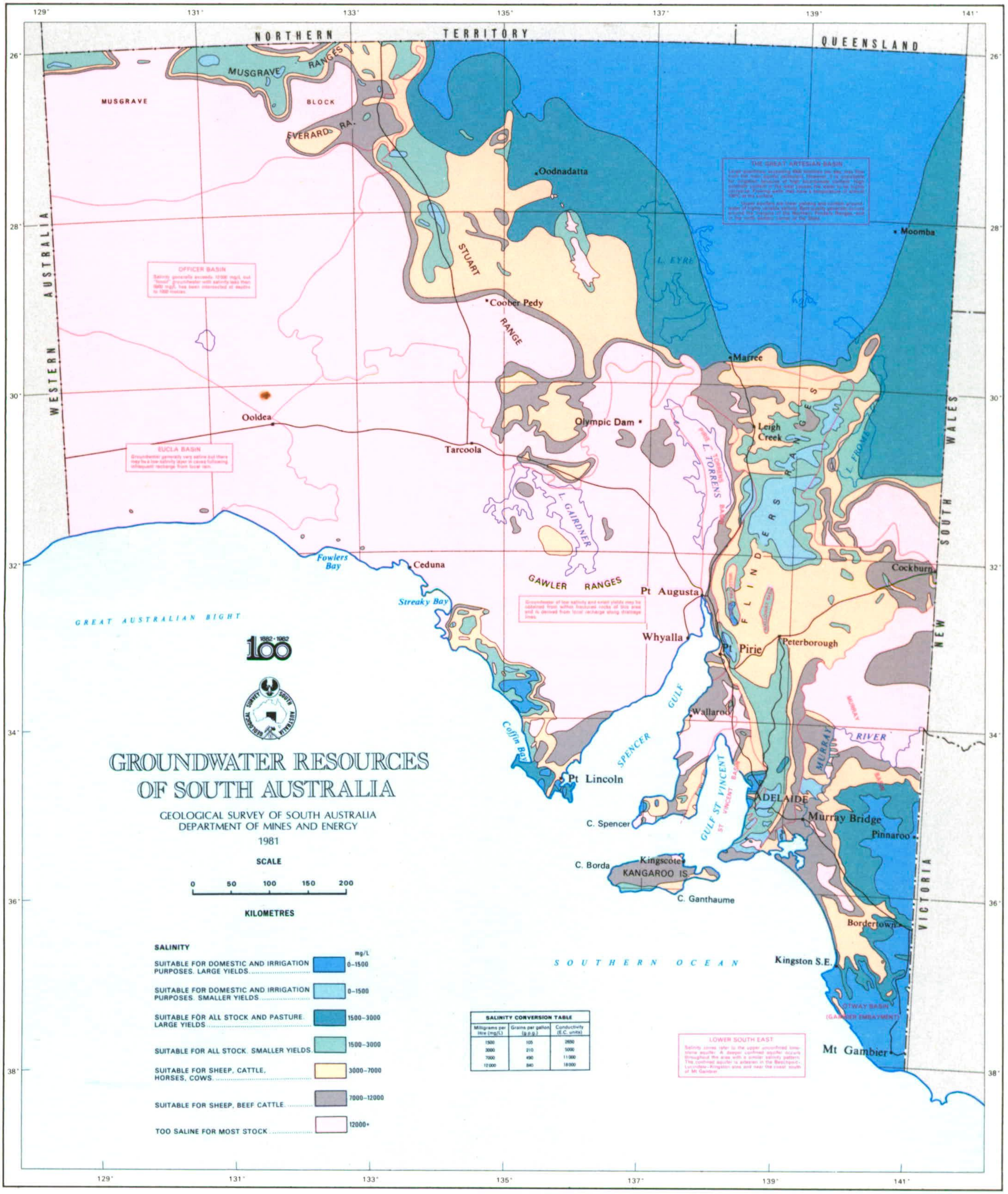
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
NEW SOUTH WALES
VICTORIA
SOUTHERN OCEAN
MUSGRAVE RANGES
EVERARD RA.
Oodnadatta
Moomba
L. EYRE
Coober Pedy
STUART RANGES
Marree
Leigh Creek
FLINDERS RANGES
Olympic Dam
Ooldea
Tarcoola
L. GAIRDNER
GAWLER RANGES
Fowlers Bay
Ceduna
Streaky Bay
Pt. Augusta
Cockburn
Whyalla
Pt Pirie
Peterborough
Wallaroo
SPENCER GULF
Coffin Bay
Pt Lincoln
ADELAIDE
Murray Bridge
Pinnaroo
MURRAY RIVER
C. Spencer
Borda
Kingscote
KANGAROO IS
C. Ganthaume
Bordertown
Kingston S.E.
Mt Gambier
C. Northumberland
1882-1982
100
INTERPRETED DEPTHS
TO MAGNETIC BASEMENT MAP
SOUTH AUSTRALIA
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES AND ENERGY
1981
SCALE
0 50 100 150 200
KILOMETRES
MAGNETIC BASEMENT DEPTH
(Kilometres below sea level)
Shallow magnetic basement
Deep magnetic basement

FIG 12

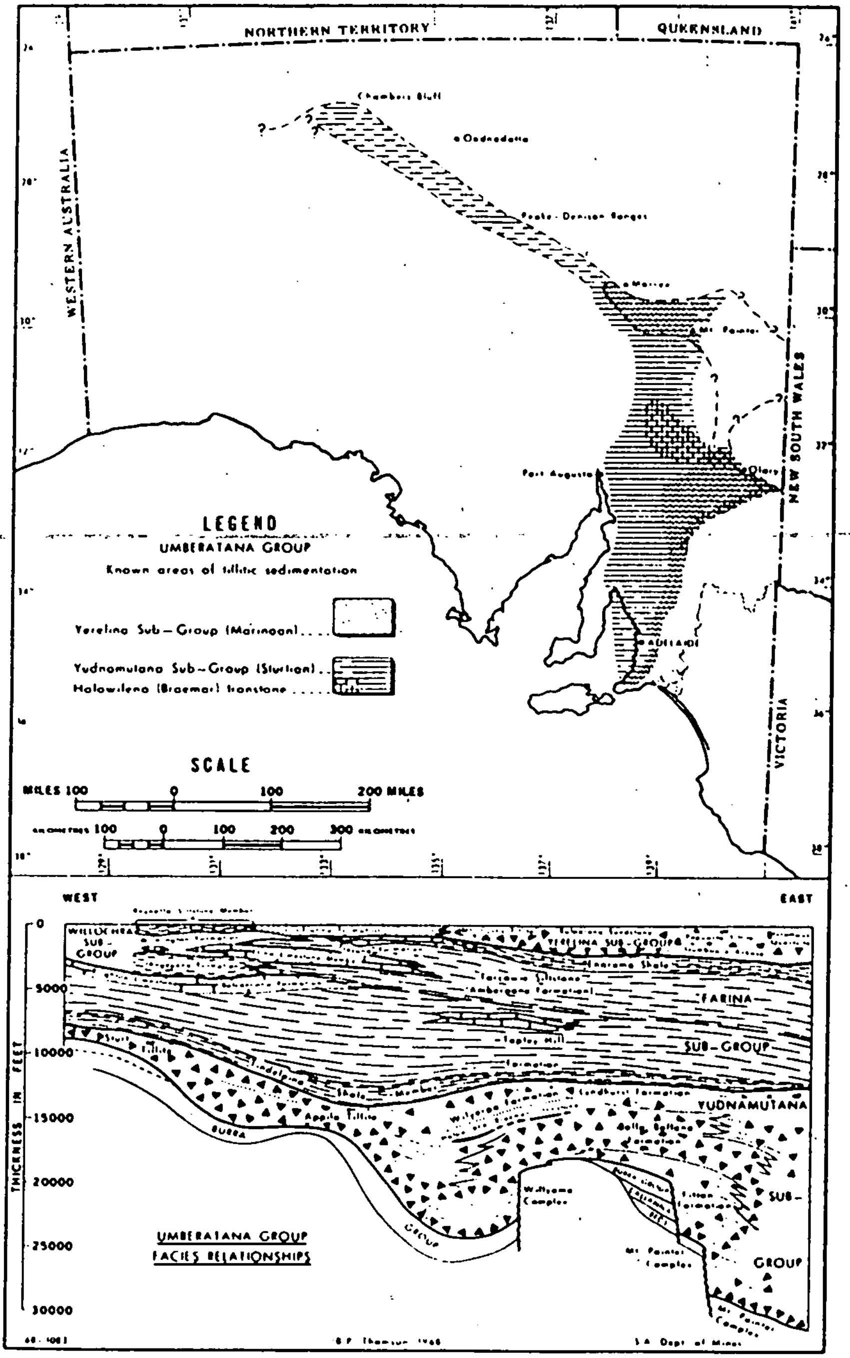


D.J.Woolman, Government Printer.

FIG 13

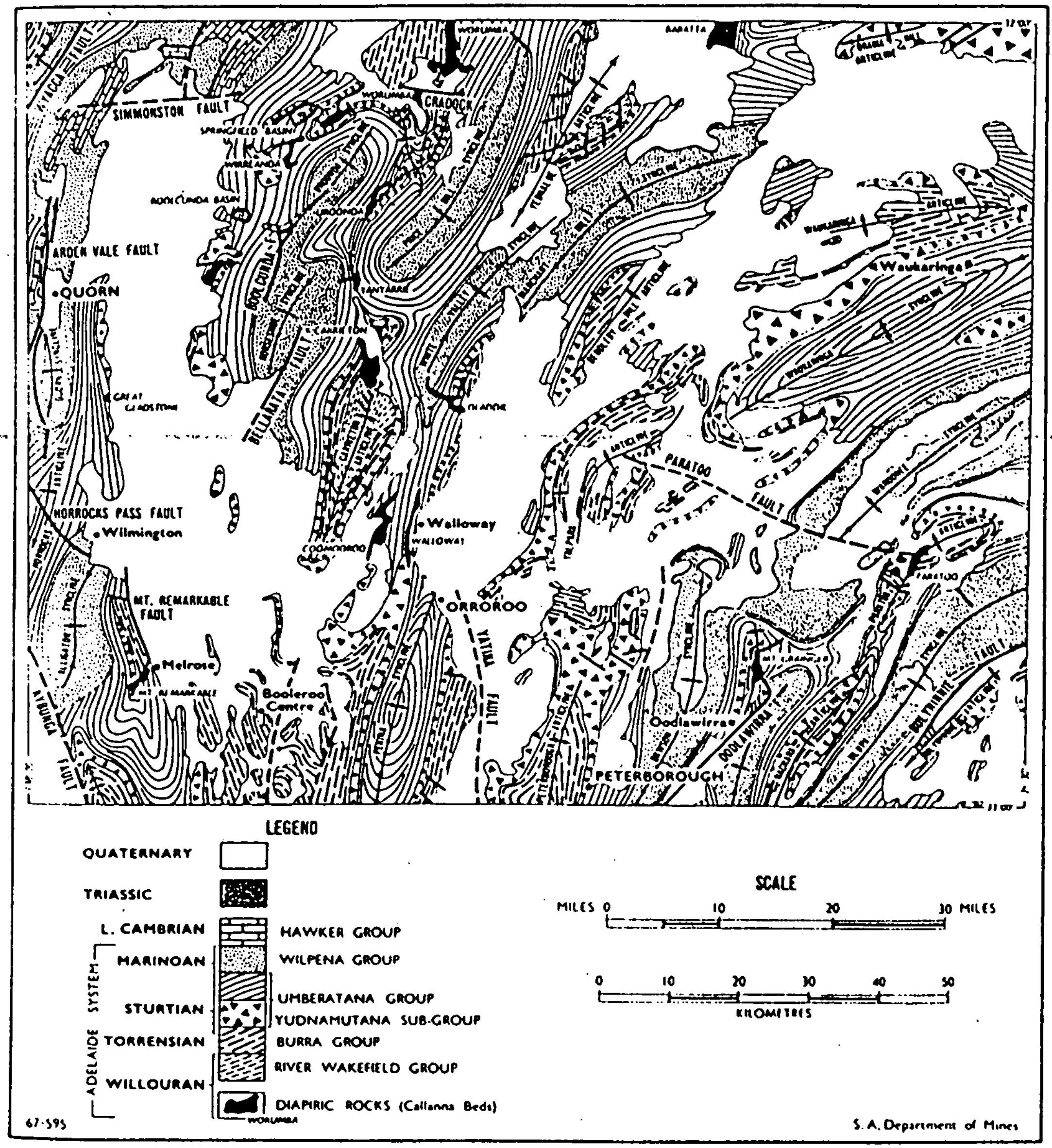


SALINITY CONVERSION TABLE		
Milligrams per litre (mg/L)	Grains per gallon (g.p.g.)	Conductivity (E.C. units)
1500	105	2650
3000	210	5000
7000	490	11000
12000	840	18000



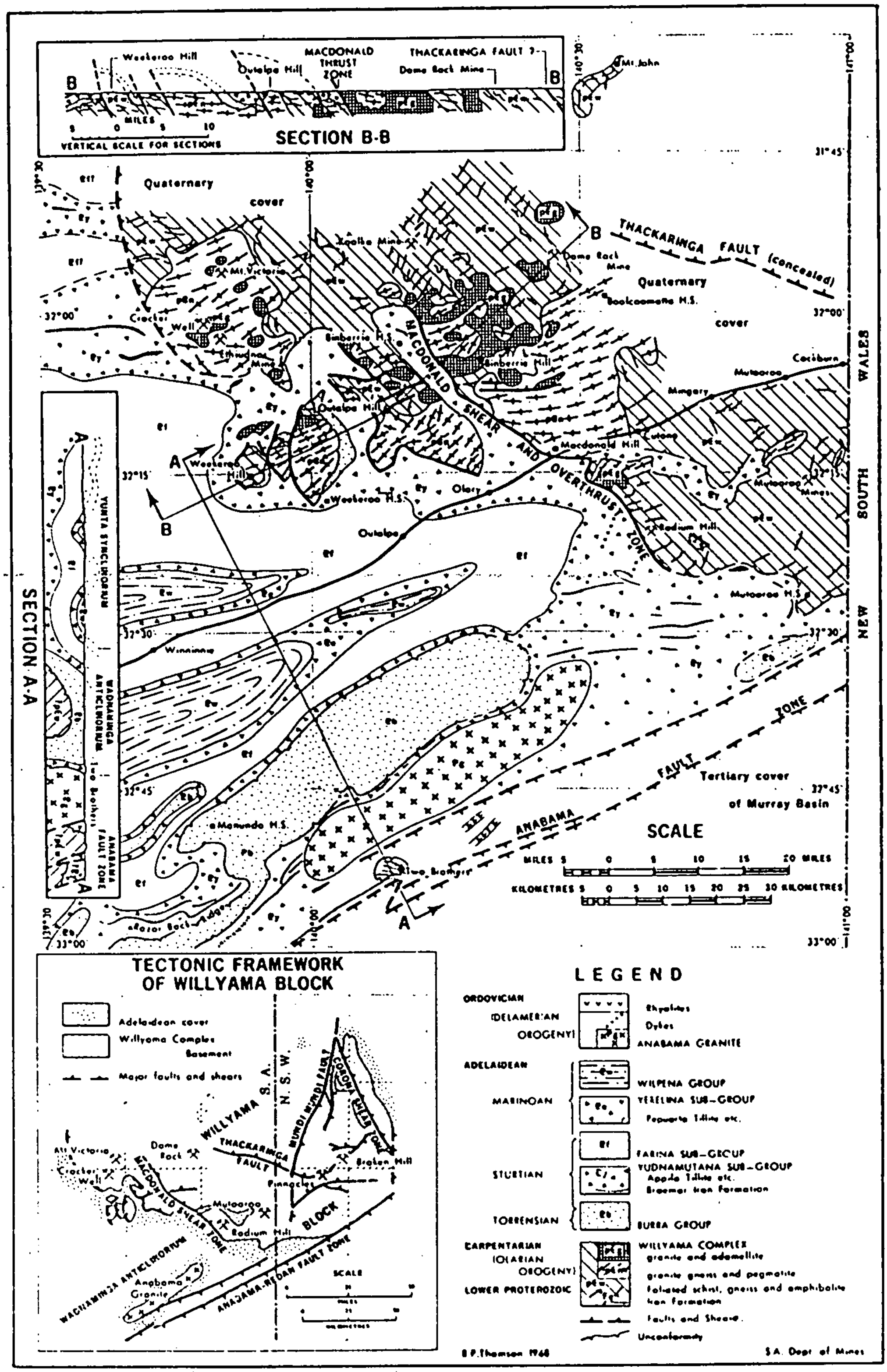
Areas of sedimentation, and diagrammatic section showing facies relationships of the Umberatana Group.

Fig. 15



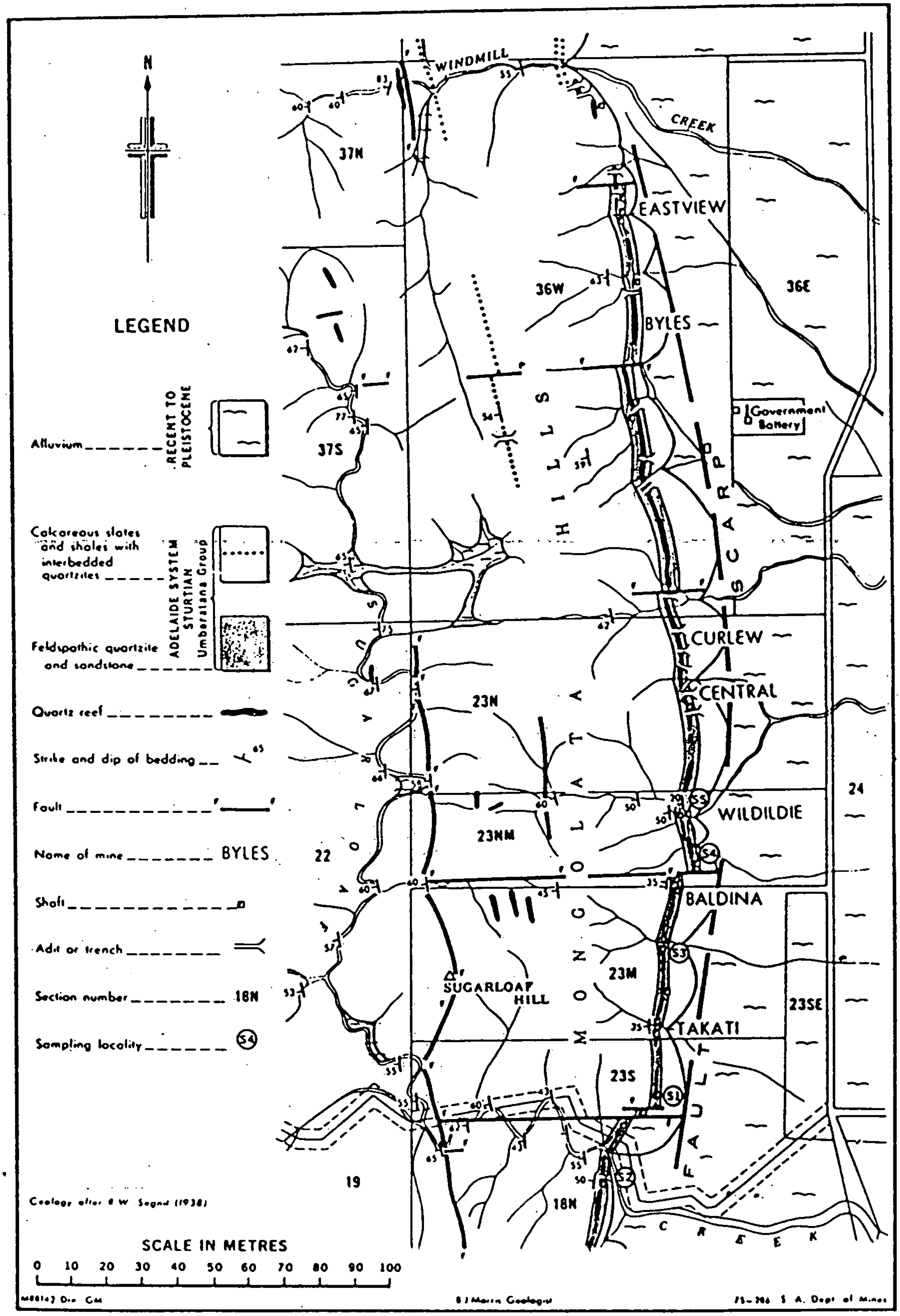
Regional structure map of the ORROROO 1:250,000 map area.

Fig. 16



Generalized geological map of the Olary Province, Willyama Block.

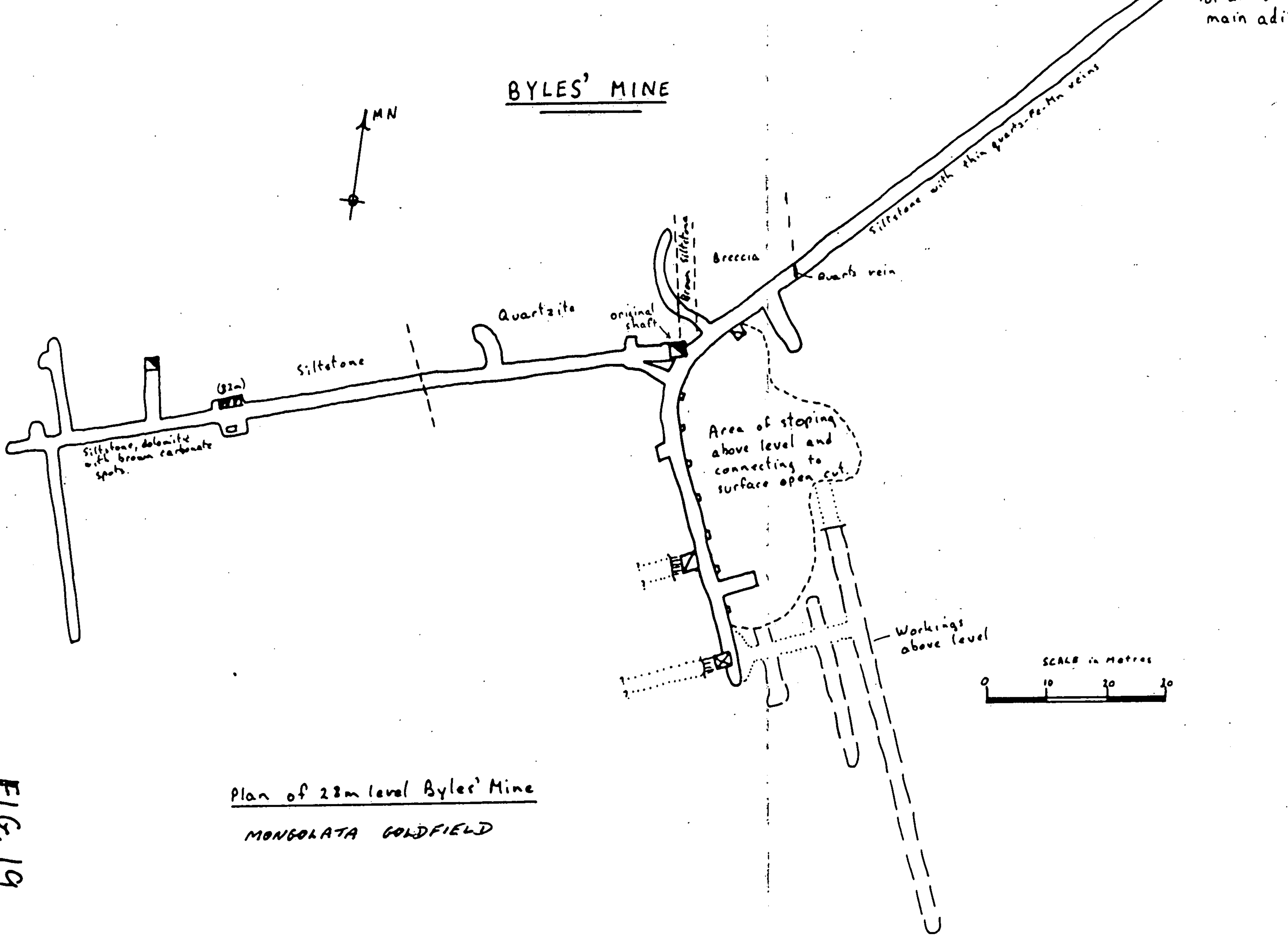
Fig. 17



Geological plan of Mongolata Goldfield

Fig. 18

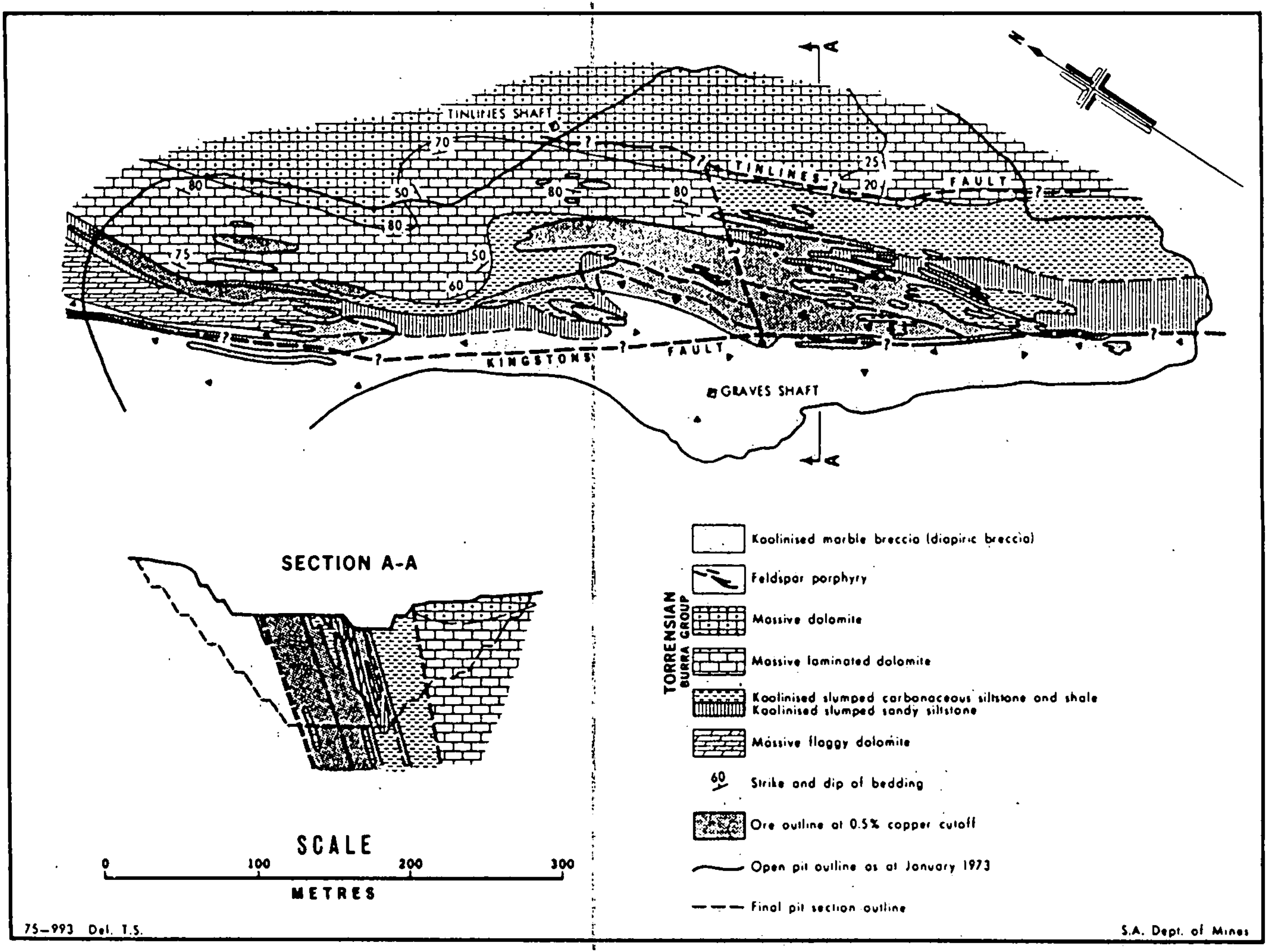
BYLES' MINE



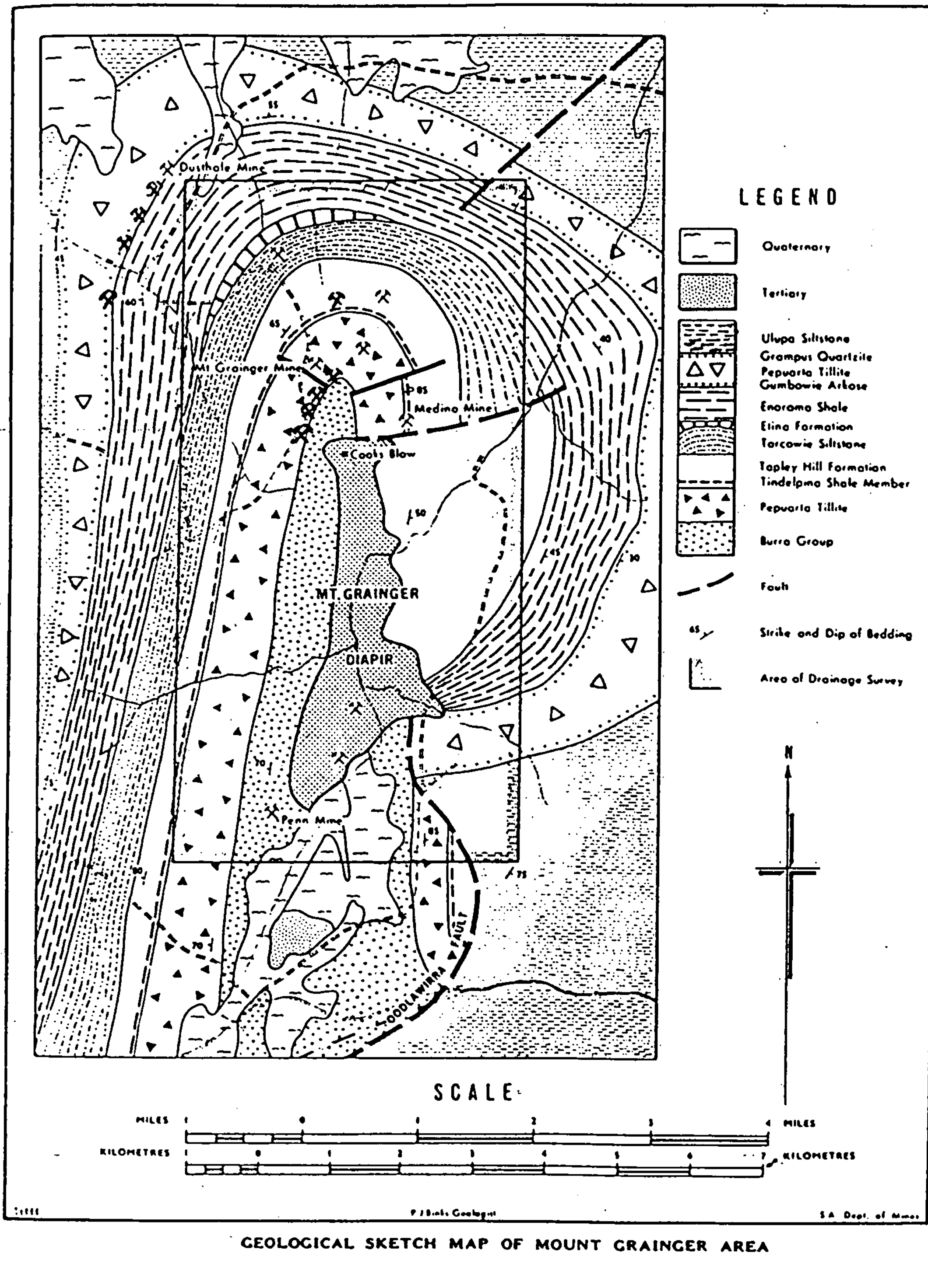
Plan of 28m level Byles' Mine

MONGOLATA GOLDFIELD

FIG. 19

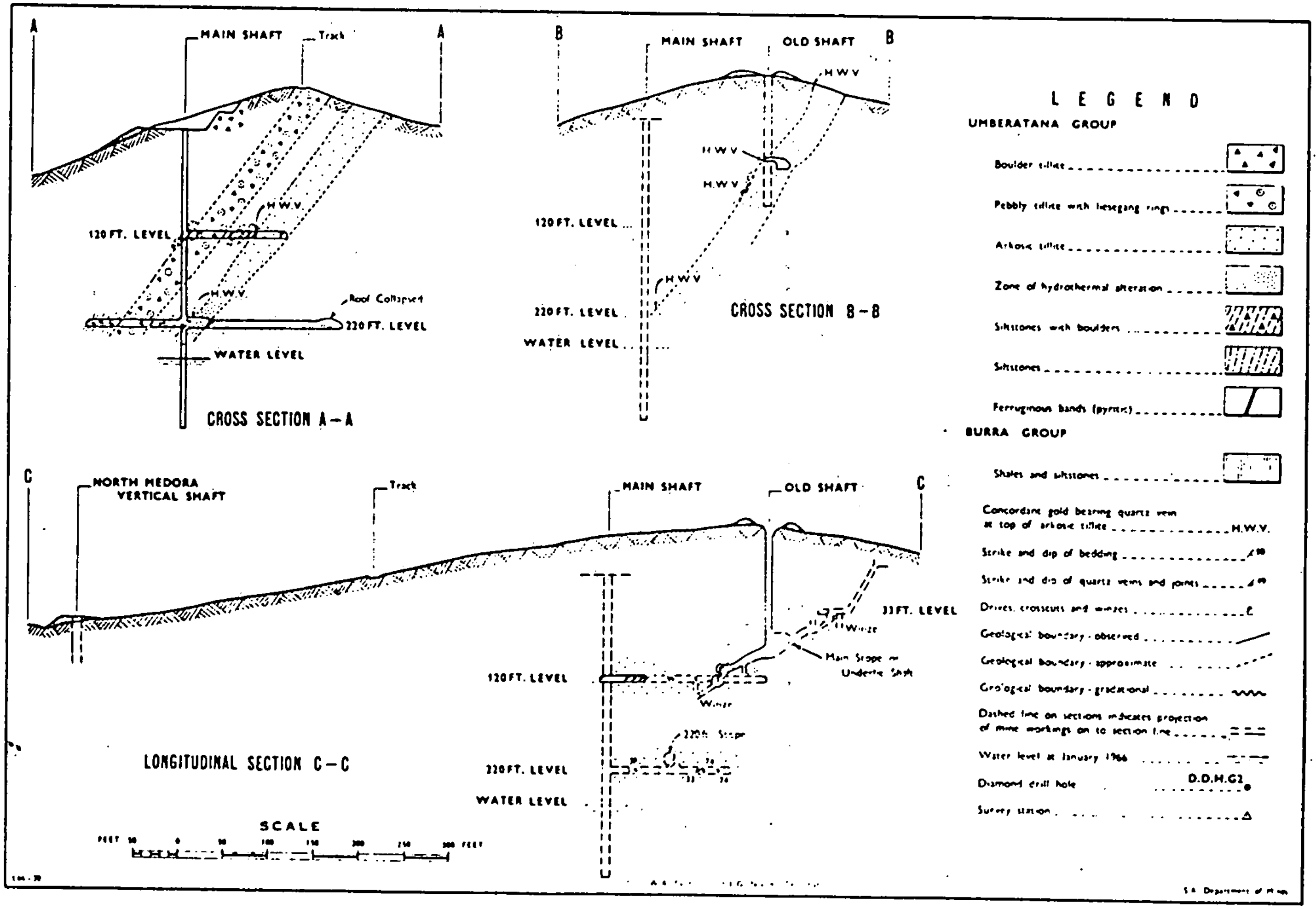


Geological plan of the Burra copper deposit, after Wright, 1976.



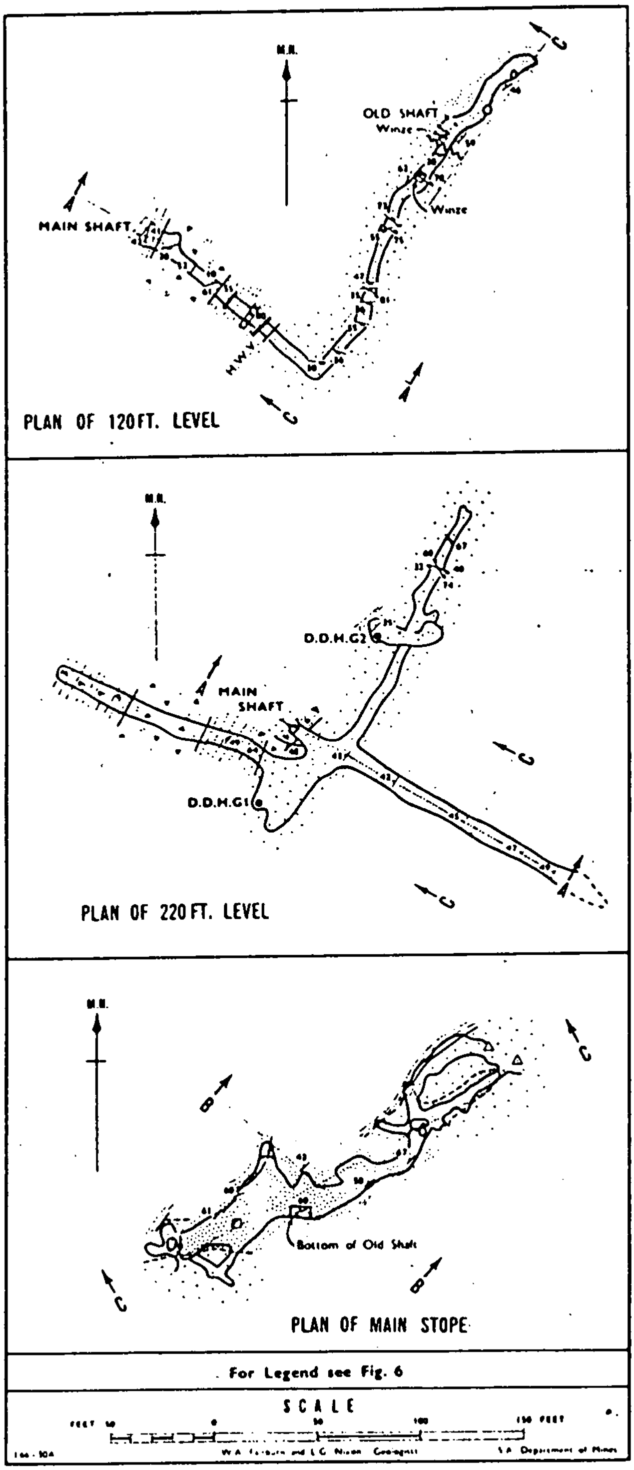
GEOLOGICAL SKETCH MAP OF MOUNT GRAINGER AREA

Fig. 21



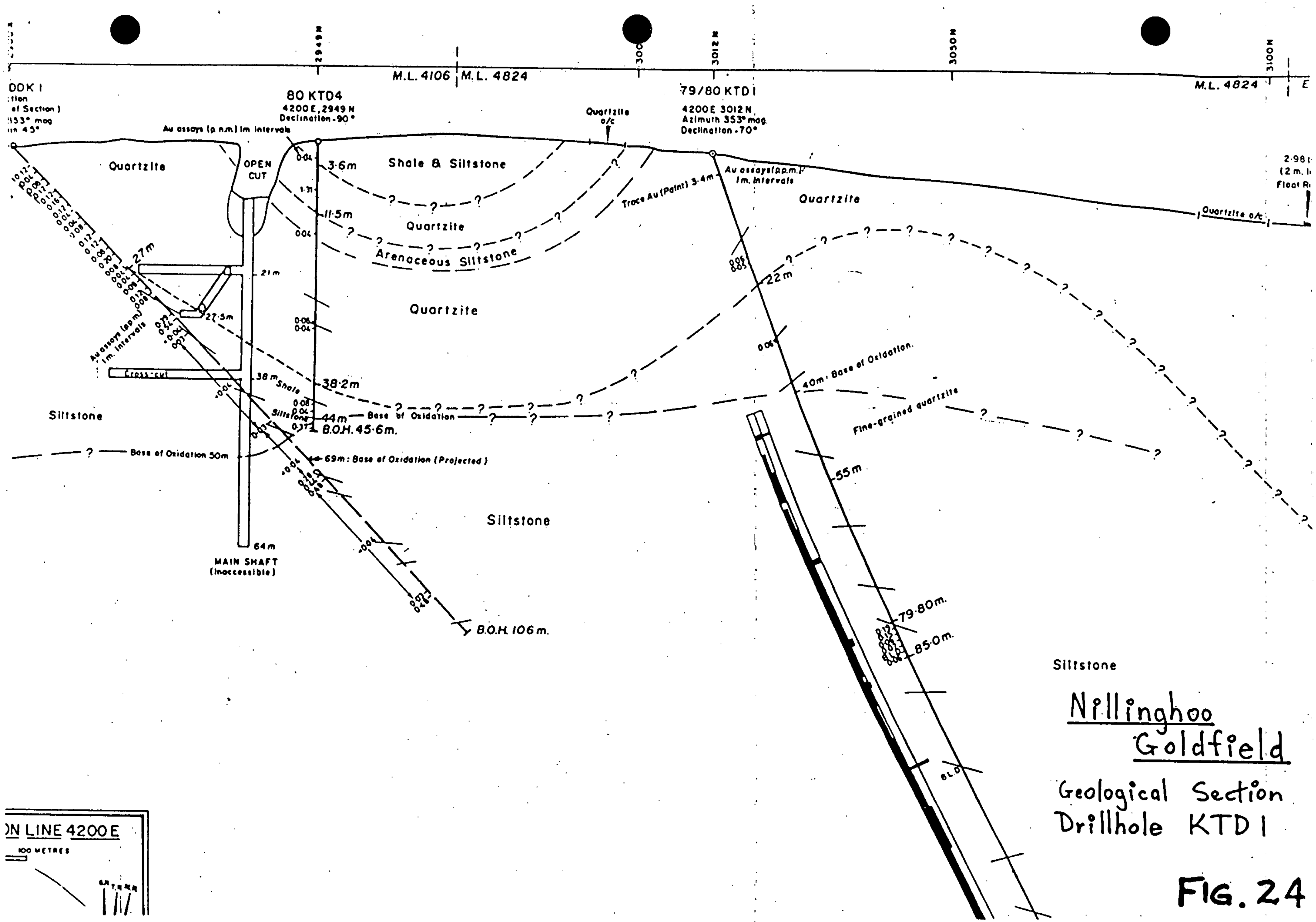
MOUNT GRAINGER GOLD MINE
Geological sections of underground workings

Fig. 22



MOUNT GRAINGER GOLD MINE
Geological level-plans

Fig 23



Nillinghoo Goldfield

Geological Section Drillhole KTD1

FIG. 24

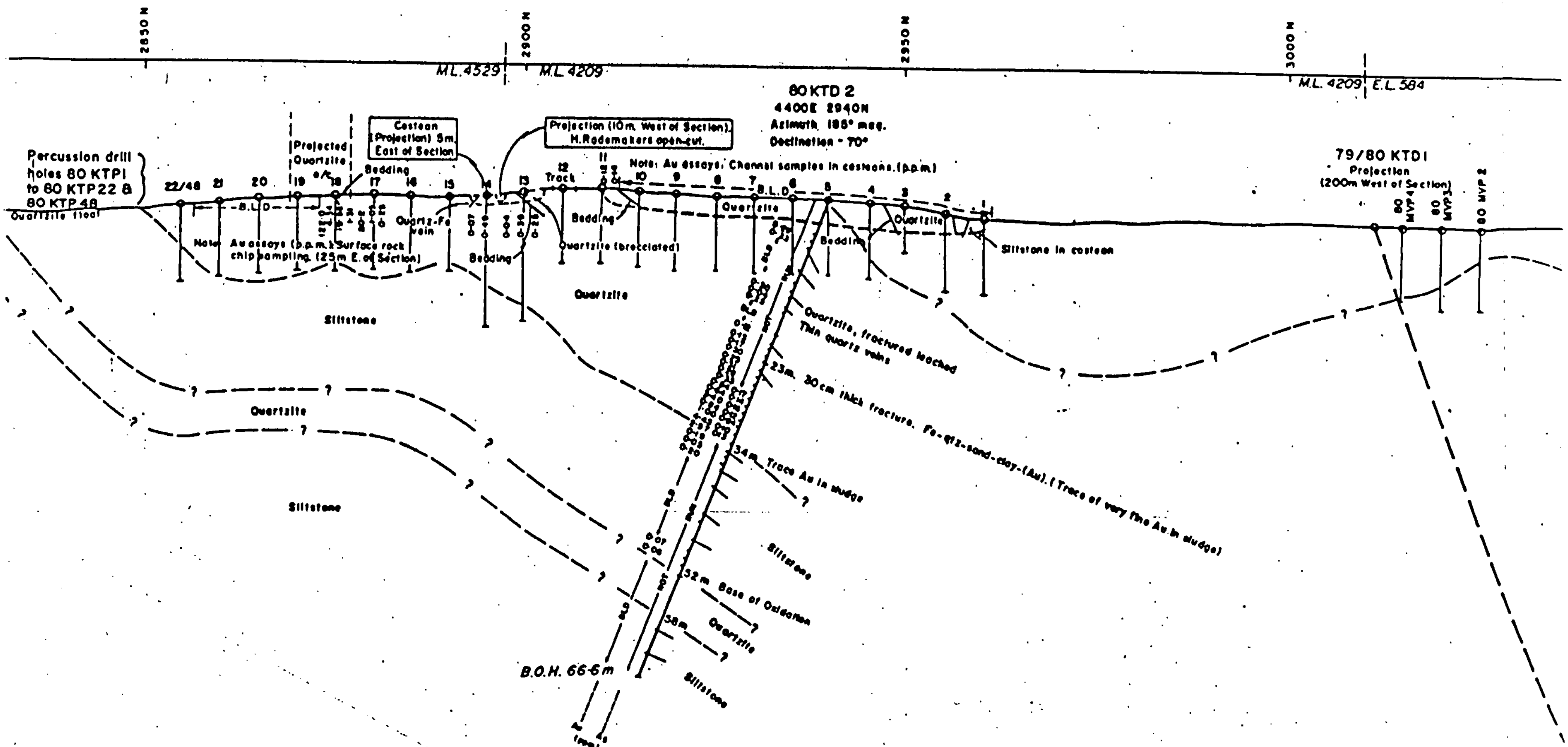
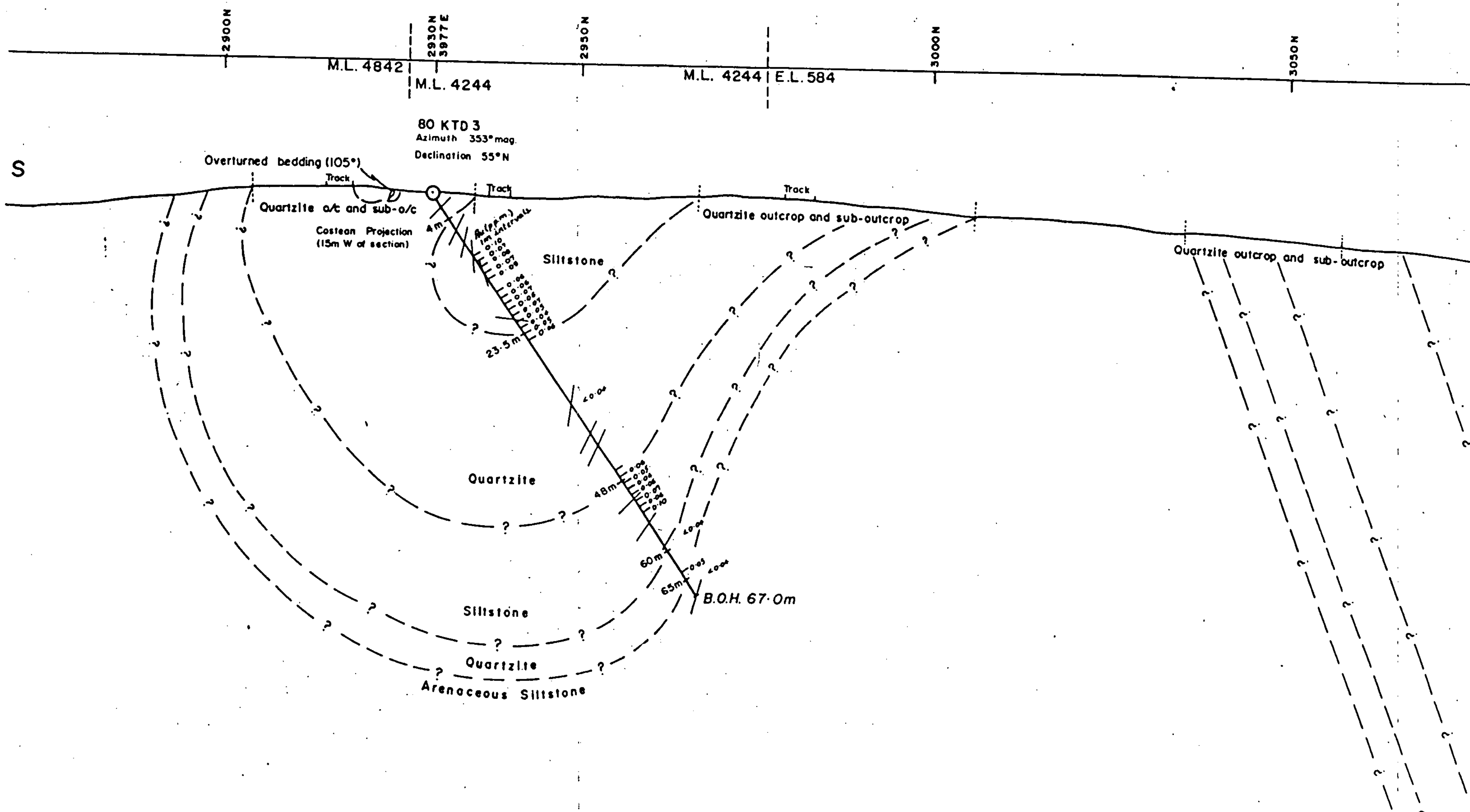

2850 N
2900 N
2950 N
3000 N
M.L. 4529
M.L. 4209
M.L. 4209
E.L. 584
80 KTD 2
4400E 2940N
Azimuth 185° mag.
Declination - 70°
Percussion drill holes 80 KTP1 to 80 KTP22 & 80 KTP 48
Quartzite float
Projected Quartzite o/c
Costean (Projection) 5m East of Section
Projection (10m West of Section) H. Rademakers open-cut.
Note: Au assays: Channel samples in costeans. (p.p.m.)
79/80 KTD1
Projection (200m West of Section)
Note: Au assays (p.p.m.) Surface rock chip sampling. (25m E. of Section)
B.L.O
Bedding
Quartz-Fe vein
Track
Quartzite (brecciated)
Quartzite
Siltstone in costean
Siltstone
Quartzite, fractured leached
Thin quartz veins
23m. 30cm thick fracture. Fe-qtz-sand-clay-(Au). (Trace of very fine Au in sludge)
34m. Trace Au in sludge
32m Base of Oxidation
38m
B.O.H. 66·6m
Au (ppm)

FIG. 25



2900N
2930N
3977E
2950N
3000N
3050N
M.L. 4842
M.L. 4244
M.L. 4244
E.L. 584
80 KTD 3
Azimuth 353° mag.
Declination 55°N
S
Overturned bedding (105°)
Track
Track
Track
Quartzite o/c and sub-o/c
Costean Projection
(15m W of section)
4m
Au(ppm.)
1m intervals
23.5m
48m
60m
65m
B.O.H. 67·0m
Siltstone
Quartzite outcrop and sub-outcrop
Quartzite outcrop and sub-outcrop
Quartzite
Siltstone
Quartzite
Arenaceous Siltstone

FIG. 26

ROXBY DOWNS ORE – PROCESS FLOW DIAGRAM

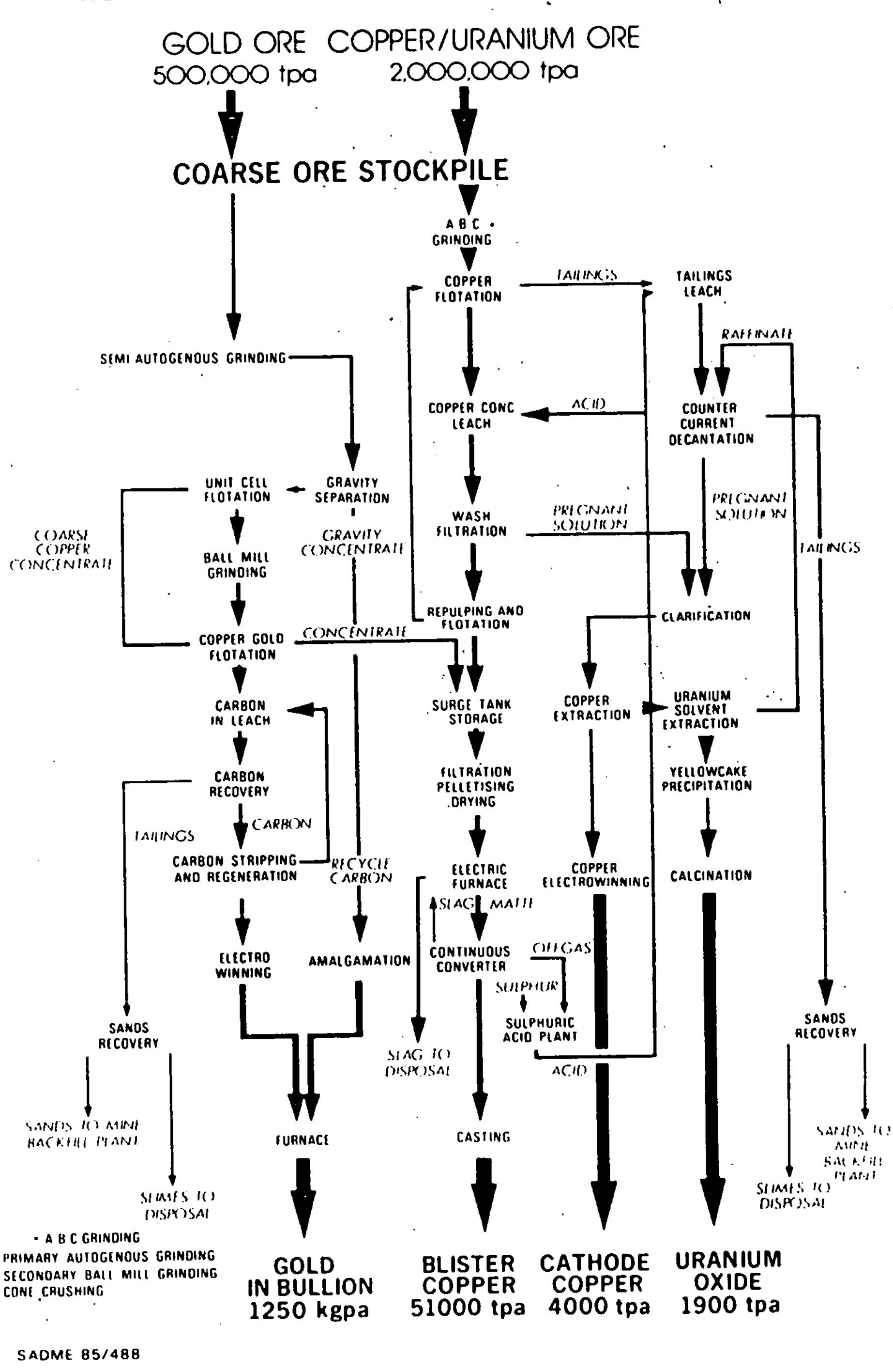
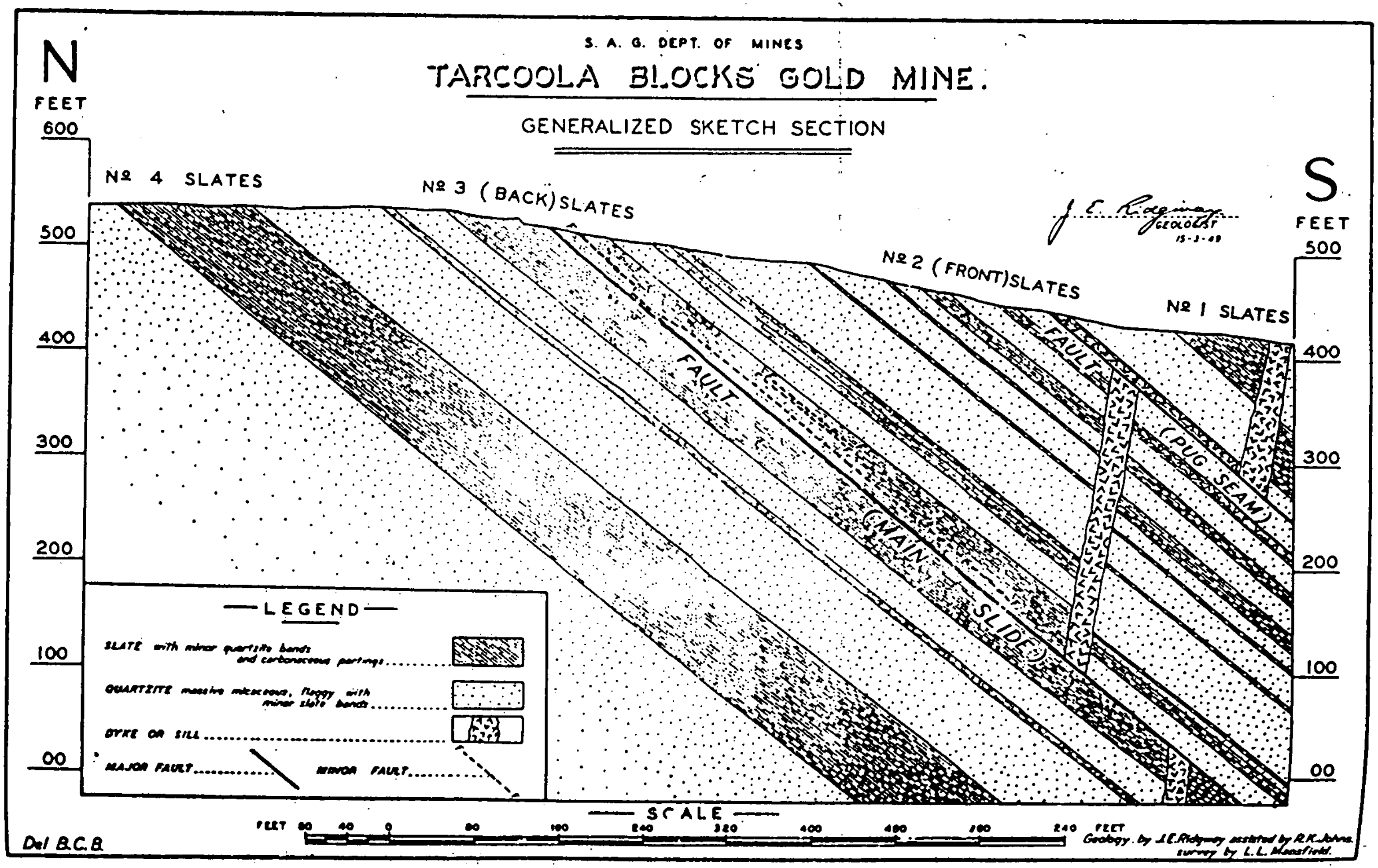


FIG 53



S. A. G. DEPT. OF MINES
TARCOOLA BLOCKS GOLD MINE.
GENERALIZED SKETCH SECTION
N
FEET
600
500
400
300
200
100
00
S
FEET
500
400
300
200
100
00
Nº 4 SLATES
Nº 3 (BACK) SLATES
Nº 2 (FRONT) SLATES
Nº 1 SLATES
FAULT
(MAIN SLIDE)
FAULT
(PUG SEAM)
J. E. Ridgway
GEOLOGIST
LEGEND
SLATE with minor quartzite bands and carbonaceous partings
QUARTZITE massive micaceous, flaggy with minor slate bands
DYKE OR SILL
MAJOR FAULT
MINOR FAULT
SCALE
FEET
Del B.C.B.
Geology by J.E. Ridgway assisted by R.K. Johns
survey by L.L. Mansfield.

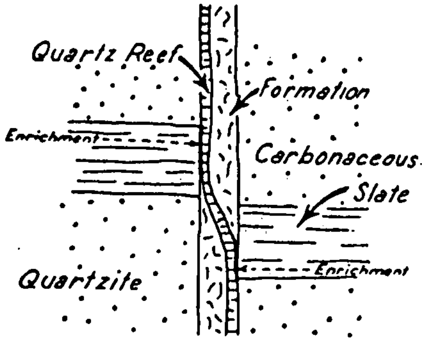
FIG 54

FIG 55

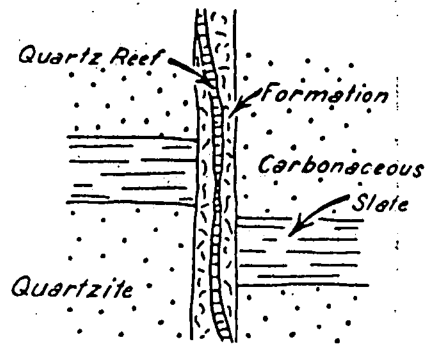
S.A.G. DEPT. OF MINES

TARCOOLA BLOCKS GOLD MINE

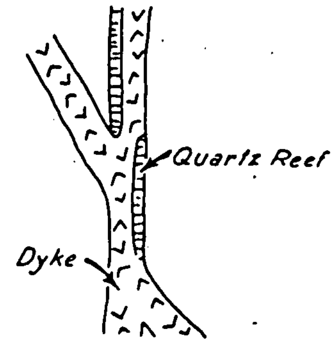
DIAGRAMMATIC SKETCHES
SHOWING FACTORS OF ENRICHMENT OR NON-ENRICHMENT IN A QUARTZ VEIN



Illustrating how faulting along a reef fissure prior to the deposition of gold may cause a single quartz vein to be enriched in two places by the same carbonaceous slate bed.



Showing how a quartz vein could pass through a carbonaceous slate bed and yet not be enriched by it.



Showing that dykes are post-reef and therefore have not influenced gold deposition.

Del. C.F.W.

J.E. Ridgway
GEOLOGIST

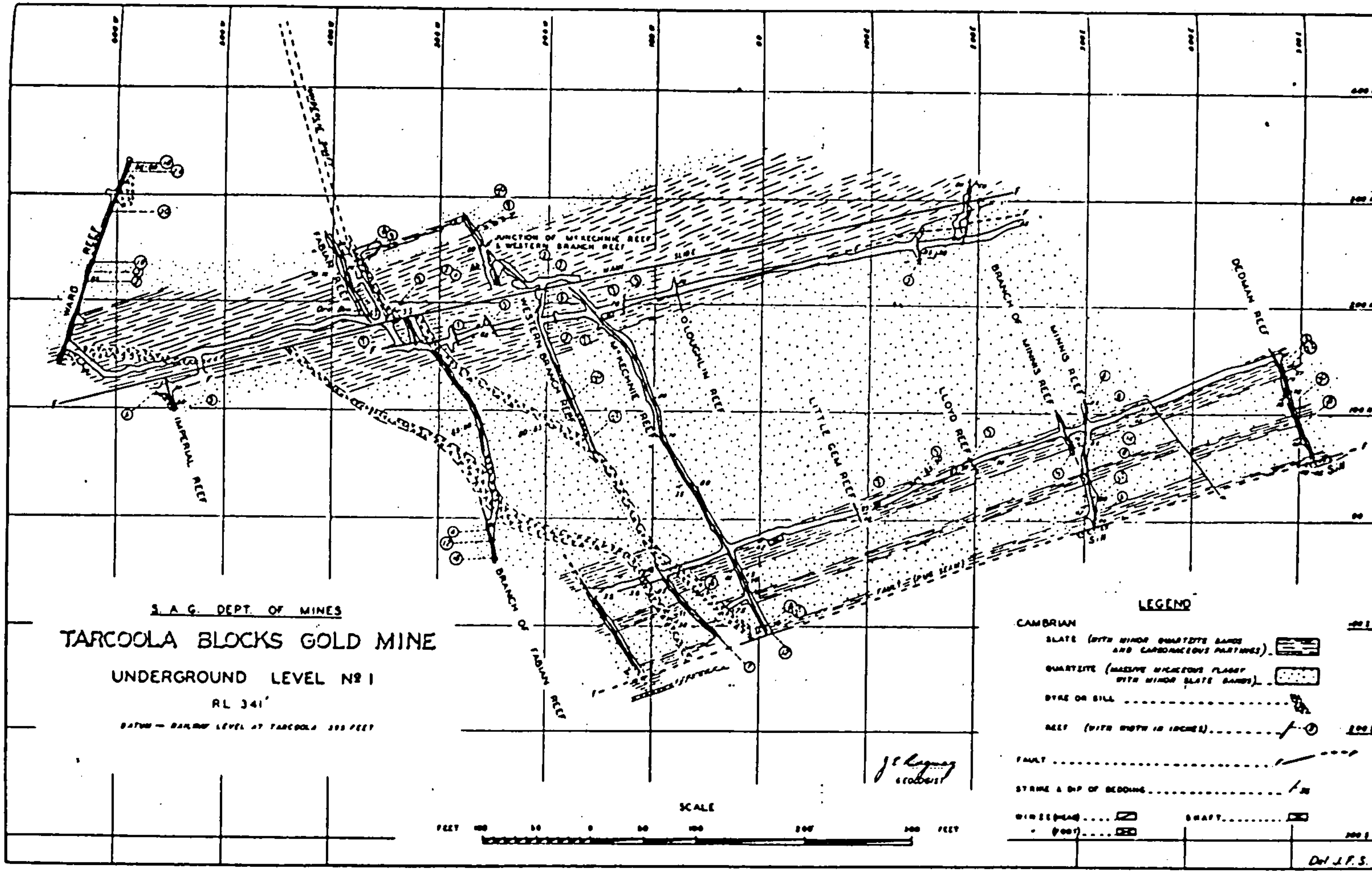
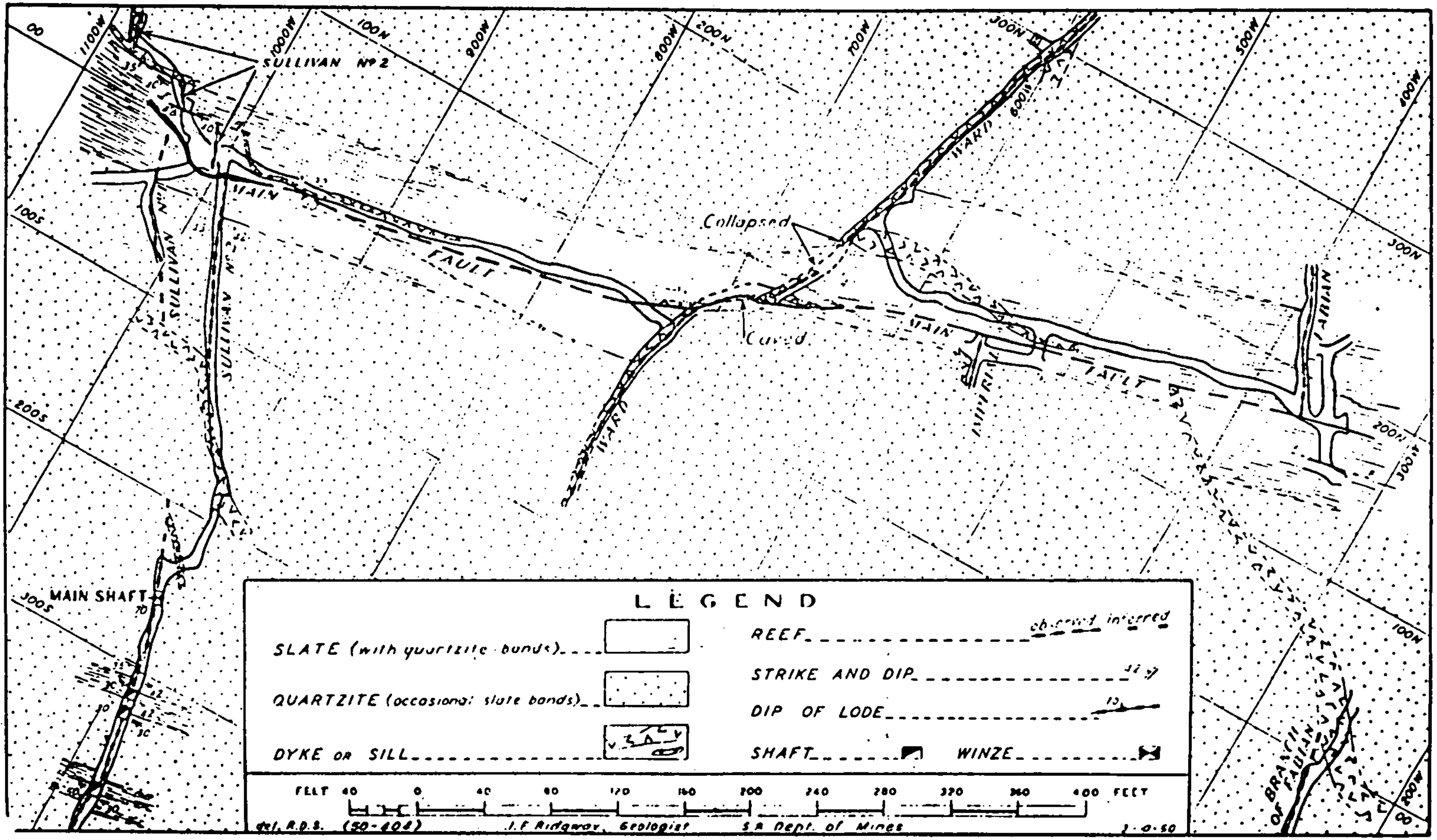

S. A. G. DEPT. OF MINES
TARCOOLA BLOCKS GOLD MINE
UNDERGROUND LEVEL Nº 1
RL 341'
WARD REEF
IMPERIAL REEF
FABIAN REEF
BRANCH OF FABIAN REEF
JUNCTION OF McKECHNIE REEF & WESTERN BRANCH REEF
WESTERN BRANCH REEF
McKECHNIE REEF
O'LOUGHLIN REEF
LITTLE GEM REEF
LLOYD REEF
BRANCH OF MINNIS REEF
MINNIS REEF
DEDMAN REEF
LEGEND
CAMBRIAN
SCALE
Del. J. F. S.

FIG 56

FIG 57



—Tarcoola Blocks gold leases 1654 and 1666—Geological plan of No. 1 level

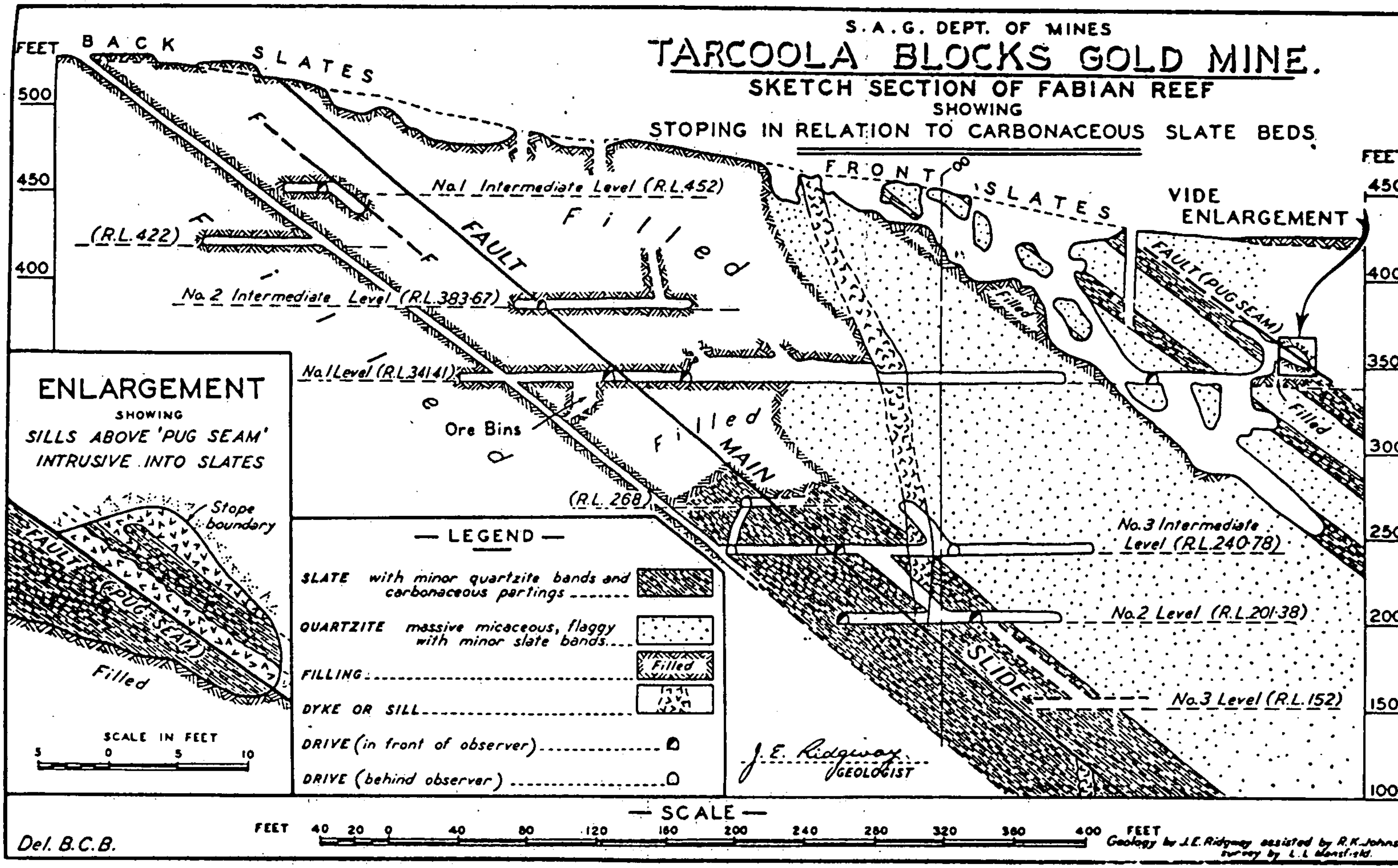

S.A.G. DEPT. OF MINES
TARCOOLA BLOCKS GOLD MINE.
SKETCH SECTION OF FABIAN REEF
SHOWING
STOPING IN RELATION TO CARBONACEOUS SLATE BEDS
FEET
500
450
400
BACK SLATES
FRONT SLATES
No.1 Intermediate Level (R.L.452)
(R.L.422)
No.2 Intermediate Level (R.L.383·67)
No.1 Level (R.L.341·41)
Ore Bins
(R.L.268)
No.3 Intermediate Level (R.L.240·78)
No.2 Level (R.L.201·38)
No.3 Level (R.L.152)
FAULT
MAIN
SLIDE
FAULT (PUG SEAM)
Filled
VIDE ENLARGEMENT
FEET
450
400
350
300
250
200
150
100
ENLARGEMENT
SHOWING
SILLS ABOVE 'PUG SEAM' INTRUSIVE INTO SLATES
Stope boundary
FAULT (PUG SEAM)
Filled
SCALE IN FEET
5 0 5 10
— LEGEND —
SLATE with minor quartzite bands and carbonaceous partings
QUARTZITE massive micaceous, flaggy with minor slate bands
FILLING
DYKE OR SILL
DRIVE (in front of observer)
DRIVE (behind observer)
J.E. Ridgway
GEOLOGIST
— SCALE —
FEET 40 20 0 40 80 120 160 200 240 280 320 360 400 FEET
Del. B.C.B.
Geology by J.E. Ridgway assisted by R.K. Johns.
survey by L.L. Mansfield.

FIG 58

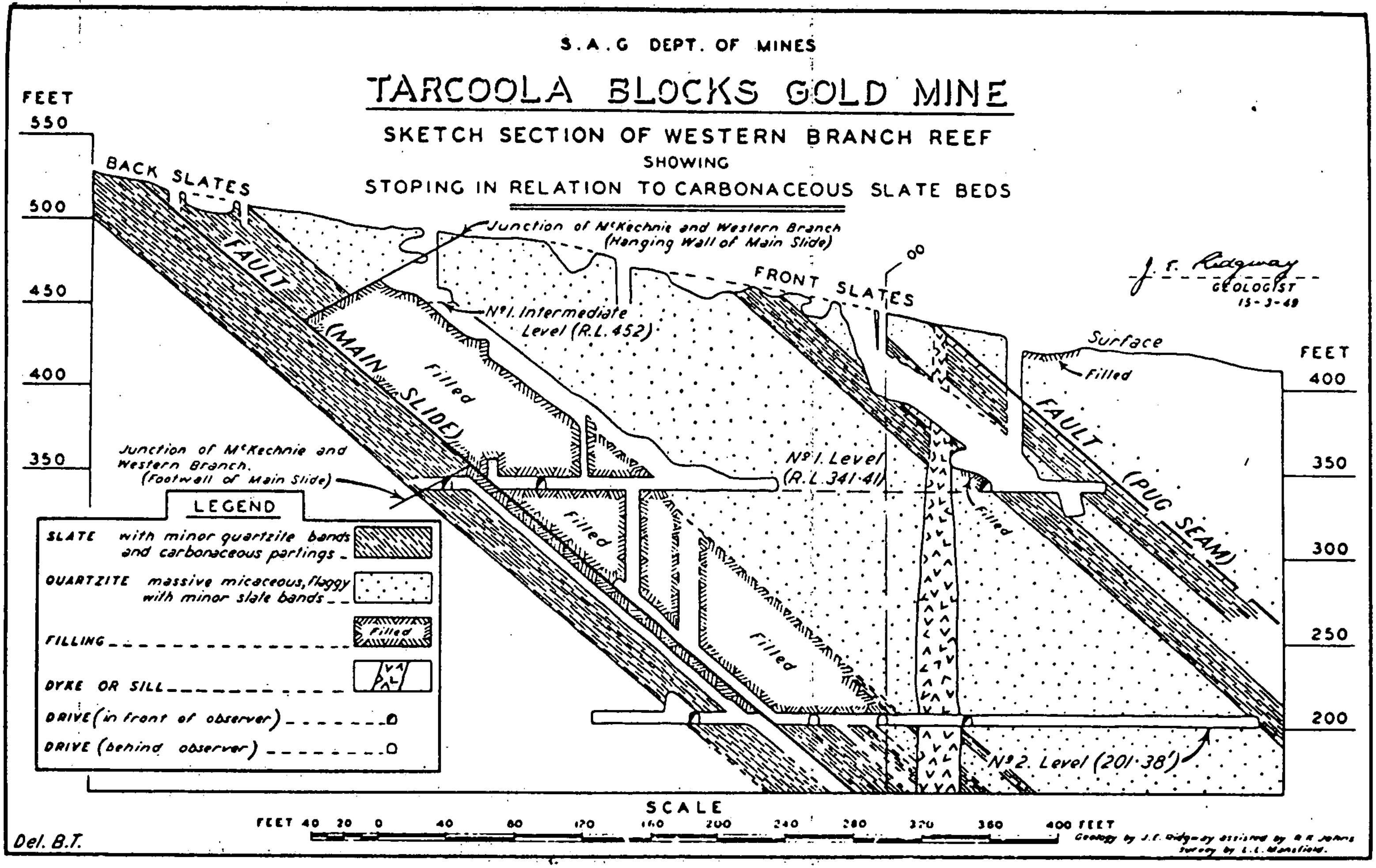

S.A.G DEPT. OF MINES
TARCOOLA BLOCKS GOLD MINE
SKETCH SECTION OF WESTERN BRANCH REEF
SHOWING
STOPING IN RELATION TO CARBONACEOUS SLATE BEDS
FEET
550
500
450
400
350
BACK SLATES
FAULT
(MAIN SLIDE)
Filled
Junction of McKechnie and Western Branch (Hanging Wall of Main Slide)
No. 1. Intermediate Level (R.L. 452)
FRONT SLATES
J. F. Ridgway
GEOLOGIST
15-3-49
Surface
Filled
FAULT (PUG SEAM)
FEET
400
350
300
250
200
Junction of McKechnie and Western Branch. (Footwall of Main Slide)
No. 1. Level (R.L. 341·41)
Filled
Filled
Filled
No. 2. Level (201·38')
LEGEND
SLATE with minor quartzite bands and carbonaceous partings
QUARTZITE massive micaceous, flaggy with minor slate bands
FILLING
Filled
DYKE OR SILL
DRIVE (in front of observer)
DRIVE (behind observer)
SCALE
FEET 40 20 0 40 80 120 160 200 240 280 320 360 400 FEET
Del. B.T.
Geology by J.F. Ridgway assisted by R.R. Johns
Survey by L.L. Mansfield.

FIG 59

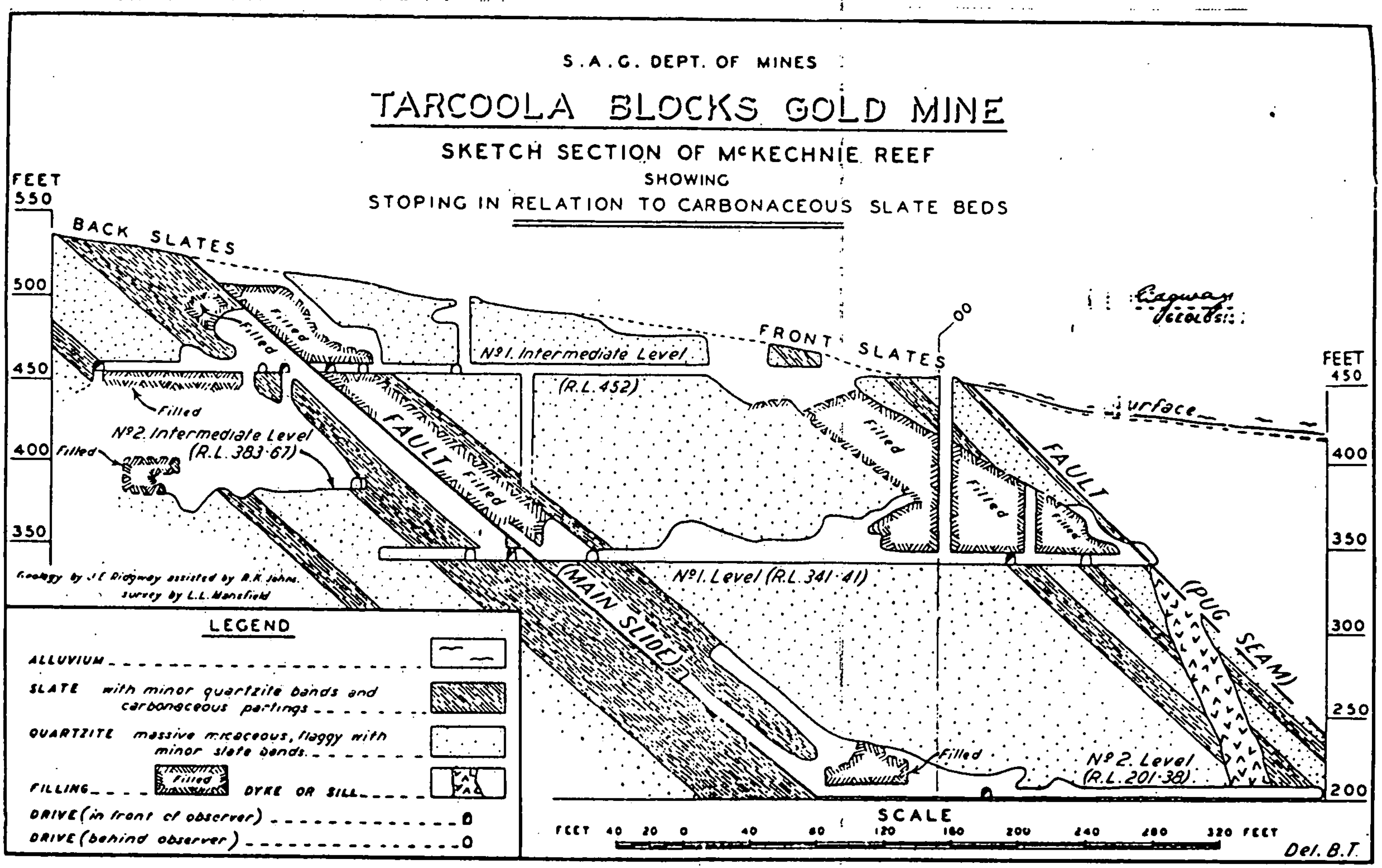
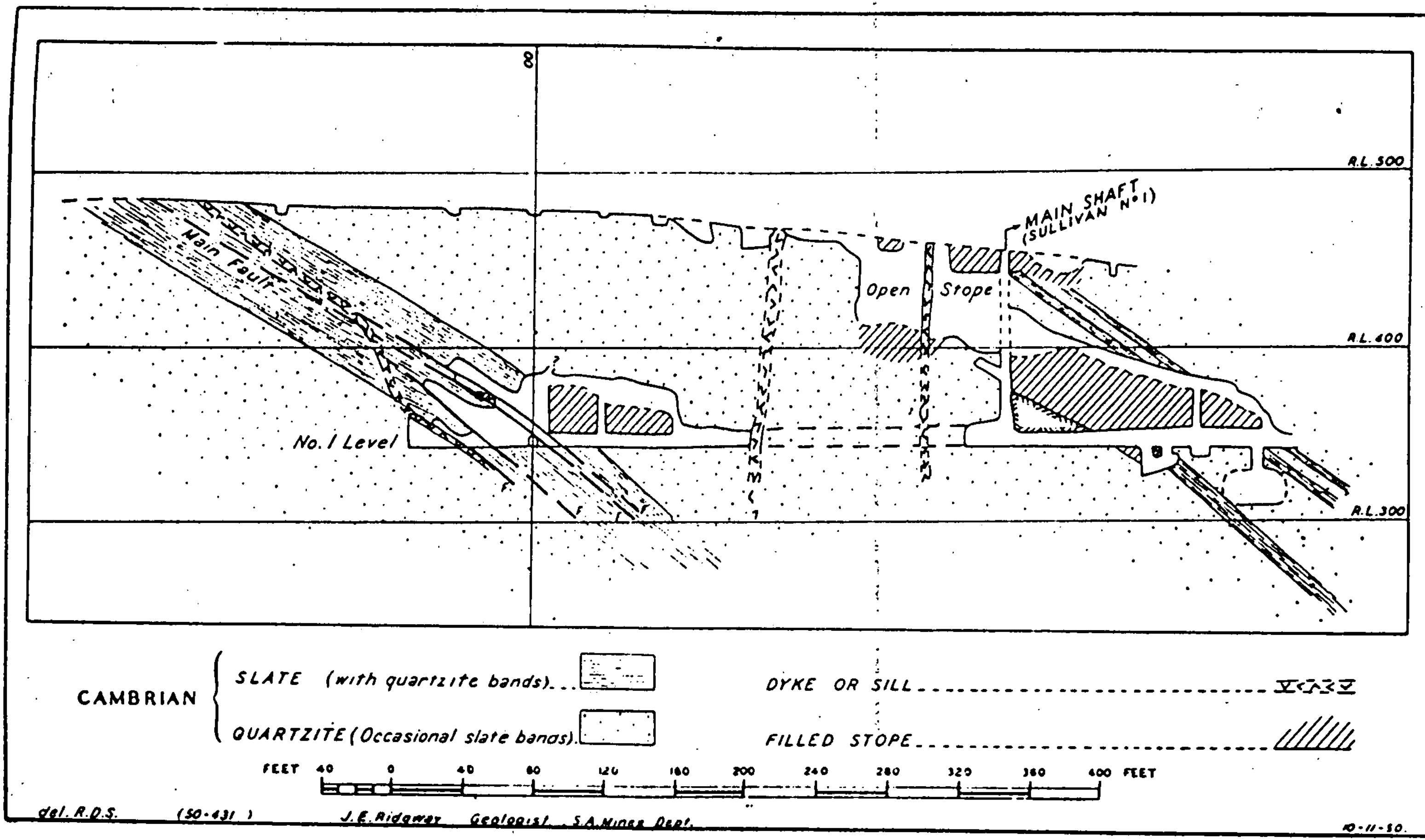

S.A.G. DEPT. OF MINES
TARCOOLA BLOCKS GOLD MINE
SKETCH SECTION OF McKECHNIE REEF
SHOWING
STOPING IN RELATION TO CARBONACEOUS SLATE BEDS
FEET
550
500
450
400
350
BACK SLATES
FRONT SLATES
Filled
No1. Intermediate Level
(R.L. 452)
No2. Intermediate Level
(R.L. 383·67)
FAULT
Surface
(MAIN SLIDE)
No1. Level (R.L. 341·41)
(PUG SEAM)
No2. Level
(R.L. 201·38)
FEET
450
400
350
300
250
200
Geology by J.E. Ridgway assisted by R.K. Johns.
survey by L.L. Mansfield
LEGEND
ALLUVIUM
SLATE with minor quartzite bands and carbonaceous partings
QUARTZITE massive micaceous, flaggy with minor slate bands.
FILLING
DYKE OR SILL
DRIVE (in front of observer)
DRIVE (behind observer)
SCALE
FEET 40 20 0 40 80 120 160 200 240 280 320 FEET
Del. B.T.

FIG 60

FIG 61



—Tarcoola Blocks gold lease 1654—Sketch section along Sullivan No. 1 reef showing stoping relative to slate beds

Sullivans Mine – Tarcoola.

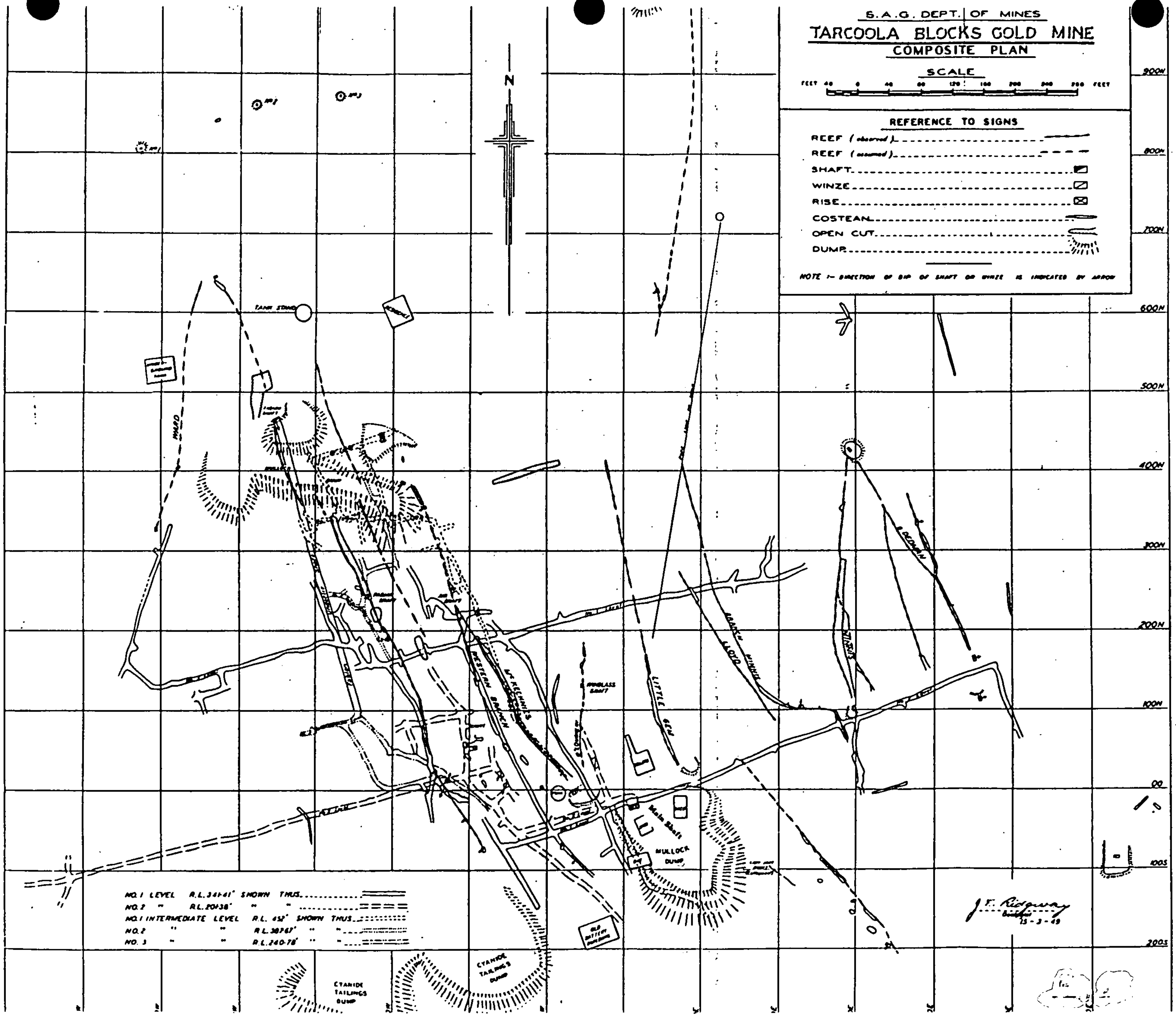

S.A.G. DEPT. OF MINES
TARCOOLA BLOCKS GOLD MINE
COMPOSITE PLAN
SCALE
REFERENCE TO SIGNS
REEF (observed)
REEF (assumed)
SHAFT
WINZE
RISE
COSTEAN
OPEN CUT
DUMP
NOTE :- DIRECTION OF DIP OF SHAFT OR WINZE IS INDICATED BY ARROW
N
900N
800N
700N
600N
500N
400N
300N
200N
100N
00
100S
200S
WESTERN BRANCH
LITTLE GEM
LLOYD
Main Shaft
MULLOCK DUMP
CYANIDE TAILINGS DUMP
NO. 1 LEVEL R.L. 341·41' SHOWN THUS
NO. 2 " R.L. 201·38' " "
NO. 1 INTERMEDIATE LEVEL R.L. 452' SHOWN THUS
NO. 2 " " R.L. 307·67' " "
NO. 3 " " R.L. 240·78' " "
25-3-49

FIG 62

EAREA DAM GOLDFIELD

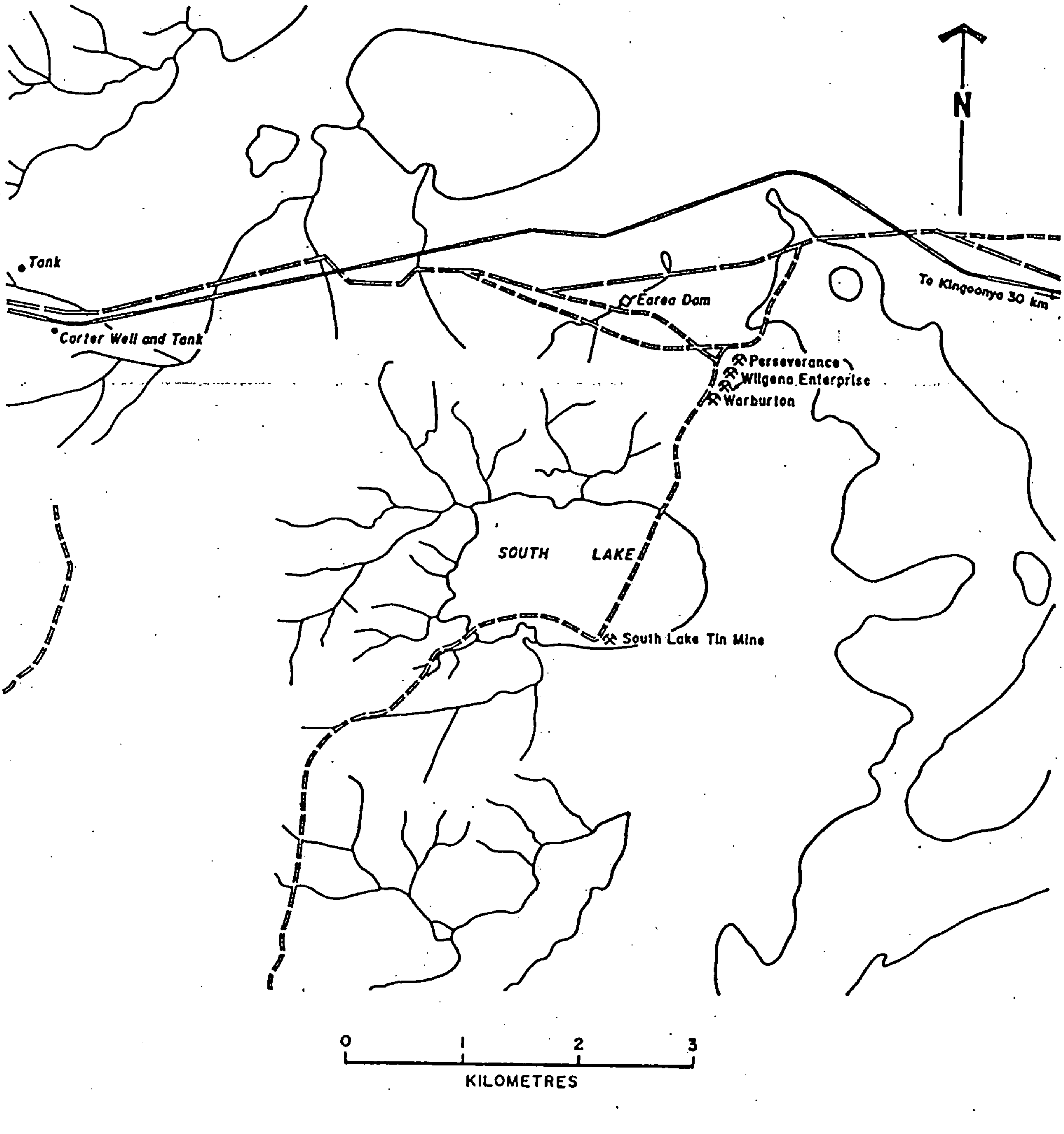


FIG 63

GLENLOTH GOLDFIELD

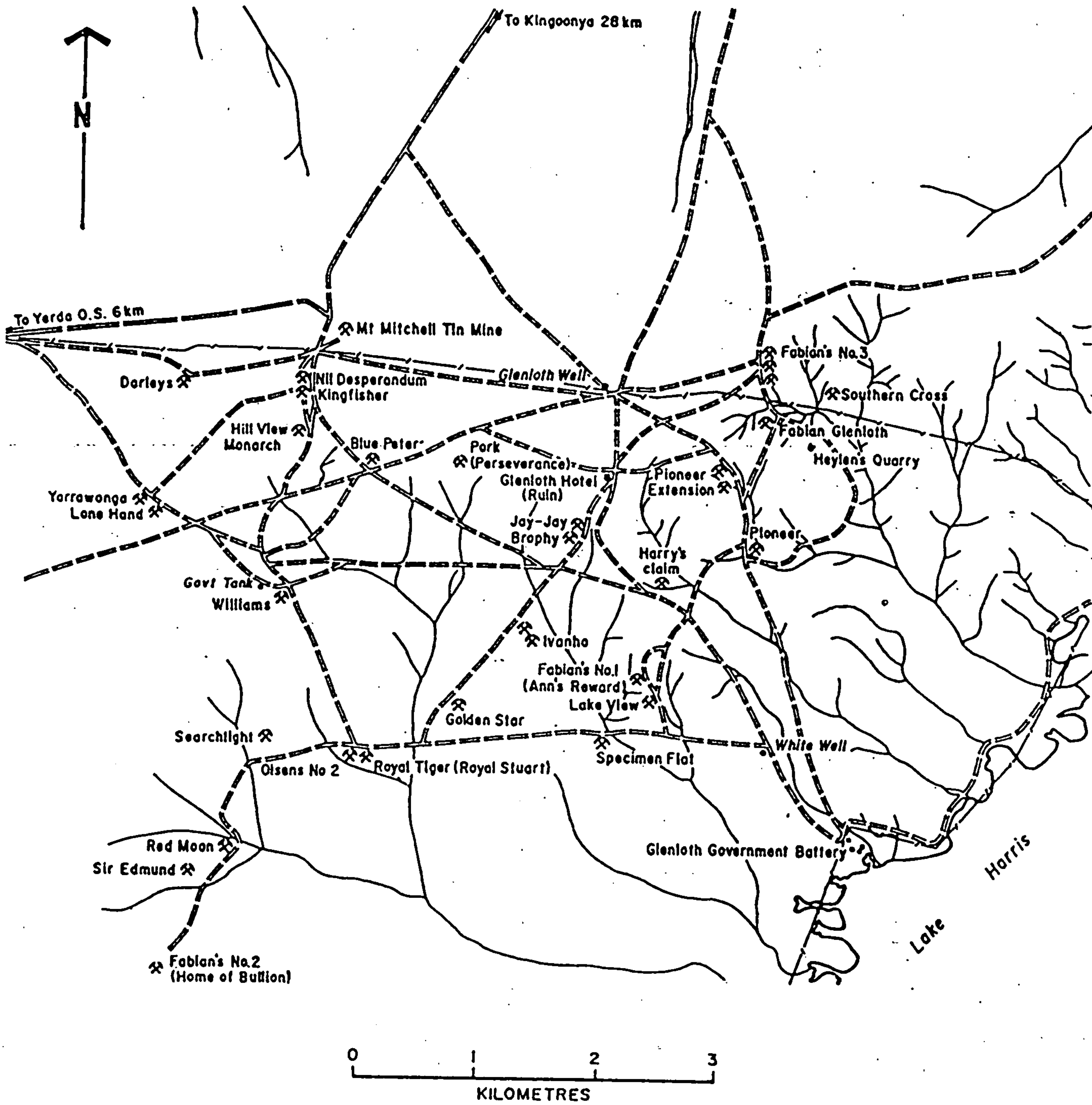
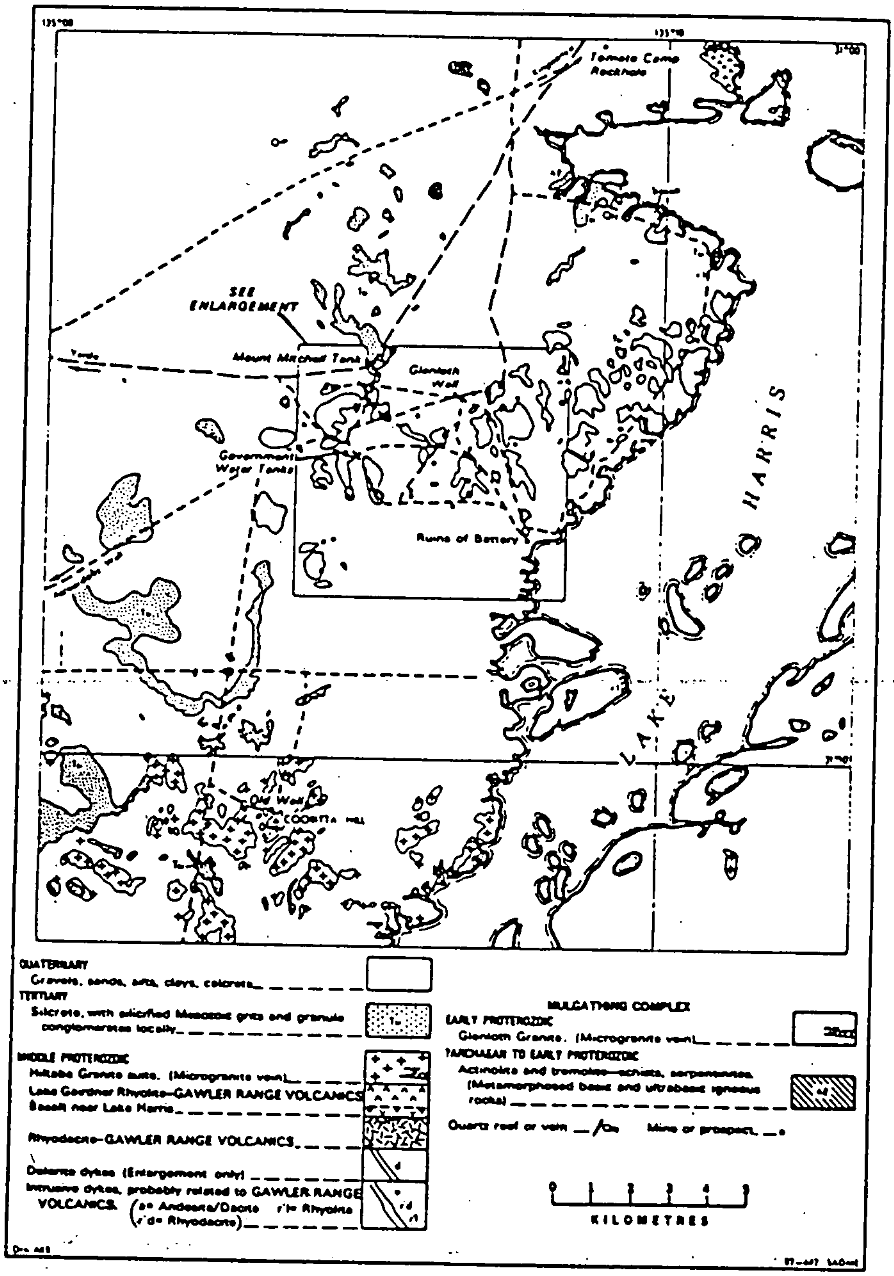


FIG 64

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA



Geological map of Glenloth Goldfield.

FIG 65

Figure 66 "Glenloth Goldfield - Enlargement" Missing