DEPARTMENT OF MINES
SOUTH AUSTRALIA

GYPSUM

SOUTH AUSTRALIA

by

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In addition to the commercially productive deposits discussed below, gypsum occurs extensively throughout the low rainfall areas of South Australia. A crust of coarse crystalline gypsum, to which the name gypsite or gipcrete has been applied (Wopfner and Twidale, 1967) impregnates the upper surface of all but highly permeable arenaceous sediments underlying the extensive sand dune systems and gibber surfaces of the inland. This has been placed stratigraphically at the top of the Pleistocene in a position which corresponds with the calcrete referred to by Firman (1967) as Loveday Soil in the southern part of the State. The parent material from which the Craigie Plain gypsum originates may be equated with this. From the gypsite are derived the abundant seams and veins of selenite and satin spar exposed in workings in the opal fields and other inland areas of the State.

Stratigraphic drilling on central Yorke Penisula disclosed thin bands of gypsum interbedded with dolomite over a 14 metre section in the upper portion of a Lower Cambrian red bed sequence. Subsequent drilling, although not exhaustive, did not locate better developments of this evaporite bed (Blissett, 1968).

Thin veins of pink anhydrite, partially remobilised, were intersected in upper Devonian dolomitic sediments at a depth of approximately 900 metres in the Cootanoorina No. 1 Well, 60 kilometres south of Oodnadatta (Wopfner and Allchurch, 1967). In follow-up drilling only minor anhydrite was intersected in Weedina No. 1 Well, 60 kilometres to the south and the Devonian sequence is absent in Boorthanna No. 1, 50 kilometres south of Weedina No. 1 (Holmes, 1970).

All of the commercially developed gypsum deposits of the State are of Quaternary age except for a minor deposit, in terms of current production, which occurs in the Lower Pleistocene Blanchetown Clay near Blanchetown. The remainder of the deposits are equated with the Recent Yamba Formation (Firman, 1973) and are of three principal types.

1. Granular gypsum in lake beds with associated flour and seed gypsum accumulated in lunetta type dunes on the leeward side of the lake. The most common impurity is silica sand, derived from adjacent sand spreads. The highest grade deposits, where the assays exceed 90% gypsum, are located in the southern areas where sand dunes are either absent or fixed by vegetation. The lake beds comprise impervious clay, and gypsum is considered to be derived from runoff fed from cyclic salt or saline groundwaters. These evaporate in summer and the resultant gypsum is blown onto dunes on the lake shore. Fixed vegetation and an upper layer of fine flour gypsum, usually of higher grade than the underlying seed, indicate that this process of gypsum accumulation is no longer active. Gypsum of the type section of Yamba Formation is of this form.

2. Rock gypsum and associated gypsum sand lying beneath saline swamps and lakes located adjacent to the modern coast. Although not included in the definition of Yamba Formation, these deposits occupy landforms which were developed in the Recent and are therefore equated with or are slightly older than Yamba Formation of the type area.

The rock gypsum is comprised of prismatic crystals over 50 mm long, oriented vertically, which form a bed several metres thick. It is overlain by a similar thickness of fine gypsum sand.

Both types of gypsum may reach up to 98% purity with production grades usually running at about 94% $CaSO_4\ 2H_2O$. Chemically precipitated lime is the principal impurity. Anhydrite has been reported from the upper layers beneath Lake MacDonnell.

Samples of rock gypsum from Stenhouse Bay display horizontal banding of thin semi-opaque layers richer in calcium carbonate which are considered to represent cyclic deposition.

In contrast to the deposits of type 1 above, the lake bed beneath the rock gypsum consists of porous calcareous aeolianite of the Bridgewater Formation and a different mode of formation is required. Early workers proposed that gypsum formed in closed embayments of the sea with the water replenished by periodic incursions of sea water. Later this theory was modified by postulating that water entered by seepage through the coastal dune barrier. In both cases it was considered that gypsum was deposited in rock form, the overlying gypsum sand being derived later by mechanical break-down of rock gypsum nearer the shore and transported into the lake.

Evidence from more recent drilling at Lake MacDonnell suggests that the source of gypsum is saline groundwater, possibly connected to the sea, from which gypsum sand and whiting are deposited as a result of partial evaporation and that the rock gypsum is a product of diagenesis.

3. Beds of granular gypsum, contaminated by silica sand, underlying gypsiferous silts and clays in the major inland salinas. Beds of this type occur in Lake Gairdner and Lake Torrens.

Production and Grades

Current production is in excess of 700 000 tonnes per annum and has shown a steady increase since gypsum mining began in the 1880's. Rock gypsum from Lake MacDonnell, Kangaroo Island and Stenhouse Bay is the principal material won. Total recorded production amounts to 12.25 million tonnes valued at $26.7 million.

Reviews of the industry are provided by Jack (1921) and Willington (1952).

Analyses of the various types of gypsum from the principal deposits are shown in Table 1 over-leaf.

Lake and Dune Deposits

1. Southern Yorke Peninsula

An extensive lake system is developed in the area between Yorketown and Warooka. As discussed by Crawford (1965) the lake floors consist of Permian glacial clays and the lakes owe their origin to removal of previously overlying Tertiary limestones by solution and deflation.

A dune of rounded gypsum fragments, referred to as seed gypsum, is developed over a length of 1.6 kilometres on the eastern and south eastern shore of Lake Fowler, the largest of the lakes in the area. Described by King (1952a), the dune reaches a maximum height of 23 metres above the lake floor on the south-eastern side of the lake and in workings is seen to comprise both seed and fine flour gypsum in the ratio 2 : 1. A bed of granular gypsum up to 1 metre thick underlies the lake floor and similar material occurs beneath the samphire swamp on the leeward side of the dune (Hiern, 1959). Analyses are shown in Table 1.

Deposit	Type	$CaSO_4$ 2H 0	$CaCo_3$	Insol	NaCl	Fe_2O_3
Lake Fowler	Main dune - average of 33 samples.	92.9	1.1	3.9	0.7	0.1
	North dune - average of 6 samples.	85.2	2.4	9.8	1.0	0.2
	Seed beneath samphire.	72.80	5.0	-	-	-
Parcoola	Flour - one drillhole. Seed - average of two drillholes.	90.8 70	0.11 0.3	7.7 2.8	0.05 -	0.27 0.4
Cooke Plains	Average flour. " seed Lake bed seed	92.35 83.88 40 - 60	2.33 2.80 8 - 20	3.01 11.21 12 - 28	- - -	- - -
Morgan	Average flour " seed	83.62 75.6	4.1 4.7	10.8 17.4	0.15 0.16	0.30 0.58
Lake MacDonnell	Average 41 holes in rock gypsum. Granular gypsum beneath lake.	94.49 82.7	3.46 10.1	0.18 -	0.93 -	- -
Kangaroo Island	Rock	92.0	4.5	-	-	-
Stenhouse Bay	Average sand.	91.0	6.0	0.3	2.5	-
	Dune	94 - 98	-	-	-	-
Hd. Bartlett	Sand - lake - one hole	93.3	2.3	0.48	2.3	-
	Dune - one hole.	99.0	0.20	0.27	0.19	-
Craigie Plain	Washed gypsum. Dune - bulk sample.	91.88 71.56	3.0 5.00	2.65 18.60	- -	- -

TABLE 1 - TYPICAL ANALYSES OF SOUTH AUSTRALIAN GYPSUM

Gypsum dunes of lower grade border Peeseys Swaym to the west (Willington, 1952b) and Johns (1960) describes gypsum bearing muds up to 30 cm thick on the floor of an adjacent lake. This material when washed, showed a grade of 98-99% gypsum.

2. Murray Basin

Several deposits of this type are located adjacent to the River Murray between Renmark and the lakes at the Murray Mouth. Some of these occupy swamps associated with a former higher level of the river and lakes.

The largest deposit, referred to as Parcoola, is located 50 kilometres north of Waikerie. Six auger holes were drilled in one of several lake and dune associations and showed seed gypsum ranging from 67-81% $CaSO_2 2H_2O$ contaminated by red aeolian sand (Hiern, 1971). Granular gypsum in the lake bed analysed 63.3% gypsum, 23.4% insoluble and 12.5% not determined. The presence of alunite was shown by X-ray analysis. A preliminary estimate suggested the presence of 12-17 million tonnes of gypsum.

King (1951a) estimated reserves of over 3 million tonnes of seed gypsum at the Cooke Plains deposit located 5 kilometres west of the Adelaide - Melbourne railway near Tailem Bend. In the raw state the gypsum produces inferior quality plaster but has been used for cement and agricultural purposes. Grades are shown in Table 1.

Plaster is manufactured from seed gypsum quarried from a few kilometres north of Morgan. Olliver (1967) estimated reserves of 1 million tonnes and Whitten (1962) investigated crystalline gypsum on the lake floor.

Deposits in the Renmark area at Rotten Lake (Johns, 1953) and in the Yamba - Noora district (Johns, 1954a) are used on a small scale for agricultural purposes.

Small low grade deposits are recorded from Burra (Willington, 1956b) and Tintinara (Jack, 1921).

3. Eyre Peninsula

Gypsum dunes associated with inland lakes are recorded from the Middleback Range area (Solomon, 1952) and central Eyre Peninsula (Forbes, 1960b, 1960c). Grades of 90-98% are reported.

4. Northern St. Vincent Basin

Shepherd (1959) describes low dunes of variable quality ranging up to 97% gypsum associated with Diamond Lake and a large low grade dune is developed adjacent to Lake Bumbunga near Lochiel (King, 1951c). Jack (1921) refers to 2 metres of gypsiferous mud overlying a hard layer, considered to be crystalline gypsum, in the lake floor.

Rock and Sand Gypsum Deposits

1. Western Eyre Peninsula

(a) Lake MacDonnell

Original estimates showed the presence of 777 million tonnes of high grade rock and sand gypsum, averaging 4.6 metres in thickness, underlying a depression 85 km^2 in area, surrounding the present lake (Dickinson and King, 1949). This material comprised a surface layer of flour gypsum contaminated by organic matter (excluded from the calculation), underlain by about 1 metre of gypsum sand which overlay a bed of massive rock gypsum, up to 7.3 metres thick.

Subsequent drilling (Dickinson and King, 1950; Forbes, 1960a; Willington, 1962; Hiern, 1970 and Whiting 1970a) has further defined the limits of the deposit and demonstrated that much of the gypsum beneath the lake is in coarse granular form of a grade between 80% and 90%. These data, at present being collated, will reduce the original reserve estimate to the order of 500 million tonnes with consequent adjustment of grades.

Dunes of flour and seed gypsum, representing succeeding shrinking of the lake, are estimated to contain 50 million tonnes of lower grade material.

(b) Streaky Bay

Investigation of a lake system adjacent to the coast 16 kilometres south of Streaky Bay showed the presence of gypsum sand underlying a surface layer of flour gypsum contaminated by organic matter (Forbes, 1960b).

Drilling of the largest lake showed an average of 1.5 metres of gypsum sand with minor development of rock gypsum. Analyses averaged 91% $CaSO_4$ $2H_2O$, 6% $CaCO_3$ and 2% NaCl. The calcium carbonate impurity comprised both fine whiting and shell fragments. Stated reserves of approximately 30 million tonnes were confirmed by subsequent drilling (Whiting, 1970b).

Adjacent dunes, reported to be free of flour gypsum, were estimated to contain approximately 0.5 million tons ranging from 94-98% gypsum.

(c) Hd. Bartlett

Three hand auger holes in two of several small coastal lakes passed through 1 metre of cream gypsum sand without penetrating the base of the unit. Samples averaged 93.3% gypsum, 2.3% $NaCO_3$ and 2.3% NaCl while one hole in adjacent dunes, drilled only to 1 metre, showed 99% $CaSO_4$ $2H_2O$ (Forbes, 1960b).

Further testing is necessary to define the limits of the deposit and to explore for rock gypsum below.

(d) Fowler Bay

Coastal swamps in Hd. Caldwell near Fowlers Bay show rock gypsum in shallow excavations and require further testing.

2. Stenhouse Bay

Sand and rock gypsum occur in a number of lakes lying between Royston Head and Stenhouse Bay on the extreme western tip of lower Yorke Peninsula. (Dickinson and King, 1951). Production commenced in 1905 and to date over 4 million tonnes of rock gypsum, averaging 94% $CaSO_4$ $2H_2O$ have been won, mainly from Marion Lake. The overlying gypsum sand is also recovered. Like the Lake MacDonnell deposit with which it has many other similarities, fine whiting is the chief impurity. The deposit is now almost depleted.

3. Kangaroo Island

Drilling on Salt Lake, Hd. Haines in 1954 showed the presence of 2.6 million tonnes of rock gypsum in a bed up to 2 metres thick of an average grade of 92% gypsum and 4.5% $CaCO_3$ (Willington, 1958). The deposit overlies green calcareous clay and aeolianite and is currently being worked.

4. Tickera

Several small deposits of up to 20 000 tonnes each occur between aeolianite dunes flanking samphire flats adjacent to the coast south of Pt. Broughton. Gypsum sand ranging from 90-94% $CaSO_4 2H_2O$ constitues the bulk of the deposit although rock gypsum forms the floor to the formation in some places (King, 1951b; Solomon,1953). The thickest recorded section in an extensive hand auger programme was 3.5 metres.

Inland Salinas

Only three of the major inland lakes of South Australia have been drilled and beds of granular gypsum, contaminated by sand, have been intersected in each case.

Four holes drilled on a northwesterly alignment in Madigan Gulf, Lake Eyre, showed the modern lake sediments to be thin, comprising mainly gypsum and silica sand 5 metres thick grading to essentially silica sand near the shore. A 4 metre sample from Bore 20 assayed 51.2% gypsum (Johns and Ludbrook, 1963). King (1956) records a thin bed of crystalline gypsum in the cliff sequence on the southern shore of the Lake

A bed of fine gypsum sand, up to 13 metres thick with silica sand and minor clay was intersected beneath 16 metres of clay and silt in three holes drilled on the eastern side of Lake Torrens (Johns, 1968). The weighted mean of samples from the thickest section returned 54% $CaSO_4 2H_2O$. Low gypsum dunes on the eastern shore of the lake were test drilled in three areas by Delhi Australia Ltd. (Callow, 1970a,b). The best results were obtained midway along the lake opposite the site of the lake bed drilling,

where 9 metres of seed gypsum returned an analysis of 84%, $CaSO_4 2H_2O$. The gypsum is up to 15 metres thick in cliffs on the lake shore but wedges rapidly inland. The gypsum bed located beneath the lake was shown to extend beyond the lake shore at uniform grade and thickness.

One hole drilled on Lake Gairdner intersected 14 metres of clayey gypsum sand of approximately 50% grade including a 4 metre bed averaging 82% gypsum (Johns, 1968).

With the exception of the southern section of the eastern shore of Lake Torrens drilling of the inland lakes to date has not been sufficiently detailed to apply the above results to the whole of the lake system.

Bedded seed gypsum is exposed in cliffs on the eastern shore of Spencer Gulf at Redcliff Point 25 km south of Pt.Augusta.

Miscellaneous Deposits

1. Blanchetown Plain

A bed of laminated crystalline rock gypsum, 5-6 metres thick, is worked from the bank of a depression 3 kilometres east of Blanchetown as an additive for cement. The gypsum overlies yellow and green clays equated with the Blanchetown Clay of Pleistocene age. A few low dunes of seed and flour gypsum also occur.

Gypsum beds of similar thickness have been intersected in the Blanchetown Clay in drilling associated with hydrogeological investigations in the Waikerie area. (Roberts and Cramsie, 1971).

2. Craigie Plain

Plaster grade gypsum, including high purity selenite for dental and medical preparations, has previously been won from deposits located 20 kilometres west of Blanchetown (King, 1952a). Thin bands of coarse selenite crystals, interbedded with finer material, were worked to a depth of 2 metres and processed in a washing plant. These deposits appear to be detrital in origin. Nearby a deeper excavation exposes the upper surface of a fossiliferous Tertiary limestone intensely impregnated by coarse crystalline gypsum. The detrital (?) material occupies the floor of a broad depression and could have been derived from erosion of a broad depression and could have been derived from erosion of a gypsite surface, similar to that in the deeper pit, located around the margin of the depression.

A seed gypsum dune, averaging 71% $CaSO_4$ $2H_2O$ and 18.6% sand impurity flanks the eastern side of the depression.

Other depressions in the area were examined by Forbes (1961) but no extensions to the deposit were noted.

References

Blissett, A.H., 1968. Minlaton Stratigraphic Bore No. 2. Dept. Mines unpublished report R.B.67/85.

Callow, K.J., 1970. Half yearly reports S.M.L. 249, 250, Lake Torrens area. Delhi Australian Petroleum Ltd. Dept. Mines open file envelopes 1055, 1056, unpub.

Crawford, A.R., 1965. The geology of Yorke Peninsula. Geol. Surv. S.Aust. Bull. 38.

Dickinson, S.B., and King, D., 1949. Lake MacDonnell gypsum deposit, Min. Rev. Adelaide 87 : 109-136.

_____ 1950. Lake MacDonnell gypsum deposit. Min. Rev. Adelaide 89 : 103-111.

_____ 1951. The Stenhouse Bay gypsum deposits. Min. Rev. Adelaide 91 : 95-113.

Firman, J.B., 1967. Stratigraphy of late Cainozoic deposits in South Australia. Trans. Roy. Soc. S.Aust. 91 : 165-178.

_____ 1973. Regional stratigraphy of surficial deposits in the Murray Basin and Gambier Embayment. Geol. Surv. S.Aust. Rept. Invest. 39.

Forbes, B.G., 1960a. Testing of marginal gypsum and estimation of gypsum reserves Lake MacDonnell. Min. Rev. Adelaide 110 : 78-82.

_____ 1960b. Gypsum deposits near Streaky Bay and some other localities on Eyre Peninsula. Min. Rev. Adelaide 110 : 83-105.

Forbes, B.G., 1960. Gypsum deposits near Yaninee and Kopi. Min. Rev. Adelaide. 110 : 106-107.

_____ 1961. Gypsum deposit - Craigie Plain area. Min. Rev. Adelaide 112 : 62-64.

Hiern, M.N., 1959. Lake Fowler gypsum deposit. Min. Rev. Adelaide 106 : 35-41.

_____ 1970. Drilling for gypsum beneath Lake MacDonnell. Mineral Resour. Rev. S.Aust. 129 : 70-80.

_____ 1971. Parcoola gypsum deposit. Mineral Resour. Rev. S.Aust. 130 : 157-161.

Holmes, D.A., 1970. Occidental Minerals Corporation of Australia. South Australian Potash Project. S.M.L. 329. Dept. Mines open file envelope 1313 unpublished.

Jack, R.L., 1921. The salt and gypsum resources of South Australia. Geol. Surv. S.Aust. Bull. 8.

Johns, R.K., 1953. Gypsum deposits at Rotten Lake in the Renmark district. Min. Rev. Adelaide 94 : 52-55.

_____ 1954a. Gypsum deposits southeast of Renmark. Min. Rev. Adelaide 96 : 45-48.

_____ 1954b. Gypsum deposits, Blanchetown Plain. Min. Rev. Adelaide 96 : 48-50.

_____ 1960. Gypsum deposits - Sections 72-74 and 78 Hd. Melville. Min. Rev. Adelaide 109 : 57-60.

_____ 1968. Investigation of Lakes Torrens and Gairdner. Geol. Surv. S.Aust. Rept. Inv. 31.

_____ and Ludbrook, N.H., 1963. Investigation of Lake Eyre. Geol. Surv. S.Aust. Rept. Inv. 24.

King, D., 1951a. Cooke Plains gypsum deposit. Min. Rev. Adelaide 91 : 141-148.

_____ 1951b. Gypsum deposits, Hd. Tickera. Min. Rev. Adelaide 91 : 149-158.

_____ 1951c. Lake Bumbunga gypsum deposit. Min. Rev. Adelaide 91 : 159-163.

_____ 1952a. Lake Fowler gypsum deposit. Min. Rev. Adelaide 92 : 60-67.

_____ 1952b. Craigie Plain gypsum deposit. Min. Rev. Adelaide 93 : 112-116.

_____ 1956. The Quaternary Stratigraphic record of Lake Eyre North and the evaluation of existing topographic forms. Trans. Soc. S.Aust. 79 : 99-103.

Olliver, J.G., 1967. Gypsum deposit, Blocks Q and N. Hd. Stuart. Min. Rev. Adelaide 120 : 75-80.

Roberts, G.T. and Cramsie, J.N., 1971. Drainage investigations in the Waikerie district irrigation areas. Mineral Resour. Rev. S.Aust. 131 : 43-61.

Solomon, M., 1952. Middleback gypsum deposits. Min. Rev. Adelaide 93 : 126-130.

Solomon, M., 1953. Gypsum deposits near Pt. Broughton and Tickera. Min. Rev. Adelaide 95 : 93-95.

Shepherd, R.G. 1959. Diamond Lake gypsum deposits. Min. Rev. Adelaide 107 : 83-88.

Willington, C.M., 1952a. Gypsum resources of South Australia. Min. Rev. Adelaide 92 : 167-192.

_____ 1952b. Peesey Swamp gypsum deposit. Min. Rev. Adelaide 93 : 138.

_____ 1956a. Seed gypsum. Craigie Plain. Min. Rev. Adelaide 99 : 216-217.

_____ 1956b. Gypsum occurrence. Hds. Baldina and King. Min. Rev. Adelaide 99 : 218-219.

_____ 1958. Drilling operations on gypsum deposit. Hd. Haines. Min. Rev. Adelaide 105 : 50-57.

_____ 1962. Exploratory drilling - Lake MacDonnell gypsum deposit. Min. Rev. Adelaide 114 : 5-8.

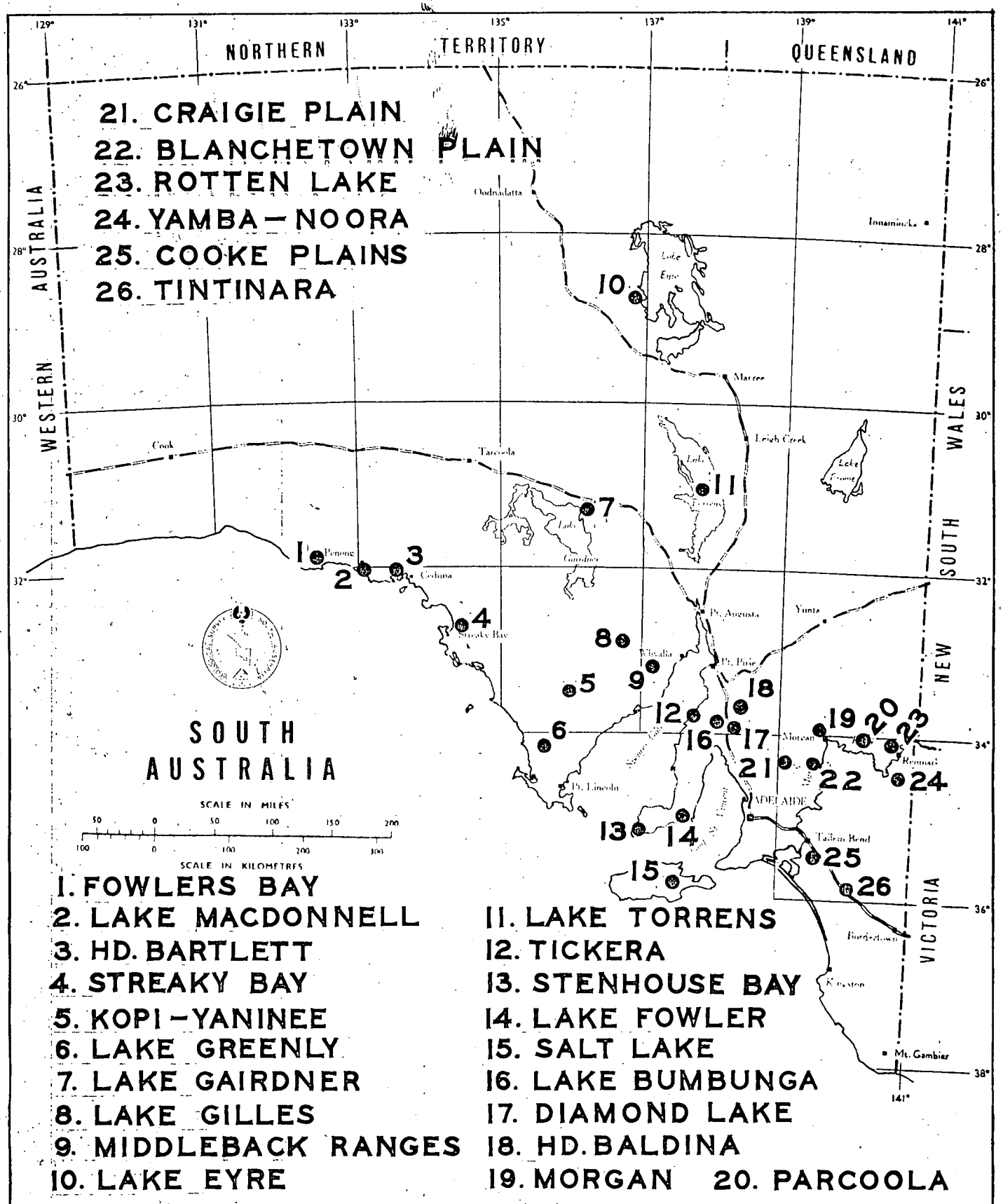
Wopfner, H. and Allchurch, P.D., 1967. South Australian Government Cootanoorina No. 1 Well completion report. Dept. Mines unpublished report RB.65/104.

_____ Twidale, C.R., 1967. Geomorphological history of the Lake Eyre Basin in "Land form studies from Australia and New Guinea", (Eds. J.N. Jennings and J.A. Mabbutt). A.N.U. Press.

Whiting, J.W., 1970a. Geological report on Lake MacDonnell gypsum deposit. S.M.L. 254. Elcor (Australia) Pty. Ltd. - Dept. Mines open file envelope 1060 - unpublished..

_____ 1970b. Geological report on gypsum deposit Sceale Bay district, South Australia. S.M.L.251. Elcore (Australia) Pty. Ltd. - Dept. Mines open file envelope 1057 - unpublished.

Whitten, G.F., 1962. Gypsum deposits - Blocks Q and N. Hd. Stuart, Min. Rev. Adelaide 113 : 25-31.



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