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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
MINERAL RESOURCES DIVISION

MINERAL RESOURCES OF EYRE PLANNING AREA

- STATE PLANNING OFFICE -

by

M.N. HIERN
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MINERAL RESOURCES DIVISION

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CONTENTS — PAGE.

CONTENTS	PAGE.
ABSTRACT	1
INTRODUCTION	3
PHYSIOGRAPHY	4
GEOLOGICAL SETTING	5
ECONOMIC GEOLOGY	10
Producing Deposits	11
Aggregate	11
Groundwater	13
Gypsum	15
Limesand	17
Ornamental and Semi Precious Gem Stones	18
Salt	20
Non Producing Deposits	21
Asbestos	21
Base Metals	22
Clay	24
Coal	26
Dolomite	27
Graphite	28
Heavy Mineral Sand	30
Iron Ore	30
Limestone	34
Magnesite	34
Molybdenum and Tungsten	35
Phosphate	36
Talc	36
Uranium	38
Whiting	40
Miscellaneous Mineral Occurrences	41
SUMMARY	41
MINERAL DEPOSITS AND LAND USE	45
REFERENCES	47

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REPORT ON

MINERAL RESOURCES OF EYRE PLANNING AREA

- State Planning Office -

ABSTRACT

A comprehensive review of mineral deposits and their geological setting is presented to guide planning decisions relating to the mineral industry. The report also provides basic geological data and literature references useful to mineral exploration groups.

Gypsum and limesand, both of Quaternary age, are the major mineral deposits being exploited in the area. Enormous reserves of high grade material are available at Lake MacDonnell, Coffin Bay and in other deposits of lower grade.

Few suitable surface water storage sites exist and groundwater, which occurs in large quantities in a number of Tertiary - Quaternary basins, is the main source of water supply.

Extensive exploration of both surface and concealed iron formation has defined large reserves of low grade magnetite ore at Warramboo and other localities. Preliminary testing has shown beneficiation to be feasible.

Quartz-kaolin rocks, a product of intense surface leaching in the Tertiary, are widespread and are a potential future source of aluminium and possibly paper clays. Deposits near Kimba and Tumby Bay have been investigated.

High grade talc, impregnated with jasper, occurs near Tumby Bay and could provide a moderate tonnage of talc suitable for most industrial uses if a beneficiation process is developed.

Outcropping basemetal, uranium and molybdenum-tungsten deposits in the basement have been thoroughly tested during several phases of exploration without locating viable deposits or revealing significant targets for further testing. However much of the basement is concealed by younger cover and these areas remain unexplored.

Carbonaceous sands of Tertiary and in one case Jurassic age flank the hinterland containing minor primary uranium mineralisation. Only one small area has been tested for sedimentary uranium and anomalous but non-economic uranium values were detected at the base of the oxidised zone. The possibility of sedimentary uranium exists in large areas which are untested.

Graphitic schists occur frequently in the basement sequence and two deposits were successfully worked to provide internal needs during World War II.

Marine sediments of Permian, Mesozoic and Tertiary age underlie the Eucla Basin and extend off shore in the Great Australian Bight. Hydrocarbon potential is currently being examined.

High quality coarse aggregate is confined to areas of basement outcrop and useful deposits are restricted because of surface weathering and unsuitable rock type. Calcrete limestone is the only material available over a large part of the planning area.

Minor occurrences of dolomite, magnesite, whiting, asbestos, ornamental stone and lignite are recorded.

General aspects of land use related to mineral deposits are discussed.

INTRODUCTION

This report has been prepared at the request of the State Planning Office who are assessing future development in the planning area. It has been compiled with the object of providing a basic reference for decisions involving the mineral industry and has therefore been given comprehensive treatment.

Present knowledge of the geological setting and the potential of mineral deposits in the planning area is summarised and possible future developments are forecast. These are made in the light of conditions applying in mid-1970 and the reader should be aware that these are liable to be outdated under the present changing conditions of economics, technology and demand.

The author has consulted the extensive Departmental files containing observations and technical judgement of many previous workers. The principal reports used are listed in the references and these in turn refer to more detailed work on specific areas.

The accompanying plan (L70-60) shows the general geological setting of the area and has been compiled from published and unpublished mapping and air photo interpretation by members of the Geological Survey. Most of the individual deposits referred to in the text are located on this plan.

PHYSIOGRAPHY

Several physiographic provinces are recognised in the area and each has a fundamental relation to the underlying rocks (plan 70-698).

On Eyre Peninsula proper Johns (1961) defined four physiographic elements based on topographic relief. The Eastern Coastal Plain skirts the east coast from North Shields, near Pt. Lincoln, northerly to beyond Cowell. The plain is bounded to the west by uplifted blocks of Precambrian basement rock grouped collectively as the Eastern Highlands but made up of three distinct units, viz Cleve Uplands, Blue Range and Lincoln Uplands. Although of subdued relief these blocks form an elevated tableland, now dissected by erosion, with individual peaks rising to over 1000 ft. above sea level. Undulating country, generally distinct from the Coastal Plain, lies between these units. The Cleve Uplands merge to the northeast into the Middleback Range which lies outside of the planning area. Another uplifted basement block adjoins the west coast of lower Eyre Peninsula and is known as the Western Highlands. It comprises prominent isolated bedrock hills surrounded by generally flat terrain which is underlain at shallow depth by basement rock.

Separating the Lincoln Uplands and Western Highlands is the Central Basin, consisting of a tract of undulating country with internal drainage containing several small sedimentary basins developed on an irregular basement floor.

Extending across the northern part of the planning area are the Gawler Ranges, a locally imposing mass of hills with individual peaks rising to 1400 ft. above sea level.

The large tract of country forming central and western Eyre Peninsula is generally undulating with isolated inselbergs of basement rock, chiefly granite. Inland playa lakes and marginal coastal lagoons are common and sand dunes, composed of both carbonate sand (coastal areas) and silica sand (inland) are widely developed. This is referred to by Whitten (1963b) as the Western Plain and Basin area (and includes the Central Basin of Johns (op cit).

In the far west of the planning area the Eucla Basin underlies the extensive flat to very gently undulating surface of which the Nullarbor Plain is part.

GEOLOGICAL SETTING

Eyre Peninsula forms the eastern margin of the Australian Precambrian Shield and is underlain by rocks which are among the oldest known on the Australian continent. The South Australian portion of the shield is called the Gawler Platform and is subdivided into the Gawler Block, containing the outcropping and near surface basement rocks of Eyre Peninsula and the Stuart Shelf to the north where the basement lies at greater depth.

Within the Gawler Block basement rocks outcrop in the Eastern and Western Highlands on southern and central Eyre Peninsula, in the Gawler Ranges to the north and as isolated inselbergs in the Western Plain and Basin province to the west. Elsewhere within the planning area the basement is overlain by varying thicknesses of Mesozoic Tertiary and younger sediments.

In the most recent study of the basement, the Precambrian metasediments of the Gawler Block are referred to as the Cleve Metamorphics (Thomson 1969). These include the Flinders and Hutchinson Group metasediments of Johns (1961) on southern Eyre Peninsula and the Gneiss Complex of Miles (1955) from the Middleback Range. The Cleve Metamorphics are assigned a Lower Proterozoic age (1800 to 2300 million years) and consist of metasediments including quartzite, dolomite, iron formation and a variety of schists and gneisses. These rocks were originally deposited as a sedimentary sequence and subsequently folded into a mountain range system during which time they were altered by metamorphism.

Two cycles of deposition and igneous activity took place in Carpentarian times (1400 to 1800 million years) on the Gawler Platform. The arenaceous Moonabie Formation and Corunna Conglomerate outcrop principally in the Whyalla district beyond the margin of the planning area but Corunna Conglomerate underlies hills in the Blue Range area. Many of the igneous rocks emplaced in Carpentarian times lie within the planning area. These include the granites of the Minnipa-Wudinna area and the Charleston Granite near Cowell and the extensive extrusive porphries of the Gawler Range, known as the Gawler Range Volcanics.

Both the Cleve Metamorphics and the igneous rocks described above are referred to collectively as basement and the distribution of basement rock outcrops, somewhat generalised, is shown on the accompanying plan (L70-60). These rocks are important economically as they are host rocks for the Middleback Range and other iron formations, for sporadic base metal and uranium mineralisation and for a variety of non-metallic minerals including asbestos, graphite, talc, dolomite white clay and coarse aggregate.

Permian, Mesozoic and younger sediments flank the basement blocks and in contrast to the basement rocks occur as mainly soft or unconsolidated flat lying beds.

Upper Jurassic lignitic clays have been recorded from the Polda Basin near Lock (Harris 1964), and sandstone and shales, correlated with the Lower Cretaceous of the Artesian Basin occur in the lower part of the Eucla Basin where they rest in part on Permian sediments. The Mesozoic rocks, like most of the overlying Tertiary beds, do not outcrop. The Permian, Mesozoic and possibly Tertiary sequences extend off shore from the Eucla Basin in the Great Australian Bight with a latitudinally trending trough joining into the Polda Basin on western central Eyre Peninsula. The Duntroon Basin lies off shore from south-western Eyre Peninsula. These sediments provide a possible environment for hydrocarbon accumulation and the off shore areas are currently being examined by private companies.

Flat lying marine limestones of Tertiary age (Middle Eocene to Lower Miocene) overlie freshwater carbonaceous and pyritic sands and clays in the Eucla Basin. (Ludbrook 1969) The upper member, the Nullarbor Limestone, is exposed in cliffs in the Great Australian Bight and outcrops over a large area of the basin with a hard recrystallised capping. Carbonaceous sands, clays and silts underlie Quaternary sediments in the freshwater basins along the west coast of Eyre Peninsula and have been intersected in bores in the Eastern Coastal Plain. Palynological study of bore samples indicates a middle to upper Eocene age (Harris 1966). Tertiary sediments of this type probably underlie much of the Western Plain and Basin province.

The Tertiary sediments have little economic importance at present. Although the Eucla Basin limestones are among the highest grade 'soft' limestones known in the State, their remote location detracts from their value. The known lignite beds are generally low grade and discontinuous but the Tertiary sequence is not often penetrated during drilling for water, and small basins of better quality lignite may exist. Sedimentary sandy sequences containing carbonaceous material are hosts for important uranium deposits in central and western U.S.A. While it cannot be said that sedimentary uranium will occur on Eyre Peninsula some of the criteria recognised in the overseas deposits exist in this area and these rocks will receive detailed investigation from exploration companies in the future.

Large areas of southern and central Australia were subjected to intense chemical leaching in the middle Tertiary with the development of silcrete, laterite and bauxite and an underlying kaolinitic zone. The basement rocks of the Cleve and Lincoln Uplands were affected by this process and erosional remnants of kaolinitic rocks are widespread in these areas. White clays developed in this zone may be worked as a source of ceramic and possibly paper clay and aluminium in the future.

Quaternary sediments are widely distributed throughout the area. Although they occupy a range of environments and lithologies the most abundant are aeolian deposits, consisting of carbonate sand along the coastal strip and quartz sand in the interior. The carbonate sand occurs as both an older semi-consolidated sand spread with some dunes, referred to by Firman (1969) as Bridgewater Formation and a younger coastal strip of mobile dunes derived from Bridgewater Formation and correlated by Firman (op cit.) with the Semaphore Sand. The Semaphore Sand provides enormous reserves of high quality metallurgical granular limestone and in terms of available tonnage is the largest mineral deposit in the area.

Two types of gypsum deposit, both of Quaternary age, occur in the planning area. Bedded rock gypsum, deposited in a former restricted arm of the sea, is mined at Lake MacDonnell west of Ceduna and is the largest gypsum deposit in Australia. Granular gypsum occurring principally in dunes is associated with many of the inland lakes.

Another widespread Quaternary rock is the limestone crust formerly known as travertine or kunkar and now described as calcrete. Although a disadvantage in agricultural land the calcrete horizon forms the only source of coarse aggregate for construction purposes in a large part of the western portion of the planning area.

Sand and gravel beds in the modern stream channels, principally those draining from the basement blocks, provide a source of construction sand.

ECONOMIC GEOLOGY

Limesand, gypsum and salt are the principal mineral products of the area and these are major suppliers to Australian industry. Other minerals being exploited are aggregate, ornamental stone and groundwater.

In 1968 South Australia supplied about 75% of the 846,000 tons of gypsum produced in Australia and a substantial proportion of this was won from the deposit at Lake MacDonnell. In the same year 402,000 tons of limesand were shipped from the Coffin Bay deposit for use in the Australian steel industry.

Many other mineral deposits occur in the planning area. Some of these have been worked in the past and others, although never worked, possess potential for the future.

For the detailed discussion which follows, the various mineral deposits have been divided into producing and non-producing groups and arranged in alphabetical order. The deposits are located on the accompanying plan. (L70-60).

Producing deposits

Aggregate

Coarse aggregate for road and railway construction and for concrete is available in the basement rocks of the Eastern and Western Highlands and the Gawler Range. However suitable materials are not as widespread as might be supposed because of the abundance of schistose rocks in the Cleve Metamorphics and the effects of the widespread Tertiary weathering process. Some of the best material, particularly for bitumen surfacing, is won from the Gawler Range Volcanics but sources of this rock are generally remote from most places of usage.

Dolomite, amphibolite and granite gneiss are the principal sources of coarse aggregate for road work. Railway ballast has been won from sericitic quartzite deposits at Tooligie and Darke Peak, granite gneiss near Port Lincoln and granite from Yarwondutta Rocks at Minnipa.

In the Western Plain and Basin province, which makes up a large proportion of the planning area, calcrete limestone is practically the only source of construction material, particularly for road work. Generally the calcrete horizon is only a few feet thick and the rock is of variable quality. These deposits are characterised by a high wastage in fines. However the crushed rock is suitable for base course formations and the widespread occurrence of the calcrete horizon provides abundant sites conveniently located to most road construction projects.

At several quarries along the west coast of Eyre Peninsula from Mount Hope to beyond Ceduna a higher quality nodular calcrete up to 20 feet thick is exposed. This material has been used for railway ballast from Hundred Moule, west of Ceduna. The bed is equated with the Ripon Calcrete of Firman (1969) and many additional sites in this formation could no doubt be located.

Large scale deposits of high quality aggregate in the Plain and Basin province are restricted to the isolated inselbergs of basement rock such as Mount Cooper and Yarwondutta Rocks. This latter material is too coarse grained for road work or high strength concrete but provides satisfactory railway ballast.

On the Nullarbor Plain ballast for the transcontinental railway is won from the recrystallised capping of the Nullarbor Limestone (Hiern, 1970a). Similar material is likely to exist to the south along the Eyre Highway.

Laterite gravels developed on basement rocks in the Western Highlands have been used for road work and could be exploited more in the future from here and in the Eastern Highlands.

Quarries from which crushed rock for road building or railway ballast has been won are shown on the accompanying plan and known coarse aggregate sources are summarised in Appendix 1.

Construction sand is available from most of the creek beds draining from the basement blocks. Sand for use in

Pt. Lincoln is won from pits at the mouth of the Tod River and many other unrecorded sources probably exist.

Sieve analysis of one sand sample from the bed of the River Dutton showed it to be suitable for foundry use.

The widespread dune sands have not been tested for construction purposes. Generally in South Australia these are too fine for concrete but are sometimes used for mortar and plaster sand.

Groundwater

Although the rainfall on southern Eyre Peninsula and along the west coast is sufficiently high to supply surface storage schemes the topography in these areas provides no suitable dam sites. Further north where sites exist, intake from catchment areas is subject to seasonal variation in both quantity and salinity. While some small surface storages are in use they are inadequate to supply the expanding consumption of the towns.

The Pleistocene aeolianite (Bridgewater Formation) and to a lesser extent the Tertiary sediments are sufficiently porous to absorb and store large quantities of surface run-off. These aquifers have been subjected to extensive investigations in recent years and domestic quality groundwater has been found in fourteen separate basins located along the west coast of the peninsula from south of Pt. Lincoln to Streaky

Bay (see plan S.7435).

The most important of these are the Lincoln, Uley-Wanilla and Uley Homestead Basins in the south and the Polda and Kappawanta Basins in County Musgrave. The Robinson Basin, not shown on the plan, is a small basin which supplies Streaky Bay township.

Investigations have been directed to defining water quality and determining potential pumping rates and yield.

The Lincoln and Uley-Wanilla Basins are developed to their full capacity and yield 425 million gallons and 240 million gallons per annum respectively. At present approximately 100 million gallons per annum are drawn from the E. & W. S. Department trench near Polda Homestead in the Polda Basin.

Painter (1968b) prepared a preliminary summary of the potential yields of the basins and recorded that each of the fourteen groundwater basins on Eyre Peninsula contains one, two or three aquifers. The basins range in area from 2 to 73 square miles and have a total area of 392 square miles. The assessed natural yield of the individual basins ranges from 0.3 to 20 cusecs with a potential to produce approximately 1,400 million gallons or 6.37 million cubic metres per annum.

Salinities vary from 650-700 parts per million dissolved solids in the Uley-Wanilla Basin to 900 - 1000 parts per million in the Polda Basin. Quality of water in the Robinson Basin varies from 500 to 700 parts per million in the winter months to up to 1700 parts per million in the summer. This fluctuation is due to the presence of a fresh water layer of 500-700 parts per million dissolved solids lying above brackish water containing up to 3000 parts per million dissolved solids. The high summer salinities are due to mixing of these two waters as a result of greater pumping rates.

Elsewhere on Eyre Peninsula proper, both in the basement blocks and the surrounding areas of younger sediments, the water is usually too saline for domestic use and is often unsuitable for stock. Generally only small supplies are available.

Groundwater in the Eucla Basin in too saline for use (Ward 1946) except in some localised areas where it is suitable for stock.

Investigation of the fresh water basins is continuing to define basin limits and safe pumping rates. This work is of considerable importance because of the dependence of future population expansion on water supplies.

Gypsum

South Australia possesses the largest reserves of gypsum in the Commonwealth and the Lake MacDonnell deposit, located on the coast south of Penong, contains in excess of 200 million tons of high grade rock gypsum exceeding 96% purity with an even larger reserve of granular gypsum of slightly lower grade. The deposit is worked by Waratah Gypsum Pty. Ltd. who rail crushed and screened rock from the deposit 38 miles to bulk loading facilities at Thevenard. Both domestic and overseas markets are supplied. Leases are also held by other companies but these are worked to a much lesser extent. Recent drilling on the lake surface is described by Hiern (1970c) who also lists earlier references.

There are prospects of a similar deposit occurring in an extensive lake system at Fowler's Bay.

A deposit estimated to contain over 30 million tons of granular gypsum was discovered in a lake 10 miles south of Streaky Bay in 1959 (Forbes 1960a). The grade determined by analyses of auger hole samples averages 91% gypsum. The Streaky Bay deposit has been further explored by Elcor Australia Ltd. under Special Mining Lease 251, and the reserves quoted by Forbes (op cit) confirmed. (Hall, Relph 1970).

Lake areas south of Streaky Bay warrant testing for further deposits of the Lake MacDonnell type.

Gypsum dunes are associated with many of the inland lakes of South Australia where gypsum, deposited from evaporation of lake waters in the summer, is blown into lunette type dunes on the leeward (eastern to southeastern) shore of the lake. This material, known as seed gypsum, is generally of lower grade than the rock gypsum at Lake MacDonnell but is frequently used to supply the plaster and cement industries and as a source of agricultural gypsum.

Deposits of this type are known at Kopi and Yaninee (Forbes 1960b) and Lake Gilles (Solomon 1952).

In recent years, apart from the traditional uses for plaster and cement manufacture, gypsum has been considered as a raw material for the production of sulphur and one plant at least is preparing for operation in the U.S.A. The gypsum deposits of Eyre Peninsula were examined by overseas companies during 1969 for this purpose.

The situation at the time of writing (August 1970) is that the world sulphur market is in a state of considerable oversupply and growth of demand is not meeting earlier forecast figures. These conditions are likely to persist for some years because of new plants already committed coming on stream. Thus although the Eyre Peninsula deposits can be regarded as a source of indigenous sulphur they are unlikely to be exploited for this purpose for many years.

Difficulties in developing deep sea ports for bulk loading will be the main brake to larger scale development of gypsum deposits on Eyre Peninsula.

Limesand

Enormous accumulations of carbonate sand occur in coastal dunes along the western coast of Eyre Peninsula from Sleaford Bay in the south to Fowler's Bay in the west. These deposits have been investigated and sampled by Johns

(1968a) who showed the highest grade dunes to occur in the vicinity of Coffin Bay. The B.H.P. Co. Ltd. subsequently developed the Coffin Bay deposits as a source of lime for steel making by constructing a railway to newly developed loading facilities at Pt. Lincoln. Reserves at the Coffin Bay deposit exceed 750 million cubic yards of unconsolidated sand averaging 51.3% CaO, 2.60% MgO, 0.74% SiO_2 (Johns 1967). An Act of Parliament requires the B.H.P. Co. Ltd. to provide and load limesand from these facilities to other parties at 'reasonable cost'.

Sampling of deposits further up the coast from Coffin Bay showed a higher silica impurity and this together with a lack of naturally protected deep water harbour sites along the western coast, makes these deposits less attractive for exploitation. Limesand deposits on the seaward side of Lake MacDonnell were sampled by Peninsula Prospecting and Mining Pty. Ltd. in Special Mining Leases 116 and 122. Exploitation of these deposits would be assisted by sharing the gypsum and salt loading facilities which exist at Thevenard.

Ornamental and Semi Precious Gem Stones

Dolomite beds in the Cleve Uplands are in part metamorphosed to white coarse grained marble and yellow green serpentinous marble. The serpentinised marbles in particular have sufficient compositional variations to present attractive patterns on polished material. The various shades of green are unique among South Australian ornamental marbles which elsewhere are white, pink and shades of grey.

The Cowell deposits have not been exploited to any great extent but new developments in the building industry, such as the use of preformed terrazzo slabs and tiles, may create a demand for material from this area. One small operation near Cowell at present supplies chippings to the terrazzo trade and this industry could be expanded.

Deposits in Section 110, Hd. Minbrie have been described by Johns (1957) and by Mason (1970) from Section 116, Hd. Minbrie.

Ornamental marble is won from Section 288, Hd. Hutchinson, 6 miles northwest of Tumby Bay.

Dark green nephrite is also associated with the marbles in Section 116, Hd. Minbrie (Mason op cit) and is marketed by a local lapidary for costume jewellery.

The coarse grained pink granite from Minnipa has been used in a small way for ornamental stone and is similar in appearance to the Swanport (Murray Bridge) granite. Several large inselbergs of massive unstressed granite occur in the Minnipa-Wudinna area but sheet jointing in the surface zone tends to limit the size of blocks available. The opening of a ballast quarry at Yarwondutta Rocks near Minnipa should make larger blocks available.

A find of opal was made near Cleve in 1919 but was of the common variety (Jones 1920). Although no precious opal has been recorded from the area this material is a product of the bleached duricrusted profile which is developed extensively in the planning area. Hiern (1965) showed that precious opal is most commonly developed in flat lying rock sequences within this profile where porous sandstones are underlain by impermeable clay layers. This environment might exist in the area flanking the southern edge of the Gawler Ranges.

Banded agate and some amethyst have been won from porphry of the Gawler Range Volcanics near Pandurra Homestead, 25 miles west of Pt. August (Hiern 1970b). Similar material might exist in the Gawler Ranges within the planning area.

Amethyst has been recorded from Mineral Claims 5561, 5562, 5563 in Section 24, Hd. Kelly, 12 miles south-east of Kimba.

Salt

South Australia has for many years supplied most of the salt used in chemical manufacture in Australia. All salt produced in this country is from solar evaporation of brines, mainly seawater, in artificially constructed ponds. The main requirements are the availability of large flat areas adjacent to the sea coast and a long dry summer with a high evaporation rate.

Waratah Gypsum Pty. Ltd. has recently commenced salt making operations on the floor of Lake MacDonnell and other sites in the area have been considered for salt production. Similar developments have taken place in Western Australia where better ship loading facilities exist. Although overseas demand for salt is rising continually, particularly in Japan, the lack of suitable harbour sites along the west coast of Eyre Peninsula will be a major obstacle to expansion of salt making sites in the planning area.

Non Producing Deposits

Asbestos

Thin veins of chrysotile asbestos are associated with serpentinised dolomites and dolomitic marbles in the Cleve Uplands and one occurrence is recorded from the Lincoln Uplands west of Tumby Bay.

The deposits are described by Johns (1961) and were further investigated by Mines Exploration Pty. Ltd. in Special Mining Lease No.80 during 1965. Although a number of new deposits were located in the area west of Cowell, detailed investigation of both these and previously recorded occurrences revealed no deposits of economic significance (Russell 1965).

Chrysotile is the most useful of the asbestos minerals. The major world deposits are associated with ultrabasic igneous rocks rather than serpentinised carbonate rocks. Although further search for asbestos will be undertaken it is unlikely that major new deposits will be found associated with the dolomites of the planning area.

Base Metals

Small deposits of copper and silver lead ores occur in the Cleve and Lincoln Uplands and in the Western Highlands. Most of these were discovered and worked in the last century but during the years 1910-1916 many were reopened and sampled and exploratory drilling carried out at some. These deposits were all re-examined in the 1950's during the intensive search for radioactive ores carried out by the Department of Mines and some were further examined and drilled during 1968 and 1969 as part of a programme of exploration conducted by a private company. All of this work has been done without significant result.

In the Cleve Uplands secondary ores of copper and silver-lead occur either in shear zones within the basement schists or in crush zones on the margins of intrusive pegmatites (Johns 1961). All of these prospects lie adjacent to or in a dolomite horizon. Production records are incomplete but it is unlikely that more than a few hundred tons of hand selected ore, probably of the order of 15-20% copper have been won from the area. At many of the prospects well defined lodes were exposed by shaft sinking and driving, in some cases to depths of 120 ft., but no significant strike extensions were found. Although these deposits will be subject to further exploration in the future, the prospects of major extensions of the existing deposits must be rated as slight. However a large proportion of the basement rocks is concealed by younger cover and these areas will undergo intensive exploration in the future which may result in new discoveries of greater value.

A recent small discovery of malachite and azurite in Section 28, Hd. Campoona near Darke Peak has been tested by trenching and drilling without significant result. (Mason 1968).

Relatively larger production was attained from two groups of copper mines in the Lincoln Uplands in the vicinity of Tumby Bay. These were opened in the mid-1880's and were worked intermittently until about 1910. Workings extend to depths of over 200 ft., being mostly in secondary carbonate ores although primary sulphide is recorded from the Tumby Bay Mine at a depth of 210 ft. (Johns 1961).

Production records from these mines are also incomplete but at least 1000 tons of ore, probably averaging 20-25% copper are reported to have been won.

The lodes in this area appear to be more extensive than those in the Cleve Uplands. The mines are grouped in an area where there is evidence of hydrothermal activity and intrusive pegmatites have been recorded. Prospects of further discoveries in the Lincoln Uplands are rated higher than those in the Cleve Uplands and this area will be subjected to further exploration in the future.

The only metallic minerals associated with the Gawler

Range Volcanics are minor tin and gold in the Glenloth area near Kingoonya. The absence of recorded deposits elsewhere in the Gawler Ranges is puzzling, particularly in view of the abundance of good outcrop which facilitates prospecting.

Clay

In Tertiary times the basement rocks of the Cleve and Lincoln Uplands occupied an extensive peneplain surface which was subject to intense chemical leaching with the development of kaolin minerals particularly in the more feldspathic metasediments and igneous rocks. Erosional remnants of this surface are widespread in the planning area and abundant exposures of quartz-kaolin rocks exist (Hiern 1968).

Laboratory testing of samples from several localities including Salt Creek (Section 87, Hd. Miltalie), Sections 12, 36, 60, 90, Hd. Stokes, showed the clays to be suitable for ceramic whiteware after washing and screening to remove coarse quartz. However the tonnage of ceramic clays used in Australia is not large and suitable materials are available at present closer to the manufacturing sites.

The particle size of samples tested is generally too coarse for use in the paper industry which consumes over 50% of world production of white clay. However insufficient testing has been done to preclude a source of paper clay existing in the area.

The washed (quartz free) clays contain over 35% Al_2O_3 and are a potential raw material for aluminium production. World reserves of bauxite, although large, are fully committed and high alumina clays are a future source of aluminium metal. Two areas, near Tumby Bay and further north near Kimba are currently being examined by a private company for this purpose. The paper making properties of these clays will no doubt be evaluated during these investigations.

The Charleston Granite, which outcrops sporadically in the area north of Cowell, is kaolinised in some outcrops although in others fresh rock is exposed at the surface. If the kaolinised profile is developed on a large scale the deposit could provide an important source of kaolin on account of its large size, uniform lithology and proximity to the coast and the industrial centre of Whyalla. Most of the granite is covered by red sand and an extensive exploratory programme would be necessary to prove reserves. Molybdenite has been found in one outcrop of fresh granite and prospecting should be directed towards both molybdenum and kaolin.

Samples of Gawler Range Volcanics from the bleached profile near Pandurra Station, 25 miles west of Pt. Augusta, have been test fired with no outstanding results. However material from an extensive belt of kaolinised rocks southwest of Kingoonya was shown to be refractory. No particle size analysis was made. The Gawler Range Volcanics in the planning area have not been examined for clay minerals.

Red plastic clay underlies the surface of the Eastern Coastal Plain and is exploited for brick manufacture at Poonindie 12 miles north of Pt. Lincoln. The clay has a high drying and firing shrinkage and can only be used for bricks when blended with less plastic clays derived from weathering of basement rocks. Suitable clays of this type occur in the Lincoln Uplands and both red and cream bricks are manufactured at Poonindie.

There is a lack of white plastic clay for production of light cream building bricks. Erosion of the kaolinised basement rocks would provide source material for the deposition of sedimentary plastic clays but to date no deposits of this type have been recorded.

Marketing trends of building bricks nowadays are such that country centres can usually be economically supplied from the large kilns in the Adelaide metropolitan area and usage of clays for local brick manufacture will decline in the future.

Coal

Carbonaceous sands and low grade lignites occur in Jurassic and Tertiary sediments in the areas flanking the basement blocks. These have been intersected in scattered water bores but have not been systematically explored. Few water bores penetrate the Tertiary beds as water is usually encountered in the overlying Quaternary sediments.

Harris (1964) identified lignitic clays of Jurassic age in a bore located near Lock in the Polda Basin. This material is slightly younger than the sub-bituminous coal of Leigh Creek.

Brown coal occurrences on Eyre Peninsula were reviewed by King (1951) who recorded lignite and carbonaceous sands around the eastern margin of the Eucla Basin, in isolated bores in the Western Plain and Basin province and in several bores in the Wanilla area, approximately 20 miles north of Pt. Lincoln.

The deposits at Wanilla and also in the Uley and Lincoln Basins were examined by Hillwood (1960b) who, although using inadequate bore data, concluded that the carbonaceous sediments in these areas were likely to be too low grade and covered by too much overburden to be economic.

Exploratory drilling in Tertiary sediments in the Verran Rudall area by Kerr McGee Australia Ltd. for sedimentary uranium intersected 'lignite' and 'coal' in 5 of 72 bores drilled (Moulton 1969). However the drilling method was not suited to recovery of adequate coal samples and the quality of this material is not known. The lignite formation does not appear to be extensive.

Lignite has been intersected recently during water drilling in County Musgrave and data from this area are currently being assessed.

Dolomite

The most important use of dolomite is in the steel industry. Dolomites in the Cleve Uplands were investigated by Cramsie (1968) who sampled twenty-four localities. Chemical analysis of several samples exceeded 40% MgO (theoretical value 45.6% MgO) but except for three deposits in Sections 75 and 114, Hd. Hawker and Section 31, Hd. Miltalie reserves appear to be too small for a commercial source of steel making flux. The B.H.P. Co. Ltd., the largest consumer of dolomite in Australia, operates a quarry at Ardrossan on Yorke Peninsula which supplies B.H.P. Co. dolomite needs throughout the continent. Reserves at this deposit are sufficient for many years operation and it is doubtful whether the deposits in the Cleve Uplands will ever be exploited for steel making.

Dolomites in the Cleve Metamorphics are host rocks for talc and asbestos minerals and the small base metal deposits described earlier in this report are located along the margins of dolomite beds.

The dolomites and associated dolomitic marbles are a present and future source of coarse aggregate and building stone.

Graphite

Graphitic schists are widespread in the basement rocks of both the Cleve and Lincoln Uplands where they occur as district stratigraphic horizons adjacent to the iron formations in the Hutchinson Group of Johns (1961). The graphite is often associated with magnesite. Exploration has shown that grade improves with depth at most deposits.

Ten deposits are recorded in the Cleve Uplands and are summarised by Johns (1961). Many of these have been tested by shafts and trenches and at one locality (Miltalie) diamond drilling was undertaken. Generally the graphite flake is fine and the grade variable. Testing has shown the deposits to be too low grade for economic development.

In the Lincoln Uplands the flake is coarser grained and the graphite beds persist with uniform quality, although of variable width, over considerable distances. Some production has been undertaken, particularly during World War II, when 550 tons valued at £16,000 were won from the Uley deposit and approximately 100 tons valued at £6,500 produced from Koppio.

The Uley deposit in Section 2AE, Hd. Uley is 14 miles by road southwest of Pt. Lincoln. Here an open cut and several shafts, reported to have been connected to now collapsed underground workings, exist. The bed ranges from 5-30 ft. in thickness. Following a programme of seven vertical diamond drill holes, reserves of 63,000 tons of ore "in sight" containing 7,000 tons of graphite were calculated (Johns 1961).

Workings at the Koppio deposit are located in Section 35, Hd. Koppio, 22 miles north of Pt. Lincoln, but the graphite bed extends for a few miles to the north and south. Betheras (1952) quotes reserves of 4,000 tons of proved ore and 14,000 tons of probable ore at grades of 12-14% C. At the workings the bed is 40 ft. wide.

Numerous other deposits occur in the Pt. Lincoln area as shown on the accompanying map (L70-60).

Production at Uley and Koppio was undertaken as a war time measure but operations were abandoned once normal overseas sources became accessible again. No graphite is produced in Australia at present. Imports of natural and artificial graphite into Australia in 1968 (the latest available figure) amounted to only 2,100 tons, the main supplier being South Korea.

Thus while there is some potential for graphite mining in the Pt. Lincoln area the deposits are unlikely to be worked except in times of conflict involving overseas supplying countries. In such circumstances the Pt. Lincoln deposits would be regarded as strategic minerals.

Heavy Mineral Sand

No economic concentrations of heavy mineral sand are known on Eyre Peninsula although small deposits of garnet sand are recorded by Mansfield (1952) from Sleaford Bay and ilmenite by Whitten (1963a) at Pt. Gibbon near Cowell.

Hillwood (1960a) examined the entire west coast of Eyre Peninsula without locating significant deposits and Johns (1961) records only minor concentrations along the east coast. These are generally high in iron minerals and low in rutile and zircon.

Iron Ore

The deposits of iron ore in the Middleback Range, which adjoins the planning area, constitute the largest reserves of iron ore in South Australia and provide a substantial proportion of ore consumed by the Australian steel industry. The ore mineral is hematite which occurs in jaspilite (banded hematite quartzite) beds in the Cleve Metamorphics. There is also a small production at Iron Monarch from limonite cemented hematite scree ore.

Magnetite occurs in place of hematite at depth in many of the Middleback Range deposits (Owen and Whitehead 1965).

Iron formations respond to the airborne magnetometer even under 100 ft. or more of cover and the whole of Eyre Peninsula has been surveyed by this method. Several significant airborne anomalies were located and these, together with outcropping iron formation in the Cleve and Lincoln Uplands, were systematically tested by the Department of Mines during the years 1956-1966. Exploration methods included geological mapping, ground geophysics and drilling. The results of this work are summarised by Whitten (1965a and b) and Whitten & Risely (1968).

In contrast to the deposits being worked in the Middleback Range, iron formations investigated in the planning area all consist of magnetite in metajaspilite and are low grade ores with acid soluble iron rarely exceeding 30%. Viability of the deposits depends not only on size, grade and economic access to deep sea ports but also on ease of beneficiation. As a consequence the Departmental investigations included preliminary work on beneficiation methods and costs.

Airborne anomalies and outcropping iron formations are shown on the accompanying plan and the status of all prospects is summarised briefly below.

Both equidimensional and elongate anomalies were located during the airborne survey. Equidimensional anomalies near Streaky Bay, Poochera, and Minnipa were shown by drilling to be due to intrusive gabbro bodies and are unrelated to iron formation (Whitten 1963b).

Several elongate anomalies are located in the planning area, and these have been shown to be due to iron formation buried beneath Tertiary and Quaternary cover.

Exploration of the largest anomalies, those at Warramboo and Kopi, disclosed a potential reserve of approximately 1,000 million tons of very low grade ore under overburden ranging from 0 to more than 100 ft. Metallurgical testing showed that beneficiation may not be difficult with possibly 250 million tons of concentrate being available. (Whitten 1965a and Whitten & Risely 1968). An economic appraisal in 1964, based on ore transport over the existing narrow gauge railway to Pt. Lincoln, showed that exploitation would not be economic. (Dutton 1964). However the possibility of working the deposits is again being examined by private companies utilising more efficient means of ore haulage to the seaboard.

In the Lincoln Uplands eleven separate prospects were thoroughly tested because of their proximity to a deep water port and community services. However these deposits, with the possible exception of Greenpatch, were shown to be too small and of insufficient grade to be worked under current economic conditions (Whitten 1965b).

Testing of the airborne anomalies over the coastal plain north of Cowell revealed only narrow iron formation. (Whitten 1965b).

Iron formations in the Cleve Uplands are generally narrow and consist also of low grade magnetite ore in metajaspilite. Existing port and transport facilities are not suitable for large scale iron ore shipments from the Cowell area. The water in Franklin Harbour is too shallow for a suitable export port to be developed but deeper water exists to the south towards Arno Bay. Deposits in the western portion of the area lie near to the Kimba - Pt. Lincoln railway which runs close to the Arno Bay area.

The Wangary Anomaly in the Coffin Bay - Mount Hope area was investigated in 1969 by a private company. Preliminary ground geophysical surveys confirmed the presence of a magnetic anomaly. Finely disseminated magnetite-martite in weathered basement schists was intersected beneath 250 feet of Quaternary cover in two of four diamond core holes drilled to a maximum depth of 600 feet. Grades were less than 10% acid soluble iron over only narrow widths (Lewis 1970).

The jaspilites in the planning area all consist of low grade magnetite formations which require beneficiation. Although large reserves exist and some of the deposits are reasonably well located to deep water, the presence of enormous reserves of high grade hematite ore in Western Australia means that the deposits on Eyre Peninsula could only be worked when there is a particular need for magnetite ore. Should this eventuate, transport to the coast would not necessarily utilise the existing narrow gauge railway routes. On the contrary, entirely new transport and ship loading facilities, tailored specifically to meet ore transport requirements, would be developed.

Limestone

In addition to the large deposits of limesand described previously, the Eucla Basin contains enormous reserves of 'soft' limestone. There the flat lying fossiliferous Nullarbor Limestone forms the surface of the Nullarbor Plain and according to Johns (1963) is "the largest (and is among the highest grade) deposits in the State".

Along the transcontinental railway and probably throughout the remainder of the Eucla Basin the Nullarbor Limestone consists of an upper hard recrystallised cap zone, ranging from 10 to 40 ft. thick, underlain by porous fossiliferous limestone (Hiern 1970a).

As the State is well endowed with more favourably located deposits of high grade limestone it is unlikely that the limestones of the Eucla Basin will be exploited. Suitable ship loading facilities would have to be developed in the Great Australian Bight.

Magnesite

Narrow lenses of magnesite occur in the Cleve Metamorphics in both the Cleve and Lincoln Uplands, often associated with graphitic schists. The main deposits occur in Sections 33 and 42, Hd. Stokes and Section 178, Hd. Koppio. They are not commercial sources of magnesite (Johns 1963).

Molybdenum and Tungsten

Molybdenite and scheelite were discovered in granitic rocks of the Cleve Metamorphics on the southern tip of Spilsby Island, in the Sir Joseph Banks Group in 1963. A few small flakes of molybdenite have also been recorded from a road cutting in the Charleston Granite north of Cowell.

The deposit on Spilsby Island has been tested exhaustively by both the Department of Mines (Miller 1970) and Kennecott Explorations (Aust.) Pty. Ltd. in Special Mining Lease 146. Geological mapping and drilling showed reserves to be less than 0.25 million tons of 0.25% combined MoS_2/WO_3 (Brooks 1967) and studies by mining consultants to Kennecott Explorations showed this to be far short of the reserves required for a viable mining operation (Evans 1967).

Nixon (1967) examined a large area of central and southern Eyre Peninsula for molybdenum and tungsten without significant result. The Charleston Granite was not included in this reconnaissance.

The potential of the Charleston Granite as a commercial source of molybdenum is difficult to assess. Although the granite extends over a large area it is mostly covered by red aeolian sand and geophysical methods of prospecting would need to be employed. Exploration of this area would be costly and results difficult to interpret and it is doubtful whether such work will be undertaken in the near future. However the granite may be extensively weathered and be a commercial source of kaolin and a mining operation might produce both molybdenum and clay.

The prospects of active mining for molybdenite and scheelite in the planning area are remote at present.

Phosphate

Guano deposits on several of the islands of the Sir Joseph Banks Group were exploited at the turn of the century, the product being applied directly to the soil. Generally the phosphatic material occurs as earthy guano overlying calcrete limestone.

The deposits were recently examined by Johns (1968b) who concluded that no useful reserves of guano remain. The underlying limestone was sampled extensively but only at one locality, on Sibsey Island, was there evidence of replacement of the limestone to form rock phosphate.

Small deposits occur on the Brothers islands off Coffin Bay but are not significant.

Talc

Talc is one of the most widely used industrial minerals, its physical properties being used to advantage in cosmetics, ceramics, paint and paper, insecticide dusts and a variety of minor uses (Hiern 1969a).

High quality cosmetic grade talc has been produced from the Tumby Bay deposit located in Sections

A^s^, 33, 46 and 413, Hd. Yaranyacka 7 miles north of Tumby Bay. Production records show that approximately 12,000 tons were won from underground workings during the years 1911-1956. The talc occurs in a number of narrow lenticular bodies adjacent to a tightly folded dolomite bed in the Cleve Metamorphics. Development was unsystematic and the workings have been virtually abandoned since 1956 except for the opening of a small open cut in the western side of the main talc body. Hard grey and brown jasper is dispersed irregularly throughout the talc bodies in fragments ranging from less than 1" to over 24" in diameter. The upper 20 feet or so are stained by iron oxide and this, together with the jasper, necessitated underground mining in the past and hand selection of white, grit free material which was sold for cosmetics.

Preliminary testing has shown the jasper free talc to be suitable for most industrial uses. Some of the talc bodies are sufficiently wide to permit open cut mining and the deposits could become viable if a method of separating jasper from run of mine material was developed. (Hiern 1969b).

The deposits are reasonably accessible to the deep sea port at Port Lincoln and prospects of reopening the mine have been recently examined by overseas interests. It is possible that the Tumby Bay deposit will be worked in the near future.

Fine grained pale green talc is associated with dolomitic marble in the Cleve Uplands in Sections 110, 116 Hd. Minbrie. Material from this source has not been tested for industrial use but chemical analyses show 2-3% iron rendering the talc unsuitable for ceramic use by present day colour standards. The talc bodies are small and are unlikely to be exploited.

Uranium

Minor occurrences of uranium minerals have been recorded in the basement rocks of the Cleve and Lincoln Uplands and in Tertiary sediments in the northern portion of the Central Basin. These areas have been subjected to two phases of exploration involving airborne surveys, surface geological mapping, trenching and drilling without locating significant orebodies. Exploration is continuing by private companies on previously reported occurrences in the vicinity of Pt. Lincoln (S.M.L.183) and also in the Western Plain and Basin province.

In the period from 1949 to 1953 outcropping basement rocks in the Cleve Uplands and to a lesser extent in the Lincoln Uplands were examined by Departmental prospectors with some minor occurrences being found (Anon.1952). The Calcookra Mine was tested by diamond drilling in this period.

Six occurrences of primary uranium mineral were discovered by private prospectors in the vicinity of Pt. Lincoln in 1954. These were all examined by Departmental geologists and three deposits were tested by diamond drilling. All six deposits are similar in that the uranium occurs as small disseminations of pitchblende, with secondary minerals, in granitised gneissic metasediments. Mineralisation is confined to a narrow stratigraphic range and the orebodies have the form of thin tabular bodies dipping steeply to the west. These would require mining by underground methods. Largely theoretical ore reserves amount to 6,000 tons of ore at a grade of 1 lb. U_3O_8/ton. The geology of the deposits is summarised by Woodmansee (1955).

The Cleve and Lincoln Uplands and the Western Highlands were covered by an airborne scintillometer survey in late 1953-early 1954 using an Avro Anson aircraft flying at 200 ft. A map showing both major and minor anomalies is given by Seedsman and Harris (1956). The Pt. Lincoln deposits were not detected in this survey. The anomalies recorded were checked on the ground but most were attributed to high background effects of the basement. Anomalies located over the Driver River and a saline lake at the mouth of the Dutton River were shown to be due to radioactive mud. (Parkin 1954).

Portion of the Cleve Uplands was held under Special Mining Leases 158 and 163 from late 1967 to early 1969 by Kerr-McGee Australia Ltd. for uranium minerals. The area was reflown with a gamma ray spectrometer and anomalies followed up on the ground by surface mapping, trenching and drilling. The radioactive muds in the Driver River showed as anomalies and ground examination indicated the cause to be radioactive water issuing from a spring in Tertiary sediments. As these sediments contain some of the criteria for sedimentary uranium, an area of about 300 square miles was tested by 72 rotary drill holes. Minor accumulation of uranium was detected in carbonaceous beds at the base of the oxidised zone but there was no indication of significant uranium deposits. Four of the strongest anomalies in the basement were tested by diamond drilling without significant result. Results of this work are summarised by Moulton (1969).

The results of investigation to date of the basement deposits are not encouraging and it is unlikely that commercial deposits, on present day values of uranium, exist in the basement rocks. Exploration will in future be directed to the sedimentary basins surrounding the basement blocks. The results of such work cannot be predicted. Mineralisation of this type has been found in South Australia in the Lake Frome Plains area and there is at present no evidence to negate similar deposits occurring elsewhere in this State.

Whiting

Natural whiting occupies the normally dry bed of a lagoon at Sleaford Bay and an unusual dolomitic variety occurs in Lake Pillie a few miles north of Sleaford Bay (Johns 1961). Commercial whiting is generally produced nowadays by grinding of high grade limestone or marble and these deposits are unimportant commercially.

Miscellaneous Mineral Occurrences

Manganese has been recorded from Section 432, Hd. Louth (Painter 1968a) and the pegmatite minerals feldspar from Section 32, Hd. Yalanda and Section 24, Hd. James (Armstrong 1949) and near McLaren Point, Hd. Flinders (Johns 1950) and beryl from Section 157 Hd. Warran and near Mount Geharty (Johns 1961).

Muscovite mica occurs in a kaolinised pegmatite in Section 36, Hd. Stokes.

None of these deposits are significant.

The presence of promising manganese deposits associated with iron formation has recently been recorded by private prospectors from the Cleve Uplands. No other details are available.

SUMMARY

Mineral deposits in the planning area are best considered in relation to their geological setting.

Precambrian metasediments and igneous rocks underlie Eyre Peninsula, outcropping as elevated basement blocks in the Western and Eastern Highlands and in the Gawler Range. Elsewhere the basement rocks are covered by flat lying unconsolidated sediments chiefly of Tertiary and Quaternary age. Scattered inselbergs of basement, consisting mainly of granite, protrude through the younger cover in the Western

Plain and Basin province. Basement is also exposed along the coast around Ceduna in wave cut platforms. A thick sequence of sediments, including Permian, Cretaceous and Tertiary marine beds occupy the Eucla Basin in the far west and extend off shore along the western coast of Eyre Peninsula.

The most important mineral deposits in the area are limesand and gypsum, both of Quaternary age. Enormous reserves of these materials exist and the deposits at Coffin Bay and Lake MacDonnell are the principal source of supply in Australia.

Groundwater is also important in the area because of the paucity of suitable surface storage sites. The location of groundwater basins and the available supply should always be considered in planning matters affecting the area.

The Precambrian rocks are hosts to most of the recorded mineral deposits in the planning area. These include base metals, uranium, molybdenum, iron ore and a wide range of non-metallic minerals, the most important being talc, white clays, graphite and construction materials. None of these minerals occur in large scale - high grade orebodies and past mining operations have been in a small way.

Although iron formation occupies many miles of strike length, it is a low grade magnetite type, requiring beneficiation. The more significant prospects have been thoroughly tested but are such that they could not compete economically with other Australian deposits unless magnetite ore is specifically required. While the largest proven reserves are located in the Warramboo-Kopi area, other factors, such as ease of beneficiation, might direct attention to some of the smaller deposits. When any of the deposits in the planning area are exploited it is certain that new transport routes designed specifically to meet the needs of the project will be developed.

The talc deposit at Tumby Bay could supply material meeting most industrial specifications if a beneficiation process to remove jasper is developed. The deposit, although not large, is reasonably well located to a deep sea port.

White clays in the Tumby Bay, Kimba and Cowell areas are a potential future source of aluminium and are currently being investigated. However no industrial development from these investigations can be foreseen in the immediate future. These clays have not as yet been fully evaluated for use in paper manufacture. If suitable they could support a large mining operation. The known base metal occurrences are all small and consist, with a few exceptions, of secondary carbonate ores. These have little prospect of further development on any but a minor scale. However the basement rocks will without doubt be subjected to more intensive exploration by private companies in the future. While prospects of new large discoveries cannot be rated very highly at present, new thinking, oriented towards the primary ore sources and exploration of the large areas of basement concealed by younger cover may lead to the discovery of orebodies.

Molybdenum-tungsten deposits on Spilsby Island in the Sir Joseph Banks Group have been extensively tested and are not viable at present.

Sporadic minor occurrences of uranium minerals are known in the basement rocks but are not important commercially. The possibility of sedimentary uranium in the neighbouring Tertiary sediments exists and has been tested in only one area. Further exploration of these sediments will undoubtedly take place but the chances of success cannot be assessed at this stage.

Graphite was produced from the Uley and Koppio deposits to fill a war time need and could be worked again. However, Australian consumption of graphite is small and can be normally supplied more economically from overseas sources.

High quality coarse aggregate for construction purposes is confined to the areas of basement outcrop and the predominance of schistose and weathered material within these masses further restricts the distribution of useful deposits. In the Western Basin and Plain province calcrete is utilised extensively for road making purposes.

Brown coal occurs in many of the Tertiary basins but the extent of these deposits is poorly defined because of the wide spacing of drill holes. General indications are that the lignites are low grade, of limited extent and covered by excessive overburden.

A variety of minor mineral deposits occur. Marble is worked at present and other minerals may be produced on a small scale in the future.

MINERAL DEPOSITS AND LAND USE

Proper utilisation and conservation of natural resources requires thorough land use study and advance planning. With the possible exception of groundwater and salt, mineral deposits are irreplaceable and it is important that land containing useful deposits be set aside so that the continuing and expanding demand for mineral raw materials can be met.

Detailed definition of areas containing mineral deposits is beyond the scope of this report but the following general comments are made.

The coastal strip from Sleaford Bay westward to Fowler's Bay contains the important limesand and gypsum deposits. Not all of the carbonate dunes can be exploited because of silica and magnesia impurities and it will be possible to define, by sampling, large areas of dunes suitable for preservation of natural phenomena while still reserving sufficient material for future limesand requirements. Mining consists of complete removal of dunes and few landscape scars remain.

Gypsum at Lake MacDonnell is won by dragline from below water level on land which has little other use. The potentially productive areas at Fowler's Bay and Streaky Bay are also on swamp land. Salt making operations are developed on similar low lying land which usually has no other use.

Development of groundwater basins is accomplished through bores and shallow trenches connected to a pipeline system and has little effect on the surrounding land.

However problems of pollution will arise if large human or animal populations or certain types of industrial works are permitted to be established in the basin intake areas.

Costs of transporting crushed aggregate are a significant component in construction works budgets and sources of material are always required close to works sites. Supplies of aggregate are established over most of the planning area and these sites will continue to be exploited. Increasing traffic loads are requiring more stringent specifications in construction materials and new sites in higher quality rock will be required to supply these needs.

Development of new deposits of white clay, sedimentary uranium, iron ore or base metals will be on a large scale using open cut mining methods. In some cases considerable depths of overburden will need removal and this material, together with tailings from concentration processes will introduce problems of disposal. These operations will require relatively large areas of land.

Mining of talc, graphite, ornamental stone etc. will be by small scale open cut operations.

Hydrocarbons, if they exist in the sedimentary basins, will be produced off shore but on shore collecting facilities will be required.

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Summary of course aggregate sources in planning area.

PLANS ACCOMPANYING THE REPORT

Number	Title	Scale
L70-60	Regional Geology and Mineral Deposits. Eyre Planning Area.	1:1,000,000.
70-698	Eyre Planning Area - Physiographic Provinces	1" to 50 miles
S 7435	Eyre Peninsula - Fresh Water Basins	1" to 16 miles

APPENDIX 1

SUMMARY OF COARSE AGGREGATE - CONSTRUCTION MATERIALS IN EYRE PLANNING AREA

List of deposits by Counties, at which either crushing contracts have been let, laboratory testing of samples performed or geological investigations are recorded as having been carried out.

Abbreviations: M.R. = Mining Review published by Department of Mines.
R.B. = Report Book reference to unpublished Dept. of Mines Report.
H.D. Record = List of sites supplied by Highways Department Test Laboratory.
L.A. = Los Angeles Abrasion Test value.

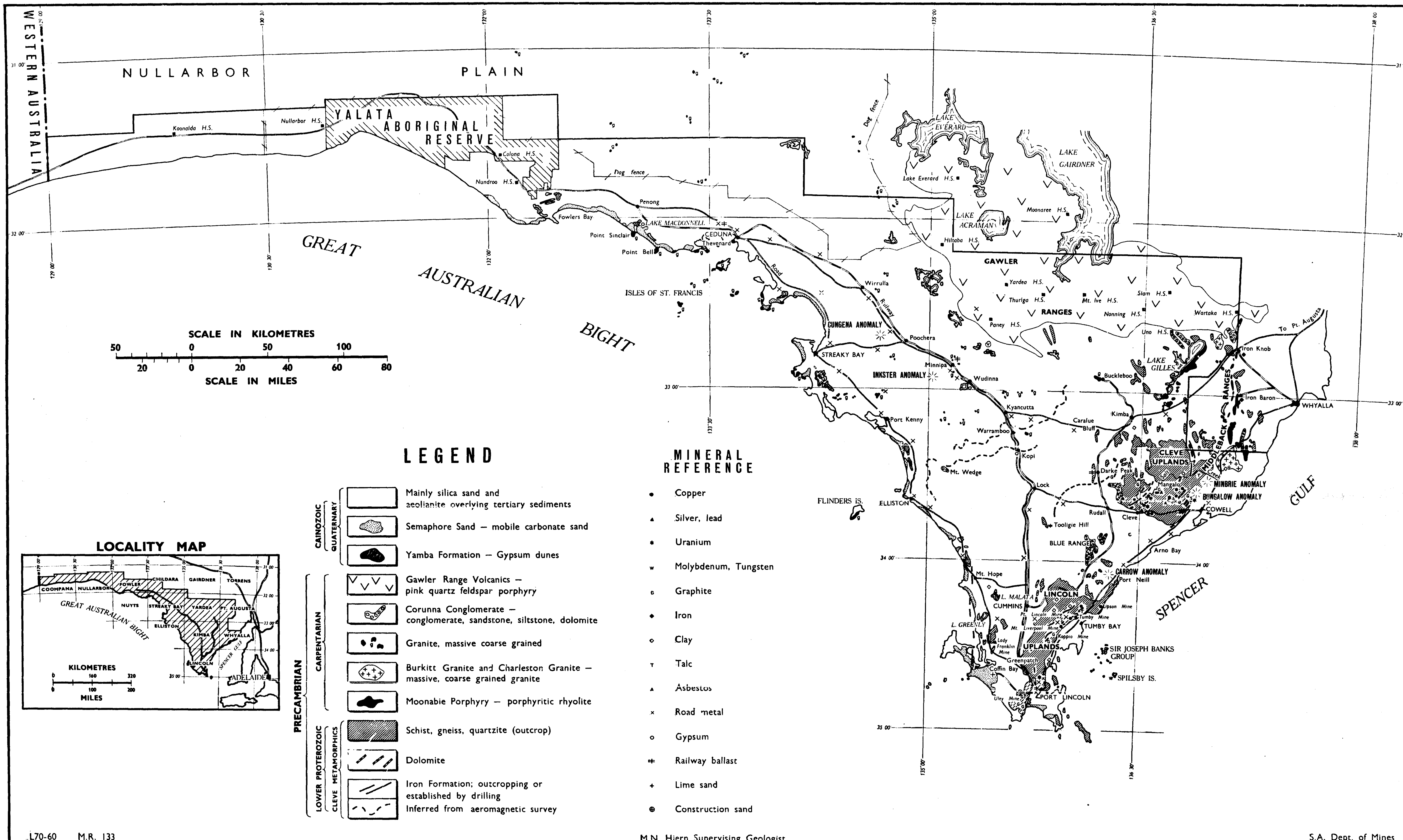
COUNTY	HUNDRED	SECTION	REFERENCE	REMARKS
Buxton	O'Connor	20	H.D.Record	Calcrete rubble used for crushed rock. L.A.47.
	Panitya	7	H.D.Record	Ferruginous quartzite used for crushed rock. L.A.40.
Dufferin	Hague	36	H.D.Record	2' Calcrete capping used for crushed rock and chippings LA34
	Haslam	14	H.D.Record	2' Calcrete capping used for crushed rock. L.A.38.
	Walpuppie	17	H.D.Record	2' Calcrete capping used for crushed rock. L.A.35.
Flinders	Hutchinson	36,37,97,98) 105,109)	R.B.38/57	Survey of road metal deposits Tumby Bay.
	Hutchinson	97	R.B.50/62	Survey of roadmetal Tumby Bay - Cummins area.
	Hutchinson	105	R.B.39/72	Diamond drilling of quartzite deposit.
	Hutchinson	288	H.D.Record	Dolomitic marble used for crushed rock & chippings.LA32. Gd quality

COUNTY	HUNDRED	SECTION	REFERENCE	REMARKS
Flinders	Hutchinson	293	H.D.Record	Ferruginous quartzite used for crushed rock. L.A.40.
	Hutchinson	several	R.B.38/34	Survey of roadmetal. Tumby Bay area.
	Koppio	82,83,113,128) 139,185)	R.B.50/62	Survey of roadmetal. Tumby Bay - Cummins area.
	Koppio	110	M.R.123.) p.118,121.) H.D.Record)	Amphibolite used for chippings.
		185	M.R.120.) p.120.) H.D.Record)	Soft quartzite used for crushed rock - L.A.60.
	Lincoln	16,17.	H.D.Record	Granite used for chippings.LA.21.
		96	-	Old railway ballast quarry in granite gneiss.
		85,160,199	R.B.61/44	Jaspilite for roadmetal.
		107	R.B.38/51	Ferruginous gravel deposit.
		147	M.R.120) p.117)	Quartzite deposit.
		208	-	Large quartz reef.
		402	H.D.Record	Granite used for chippings LA.23
		467	H.D.Record	Calcrete used for crushed rock L.A.50.
	Louth	329	M.R.116. p.136	Quartz felspar gneiss.
	Warrow	Block M	H.D.Record	Brown lateritic gravel used for base course L.A.29

COUNTY	HUNDRED	SECTION	REFERENCE	REMARKS
Jervois	Boothby	78	H.D.Record	Calcrete used for crushed rock. L.A.30.
	Brooker	52	R.B.58/124	Roadmetal deposits Central and Lower Eyre Peninsula.
	Darke	Railway Reserve	R.B.41/12) H.D.Record)	S.A.R. Ballast quarry. Sericitic quartzite L.A.28.
	Dixson	19	H.D.Record	Calcrete used for crushed rock L.A.35
	Hawker	6, 226	H.D.Record	Calcrete used for crushed rock L.A.38
	Hawker	114W,115,137,246	R.B.38/56	Stone deposits. Hd. Hawker.
	Hawker	385	M.R.126.) p.147) H.D.Record)	Dolomite deposit used for chippings. L.A.21. Good quality.
	Murlong	7	H.D.Record	Calcrete - only 9" capping used for crushed rock. L.A.45.
	Palkagee	15	R.B.61/55	Drilling of ferruginous sandstone
	Playford	Block I. H.	H.D.Record	Calcrete 2' thick used for crushed rock L.A.40.
	Tooligie	12	R.B.65/10) H.D.Record)	S.A.R. Ballast quarry. Sericitic quartzite.
	Yadnarie	66	R.B.61/32	Dolomite deposit
	Yadnarie	73	M.R.123	Dolomite deposit. Cleve.
Le Hunte	Mamblin	24, 26	H.D.Record	Calcrete used for crushed rock. L.A.40.
	Minnipa	10	H.D.Record	Calcrete used for crushed rock and chippings L.A.45.
	Minnipa	27	R.B.67/114,) 66/52)	Yarwondutta Rocks. S.A.R. ballast site in granite.

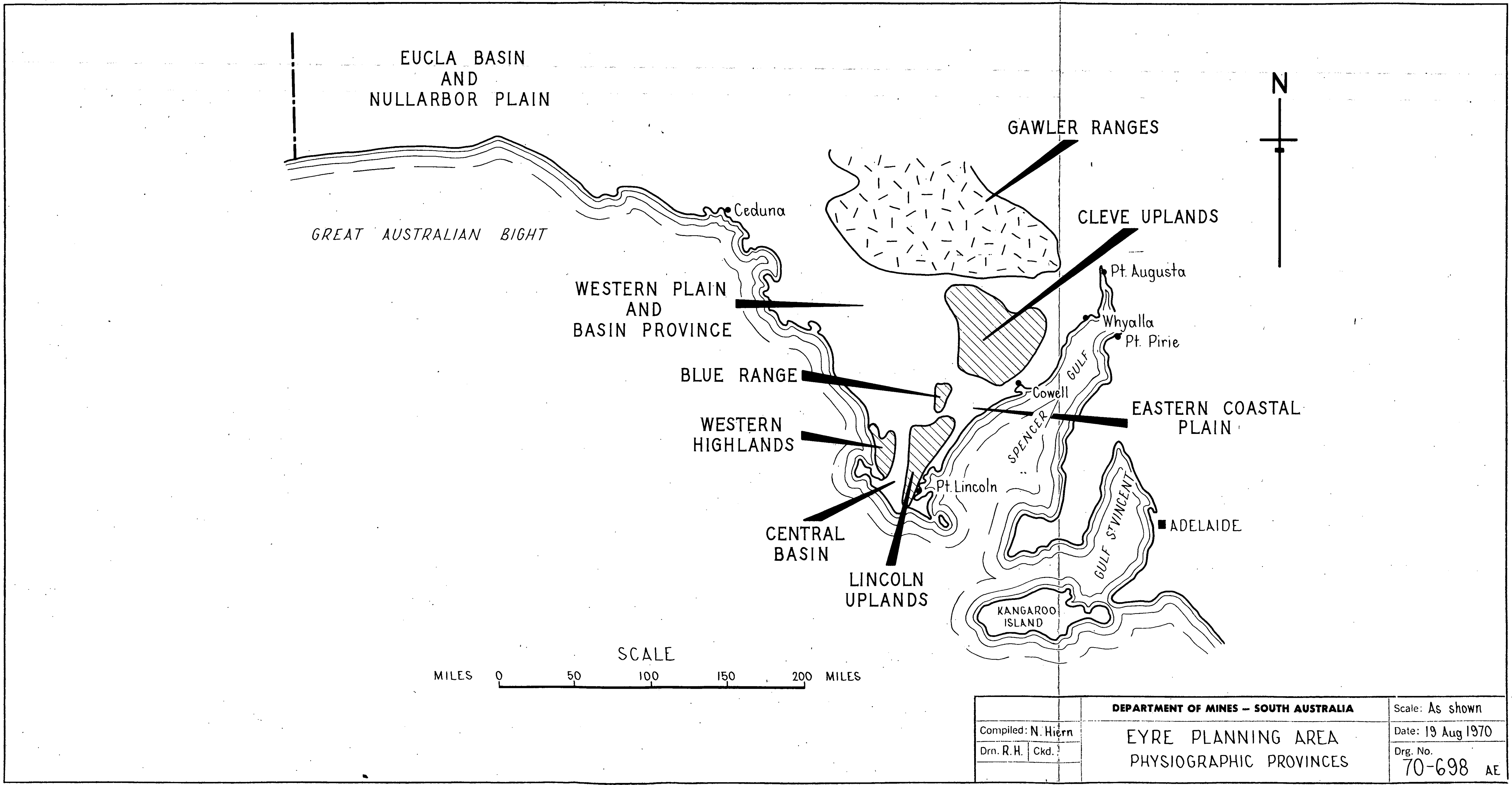
COUNTY	HUNDRED	SECTIONS	REFERENCE	REMARKS
Le Hunte	Minnipa	many	M.R.126 p. 130	Granite deposits Minnipa area.
	Pygery	8	H.D.Record	Calcrete used for crushed rock. L.A.32.
	Wannamana	34	H.D.Record	Calcrete used for crushed rock. L.A.38.
Musgrave	Cowan	19	H.D.Record	Calcrete 3'. Used for crushed rock L.A.52.
	Kiana	8	H.D.Record	Calcrete 12' deep. Hard. Used for crushed rock and chippings. L.A.32.
	Shannon	39	H.D.Record	Calcrete, sandy, poor. Used for Crushed rock. L.A.60.
	Ward	44	H.D.Record	Calcrete, 20' deep, good. Used for crushed rock. L.A.36.
	Ward	87	M.R.116. p.133.	Granite deposit.
	Ward	93	H.D.Record	Calcrete - quarry closed.
Robinson	Chandada	13	H.D.Record	Calcrete 4' - used for crushed rock. L.A.43 'Dead' stone.
	Cungena	44	H.D.Record	Calcrete - used for crushed rock L.A.40.
	Downer	Block 2	H.D.Record	Calcrete 8' - hard, good - used for crushed rock L.A.33.
	Forrest	10A, C.	H.D.Record	Calcrete 4-5' - used for base course.
	Scott	17	H.D.Record	Calcrete 12'-15' - good - used for chippings
	Wright	14A	H.D.Record	Calcrete 3' - used for crushed rock L.A.30.

COUNTY	HUNDRED	SECTIONS	REFERENCE	REMARKS
Robinson	Witera	21B	H.D.Record	Granite. Mt. Cooper - used for chippings. L.A.16.
Way	Blacker	51	H.D.Record	Calcrete 2-4' used for crushed rock. L.A.43.
	Bonython	35	H.D.Record	Calcrete 3' used for chippings. L.A.31.
	Catt	17	H.D.Record	Calcrete 6' used for base course. L.A.28.
	Chillundie	16	H.D.Record	Calcrete - shallow used for crushed rock. L.A.32.
	Moule	7AE	H.D.Record	Calcrete 2', good. used for chippings L.A.27.
	Moule	25	H.D.Record RB64/23	Calcrete 6-8' good. S.A.R. ballast quarry L.A.24.
	Wallanippie	6	H.D.Record	Calcrete 2-4' used for crushed rock L.A.40.
	Wandana	34	R.B.64/24	Calcrete test drilled for rail ballast.
York	Batchelor	B	H.D.Record	Porphry - used for chippings LA.13
Out of Counties.	Paney	H.S.	H.D.Record	Porphry in creek bed - used for chippings. L.A.16.



Map Showing Eyre Planning Area and Regional Geology with Mineral Deposits M.R.133

L70-60/4


EUCLA BASIN
AND
NULLARBOR PLAIN
GREAT AUSTRALIAN BIGHT
Ceduna
GAWLER RANGES
CLEVE UPLANDS
Pt. Augusta
Whyalla
Pt. Pirie
WESTERN PLAIN
AND
BASIN PROVINCE
BLUE RANGE
Cowell
EASTERN COASTAL
PLAIN
WESTERN
HIGHLANDS
SPENCER GULF
Pt. Lincoln
CENTRAL
BASIN
LINCOLN
UPLANDS
GULF ST VINCENT
ADELAIDE
KANGAROO
ISLAND
N
SCALE
MILES 0 50 100 150 200 MILES
DEPARTMENT OF MINES – SOUTH AUSTRALIA
Compiled: N. Hiern
Drn. R.H. Ckd.
EYRE PLANNING AREA
PHYSIOGRAPHIC PROVINCES
Scale: As shown
Date: 19 Aug 1970
Drg. No.
70-698 AE

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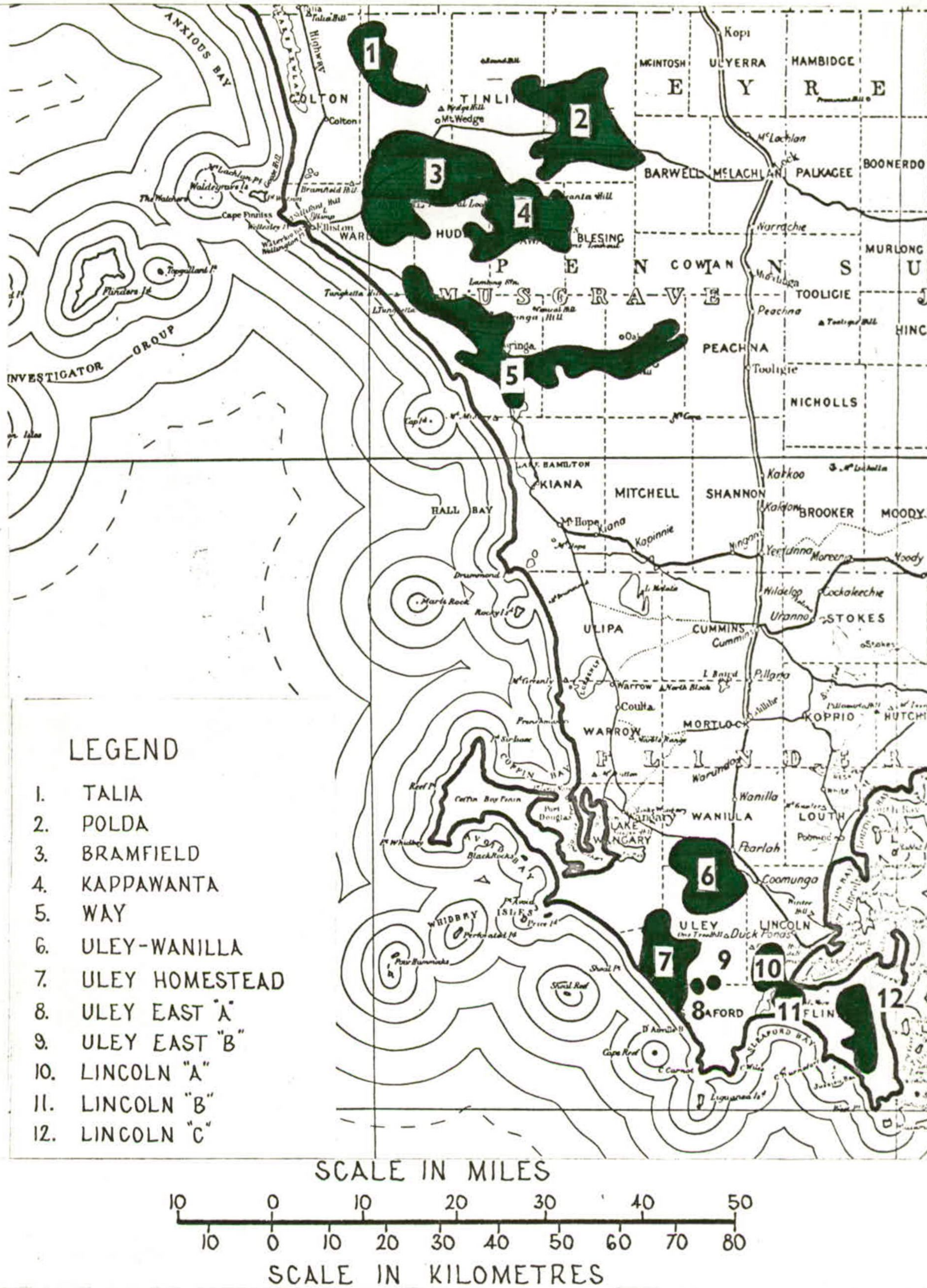

DEPARTMENT OF MINES — SOUTH AUSTRALIA

HYDROGEOLOGY SECTION	Drn. C.B.	EYRE PENINSULA	SCALE: 1 inch = 16 miles
	Tcd. R.H.	FRESH WATER BASINS	S7435
	Ckd.	STATE PLANNING OFFICE	Dan
Director of Mines	Exd.		DATE: 29 Aug 1969

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TRIM - LINE