

1958

WESTERN AUSTRALIA

DEPARTMENT OF MINES

MINERAL RESOURCES OF WESTERN AUSTRALIA

BULLETIN No. 6

THE GYPSUM DEPOSITS OF WESTERN AUSTRALIA

BY

L. E. DE LA HUNTY, B.Sc., and G. H. LOW, B.Sc.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

WITH

SIX PLATES AND TWO FIGURES

*Issued under the authority of the Hon. A. M. Moir,
Minister for Mines.*



PERTH:

By Authority: ALEX. B. DAVIES, Government Printer, Perth.

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PREFATORY NOTE.

This report contains quantity and quality data about all of the known gypsum deposits in that part of Western Australia situated south of a line joining Geraldton on the west coast and Kanowna, 12 miles north of Kalgoorlie in the Eastern Goldfields, and west of a line joining Kanowna and Esperance on the south coast.

Some of the deposits are being exploited as a source of the State's requirements of Plaster of Paris, though only those favourably situated with respect to transport facilities are being worked.

No deposits of gypsum of any size are known beyond the above limits, and the authors have arrived at an approximate figure of 30,000,000 tons as representing the reserves of commercial grade gypsum in the area examined.

Several of the larger unworked lower grade deposits were bulk sampled, and the material submitted to the W.A. Government Chemical Laboratories (Mineral Section) for beneficiation tests, with a view to the possible ultimate production of commercial sulphur and cement from the material.

No results of these tests had been received by the Geological Survey up to the time this bulletin went to the Printer (10th July, 1957).

H. A. ELLIS,
Government Geologist.

15th April, 1955.

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INTRODUCTION.

The information contained in this bulletin is the result of work undertaken by the authors in 1952. Up till that time, very little was known of the gypsum deposits of the State. The purpose of the work was to establish the number, size, and grade of the known deposits and to indicate reserves.

Gypsum is considered to be one of the most important of the non-metallic minerals—due mainly to its use in the manufacture of plaster and plaster products. Production of gypsum in post-war years has shown a continued sharp rise to more than double the pre-war peak.

METHOD OF SURVEY.

Only deposits included in the south-west portion of W.A.—bounded by latitude 27° S. and longitude 123° E. and the south and west coasts—were examined. (See frontispiece.) Very little is known of any deposits outside this area and they would have to be very good to be worked at a profit.

This portion of the State was subdivided (geographically into six areas and the deposits in each area were visited in an order designed to give greatest economy of time and travelling. Camps were made either at the deposits or as close to them as possible.

Places inspected included all mineral claims for, and all known sources of, gypsum. Sources of information were Mines Department records, Geological Survey files, and files from the Government Chemical Laboratories. Some deposits were also located as a result of personal communication. Attempts were made (quite a few of which were unsuccessful) to locate all places from which gypsum samples had been obtained and/or all people who had ever sent in samples of gypsum for analysis by the Government Chemical Laboratories. Since the records dated back 50 years, and a large number of the samples were taken more than 25 years ago, it was inevitable that many of the samplers had since died, or left the district from which the samples had been taken (see G.S.W.A. File No. 21/53 for details of samples whose locality could not be fixed—also for record of deposits outside the area investigated).

The authors shared the field work, which was commenced on 24th March and completed on 17th August, 1952. Mr. Low assisted in the early stages of the compilation of this bulletin until called away for supervision work in the Collie Mineral Field. The other author completed the majority of the writing and is responsible for estimates of reserves.

Mapping of the deposits was done with plane table and telescopic alidade for the most part. The pace and compass method was also used. Mapping was done on scales of 5, 10, 20, 40, and 80 chains to an inch—depending on the size and nature of each deposit. The exact limits of some deposits were not delineated but probable boundaries, only, were indicated.

SAMPLING.

Method.

A total of 191 samples were taken of seed gypsum, kopi, granular gypsum, gypsum crystals (selenite) and clay with crystals. Samples were numbered GS/G/1-68, GS/G/59A-68A, GS/G/69-71, GS/G/71A, GS/G/72-180. (The "A" numbers are a result of an overlap in the original numbering.) The sample numbers have been shortened in this text to G1-68, etc.

Samples Nos. G. 1-51 were taken using a post-hole borer (except in the case of channel samples). An auger bit was then substituted for the post-hole attachment and it proved much more efficient. The auger was particularly useful for boring beds of compacted seed gypsum. It was also better for boring loose dry material which needed wetting, as less water was needed for the work.

Other methods of sampling included channel samples dug with a small trenching shovel down the faces of quarries and diggings, also down the faces of pits.

The deposits were scout sampled only—as few as one or two samples being taken from some deposits. In some other deposits the sampling interval was 80 chains and more. Samples were not taken from every hole put down but were taken mostly where a change in character, within the deposit, was noticed.

Composite samples were sometimes made—for example, where 6 inches of kopi was found to overlie 6 feet of granular gypsum, the kopi was included in the sample.

Samples were quartered in the usual manner, and all of the analyses were done by the Government Chemical Laboratories, Mines Department, Perth.

Limitations.

It was practically impossible to sample below a depth of 10 feet as the borings would not pull (whether the material was dry, damp, or thoroughly wet). This limitation was felt when boring in the crest of a seed dune which was more than 10 feet in height, since the bottom of the dune is rarely flat—usually being on ground which rises away from the lake. A further limitation at this depth was that the action of putting the auger down the hole sometimes knocked down more of the wall than had been bored out on the previous "pull."

Water in lake beds was always a limiting factor to the depth sampled—very little material could be pulled from below water level. Samples of crystals dug from beneath water level were "semi-washed" during the process of extraction.

ACKNOWLEDGMENTS.

The writers wish to thank members of the plaster industry for their valuable assistance and helpful information ; also the chemists, draftsmen, statistician, and others who helped in the preparation of this publication.

Thanks are also due to the various Road Board Secretaries and Mining Registrars for their kind co-operation in the field.

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MINERALOGY OF GYPSUM.

The information quoted below is drawn from recognised text books—all containing similar information.

The mineral gypsum is a hydrated calcium sulphate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ and crystallises in the Monoclinic System. Common forms are swallow-tail twins, arrow-head twins and stellate interpenetrated groups. Gypsum also occurs in laminated, granular or compact masses, fibrous and powder forms.

Gypsum is colourless in the pure form but is often coloured with impurities (usually red in W.A.). It has a white streak with a pearly lustre—sub-vitreous on some faces. It is pellucidly transparent (like glass), to translucent or even opaque, from admixture with impurities. Its hardness (1.5 to 2) is taken as 2 on Moh's Scale of Hardness—it may be scratched easily with the finger nail. Its specific gravity is 2.3 (i.e., it weighs 2.3 times the weight of an equal volume of water). Gypsum exhibits perfect cleavage in one direction (parallel to the clinopinacoid, 010), giving very thin, flexible, but non-elastic plates. It is sectile. This means it can be cut with a knife but is not malleable.

Varities of gypsum include selenite, satin-spar, rock gypsum, seed (or sand) gypsum and kopi (flour gypsum). Anhydrite (CaSO_4) is the non-hydrous form of calcium sulphate often found with gypsum.

Selenite.

In the pure form, selenite is colourless and transparent—occurring in broad folia or distinct crystals. It may be easily split into sheets, which are slightly flexible but not elastic. This lack of elasticity distinguishes selenite from the clear variety of mica. Some selenite looks like calcite at first glance but does not possess calcite's high degree of cleavage, its hardness nor its double refraction.

Satin-spar.

Occurs in narrow veins and seams which rarely exceed 3 or 4 inches in thickness. It is a fibrous variety consisting of a mass of needle-like crystals, arranged parallel to each other and perpendicular to the edges of the seams. It is found in deposits of rock gypsum or in rock adjacent to these deposits—also in gypseous shales. It is never found in sufficient quantity to be an economic source of gypsum.

Rock gypsum.

This is the massive variety and is the form most commonly found in nature. The majority of the world's workable deposits are of this type. It is found interbedded with sedimentary rocks and consists of minute crystals, making a rock which is generally opaque.

Pure rock gypsum is white, but the presence of impurities (quite common) makes it pink, brown, blue grey or green. Alabaster is a white, slightly translucent, fine grained rock gypsum suitable for sculpturing and carving.

Seed Gypsum.

Sometimes known as sand gypsum or gypsum sand. It consists of small grains formed by the mechanical break-down of larger crystals. The grains are about the size of rice grains and usually have two flat parallel sides. They are white to colourless and collect in wind blown dunes and banks. Distinguished from quartz sand by its hardness and grain shape.

Kopi.

This is known variously as gypsite, earthy gypsum, flour gypsum, kopai or kopi. It is a soft, incoherent, impure gypsum and is very like flour in texture. It is usually a buff or creamy colour but may be grey, mottled with white, rusty, pink, or even red. Distinguishable from clay by its incoherency—it will not “ball.”

Anhydrite.

Anhydrite is usually found in close association with gypsum deposits. It is calcium sulphate—having the same composition as dead-burned gypsum. Anhydrite, in nature, will absorb water and slowly revert to gypsum. It may be deposited from certain impure gypseous solutions at various temperatures. Its presence in any quantity in a gypsum deposit renders the deposit useless for the manufacture of Plaster of Paris. Anhydrite has not been recognised in W.A.

The similarity of gypsum and anhydrite is very marked but there are several simple tests which may be used to distinguish the two. Anhydrite is harder and heavier than gypsum. When heated in a closed tube, gypsum gives off water more copiously, but anhydrite yields very little or none. Anhydrite has a pseudocubic aspect. Gypsum is easily soluble in dilute hydrochloric acid while anhydrite is soluble with difficulty, in a solution of the same strength. Under weathering, anhydrite remains hard and white, while gypsum breaks down to a soft incoherent powder (kopi).

CHEMISTRY OF FORMATION.

Bowles and Farnsworth, 1925¹, recognise four methods of formation of gypsum deposits. These are

1. Direct deposition by evaporation of sea water.
2. Concentration of disseminated gypsum by moving waters.
3. Alteration of limestone beds by acid sulphate waters.
4. Alteration of anhydrite.

The third method could be expanded by altering “limestone beds” to “lime-bearing rocks.”

1. *Evaporation of Sea Water.*

Van 't Hoff found that evaporation of a solution of pure calcium sulphate below 66°C (151°F) caused the deposition of gypsum. Anhydrite was deposited above this temperature.

Bowles and Farnsworth found that the presence of soluble salts (especially NaCl) altered this critical temperature and anhydrite precipitated at temperatures as low as 30°C (86°F). They also found that gypsum deposited below this temperature would change to anhydrite in the presence of a saturated solution of NaCl. The lower temperature limit at which anhydrite crystallised from the evaporation of sea water was 25°C (77°F).

In view of the above, it seems probable that conditions of solar evaporation in dry climates should favour the deposition of anhydrite (see Method 4).

11925 Bowles, Oliver and Farnsworth, M. : Physical Chemistry of the Calcium Sulphates, and Gypsum Reserves. *Economic Geology*, Vol. XX., pp. 738-745.

2. Concentration of Moving Waters.

The solubility of gypsum in pure water at 18°C (64°F) is one part in 386, but the presence of calcium carbonate and sodium chloride affect this solubility in a marked way. Solubility is highest in a solution of 14.4 per cent. NaCl—in the absence of CaCO₃. If calcium carbonate is present, the highest solubility is obtained with a solution of eight per cent. salt content.

Winterbottom² says of gypsum deposits in South Australia—

“It is probable, therefore, that some of our gypsum deposits, especially in the North, where the Mesozoic clays are found, have been derived from these clays by solution of the gypsum in percolating waters, which in the dry season would be drawn to the surface by capillary action, evaporated, and the gypsum deposited as crystals. These, together with some calcium carbonate and salt were subsequently dissolved by the rains and carried by the floodwaters on the surface or along underground channels to the lake basins, where the water evaporated, and on reaching the saturation point some of the gypsum and the calcium carbonate were deposited.”

Evaporation of inland salt lakes or of barred basins gives the same order of precipitation, namely :—

Limestone and/or dolomite

Gypsum

Halite (common salt)

Mother liquor salts (mainly potassium salts).

This order always prevails but the deposition may be interrupted from time to time by another influx of water. This water may cause re-solution of some of the deposited salts.

3. Alteration of Lime bearing Rocks.

Sulphuric acid solution, derived from the oxidation of pyrite and other sulphides will react with the CaO in rocks through which it is moving. The lime may be present as limestone, in shells, etc., in clay beds, or may come from the decomposition of lime-bearing minerals in the country rock. The H₂SO₄ may also be the result of volcanic activity. Gypsum has been known to occur at fumaroles and has been deposited from waters of hot springs.

4. Alteration of Anhydrite.

Hydration of anhydrite is a common process in nature. Beds, up to 100 feet thick, of gypsum are known to overlie anhydrite in various parts of the world. Circulation of ground water is is believed responsible for this alteration.

OCCURRENCE IN W.A.

All of the deposits examined lie in the physiographic divisions of Salinaland and Swanland (alternatively called the Salt Lake Division and South-West Division respectively—see Jutson, 1950³). Most of the deposits lie in Salinaland.

²1917 Winterbottom, D. C. : Gypsum and Plaster of Paris. *South Australia Dept. of Chemistry, Bull.* 7, p. 16.

³1950 Jutson, J. T. : The Physiography of Western Australia. *G.S.W.A. Bull.* 95 (Third Edition).

Main characteristics of this division are:—

1. 8-15 inch annual rainfall.
2. 1,000-2,000 feet above sea level.
3. Prevailing westerly winds in winter (June-August).
4. Drainage is mostly inland to salt lakes.
5. Arid cycle of erosion.

Swanland Deposits.

A few deposits at salt lakes occur in this division but they are small and/or low grade. Some gypseous clays occur in the swampy parts of the coastal plain north of Harvey, but these are of no consequence.

Deposits at Dooka and Cliff Head (seven miles and 20 miles south of Dongara, respectively) are solid bodies of crystalline gypsum. Bedding planes of variable strike and dip indicate probable re-crystallisation from old dunes. The dunes were originally built up from barred basin deposits. These are the only known deposits of this kind in W.A.

Salinaland Deposits.

The gypsum occurs associated with, and is a direct product of evaporation from, the salt lakes. Most of these lakes show evidence of some gypsum but comparatively few have economic deposits. The economic deposits all lie within the 10-15 inch rainfall belt.

Calcium carbonate is deposited by some of the lakes while others deposit more salt than gypsum. Lake Lefroy is a good example of the latter. At the southern end of the lake is an extensive deposit of salt which overlies a gypseous clay.

The gypsum of the salt lake deposits is in the form of seed, granular gypsum, kopi or crystals.

Seed gypsum occurs in dunes or on lake flats. The dunes extend around the south-east and eastern edges of the lakes while the deposits on the flats are also towards the east of the lakes. Some of the dunes are over 20 feet in height and up to five chains in width but most of them are only a few feet high and about one chain in width. Seed on the lake flats forms in banks of about one foot in height or may underlie most of the lake bed to a depth of about six inches.

Kopi often occurs on a second dune, parallelling the seed dune and lying on the other side of it away from the lake. This dune usually grades, at two feet, into a granular gypsum. This is more equidimensional in grain than seed gypsum and is believed to be a recrystallisation of the kopi. It contains a lot of kopi mixed with it and there is usually a fair amount of clay present. A dirty compacted form of kopi often occurs on lake flats. This may or may not cover seed gypsum.

Gypsum crystals occur on the surface of the lake and also down to the lowest limit of the water table. The crystals on the surface may be sparse or densely packed. Those below the surface grow *in situ* and usually include grains of quartz and clay. They often grow to four inches in diameter—pseudo-rhombic in appearance at times—the larger crystals being towards the bottom of the deposit.

Origin.

These lakes are centres for deposition and concentration of gypsum from the intermittent streams which feed them. Water in the lakes is rarely more than a few inches in depth and the lake floors are perfectly flat.

Evaporation of the water in the lake results in the deposition of gypsum crystals on the lake bed, together with salt. Further gypsum is deposited on the dry bed as a result of capillary action and efflorescence—from the water table just below the lake bed. The crystals deposited on the surface are usually small, due to rapid evaporation. The crystals below the surface have a continual growth and are, consequently, much larger.

Westerly and north-westerly winds are responsible for the distribution of the deposit, from this point. The crystals weather and are broken and rounded by wind action and piled up on the east and south-east shores of the lake. Dunes are formed in this manner as are the seed flats (about one foot thick). The finer particles are blown further and result in a kopi dune behind the seed dune. Although these westerlies only prevail for three months of the year (*see* Fig. 1) they have much more effect than the easterlies. Practically no gypsum is found on the west sides of the lakes.

Flats of kopi and seed are formed by the wind action and are packed down by periodic flooding. Samphire scrub also helps to fix them in position. The dunes are also fixed by such trees as native pines, "bull-oak," and salmon gums.

All of the gypsum deposits have a certain percentage of lime carbonate and salt. These impurities have the same source as the gypsum. The lime is sometimes dissolved and redeposited in the dunes as a thin band or crust.

Gypsum deposits are slow-forming and, unlike salt deposits which can be harvested seasonally, they require possibly hundreds of years for replenishment.

USES.

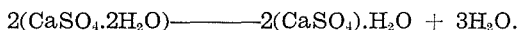
Most of the gypsum quarried in W.A. is used for the manufacture of plaster of paris. The following table shows the percentage used for that purpose, and the amount of plaster produced for the years 1949-1952. (There is some carry-over of raw material each year.)

Year.	Total. Tons.	Tons used for Plaster.	Percentage of Total Tonnage.	Plaster Produced Tons.
1949	25,907	25,705	99.2	18,635
1950	30,835	30,147	97.8	22,424
1951	77,923	75,883	97.4	44,090
1952	50,332	49,482	98.3	32,136
Totals	184,997	181,217	98.1	117,285
Average	46,249	45,304	98.1	29,231

Gypsum is also used as a retarder in the manufacture of Portland cement, and in agriculture. Minor uses include as a filler in paints, paper, textiles, chalk, etc. Kopi is also used as a road surfacing material.

Plaster.

The making of plaster involves the removal of three-quarters of the water content of gypsum, by moderate temperature calcination (less than 250° C.) in a rotary kiln.



The calcined product is crushed to give an even grain size. When the plaster is mixed with water, re-hydration to gypsum takes place—forming a crystalline network. The material sets hard when dry.

The plaster is used in the production of wall plasters, plaster-board, ornamental mouldings, tiles, stucco, etc. There is also a keen demand for good grade medical and dental plasters.

The plaster should be as nearly white as possible so the raw gypsum must be free from impurities such as iron, organic material, etc. An even grain size is also desirable for optimum calcination. Seed gypsum is, therefore, a good source as no crushing is needed—only washing and grading.

Cement Manufacture.

Gypsum has an important use as a retarder in Portland cement. Although only a comparatively small amount is used in W.A., 17 per cent. of Australia's total production for 1948 was used for this purpose.

Raw gypsum is added to the clinker, after the burning of the original lime-clay mixture. The amount of gypsum used is 2 to 4 per cent. of the mixture. The cement is then crushed and bagged.

Agriculture.

Gypsum is used more as a mechanical soil conditioner than as a fertilizer. Another name is "land plaster." It must be liberally applied for best effect—usually used to loosen heavy soils (see Burvill, 1941¹). It is also used to neutralise the injurious action produced by magnesia and alkali carbonates in soils.

Fillers, etc.

Raw gypsum is used as a body for several grades of paint. It is also used in some calcimines and water paints. The gypsum must be finely ground for all fillers and for crayons. Crayons are made by mixing with colouring and binding ingredients, then pressing to shape.

Road Making.

Kopi has been used for surfacing boggy patches of clay roads in parts of the Eastern Goldfields. It is excellent for the purpose as it packs down tightly when wet, and is not slippery.

1941 Burvill, G. H.: Gypsum. Its Place in Agriculture. *Journal of Agriculture of Western Australia*, Vol. XVIII. (Second Series), No. 4, December, 1941, pp. 249-252. (Also Leaflet No. 676.)

Fig. 1

SEASONAL AND DIURNAL WIND ROSES

FOR
SELECTED WEST AUSTRALIAN STATIONS

The lengths of the bars are proportional to the relative frequencies of the various directions of the wind being towards the centre of the rose.

In order to differentiate diurnal variation, the full black bars give the morning winds, and the open bars the afternoon winds. The numbers on each bar indicate the percentage of winds from the particular direction which exceed 20 m.p.h. The figures in the centre circle represent the percentage of calms, morning on top, afternoon below.

At most stations on or near the coast, the sea breeze in summer and the land breeze in winter are prominent during settled weather.

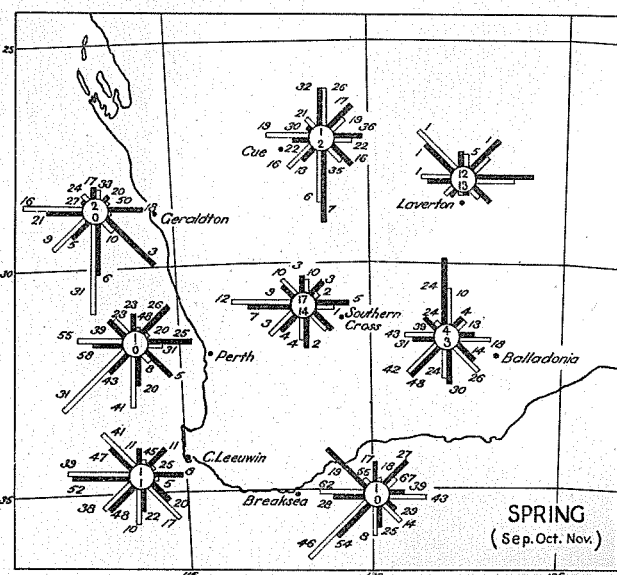
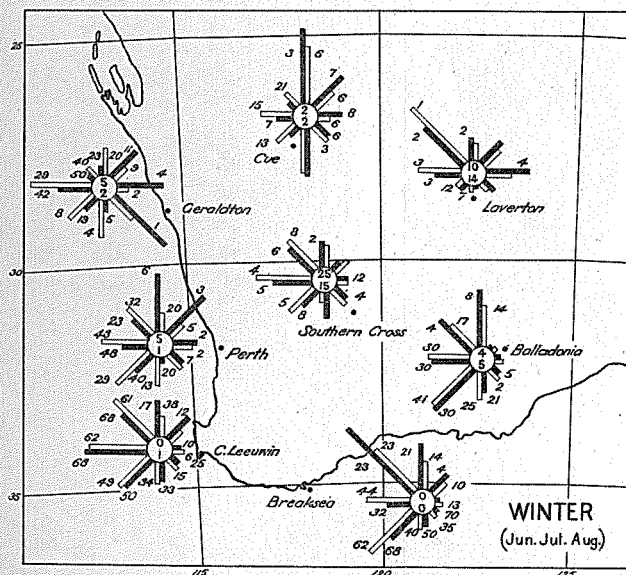
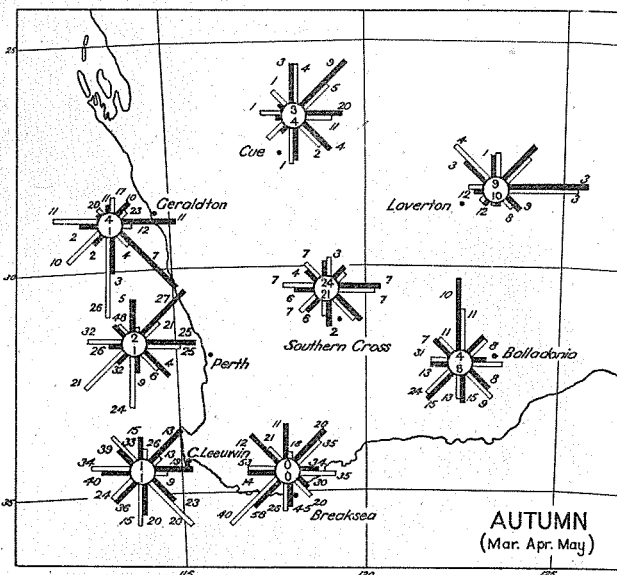
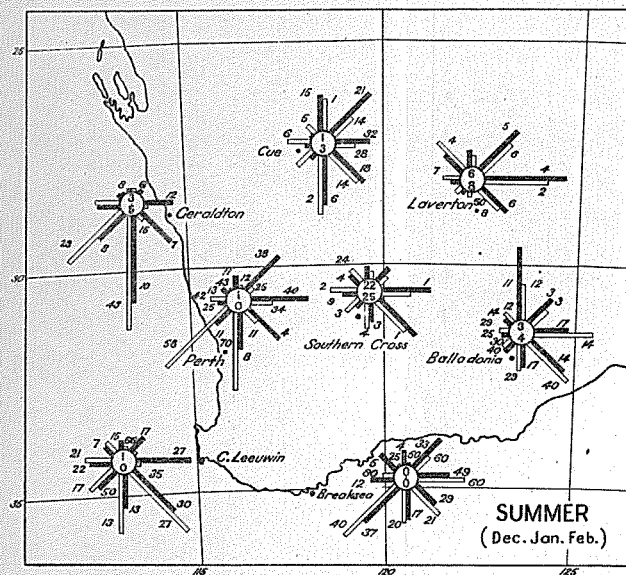
SCALE OF MAPS

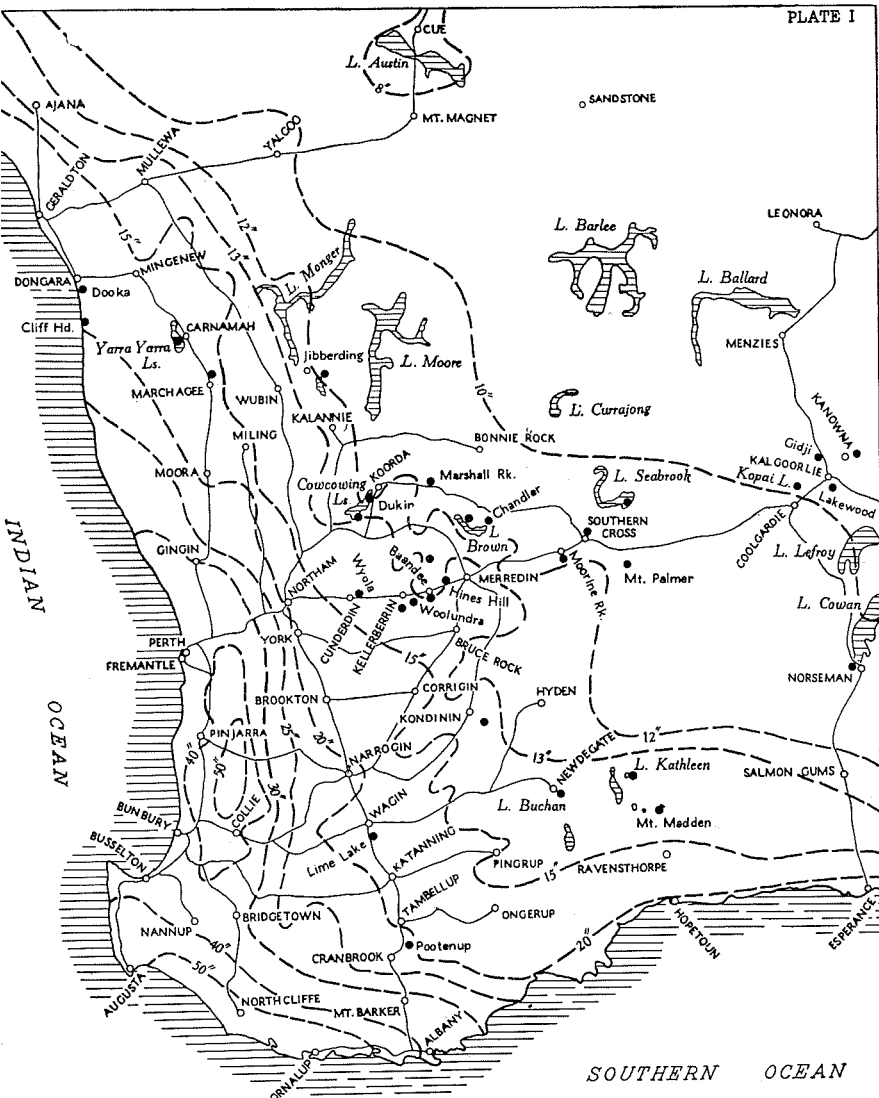
Miles to an Inch

150 100 50 0 150 300

SCALE OF PERCENTAGES

0 20 40 60 80 100





PORTION OF
WESTERN AUSTRALIA
— SHOWING —

Localities sampled.....● Isohyets — 20" —

Scale of miles

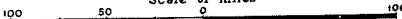
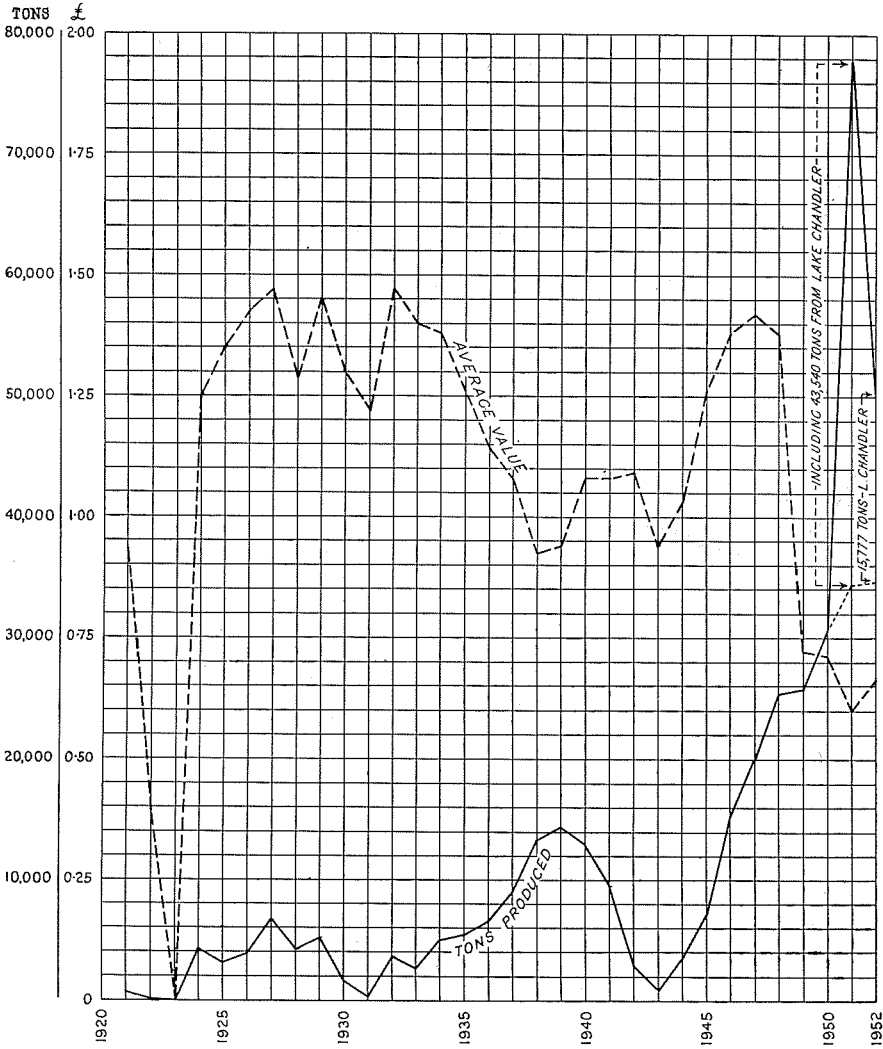


Fig. 2

PRODUCTION GRAPH

— SHOWING —

Annual Tonnage and Average Value Per Ton (See Text) of Gypsum
Produced in Western Australia, over the Period 1921-1952



PRODUCTION.

The first recorded gypsum production in W.A. was in 1921, when 644 tons were taken from Koorda. A further 63 tons were won in 1922 and production then ceased till 1924. More than 4,000 tons were produced in that year which saw the establishment of the industry in W.A.

Low production for the years 1930-31 reflects the economic depression at that time, while the influence of the 1939-45 war can be seen quite clearly. Building was at a standstill during the war and there was little call for plaster and plaster products. The greatly increased production since the war is due, naturally, to the extensive building programmes throughout the country.

Figures for 1951-52 were greatly enhanced by the operations of Australian Plaster Industry Pty., Ltd., at Chandler. This firm made plaster and exported directly to the Eastern States, for the period January, 1951, to April, 1952. A total of 29,099 tons of plaster were made from 59,317 tons of raw gypsum during that period.

TABLE I.—GYPSUM PRODUCTION—WESTERN AUSTRALIA.

Year.	Lake Seabrook.	Lake Chandler.	Lake Brown.	Koorda.	Hines Hill.	Baandee.	Wool- undra.	Miscel- laneous.	Total.	Average Cost per Ton.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	£
1921 .....	.....	.....	.....	644	.....	.....	.....	.....	664	622
1922 .....	.....	.....	.....	63	.....	.....	.....	.....	63	16
1923 .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1924 .....	.....	.....	.....	1,234	641	357	1,518	487*	4,237	5,278
1925 .....	.....	.....	.....	444	1,035	542	1,039	.....	3,060	4,118
1926	139	.....	.....	1,261	301	1,167	1,050	.....	3,918	5,618
1927	698	.....	.....	1,784	.....	1,570	2,622	.....	6,674	9,818
1928	1,214	.....	.....	278	722	552	1,449	.....	4,215	5,425
1929	761	.....	.....	831	.....	1,073	2,624	.....	5,289	7,676
1930	714	.....	.....	.....	.....	657	307	.....	1,678	2,174
1931	157	.....	.....	.....	.....	125	.....	.....	282	344
1932	366	.....	.....	.....	.....	2,945	1,336	.....	3,647	5,354
1933	713	.....	.....	.....	.....	503	1,503	.....	2,719	3,797
1934	1,404	.....	.....	.....	.....	2,167	1,488	.....	5,059	6,962
1935	487	.....	441	.....	.....	1,877	1,950	706†	5,461	6,888
1936	455	.....	.....	.....	.....	3,720	1,781	695‡	6,651	7,570
1937	479	.....	.....	.....	.....	6,076	2,518	.....	9,073	9,809
1938	2,296	.....	1,947	.....	.....	5,010	4,176	.....	13,429	12,408
1939 .....	.....	.....	2,624	.....	.....	5,216	6,500	.....	14,340	13,491
1940	1,350	.....	2,332	.....	.....	5,580	3,749	.....	13,020	14,081
1941	132	.....	1,636	.....	.....	5,233	2,446	66‡	9,513	10,246
1942 .....	.....	.....	.....	.....	.....	789	2,089	.....	2,878	3,136
1943 .....	.....	.....	.....	.....	.....	775	160	.....	935	880
1944 .....	.....	.....	1,145	.....	.....	1,248	1,211	.....	3,604	3,723
1945 .....	.....	.....	2,070	.....	.....	3,506	1,656	.....	7,232	9,136
1946	4,012	.....	2,650	.....	.....	4,500	3,976	212‡	15,350	21,153
1947	8,953	.....	4,262	.....	.....	4,416	2,002	650§	20,283	28,774
1948	15,870	.....	3,403	.....	.....	5,701	547	.....	25,521	35,173
1949	15,962	.....	3,309	.....	1,356	4,653	618	10†	25,908	18,610
1950	20,446	.....	4,765	.....	732	4,223	669	.....	30,855	21,942
1951	20,276	43,540	8,250	.....	181	4,999	671	7‡	77,924	46,726
1952	18,277	15,777	7,795	.....	1,244	5,759	1,459	21‡	50,332	33,257
Total	74,961	59,317	46,629	6,559	6,212	83,939	53,114	2,854	373,794	354,205
										0.948

* Dukin. † Dundas. ‡ Cliff Head. § Dundas, 376 tons; Weibungin, 267 tons; Kellerberrin, 7 tons.

Value.

The values quoted in the production table, and shown on the graph, can be quite misleading unless the following facts are borne in mind:—

1. Sums quoted are costs of winning the gypsum as stated by producer-consumers.
2. Figures for the periods 1921-36 and 1940-48 indicate costs of delivery to works.
3. Figures for the period 1937-39 contain some prices quoted as F.O.R. and some "at works."
4. Figures for 1949-52 are quoted as F.O.R. except where road transport is used. Price is then "at works."

It seems the value of raw gypsum depends entirely on cost of production and the demand. Swan Portland Cement, Ltd., are users of gypsum and they purchase by contract.

Consumers in W.A.

These are:—

Perth Modelling Works Pty., Ltd.
Ajax Plaster Co., Ltd.
Atlas Plaster Co., W.A.-H. B. Brady Co. Pty., Ltd.
Mt. Hawthorn Modelling Works Pty., Ltd.
Swan Portland Cement, Ltd.

The authors consider that these firms may be approachable for contracts to supply gypsum at a rate of say £1 10s. to £2 per ton, delivered at works.

RESERVES.

The reserves shown in Table II. were estimated under the following conditions:—

1. The grade of a deposit has been taken from one sample in some cases. In all cases, sampling has been insufficiently detailed to establish the overall grade of any deposit.
2. Sometimes the quantity quoted is a minimum—*e.g.*, the deposit of crystalline gypsum in Lake Seabrook is believed to contain far more than 3,000,000 tons.
3. No allowance has been made for the percentage of gypsum which is not easily recoverable from a deposit—*e.g.*, the layer of seed which must be left at the base of a seed deposit which overlies clay.
4. Ease of access, distance from railhead or port have not been taken into account.
5. The Lake Austin deposit is a notable omission from the table of reserves (*see* Chapter III., p. 103).

TABLE II.
KNOWN GYPSUM RESERVES OF WESTERN AUSTRALIA.

Locality.	Variety.*	Percentage pure $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.						Total.
		50-59.9.	60-69.9.	70-79.9.	80-89.9.	90-94.9.	95-100.	
		tons.	tons.	tons.	tons.	tons.	tons.	tons.
<i>Area No. 1.</i>								
Pootenup	S	....	....	....	....	6,000	....	6,000
	K	....	....	....	3,150	....	....	3,150
Lime Lake	X	....	10,000	....	....	....	....	10,000
Lake Buchan....	S	....	210,000	310,000	129,000	....	....	649,000
South-west of Stennetts Lake	K	....	....	....	....	19,000	....	19,000
Lake Kathleen	S	....	....	390,000	660,000	....	....	1,050,000
	G	90,000	....	....	....	....	....	90,000
Kondinin	S	....	....	35,000	....	....	....	35,000
	G	....	....	....	127,000	....	....	127,000
<i>Area No. 2.</i>								
Coorow	K	....	26,000	....	....	....	....	26,000
Yarra Yarra Lakes	S	....	....	....	10,000,000	....	....	10,000,000
	X	....	....	1,500,000	....	....	....	1,500,000
Dooka	X	....	....	....	....	40,000	....	40,000
	K	....	....	....	....	20,000	....	20,000
Cliff Head	X	....	....	....	....	5,000	....	5,000
	K	....	....	10,000	16,000	....	....	26,000
Wubin Downs	S	....	....	....	500,000	....	....	500,000
	X	....	....	200,000	....	....	....	200,000
<i>Area No. 3.</i>								
Cowcowing Lake	S	....	....	....	1,000,000	1,200,000	1,550,000	3,750,000
Nalkain	S	....	....	30,000	....	....	....	30,000
	X	....	70,000	....	....	....	....	70,000
Dukin	S	....	....	300,000	....	....	....	300,000
North-west of Koorda	S	....	....	....	6,000	....	....	6,000
Marshall Rock	S	....	78,000	....	12,000	....	....	90,000
Lake Brown	S	....	....	....	....	1,100,000	....	1,100,000
Chandler	S	....	....	70,000	100,000	....	120,000	290,000
	G	....	....	....	60,000	....	....	60,000
Hines Hill	S	16,000	....	20,000	34,500	....	19,300	89,800
	X	....	....	....	700	....	....	700
Baandee	G	....	....	....	....	3,000	....	3,000
	S	....	....	....	500,000	....	....	500,000
15 miles north of Baandee...	S	....	....	2,500	....	20,000	....	22,500
Woolundra	S	....	12,000	9,000	....	....	....	21,000
	K	....	....	....	12,000	....	....	12,000
	G	....	3,000	3,000	....	....	....	6,000
Kellerberrin	S	....	....	....	6,400	....	....	6,400
	X	....	....	....	....	1,000	....	1,000
Wyola	K	....	....	....	10,000	....	....	10,000
Cunderdin, 4 miles east	X	....	....	....	7,000	....	....	7,000
Cunderdin, 6 miles east-north-east	S	....	....	....	....	1,400	....	1,400
	K	....	....	....	....	1,500	....	1,500
Cunderdin, 4 miles east-north-east	S	....	....	....	24,000	....	....	24,000
<i>Area No. 4.</i>								
Southern Cross	S	....	....	9,000	....	....	....	9,000
	X	....	....	....	10,000	....	....	10,000
Lake Seabrook	X	....	....	....	....	....	1,020,000	1,020,000
	X	....	....	....	3,100,000	....	....	3,100,000
Mt. Palmer	K	....	....	....	....	310,000	....	310,000
	S	100,000	....	....	....	....	....	100,000
Moorine Rock	X	....	....	298,000	....	....	....	298,000
	G	....	....	....	7,500	....	....	7,500

TABLE II—continued.

Locality.	Variety.*	Percentage pure $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.						Total.
		50-59.9.	60-69.9.	70-79.9.	80-89.9.	90-94.9.	95-100.	
Area No. 5.		tons.	tons.	tons.	tons.	tons.	tons.	tons.
Kanowna	K	....	....	....	....	28,000	....	28,000
Gidji Siding	K	....	....	....	10,000	....	....	10,000
Lakewood	X	....	2,000	....	....	....	....	2,000
Kopai Lake	G	....	....	....	50,000	....	....	50,000
Lake Cowan	K	....	....	....	50,000	....	....	50,000
	S	....	....	....	....	1,000,000	2,000,000	3,000,000
	G	....	....	....	....	900,000	....	900,000
Totals	S	16,000	300,000	1,175,500	12,971,900	3,637,400	4,709,300	22,810,100
	X	Nil	82,000	1,998,000	3,117,700	46,000	Nil	5,243,700
	G	90,000	Nil	Nil	256,500	903,000	Nil	1,249,500
	K	100,000	29,000	13,000	89,150	68,500	Nil	299,650
Grand Total	....	206,000	411,000	3,186,500	16,435,250	4,654,900	4,709,300	29,602,950

* S = Seed gypsum, X = Crystalline gypsum, G = Granular gypsum, K = Kapi.

Seed gypsum is the only variety which was being worked during 1952. There is an estimated tonnage of 8,346,000 tons of seed, which has a grade of 90 to 100 per cent. pure gypsum, in the deposits sampled—while there are some 13,000,000 tons of 80 to 90 per cent. purity.

The largest deposits of seed gypsum over 90 per cent. pure are at Cowcowing Lake (2,750,000 tons), Lake Brown (1,100,000 tons), Lake Seabrook (1,020,000 tons) and Lake Cowan (3,000,000 tons).

Cowcowing Lake also contains a minimum of 1,000,000 tons of seed gypsum at 80 to 90 per cent. purity and Yarra Yarra Lakes contain some 10,000,000 tons of similar grade.

Yarra Yarra Lakes contain a deposit of some 1,500,000 tons of crystals (70 to 80 per cent.) and Lake Seabrook has a minimum of 3,000,000 tons of crystals of 80 to 90 per cent. purity.

Lake Kathleen is the only other deposit of more than 1,000,000 tons—the overall grade being about 80 per cent.

The seed deposits on Cowcowing Lake have never been worked and, since they occur close to a railway siding (Nalkain) and only 150 miles from Perth, they must be considered a good potential source of gypsum for plaster manufacture.

METHODS OF WORKING DEPOSITS.

All gypsum deposits are on the surface, so scraping and quarrying methods are used to win the material. Seed deposits are the only ones worked for plaster. The deposits differ in character and, consequently, require different methods of working. Those used in W.A. include shovelling into skips, end-loader, elevator and loading by chute.

Skips.

The seed on Perth Modelling Works Pty., Ltd., deposit south-west of Baandee forms the bed of a lake and averages about six inches in thickness—varying from 0 to 12—inches. A light railway is run from the shore to the place of working and skips are filled by hand shovelling. (This deposit can only be worked in dry weather). The gypsum is then tipped on to a dump from which it is loaded into motor trucks by elevator. Some of the gypsum is beneficiated on the spot but a railway strike at the time of inspection necessitated a speeding up of production since the more distant deposits were not producing. The gypsum from Baandee was taken straight to Perth by motor truck.

End-Loader.

The deposits worked by H. B. Brady Co. Pty., Ltd. on Lake Brown are seed banks about 18 inches thick—extending over many acres. An end-loader is used to work this seed into a dump, then to load it on to a motor truck which carts it to a dump at Elabbin Siding.

Elevator.

Ajax Plaster Co., Ltd., works its deposit at Lake Seabrook by shovelling to an elevator which raises the seed directly into a motor truck. The seed here averages about four feet in thickness. Fracture is used to loosen it for shovelling.

Chute.

Dune deposits at Lake Seabrook lend themselves to a very economical method of mining. A chute is located in the side of a dune and gypsum above is blasted, then rilled straight on to motor trucks via the chute.

BENEFICIATION.

For optimum conditions of calcination, the seed fed into the kilns should be of even grain size. Beneficiation of the raw gypsum in W.A. consists of washing to remove the fines of small seed, clay and kopi. The washing is usually done with launders at the works since the plaster manufacturers find that the losses in freight charges are usually more than offset by the lower treatment costs. Also, the washing at Perth is done with fresh water which removes much of the ever present salt. Only salt water is available in quantity at the deposits, so further leaching would still be necessary.

The deposits worked seem reasonably free from silica sand, which could not be removed by washing. Special flotation or electrostatic separation methods are necessary for the separation of silica (see Jackson, 1952).⁵

⁵1952 Jackson, Norton : Beneficiation of Gypsum. *Chemical Engineering and Mining Review* December 10, 1952. (Tait Publishing Co. Pty., Ltd., Melbourne.)

Bulk samples (approximately one cwt. each) from the following localities were submitted to the Government Chemical Laboratories on 7th April, 1954, for beneficiation :—

Deposit.		Sample No.	
Lake Buchan	....	G	14
Lake Kathleen	....	G	105
Mt. Palmer	....	G	174
Lake Seabrook	....	G	168
Cowcowing Lake	....	G	58

(The deposit at Yarra Yarra Lakes was to have been tested but was covered with 12 inches of water at the time the bulk sampling was done.)

If the results of the beneficiation tests are to hand before this bulletin is printed, they will be included as an appendix.

CHAPTER II.

DEPOSITS SAMPLED BY G.S.W.A.

	Page
<i>Area No. 1—</i>	
Pootenup	30
Lime Lake	31
Lake Buchan	32
South-West of Stennetts Lake	34
Lake Kathleen	35
Kondinin	36
<i>Area No. 2.</i>	
Coorow	41
Yarra Yarra Lakes	41
Dooka	44
Cliff Head	46
Wubin Downs	48
<i>Area No. 3.</i>	
Cowcowing Lake	56
Nalkain	58
Dukin	59
North-West of Koorda	61
Marshall Rock	62
Lake Brown	65
Chandler	66
Hines Hill	69
Baandee	71
15 miles north of Baandee	74
Woolundra	75
Kellerberrin	77
Wyola	77
Cunderdin, 4 miles east	78
Cunderdin, 6 miles east-north-east	79
Cunderdin, 4 miles east-north east	79
<i>Area No. 4.</i>	
Southern Cross	83
Lake Seabrook	84
Mt. Palmer	87
Moorine Rock	90
<i>Area No. 5.</i>	
Kanowna	93
Gidji Siding	94
Lakewood	95
Kopai Lake	96
Lake Cowan	97

TABLE III.—SAMPLE ANALYSES—AREA No. 1.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*				
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ ·2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.
				CaO.	MgO.								
1952.		<i>Lands Dept. Litho.</i> 436 D/40.		%	%	%	%	%	%	%	%		%
7744	G1	3½ miles east of Poot-enup. 86 chains west of north-west corner peg of Koj-onup Location 1459 do. do.	Kopi in dune on east side of small salt lake 0' to 2'	31.04	....	39.66	2.65	0.95	84.95	6.00	0.95	SO ₃ 0.1	8.00
7745	G2	do. do.	Seed gypsum in dune on east side of salt lake 2' to 4'	31.80	....	43.25	0.48	1.50	93.10	1.10	1.50	CaO 1.6	2.70
7746	G3	<i>Lands Dept. Litho.</i> 409/80. Lime Lake. North-west corner of Williams Location 10 do. do.	Clayey lime from bed of lake 0' to 1'	26.79	5.45	2.85	20.12	6.50	3.55	45.75	6.50	SO ₃ 1.2, MgO 5.45	37.55
7747	G4	do. do.	Clay with gypsum crystals and lumps of gypsum (up to 1" diameter) 3' to 6'	28.39	0.90	31.76	4.66	3.20	68.30	10.60	3.20	CaO 0.25, MgO 0.9	16.75
7748	G5	<i>Lands Dept. Litho.</i> 10/240. Lake Buchan. Roe Locations 53, 65, 62 (see Plan) do. do.	0' to 1' 6". In flat	8.40	3.10	7.40	2.79	4.00	14.90	6.35	4.00	SO ₃ 0.45, MgO 3.1	71.20
7749	G6	do. do.	1' 6" to 4'. In flat	18.00	2.40	23.25	0.58	3.60	50.00	1.30	3.60	CaO 1.0, MgO 2.4	41.70
7750	G7	do. do.	0' to 2' 6". Top of dune	8.28	4.90	1.63	6.37	1.50	3.50	12.25	1.50	MgCO ₃ 1.9 MgO 4.0	76.85

TABLE III—continued.

Lab. No.	Field No.	Locality	Occurrence.	Analysis.					Calculated Composition.*				
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ . 2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.
				CaO.	MgO.								
1952. 7751	G8	Lake Buchan, Roe Locations 53, 65, 62 (see Plan)—continued	0' to 1'	17.21	2.65	21.68	1.21	2.85	46.65	2.75	2.85	CaO 0.5, MgO 2.65	44.60
7752	G9	do. do.	1' to 2'	27.01	1.05	33.49	2.78	1.90	72.00	6.30	1.90	MgO 1.05	18.75
7753	G10	do. do.	0' to 3' 6"	26.49	1.10	35.00	1.44	2.10	75.25	3.25	2.10	CaO 0.15, MgO 1.1	18.15
7754	G11	do. do.	0' to 1'	24.88	1.00	34.41	0.86	2.00	73.00	1.95	2.00	SO ₃ 0.4, MgO 1.0	21.65
7755	G12	do. do.	0' to 1' 6"	25.02	1.50	34.91	0.44	1.35	75.10	1.00	1.35	MgO 1.5	21.05
7756	G13	do. do.	1' 6" to 3' 6"	28.47	0.75	37.64	0.80	1.80	81.00	1.80	1.80	CaO 1.15, MgO 0.75	13.50
7757	G14	do. do.	0' to 2'	21.15	1.20	27.98	1.12	2.60	60.20	2.55	2.60	CaO 0.15, MgO 1.2	33.30
7758	G15	do. do.	0' to 3' 6"	28.97	trace	38.96	0.49	0.55	83.80	1.10	0.55	CaO 1.1	13.45
7759	G16	do. do.	0' to 4'	28.80	0.40	39.69	0.50	0.95	85.40	1.15	0.95	CaO 0.45, MgO 0.4	11.65
7760	G17	do. do.	0' to 4'	28.44	0.45	37.30	0.76	0.30	80.25	1.75	0.30	CaO 1.4	16.30
7761	G18	South-west of Stennett's Lake, 60 chains west of north-east corner peg of Roe Location 1644	0' to 4'. Crest of dune	32.88	trace	44.98	0.75	0.35	96.80	1.70	0.35	CaO 0.5	0.65
7762	G19	6 chains south-south-east of G18	0' to 4'. Crest of dune	31.27	trace	41.97	0.96	0.25	90.25	2.20	0.25	CaO 0.75	6.55
		Lands Dept. Litho. 389/80.											
11953	G99	Lake Kathleen (see Plan)	0' to 1' 6". From lake flat	24.58	....	34.46	0.17	3.15	74.10	0.40	3.15	CaO 0.3	22.05
11954	G100	do. do.	0' to 2' 6". From lake flat	24.02	trace	33.62	0.29	2.45	72.30	0.65	2.45	CaO 0.15	24.45

11955	G101	do.	do.	0' to 3'. From crest of dune	22.68	trace	28.61	1.39	0.55	62.20	3.15	0.55	CaO 0.7	....	33.40
11956	G102	do.	do.	0' to 10'. From crest of dune	26.80	....	36.04	0.75	0.30	77.60	1.70	0.30	CaO 0.65	....	19.75
11957	G103	do.	do.	0' to 3'. From lake flat	29.44	....	41.22	0.24	1.70	88.70	0.55	1.70	CaO 0.35	....	8.70
11958	G104	do.	do.	0' to 2' 6". From lake flat	26.65	trace	36.52	0.67	2.35	78.50	1.50	2.35	CaO 0.3	....	17.35
11959	G105	do.	do.	0' to 5'. From crest of dune	18.31	trace	22.57	1.62	0.95	48.50	3.70	0.95	CaO 0.45	....	46.40
11960	G106	do.	do.	0' to 6'. From flank of dune	19.70	trace	21.83	3.22	0.65	47.00	7.35	0.65	CaO 0.35	....	44.65
11961	G107	do.	do.	0' to 7'. From flank of dune	20.40	trace	25.35	1.83	0.95	54.50	4.15	0.95	CaO 0.35	....	40.05
11962	G108	do.	do.	0' to 2' 8". From lake flat	27.05	trace	38.00	0.28	2.35	81.70	0.65	2.35	CaO 0.15	....	15.15
11963	G109	do.	do.	0' to 5' 6". From seed dune	32.12	trace	45.21	0.11	0.70	97.25	0.25	0.70	CaO 0.4	....	1.40
11964	G110	do.	do.	0' to 2' 8". From lake flat	30.00	trace	41.71	0.04	1.30	89.70	0.10	1.30	CaO 0.8	....	8.10
				<i>Lands Dept. Litho. 376/80.</i>											
11965	G111	10 miles south-east of Kondinin (see Plan)		0' to 8'. From crest of dune	27.61	trace	38.68	0.05	0.55	83.20	0.10	0.55	CaO 0.5	....	15.65
11966	G112			0' to 3' 6". From seed dune	24.56	....	35.09	0.02	0.20	75.30	0.05	0.20	....	....	24.45
11967	G113	do.	do.	0' to 7'. From crest of dune	30.49	....	40.74	1.32	0.30	87.65	3.00	0.30	CaO 0.35	....	8.70
11968	G114	do.	do.	0' to 8'. From crest of dune	27.46	....	37.23	0.89	0.65	80.10	2.00	0.65	CaO 0.3	....	16.95
11969	G115	do.	do.	0' to 4'. From seed dune	21.62	....	32.25	0.05	0.20	66.20	0.10	0.20	SO ₃ 1.4	....	32.10

* Calculated in accordance with suggestions made in "Standard Methods of Testing Gypsum and Gypsum Products" (C26-50), A.S.T.M. Standards, 1950 Supplement, Part 3.

AREA No. 1.

POOTENUP.

General Information.

The deposit is about $3\frac{1}{2}$ miles east-north-east from Pootenup Siding. The siding is 67 miles from Albany on the Great Southern Railway. Access to the deposit is from a road which heads north-east from the siding. At $3\frac{1}{2}$ miles, a track runs south to the deposit which is at the junction of Plantagenet locations 1244 and 1459, on the north boundary of location 1459.

Water in the clay pans was a few inches deep in March.

Occurrence.

The deposit is very small, in the form of a dune 20 chains long of average width $2\frac{1}{2}$ chains and maximum height six feet above lake level. The dune is on the east shore of the more westerly of two small salt lakes. A small island of gypsum also occurs in the other lake. A second dune to the east of the gypsum is composed mostly of sand but contains a little kopi.

A sample hole in the crest of the gypsum dune, on the northern boundary of location 1459, exposed two feet of kopi overlying a further two feet of seed gypsum. A reddish clay was encountered below four feet depth. These figures are considered a fair average of results obtained from other holes along the crest. Both kopi and seed contain clay and organic impurities.

Production.

No production has been recorded from this locality.

Sampling.

Two samples (G1, 2) were taken from the crest of the dune and results of analysis of these are shown in Table II. The kopi was 85 per cent. gypsum with six per cent. lime carbonate and eight per cent. clay. The seed gypsum sample showed the good figure of 93 per cent. gypsum with one per cent. lime carbonate and 2.7 per cent. clay.

Reserves.

The volume of kopi present is about 6,300 cubic yards = 3,150 long tons (85 per cent.).

There are some 6,000 tons of good grade seed gypsum = 6,000 long tons (93 per cent.).

LIME LAKE.

General Information.

The deposit is situated about 60 chains north-east of Lime Lake siding which is 201 miles from Perth on the Albany railway line (eight miles south of Wagin). Access can be gained from a track which circles the deposit but is sometimes as much as 40 chains from the lake bed. This track leaves the railway line at a point 40 chains north of the siding. MCs 16H, 129H take in the deposit but have not been surveyed.

Occurrence.

The gypsum is confined to the bed of the lake which was dry in March, 1952. Four holes bored along an east-west line showed the average composition of the deposit to be :—

0' 0" to 1' 0"	Clayey with lime carbonate
1' 0" to 1' 3"	rock gypsum
1' 3" to 4' 0"	clay with some gypsum
4' 0" to 6' 0"	crystals in clay.

Water entered the holes at five feet.

The rock gypsum consists of a mass of interlocking crystals of various sizes up to half inch in length.

Vegetation on the deposit is samphire and dead bull oak trees. The surface is hard enough to hold a vehicle in most places.

Production.

Some small pits have been dug in the lake but no production has been recorded. Lime was once burned from a marly bank along the east shore of the lake.

Sampling.

Reference—G.S.W.A. File 2/05.

Locality—Lime Lake.

Analysis (1905)—

Sample	Location.	CaO.	equal to CaCO ₃	CaSO ₄ .
1248	Lime Lake	34.64	53.19	11.75
1249	Depth 1 foot	37.10	47.34	25.79
1250	Depth 2½ feet	29.00	17.87	46.11
1251	Depth 4 feet	34.92	50.47	16.12
1252	Depth 6 feet	21.56	30.27	11.17
1253	Limestone	44.68	71.30	11.48

Remarks.—These samples are gypseous marls and are of no value except for manurial purposes—by virtue of the gypsum and carbonate of lime present. However as each sample contains one per cent. of common salt besides soluble salts of magnesia it would be necessary to use them only on well drained land.

Reference.—Chem. Lab. File 90/49.

Locality—Lime Lake.

<i>Analysis</i> (1923)—				%
Insol. in acids	....	....	....	1.34
Sodium chloride, NaCl	....	....	....	0.19
Water soluble CaO	....	....	....	32.00
Equal to CaSO ₄ .2H ₂ O	....	....	....	98.24
Acid soluble CaO	....	....	....	0.48
Equal to CaCO ₃	....	....	....	0.86

Remarks.—A massive finely crystalline gypsum coated with carbonate of lime. On calcining the material at 180° it yields a creamy white plaster of Paris which is slow setting to a strong body, and suitable for building purposes.

Samples taken by the authors, in 1952 (G3-4, see Table III.) show that lime carbonate is the main constituent of the top foot of the lake bed but sample G4 showed 68 per cent. gypsum in crystals with 11 per cent. lime and 17 per cent. clay, etc.

Reserves.

The deposit is considered useless as a source of gypsum because :—

1. It is too low grade.
 2. The overburden ratio is too high.
 3. Water level is only five feet deep—even in dry weather.
- There is an estimated 10,000 tons of 65 per cent. gypsum.

LAKE BUCHAN.

General Information.

The deposit is on the east side of Lake Buchan, three miles S. 60°E. from Newdegate. Newdegate is a rail head 306 miles south-east from Perth and 249 miles by road. The deposit lies in Roe locations 53, 65, 62, 96.

Access is gained from a made road (about one mile south of Lake Buchan) by sand track through location 651. This track is clayey near the deposit and would be boggy in wet weather. There was a little water in the lake in March, 1952.

There are no mineral claims on the deposit.

Occurrence.

Lake Buchan is about three miles long by one and a half miles and the deposit occurs on its south-east shore. The clay floor of the lake does not contain any crystals but there are scattered small crystals in thin patches on the surface.

The best gypsum here occurs in the belt of low seed dunes at the lake's edge. Overall length of this belt is 137 chains and its maximum width is five chains. The dunes are very irregular but an average thickness for this belt would be about four feet. Vegetation consists of scraggly native pine and scrub.

The flat immediately south-east of the seed has two inches of compacted kopi over 18 inches of seed. This gives way to clay at water level (20 inches). This flat is covered with low samphire.

A further samphire flat to the south-east shows a thin cover of clayey kopi on 18 inches of clayey seed overlying about four feet of seed gypsum. A two inch thick band of small gastropods ($\frac{1}{2}$ inch long) was encountered at three feet depth.

The samphire flat to the north consists of 18 inches of clayey gypsum (kopi and seed) over two and a half feet of seed. Water at four feet depth.

Sample G7 was taken from the crest of a dune 30 feet above the lake level. Material on the dune is a clay-kopi and is very hard.

Production.

None recorded.

Sampling.

A determination was made by the Government Chemical Laboratories of material submitted from Lake Buchan in 1938. It was—"Gypsum—too dirty for plaster."

In 1952, the authors took 13 samples at this deposit (G5-17, see Table III. and Plan). Logs of sample holes are as follows:—

G 5	0' 0" to 1' 6"	gypsum and clay
G 6	1' 6" to 4' 0"	seed. water, clay.
G 7	0' 0" to 2' 6"	clay, kopi. clay, kopi.
G 8	0' 0" to 1' 0"	seed in clay.
G 9	1' 0" to 2' 0"	seed. clay. 2' 6" water.
G10	0' 0" to 3' 6"	seed. clay-water.
G11	0' 0" to 1' 0"	seed. 1' 0" to 4' 0" clay. 4' 0" water, clay.
G12	0' 0" to 1' 6"	seed (kopi cover). compacted seed.
G13	0' 0" to 1' 6"	kopi on seed. 1' 6" to 3' 6" seed. 3' 6" compacted seed.
G14	0' 0" to 0' 2"	clay. 0' 2" to 2' 0" seed. 2' 0" clay, water.
G15	0' 0" to 3' 6"	seed. clay, water.
G16	0' 0" to 4' 0"	seed. 4' 0" water and seed.
G17	0' 0" to 0' 6"	kopi. 0' 6" to 4' 0" seed. 4' 0" clay.

Average grade of the area shown as seed (south of fence) is better than 80 per cent.

Reserves.

The tonnage of seed gypsum in the line of dunes along the lake shore = 129,000 tons of 82 per cent. pure gypsum.

The kopi flat immediately adjacent to the belt of seed dunes contains 210,000 tons of 60 per cent. pure gypsum (seed and kopi). The kopi cover varies in thickness from a skin to almost a foot. The grade of the seed itself is about 70 per cent. pure gypsum.

The other flat contains an estimated 310,000 tons of seed (with some kopi) of 78 per cent. pure gypsum.

SOUTH-WEST OF STENNETTS LAKE.

General Information.

This deposit is situated 11½ air miles from Mt. Madden (on the Newdegate-Hopetoun road), on a bearing of N. 70° E. It is reached by a track along a surveyed road which leaves the main road about one mile south of Pallarup Rocks.

The deposit is on Location 1644, about two miles south-west of Stennetts Lake. It is 13 chains south of the road which detours round the north end of the dry lake bed.

There is drinking water at Pallarup Rocks.

Occurrence.

Kopi is the variety of gypsum found here—in a dune, up to 30 feet high. The dune is 12 chains long and three chains wide at its base. It runs in the direction N. 30° E. through the middle of an old sand-covered lake bed, which appears to have been dry for many years.

The dune is unusual since it appears to be made up entirely of kopi. (Usually, there is only about two feet of kopi on the top of these dunes.) The kopi is a clean white colour and looks rather pure.

Low scrub and occasional thickets of ti-tree cover the flats. Some fairly large blackbutts and a considerable amount of prickly scrub grow on the dune.

Production.

No gypsum had been removed from this deposit as at March, 1952.

Sampling.

Samples G18, 19 were taken from holes sunk in the crest of the dune, distant 70 yards and 200 yards, respectively, from the northern edge of the dune. The samples were only taken to four feet depth, since the dry floury gypsum would not pull beyond this. There is at least seven feet of kopi and it seems likely that the dune is made up entirely of kopi. A depth of 24 feet in the centre is assumed.

Results of analyses (Table III.) show that this kopi is reasonably pure, average grade being about 93 per cent. gypsum.

Reserves.

The amount of gypsum present in the form of kopi is estimated at 19,000 tons.

LAKE KATHLEEN.

General Information.

Lake Kathleen is 44 miles by road due east of Lake Biddy siding. Lake Biddy is 298 miles from Perth on the Newdegate railway line. Access by road is best gained from the 288-mile peg of the Newdegate-Ravensthorpe road.

Water is present on the lake surface in winter. There are no mineral claims on the deposit.

Occurrence.

The gypsum occurs on the south-east part of the lake and on the adjacent bank. Seed dunes are present on this bank but have a kopi cover up to two feet thick. The seed is rather fine and rests on clay. The thickness of seed varies up to eight feet maximum but would average only about two feet. Small sand dunes also occur amongst these dunes. Vegetation on the dunes consists of salmon gum, blackbutt, yate, and ti-tree.

The seed gypsum in the lake flat is rather dirty. The top cover of compacted kopi and clay is up to one foot thick. This overlies fairly white seed in places but the seed is coloured in others. Thickness of the seed is about one foot in the lake flat but is a little thicker on the two islands near the clay. Vegetation is samphire, with native pine and bull oak on the islands and around the edges of the lake.

Production.

No gypsum has been produced from this deposit.

Sampling.

Samples Nos. G99-110 were taken by the authors in 1952 (see Table III.). Nos. G99, 100, 103, 104, 108-110, are from the seed gypsum on the lake flat and Nos. G101, 102, 105-107 are from the kopi dunes south-east of the lake flat.

Logs of the sample holes are as follows:—

G 99	0' 0" to 1' 6"	seed with clay. grey clay, water.
G100	{ 0' 0" to 0' 6" 0' 6" to 2' 6" 2' 6"	dirty kopi. seed. grey clay, water.
G101	{ 0' 0" to 0' 6" 0' 6" to 3' 0" 3' 0"	kopi. kopi and granular gypsum. kopi and granular gypsum.
G102	{ 0' 0" to 2' 0" 2' 0" to 10' 0" 10' 0"	kopi. seed. clay.
G103	0' 0" to 3' 0" 3' 0"	seed. clay, water.
G104	{ 0' 0" to 1' 0" 1' 0" to 2' 6" 2' 6"	dirty kopi. seed. clay, water.

G105	$\begin{Bmatrix} 0' 0'' & \text{to} & 1' 0'' \\ 1' 0'' & \text{to} & 5' 0'' \\ 5' 0'' & & \end{Bmatrix}$	kopi. seed. seed.
G106	$\begin{Bmatrix} 0' 0'' & \text{to} & 1' 6'' \\ 1' 6'' & \text{to} & 6' 0'' \\ 6' 0'' & & \end{Bmatrix}$	kopi. seed (some clay). clay.
G107	$\begin{Bmatrix} 0' 0'' & \text{to} & 1' 6'' \\ 1' 6'' & \text{to} & 7' 0'' \\ 7' 0'' & & \end{Bmatrix}$	kopi. seed. seed and clay.
G108	$\begin{Bmatrix} 0' 0'' & \text{to} & 0' 9'' \\ 0' 9'' & \text{to} & 2' 8'' \\ 2' 8'' & & \\ & & 2' 0'' \end{Bmatrix}$	kopi. seed. grey clay with seed and crystals. water level.
G109	$\begin{Bmatrix} 0' 0'' & \text{to} & 5' 0'' \\ 5' 0'' & \text{to} & 5' 6'' \\ 5' 6'' & & \\ 5' 0'' & & \end{Bmatrix}$	brownish seed. white seed. clay. water level.
G110	$\begin{Bmatrix} 0' 0'' & \text{to} & 0' 6'' \\ 0' 6'' & \text{to} & 2' 8'' \\ 2' 8'' & & \end{Bmatrix}$	kopi. seed. clay, water.

Reserves.

The seed gypsum in the lake flat varies in its purity and the northern third is taken as having the same grade as samples G99, 100. The remainder of deposit in the lake has been sampled in five places and the average figure quoted is an estimate of probable grade. Tonnages are:—

660,000 tons of 84 per cent. pure gypsum.

190,000 tons of 73 per cent. pure gypsum.

The kopi-capped dune along the east shore of the lake is represented by only one sample, G102. South of the creek, the dune contains a considerable amount of sand.

Tonnage estimate for the dune (north of the creek) is about 200,000 tons of 77 per cent. pure gypsum.

The other dunes in the belt furthest from the lake contain more than 90,000 tons of about 50 per cent. pure gypsum. Some of these dunes contain seed under the kopi, while others are composed of kopi and granular gypsum.

KONDININ.

General Information.

The deposit is one mile south-east of the south-east corner of Avon Location 18480 and approximately $12\frac{1}{4}$ miles by road and track from Kondinin railway station. It is 10 miles south-east of the station in a direct line.

A little salt water is present on the lake surfaces in winter but bedrock is very close. Groundwater of any kind is not readily available in the immediate vicinity.

Occurrence.

The deposit is small and consists of three patches. The central patch is seed gypsum and the other two are kopi over granular gypsum. Depth of kopi on the northern patch is three feet while a depth of five feet occurs on the southern bank. The granular gypsum is of similar grain size to the seed gypsum but appears to be a product of recrystallisation of the kopi. The grains are euhedral and do not have the flat sides of the seed gypsum.

Production.

This deposit has not been worked.

Sampling.

S. Repacholi, owner of the adjacent farm, submitted two samples to the Government Chemical Laboratories for identification, in 1948. These were—a "lump of strongly coloured gypsum" (probably crystalline from the lake bed clay), and some "impure kopi."

Samples G111 to 115 were taken from the crests of dunes and results of analysis are shown in Table III. Samples G112 and G115 were of seed gypsum and the average gypsum content of the dune (see Plan) is 71 per cent. with 28 per cent. of sand, clay, etc. Samples G113 and G114 were from a kopi dune and average 84 per cent. gypsum with 13 per cent. of sand, clay, etc.

The logs of the sampling holes are reproduced below:—

G111	{ 0' 0" to 3' 0"	kopi.
	{ 3' 0" to 8' 0"	granular gypsum.
	8' 0"	sand.
G112	0' 0" to 3' 6"	seed.
	3' 6"	clay,
G113	{ 0' 0" to 5' 0"	kopi.
	{ 5' 0" to 7' 0"	kopi and fine granular gypsum.
	7' 0"	red clay and fine granular gypsum.
G114	{ 0' 0" to 5' 0"	kopi.
	{ 5' 0" to 8' 0"	granular gypsum.
	8' 0" to 12' 0"	granular gypsum.
G115	0' 0" to 4' 0"	seed.
	4' 0"	clay and very small crystals.

Reserves.

Kopi and granular gypsum :—

9,000 tons 83 per cent. pure gypsum.

118,000 tons 84 per cent. pure gypsum.

Seed gypsum :—

35,000 tons 71 per cent. pure gypsum.

TABLE IV.—SAMPLE ANALYSES—AREA No. 2.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*				
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ ·2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.
				CaO.	MgO.								
1952.		<i>Lands Dept. Litho. 37/240.</i>		%	%	%	%	%	%	%	%		%
8907	G20	Coorow, 5 chains west of Geraldton Highway, $\frac{1}{2}$ mile north of 167 mile peg, Victoria Location 5822	Centre of clay pan, 0' to 3' 6"	23.48	4.55	29.90	2.33	7.25	64.30	4.55	7.25	MgCO ₃ 0.65 ; MgO 4.25	19.00
		<i>Midland District Plans No. 3.</i>											
8908	G21	Yarra Yarra Lakes (see Plan)	0' to 2'. In lake bed	14.09	5.00	18.60	2.16	11.55	40.00	1.90	11.55	MgCO ₃ 2.55, MgO 3.8	40.20
8909	G22	do. do.	2' to 3' 6"	25.03	2.15	34.12	0.93	5.80	73.25	2.10	5.80	MgO 2.15	16.70
8910	G23	do. do.	6" to 3' 6"	10.88	5.75	14.00	1.99	11.60	30.10	1.95	11.60	MgCO ₃ 2.2, MgO 4.7	49.45
8911	G24	do. do.	0' to 1'. In lake bed	20.46	2.80	26.59	1.47	5.65	57.10	3.35	5.65	MgO 2.8	31.10
8912	G25	do. do.	1' to 2'. In lake bed	19.34	4.30	25.40	2.33	7.45	54.60	2.75	7.45	MgCO ₃ 2.1, MgO 3.3	29.80
8913	G26	do. do.	2' to 3' 6". In lake bed	5.99	6.10	4.30	5.15	8.80	9.25	5.30	8.80	MgCO ₃ 5.4 ; MgO 3.5	67.75
8914	G27	do. do.	0' to 4'	6.03	7.65	0.61	8.50	6.85	1.30	10.00	6.85	MgCO ₃ 7.85, MgO 3.9	70.10
8915	G28	do. do.	0' to 2'. In lake bed	27.00	2.85	36.30	1.22	7.10	78.20	2.80	7.10	MgO 2.85	9.05
8916	G29	do. do.	1' to 2' 6". In lake bed	20.98	4.60	29.00	0.82	6.90	62.40	1.25	6.90	MgCO ₃ 0.5, MgO 4.35	24.60
8917	G30	do. do.	0' to 3' 6". In lake bed	29.25	1.35	40.81	0.61	3.80	87.40	1.40	3.80	SO ₃ 0.1, MgO 1.35	5.95

8918	G31	do	do.	1" to 3' 0". In lake bed	31.30	1.00	44.52	0.35	4.10	94.75	0.80	1.15	SO ₃ 0.35, MgCl ₂ 2.4	0.55
8919	G32	do.	do.	0' to 3' 6". In lake bed	25.41	2.95	31.98	2.40	6.05	68.65	5.45	6.05	MgO 2.95	16.90
8920	G33	do.	do.	1' to 3' 6". In lake bed	7.36	4.05	4.24	6.89	11.80	9.10	7.85	11.80	MgCO ₃ 6.6, MgO 0.9	63.75
8921	G34	do.	do.	0' to 3' 6". In lake bed	20.33	4.00	22.90	3.85	6.70	49.25	7.65	6.70	MgCO ₃ 0.9, MgO 3.6	31.90
8922	G35	do.	do.	1" to 3' 6". In lake bed	23.31	4.80	32.71	2.70	6.05	70.30	0.75	6.05	MgCO ₃ 4.55, MgO 2.65	15.70
8923	G36	do.	do.	2' to 3' 6". In lake bed	26.31	1.85	36.24	0.56	4.50	78.00	1.25	4.50	CaO 0.25, MgO 1.85	14.15
8924	G37	do.	do.	2' to 4'. In lake bed	27.60	1.35	38.44	0.40	4.40	82.70	0.90	4.40	CaO 0.2, MgO 1.35	10.45
8925	G38	do.	do.	1' 6" to 3'. In lake bed	27.83	2.40	38.58	1.88	4.55	83.00	1.45	4.55	MgCO ₃ 2.4, MgO 1.15	7.45
				<i>Lands Dept. Litho.</i> 124/80										
8926	G39	Dooka	(see Plan)	4" to 2' 6". In hollow	33.09	trace	43.52	1.57	0.45	93.60	3.55	0.45	CaO 0.7	1.70
8927	G40	do.	do.	1' to 11'. In old pit, channel sample	34.43	trace	41.59	3.85	1.00	80.45	8.75	1.10	CaO 0.45	0.25
8928	G41	do.	do.	0' to 7'. In old pit, channel sample	34.46	trace	42.29	3.66	0.60	91.00	8.30	0.60	CaO 0.1	....
8929	G42	do.	do.	0' to 2' 6". In old shaft	33.96	trace	41.96	2.95	0.10	90.25	6.70	0.10	CaO 0.9	2.05
				<i>Lands Dept. Litho.</i> 93/80.										
8930	G43	Cliff Head	(see Plan)	0' to 2'. Channel sample	37.48	trace	34.69	9.53	0.65	74.60	21.70	0.65	CaO 1.1	1.95
8931	G44	do.	do.	0' to 4' 6". Channel sample	33.49	trace	44.03	1.28	0.25	94.70	2.90	0.25	CaO 1.1	1.05
8932	G45	do.	do.	0' to 2' 6". Channel sample	32.81	trace	39.80	3.64	0.45	85.60	8.30	0.45	CaO 0.35	5.30

* Calculated in accordance with suggestions made in "Standard Methods of Testing Gypsum and Gypsum Products" (C26-50), A.S.T.M. Standards, 1950 Supplement, Part 3.

TABLE IV—continued.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*				
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ ·2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.
				CaO.	MgO.								
1952.		<i>Lands Dept. Litho.</i> 88/80		%	%	%	%	%	%	%	%		%
8933	G46	Wubin Downs (see Plan)	0' to 2' 8". Channel sample	28.74	trace	39.88	0.08	2.30	85.80	0.20	2.30	CaO 0.75	10.95
8934	G47	do. do.	2' 8" to 6' 0". Channel sample	28.36	trace	39.16	0.09	2.30	84.20	0.20	2.30	CaO 0.9	12.40
8935	G48	do. do.	0' to 2'. Channel sample	29.98	trace	42.34	0.15	0.45	91.10	0.35	0.45	CaO 0.2	7.90
8936	G49	do. do.	0' to 3'. Channel sample	22.65	trace	31.75	0.05	3.40	68.30	0.10	3.40	CaO 0.4	27.80
8937	G50	do. do.	0' to 2' 6". Channel sample	16.40	trace	22.68	0.17	2.05	48.80	0.40	2.05	CaO 0.3	48.45
8938	G51	do. do.	0" to 2' 6". Channel sample from lake bed	11.28	3.20	16.27	0.04	6.55	34.50	0.10	6.55	SO ₃ 0.2. MgO 3.2	55.45

* Calculated in accordance with suggestions made in "Standard Methods of Testing Gypsum and Gypsum Products" (C26-50), A.S.T.M. Standards, 1950 Supplement, Part 3.

Government Chemical Laboratories, Perth.

AREA No. 2.

COOROW.

General Information.

The deposit is on two clay pans at a point $167\frac{1}{2}$ miles north of Perth on the Geraldton Highway. The road runs between the two pans which are about six chains apart. The deposit is midway between Coorow and Marchagee—about seven miles from each siding.

Occurrence.

East of the road, the gypsum is in the form of thin seed cover on most of the lake bed. Clay is exposed along the eastern edge. The gypsum is thickest at its eastern edge where two inches of seed overlies seven inches of clayey kopi. A layer of black carbonaceous clay with gypsum crystals occurs at nine inches to 18 inches depth. A clayey limestone was encountered below this depth. The area of gypsum on the lake is less than two acres and the average depth of gypsum bearing material is 14 inches.

Gypsum on the pan west of the road covers about four acres and varies considerably in thickness. Banks of $3\frac{1}{2}$ feet thickness cover about half this area and the patches in between show only a skin of kopi. The banks are a mixture of kopi and massive soft gypsum. Clay is encountered below the gypsum and water is also present at that level.

Production.

There has been no production from this deposit.

Sampling.

A sample of material was submitted from the westerly clay pan, to the Government Chemical Laboratories by Miss V. P. Long, in 1945. It was determined as kopi.

Sample G20 (Table IV.) showed 64 per cent. pure gypsum. The sample consisted of kopi and soft massive gypsum and was taken from the deepest part of the deposit (3 feet six inches deep).

Reserves.

Twenty-six thousand tons of 64 per cent. pure gypsum (mostly kopi).

YARRA YARRA LAKES.

General Information.

These lakes lie two to three miles west of the Geraldton Highway and railway line and extend from the latitude of Winchester to three miles south of Three Springs. Access is best gained from a road which leaves the highway about 120 chains north of Winchester. This road gives way to a track, part sand and part clay, which skirts the southern and western shores of the lake system. Access can also be gained from Carnamah, the nearest town, which is 191 miles from Perth by road.

Salt water is present at shallow depth below the lake surface. There are no mineral claims on the deposit.

Occurrence.

There is no high grade deposit here nor are there any high dunes of seed or kopi on the banks.

The gypsum has three modes of occurrence : (a) scattered crystals on the surface ; (b) layers of crystals in the lake bed (c) seed gypsum as layers in the clay bed of the lake and occasionally in low banks around the lake.

Samples taken in the lake bed were of crystalline gypsum in clay which occurs as a one foot thick band at an average depth of 18 inches. It is overlain by dense puggy clay, green, brown or grey and grades into barren clay underneath.

The south-eastern corner of the large lake yielded up to three feet six inches of clay with seed gypsum, overlying clay. The south-east corner of the northern lake also contains some gypsum in the clay but there is little of it.

G27 is a sample of yellow clay with a little gypsum. It occurs in an area of clay pans surrounded with this yellow clay.

There is no vegetation on the lake bed but flats near the lake are covered with samphire. The surrounding sand ridges to the west are covered with spearwood and morrel while the granite country east of the lakes is under cultivation.

Production.

There is none recorded from this locality.

Sampling.

Samples G21 to G38 were taken at this deposit. Results of analyses are shown in Table IV and sample locations are shown on the plan.

Logs of the sample holes were as follows :—

G21	0' 0" to 2' 0"	green clay.
G22	2' 0" to 3' 6"	green clay with crystals.
	3' 6"	clay.
	3' 0"	water level.
G23	{ 0' 0" to 0' 6"	brown clay
	{ 0' 6" to 3' 6"	green clay with gypsum.
	3' 6"	clay.
	3' 0"	water level.
G24	0' 0" to 1' 0"	brown clay.
G25	1' 0" to 2' 0"	clay, gypsum.
G26	2' 0" to 3' 6"	stiff blue-green clay.
	3' 6"	stiff blue-green clay.
G27	0' 0" to 4' 0"	yellow clay.
	4' 0"	yellow clay.
G28	0' 0" to 2' 0"	clay, gypsum.
	2' 0"	clay, gypsum.
	1' 0"	water level.
	0' 0" to 1' 0"	green clay.

G29	1' 0" to 2' 6"	clay, gypsum.
	2' 6"	clay, gypsum.
	1' 0"	water level.
G30	0' 0" to 3' 6"	seed gypsum, clay.
	3' 6"	clay.
	1' 6"	water level.
	0' 0" to 0' 1"	salt.
G31	0' 1" to 3' 0"	seed gypsum, clay.
	3' 0"	clay.
	1' 0"	water level.
G32	0' 0" to 3' 6"	clay, seed.
	3' 6"	clay.
	1' 0"	water level.
	0' 0" to 1' 0"	dark clay.
G33	1' 0" to 3' 6"	yellow brown clay.
		gypsum crystals.
	3' 6"	yellow clay.
	1' 6"	water level.
G34	0' 0" to 3' 6"	clay, seed.
	3' 6"	clay.
	0' 0" to 0' 1"	salt.
G35	0' 1" to 3' 6"	clay, seed.
	2' 6"	water level.
	0' 0" to 1' 0"	brown clay.
	1' 0" to 2' 0"	green clay.
G36	2' 0" to 3' 6"	seed, green clay.
	3' 6"	green clay.
	2' 0"	water level.
G37	2' 0" to 4' 0"	seed gypsum.
	4' 0"	green clay.
	3' 6"	water level.
	0' 0" to 0' 6"	gypsum crystals.
	0' 6" to 1' 6"	clay.
G38	1' 6" to 3' 0"	seed gypsum.
	3' 0"	seed gypsum.
	1' 0"	water level.

Reserves.

The grade and distribution of the samples of seed gypsum in the big lake (G30, 31, 32, 35, 36, 37, 38) indicate a tonnage of 10,000,000 tons of 80 per cent. pure gypsum with as much as two feet of clay overburden in places. (Much of the seed was below water level.)

There is also a minimum of 1,500,000 tons of crystals of gypsum, at samples G28, 29. Average of results of analyses on these samples = 70 per cent. pure gypsum.

Samples G21, 22, 23 indicate some 700,000 tons of gypsum crystals, with clay, of 41 per cent. purity.

DOOKA.

General Information.

This deposit is contained in M.C. 2, T.Rs. 1282H, 1283H, and 1284H—south of Victoria. Location 3489. It is located seven miles south-south-east of Dongara and can be reached by a sand track which leaves the Geraldton Highway immediately east of the bridge over the Irwin River, about 4.5 miles east of Dongara. The track heads due south and passes the deposit about 1.4 miles to the east of it. A side track at a distance of 6.2 miles gives access to the deposit. This side track is somewhat sandy and would be difficult in dry weather.

The old well would probably yield water when deepened.

Occurrence.

The area is one of coastal sand dunes. Some of the dunes are fixed by vegetation while others show large areas of moving sand. Vegetation consists of stunted gums, "iron bark" and wattle, with some box thorn. Cap limestone outcrops in places but is occasionally covered by sand.

The deposit is in a depression between two north-trending rows of sand dunes which are about 58 chains apart. The gypsum is flanked on the west by a low-lying roughly level expanse of cap limestone which has been covered in places by advancing sand dunes. There are several low limestone ridges between the gypsum and the high sand dunes to the east, while calcareous and silica sands provide an irregular cover on the gypsum and limestone in the centre of the area.

Crystalline gypsum is exposed in two pits and several small shafts. This is overlain by kopi and sand and its extent could not be determined. The patch of kopi surrounding sample G42 may cover crystalline gypsum as each shaft bottoms on crystals at shallow depth. Samples G40, 41 were made as channel samples down the faces of old pits. These pits were 12 feet and 10 feet deep respectively, the latter being worked as a tunnel in its eastern side. (The roof is now very unstable.)

The first pit sampled was roughly circular and about 34 feet in diameter. The top two feet consisted of compacted kopi containing some crystals. This lay on a banded rock composed of aggregates of gypsum crystals about half an inch in length. Bedding planes, one inch, two inches, and three inches apart, were observed. Cavities and cracks a few inches wide were observed in places between the bedding. The bedding has no regular strike but dips of up to 20 degrees, away from the centre of the pit, were observed. These indicate a domal structure.

The marked banding with various layers of crystals, also seams of gypsum across the bedding, suggest a recrystallisation in dunes, possibly on the edge of a barred basin.

Production.

There is no record of any production from this locality although some tons must have been dug from the two pits. An old tram track runs from the westerly pit to a surface dump and the age of the workings can be gauged by the fact that a tree 20 feet in height is growing from the floor of the pit.

Sampling.

Reference—G.S.W.A. File 135/01, G.S.W.A. File 40/1951.

Locality—Samples Nos. 1, 2, 3, from five foot shaft 10 chains south of mill. Nos. 4, 5 are surface samples.

Analyses (1919)—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	0 ft. to 3 ft.	3 ft. to 5 ft.	5 ft. to 7 ft.	Surface.	Surface.
Insoluble in acids	1.51	0.48	0.85	5.41	0.86
Water soluble CaO	27.62	29.74	28.32	21.87	28.79
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	84.79	91.30	86.94	67.14	88.38
Acid soluble CaO	6.50	4.24	5.52	15.78	5.63
equal to CaCO_3	11.60	7.56	9.85	28.15	10.04

Remarks.—No. 1 was earthy gypsum (kopi).

No. 2 was a high grade coarsely crystalline gypsum yielding a pure white plaster suitable for all kinds of modelling and building purposes.

No. 3 sample was of drillings from a hole in the bottom of the shaft and was somewhat less pure and much finer than No. 2. It yielded a plaster almost as white and could probably be used for the same purpose.

Samples G39, 40, 41, 42 were taken from this deposit (see Table IV. for results of analysis). Following are the logs of the sample holes:—

	0' 0" to 0' 4"	black sand.
G39	0' 4" to 2' 6"	kopi.
	2' 6" to 3' 0"	crystals.
	0' 0" to 3' 0"	kopi.
G40	3' 0" to 5' 6"	kopi with crystals.
(1' to 11')	5' 6" to 12' 0"	intergrowth of acicular gypsum.
	12' 0" to 12' 0"	intergrowth of acicular gypsum.
G41	{ 0' 0" to 3' 0"	gypsum crystals.
	{ 3' 0" to 7' 0"	coarse crystals.
	7' 0" to 7' 0"	coarse crystals.
G42	0' 0" to 2' 6"	kopi.
	2' 6" to 2' 6"	crystals.

Reserves.

The reserves are difficult to assess, due to the sand cover, but probable minimum figures are:—

Kopi	....	....	20,000 tons of 92 per cent. pure gypsum.
Crystalline	....	....	40,000 tons of 90 per cent. pure gypsum.

CLIFF HEAD.

General Information.

This deposit is 20.5 miles south of Dongara and about 40 chains east of the coast. It is 19.4 miles by sand track south of the Geraldton Highway. The track leaves the highway on the east side of the bridge crossing the Irwin River about 4.5 miles east of Dongara.

The deposit is contained in M.Cs. 13, 14, 15, 16 (surveyed), and M.Cs. 6H, 13H, 200H, 448H (not surveyed). The only peg located was the datum peg (south-east corner) of M.C. 448H. This is shown near the well on the east of the track.

Water in the well is probably good. It was covered with slime in May, 1952.

Occurrence.

Kopi covers all of the gypsum and this kopi, in turn, is covered with sand in places. The deposit (*see* plan) parallels the track on the east slope of a north trending limestone ridge, with a densely vegetated flat to the east. Vegetation on the deposit and in the flat consists of mallee with prickly undergrowth, vines and wattles.

Some sampling done in 1921 recorded a depth of 12 feet of gypsum but the greatest thickness seen during this inspection was four feet six inches (including one foot of kopi on the surface). The deposit is somewhat variable but the workings in the southern half show the succession to be a fossiliferous limestone overlain by a hard, bedded gypsum (composed of layers of crystals) with a kopi cover, up to two feet six inches in thickness.

In places, the fossiliferous limestone is composed, almost completely, of brachiopod shells—indicating a probably lagoonal facies. This deposit probably formed on the *west* side of a barred basin which had its entry to the sea from the north. In view of the abovementioned sample at a depth of 12 feet, it seems likely that gypsum may occur beneath the shell bed—possibly interbedded with more limestone.

The crystalline gypsum is only exposed in the central portion of the deposit. Elsewhere, the kopi rests on fossiliferous limestone.

Production.

Several tons of crystalline gypsum have been removed from the pits—66 tons were recorded in 1941.

Sampling.

Reference—G.S.W.A. File 135/01.

Locality—Cliff Head deposit.

Analyses (1903)—

Kopi with CaO = 32.18, SO ₃ = 41.75.		
(1921)	No. 1. Surface.	No. 2. Average 4' to 12'.
Water soluble CaO	31.42	29.87
equal to CaSO ₄ .2H ₂ O	96.46	91.70
Acid soluble CaO ....	.06	4.98
equal to CaCO ₃ ....	.11	8.88
Insoluble in acids	3.60	0.54

Remarks.—No. 1, on burning, yields a high grade plaster of Paris—pure white and quick-setting to a strong body.

No. 2 yields a white plaster which is moderately quick-setting to a strong body.

Both samples are well suited for all kinds of building and modelling purposes.

A further analysis of some kopi in 1941 (*see* Chem. Lab. File 90/49) showed—lime, CaO = 32.80, sulphur trioxide, SO₃ = 42.21. This was called “gypsum with some calcite and organic matter.”

Logs of sample holes (1952) are shown below (*see* Table IV. for analysis results).

G43	0' 0" to 2' 0"	kopi.
	2' 0"	crystalline gypsum.
G44	{ 0' 0" to 1' 0"	kopi.
	{ 1' 0" to 3' 6"	kopi (consolidated).
	{ 3' 6" to 4' 6"	gypsum crystals.
	{ 4' 6"	shell bed.
G45	0' 0" to 2' 6"	kopi.
	2' 6"	kopi and lime carbonate.

Reserves.

The northern deposit contains some 16,000 tons of kopi (85 per cent. pure) and the southern deposit contains an estimated 10,000 tons of kopi (at 70 per cent.) with lime carbonate the main impurity.

Only 5,000 tons of crystalline gypsum can be inferred from the exposures here. Grade of sample G44 = 94.7 per cent. pure gypsum.

WUBIN DOWNS.

General Information.

The deposit is 26 miles N. 70° E. from Wubin townsite on Ninghan Locations 2378, 2379, 2380, and 2381. Access was gained from Dalwallinu east to Hughden Rock then north into Goodlands Station. The track through the station is surveyed and in good condition, being quite accessible a few days after a two-inch rainfall.

The deposit is on the east side of an unnamed lake which belongs to the same series as Lake Hillman, Monger's Lake, and Weelhamby Lake. These are in a long string with a general trend to the north-north-west.

M.C. 17H is on this deposit.

Occurrence.

The variety and purity of the gypsum was seen to vary considerably in this locality. On M.C. 17H, a general cover of kopi, varying up to two feet in thickness, overlies seed gypsum in the samphire flat. The seed gypsum was too densely packed to be bored with a post-hole borer beyond three feet depth so a pit was dug one chain north-west of the south-east corner peg of Location 2378. This pit revealed:—

0' 0" to 1' 0"	white kopi.
1' 0" to 2' 8"	discoloured kopi with lenses of brown clay.
2' 8" to 6' 0"	seed gypsum with larger crystals and thin clay bands.
6' 0"	hole abandoned as digging became very hard.

The patch of gypsum on the east bank of the larger lake consists of six inches of dirty kopi over two feet of a mixture of gypsum crystals, seed gypsum and clay with hard bands and pebbles. This graded into clay at two feet six inches depth. The gypseous material is in small banks and hillocks with some native pine.

Some dirty crystals occur in the lake bed, the largest being four inches in diameter. The larger crystals occur in a sandy clay below water level and sand and clay occur as inclusions in the crystals. Water occurs at a depth of 18 inches and the soil above this is a dense clay.

Production.

Several small pits, evidently dug a long time ago, were seen on M.C. 17H, but there is no record of any production.

Sampling.

Reference—G.S.W.A. File 135/01.

Locality—M.C. 17H.

Analyses (1921)—

	No. 1. Large crystals.	No. 2. Small crystals.
Water soluble CaO	32.01	31.44
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	98.27	96.52
Acid soluble CaO ....	.07	.12
equal to CaCO_3 ....	.12	.22
Insoluble in acids	2.08	3.17

Remarks.—No. 1 gave a high grade plaster, pure white, quick-setting to a strong body.

No. 2 gave a good white plaster, quick-setting to a strong body.

Both plasters are well suited for all kinds of modelling and building purposes.

(1922)

—	1	2	3	4	5
Depth	0 ins. to 18 ins.	0 ins. to 4 ins.	4 ins. to 1 ft. 0 ins.	1 ft. 0 ins. to 1 ft. 4 ins.	1 ft. 4 ins. to 2 ft. 4 ins.
Total pure gypsum	% 59·7	% 33·1	% 56·7	% 40·9	% 59·0
Crude gypsum, + 20 mesh	48·5	18·1	48·2	26·2	52·7
Equal to pure gypsum	45·5	17·4	46·9	24·4	50·4
Recovery of gypsum	76·2	52·6	82·7	59·7	85·4
Insoluble in acids	5·88	4·12	2·98	4·64	4·22
Water soluble CaO	30·48	31·14	31·60	30·96	31·06
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	93·57	95·60	97·01	95·05	95·35
Acid soluble CaO	·10	·10	·10	·10	·10
equal to CaCO_3	·18	·18	·18	·18	·18

Remarks.—The crude gypsum, + 20 mesh, on calcining to 180° C. in each case gives a high grade plaster—white, quick-setting to a strong body—suitable for all purposes. No. 8 (see analysis below) consisted of washed gypsum which, on calcining, yielded a high grade plaster—pure white and quick-setting to a strong body.

Analysis (No. 8)—

	%
Insoluble in acids	3·42
Water soluble CaO	31·42
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	96·46
Acid soluble CaO	0·10
equal to CaCO_3	0·18

Samples Nos. G46, 47, 48, 49, 50, 51 were taken from this deposit by the authors in 1952. Samples G50, 51 gave results below 50 per cent. pure gypsum.

Logs of the sample holes were:—

G46	0' 0" to 2' 8"	impure kopi.
G47	2' 8" to 6' 0"	seed with some clay.
	6' 0"	seed with some clay.
G48	0' 0" to 2' 0"	kopi, seed.
	2' 0"	clay.
	0' 0" to 3' 0"	kopi, seed, clay.
G49	3' 0"	clay.
G50	{ 0' 0" to 0' 6"	dirty kopi.
	{ 0' 6" to 2' 6"	crystals, seed, clay.
	2' 6"	crystals, seed, clay.
G51	{ 0' 0" to 1' 6"	clay, crystals.
	{ 1' 6" to 2' 6"	sand, crystals.
	2' 6"	sand, crystals.
	2' 0"	water level.

Reserves.

Some 500,000 tons of seed gypsum in the south-west portion of the deposit (including the island) at 85 per cent. pure, and a further 200,000 of kopi and crystals of about 70 per cent. purity in the remainder of the lake bed.

TABLE V.— SAMPLE ANALYSES—AREA No. 3.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*						Sand Clay and other constituents not determined by difference.
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ . 2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.			
				CaO.	MgO.										
1952.		<i>Lands Dept. Litho. 33/80.</i>		%	%	%	%	%	%	%	%		%		
9791	G52	Cowcowing Lake (see Plan)	0' to 10'. In gypsum dune	31.70	....	44.28	0.39	0.60	95.30	0.90	0.60	CaO 0.25	2.95	
9792	G53	do. do.	0' to 10'. In gypsum dune	31.60	trace	43.48	1.00	1.50	93.20	2.25	1.50	CaO 0.05	3.00		
9793	G54	do. do.	0' to 9' 6". In lake flat	10.73	trace	14.95	0.12	3.50	32.20	0.25	3.50	CaO 0.15	63.90		
9794	G55	do. do.	0' to 4'. In lake flat	28.36	trace	39.59	0.05	2.00	85.20	0.10	2.00	CaO 0.6	12.10		
9795	G56	do. do.	0' to 5' 6". In kopi dune	29.86	trace	39.64	1.20	0.65	85.30	2.75	0.65	CaO 0.6	10.70		
9796	G57	do. do.	0' to 7'. In gypsum dune	32.38	trace	45.51	0.24	0.15	97.90	0.55	0.15	CaO 0.25	1.15		
9797	G58	do. do.	0' to 5'. In lake flat	25.11	trace	35.70	0.08	2.35	76.80	0.20	2.35	....	20.65	
9798	G58	do. do.	0' to 3'. In lake flat	28.13	trace	39.72	0.13	2.10	85.40	0.30	2.10	CaO 0.2	12.00		
9799	G60	do. do.	3' to 5'. In lake flat	28.31	....	40.00	0.05	2.15	86.00	0.10	2.15	CaO 0.3	11.45	
9800	G61	do. do.	0' to 3' 6". In lake flat	23.48	....	33.08	0.04	2.35	71.20	0.10	2.35	CaO 0.3	26.05	
9801	G62	do. do.	0' to 10'. In gypsum dune	31.52	....	43.40	0.43	0.55	93.40	1.00	0.55	CaO 0.65	4.40	
9802	G63	do. do.	0' to 10'. In gypsum dune	32.29	....	44.59	0.72	0.40	96.00	1.65	0.40	CaO 0.2	1.75	
9803	G64	Nalkain (see Plan)	0' to 7'. In gypsum dune	16.90	....	23.84	0.03	0.80	51.30	0.05	0.80	CaO 0.2	47.65	
9804	G65	do. do.	0' to 2' 6". In lake flat.	20.39	....	29.10	0.02	1.85	62.60	0.05	1.85	CaO 0.3	35.20	
9805	G66	do. do.	0' to 4'. In lake flat	25.45	....	36.29	0.06	1.80	77.90	0.15	1.80	....	20.15	
9806	G67	do. do.	0' to 3' 6". In lake flat	16.16	....	23.52	0.04	1.55	49.50	0.10	1.55	SO ₃ 0.5	48.35	
9807	G68	do. do.	0' to 3' 6". In lake flat	23.48	....	33.07	0.07	2.20	71.10	0.15	2.20	CaO 0.3	26.25	

TABLE V.—Continued.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*					Sand Clay and other constituents not determined by difference.
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ . 2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.		
				CaO.	MgO.									
1952.		<i>Lands Dept. Litho.</i> 56/80.		%	%	%	%	%	%	%	%		%	
10748	G59A	Dukin (<i>see</i> Plan)	0' to 3'. In lake flat	23.71	....	33.81	0.08	2.85	72.50	0.20	2.85	....	....	24.45
10749	G60A	do. do.	0' to 4'. In lake flat	25.35	....	36.01	0.05	1.95	77.50	0.10	1.95	....	....	20.45
10750	G61A	do. do.	0' to 4'. In lake flat	21.63	....	30.44	0.04	2.25	65.50	0.10	2.25	CaO 0.3	....	31.85
10751	G62A	10 miles north-west of Koorda. 7 chains north-east of north-west corner peg of Ninghan Location 1143	0' to 5'. In lake flat	28.96	....	41.27	0.17	1.90	88.30	0.40	1.90	SO ₃ 0.15	....	9.25
		<i>Lands Dept. Litho.</i> 55/80.												
10752	G63A	Marshall Rock (<i>see</i> Plan)	0' to 2' 6". In lake flat	21.58	....	30.20	0.03	0.80	65.00	0.05	0.80	CaO 0.45	....	33.70
10753	G64A	do. do.	0' to 3'. From ridge in lake	11.95	trace	15.79	0.07	1.15	34.00	0.15	1.15	CaO 0.8	....	63.90
10754	G65A	do. do.	0' to 6' 6". From dune	26.23	....	37.18	0.03	0.45	80.00	0.05	0.45	CaO 0.2	....	19.30
10755	G66A	do. do.	0' to 3'. In lake flat	14.09	trace	18.71	0.02	0.90	40.25	0.05	0.90	CaO 1.0	....	57.80
10756	G67A	do. do.	0' to 3' 3". In lake flat	16.65	....	22.93	0.04	1.30	49.35	0.10	1.30	CaO 0.55	....	48.70
10757	G68A	do. do.	0' to 4'. In lake flat	9.46	....	13.13	0.03	1.75	28.25	0.05	1.75	CaO 0.25	....	69.70
10758	G69	do. do.	0' to 4'. From dune near edge of lake	21.44	....	29.42	0.04	1.00	63.30	0.10	1.00	CaO 0.8	....	34.80
10759	G70	do. do.	2' to 6". From kopi dune	11.12	trace	13.76	0.12	0.75	29.60	0.25	0.75	CaO 1.35	....	68.05
10760	G71	do. do.	0' to 7' 6". From kopi dune	17.43	trace	23.99	0.17	0.70	51.60	0.40	0.70	CaO 0.45	....	46.85
10760A	G71A	do. do.	0' to 2' 3". From lake flat	21.31	trace	20.71	0.03	1.85	63.90	0.05	1.85	CaO 0.5	....	33.70

		Lands Dept. Litho. 35/80.													
10761	G72	Lake Brown (<i>see Plan</i>)		0' to 4'. From dune (sample in two bags)	29-26	trace	41-17	0-04	0-30	88-55	0-10	0-30	CaO 0-45 ...	10-60	
10762	G73	do.	do.	0' to 2'. From dune (channel sample)	27-35	trace	38-09	0-03	1-60	82-00	0-05	1-60	CaO 0-7 ...	15-65	
10763	G74	do.	do.	0' to 5'. From dune	31-26	trace	43-84	0-02	0-40	94-40	0-05	0-40	CaO 0-6	4-55	
10764	G75	do.	do.	0' to 2'. In lake flat	31-65	....	44-95	0-03	1-25	96-70	0-05	1-25	CaO 0-2	1-80
10765	G76	do.	do.	0' to 7'. From dune	32-21	....	44-91	0-39	0-60	96-60	0-90	0-60	CaO 0-3	1-60
10766	G77	do.	do.	0' to 2' 6". In lake flat	31-29	....	44-45	0-03	1-30	95-60	0-05	1-30	CaO 0-2	2-85
10767	G78	do.	do.	0' to 4'. From dune	31-12	....	43-48	0-08	0-55	93-50	0-20	0-55	CaO 0-65	5-10
10768	G79	do.	do.	0' to 7'. From dune	26-57	....	37-45	0-05	0-35	80-60	0-10	0-35	CaO 0-35	18-60
10769	G80	do.	do.	0' to 1' 6". In lake flat	31-92	....	45-01	0-02	0-90	96-80	0-05	0-90	CaO 0-45	1-80
10770	G81	do.	do.	0' to 7'. From dune	29-38	....	41-20	0-04	0-45	88-6	0-10	0-45	CaO 0-55	10-30
10771	G82	do.	do.	0' to 3'. From dune	22-25	....	31-32	0-02	0-35	67-35	0-05	0-35	CaO 0-35	31-90
10772	G83	Chandler (<i>see Plan</i>)		0' to 12'. Channel sample from pit in dune	32-23	....	45-48	0-02	0-05	97-80	0-05	0-05	CaO 0-4	1-70
10773	G84	do.	do.	12' to 21'. Below G83	32-61	....	45-95	0-02	0-30	98-85	0-05	0-30	CaO 0-5	0-30
10774	G85	do.	do.	0' to 5'. From dune	18-98	....	27-29	0-03	0-60	58-20	0-05	0-60	SO ₃ 0-2	40-95
10775	G86	do.	do.	0' to 5'. From dune	28-83	....	40-47	0-03	0-05	87-00	0-05	0-05	CaO 0-5	12-40
10776	G87	do.	do.	0' to 7'. From dune	29-36	....	39-77	0-80	0-10	85-50	1-80	0-10	CaO 0-55	12-05
10777	G88	do.	do.	0' to 5'. From dune (channel sample)	25-55	....	36-17	0-04	0-05	77-80	0-10	0-05	CaO 0-25	21-80
10778	G89	do.	do.	0' to 5'. From dune	29-27	....	41-55	0-01	trace	89-40	trace	trace	CaO 0-25	10-35
10779	G90	do.	do.	0' to 3' 6in. Lake bank	32-09	....	44-77	0-02	trace	96-30	0-05	trace	CaO 0-8	2-85
10780	G91	do.	do.	0' to 2' 6". Lake bank	29-17	....	40-87	0-03	0-05	88-00	0-05	0-05	CaO 0-6	11-30
10781	G92	do.	do.	0' to 6'. From dune	25-33	....	35-56	0-02	0-05	76-40	0-05	0-05	CaO 0-45	23-05
10782	G93	do.	do.	0' to 5'. From dune	24-70	....	34-67	0-26	0-10	74-60	0-60	0-10	CaO 0-1	24-60
10783	G94	do.	do.	0' to 8'. From dune	24-08	....	34-04	0-02	0-15	73-20	0-05	0-15	CaO 0-25	26-35
10784	G95	do.	do.	0' to 4'. From dune	29-23	....	40-81	0-01	0-25	87-80	trace	0-25	CaO 0-7	11-25
10785	G96	4 miles south of Chand- ler (<i>see Plan</i>)		0' to 6'. From dune	19-59	....	28-98	0-01	0-15	60-10	trace	0-15	SO ₃ 0-95	38-80
10786	G97	do.	do.	0' to 5'. From dune	23-51	....	34-85	0-02	trace	72-10	0-05	trace	SO ₃ 1-25	26-60
10787	G98	do.	do.	0' to 6'. From dune	29-32	....	42-70	0-01	0-05	90-00	trace	0-05	SO ₃ 0-9	9-15
		Lands Dept. Litho. 25/80.													
11970	G116	Hines Hill (<i>see Plan</i>)		0' to 10'. From seed dune	11-71	....	26-91	0-02	0-25	54-25	0-05	0-25	SO ₃ 1-65	43-80
11971	G117	do.	do.	0' to 5'. From seed dune	21-20	....	31-76	0-04	0-10	64-95	0-10	0-10	SO ₃ 1-5	33-35
11972	G118	do.	do.	0' to 7'. From seed dune	28-25	....	39-98	0-04	0-75	86-00	0-10	0-75	CaO 0-25	12-90

* Calculated in accordance with suggestions made in "Standard Methods of Testing Gypsum and Gypsum Products" (C26-50), A.S.T.M. Standards, 1950 Supplement, Part 3.

TABLE V.—*continued.*

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.				Calculated Composition.*						
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ . 2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.	
				CaO.	MgO.									
1952.		<i>Lands. Dept Litho.</i>		%	%	%	%	%	%	%	%		%	
11973	G119	25/80— <i>contd.</i>												
		Hines Hill (<i>see Plan</i>)	0' to 8'. From seed	28·81	....	40·82	0·04	0·90	87·80	0·10	0·90	CaO 0·25	10·95
		<i>continued.</i>	dune											
11974	G120	do. do.	0' to 4' 6". From	27·00	....	39·08	0·03	0·20	82·80	0·05	0·20	SO ₃ 0·5	16·45
			seed dune											
11975	G121	do. do.	0' to 11". From seed	31·26	....	44·57	0·04	0·15	95·80	0·10	0·15	CaO 0·1	3·85
			dune											
11976	G122	do. do.	0' to 3'. From seed	11·69	....	17·52	0·02	0·90	35·80	0·05	0·90	SO ₃ 0·85	62·40
			bank											
11977	G123	do. do.	0' to 8' 6". From	31·84	....	44·93	0·05	0·35	96·70	0·10	0·35	CaO 0·4	2·45
			seed dune											
11978	G124	do. do.	0' to 11". From seed	26·64	....	37·41	0·10	0·20	80·50	0·25	0·20	CaO 0·35	18·70
			dune											
11979	G125	do. do.	0' to 4". From kopi	31·18	....	43·74	0·05	1·75	94·10	0·10	1·75	CaO 0·55	3·50
			dune											
11980	G126	Baandee (<i>see Plan</i>)	0' to 1' 0". From lake	28·22	....	38·87	0·58	0·75	83·60	1·30	0·75	CaO 0·3	14·05
			flat											
11981	G127	do. do.	0' to 0' 8". From lake	29·86	....	42·28	0·05	1·85	90·90	0·10	1·85	CaO 0·25	6·90
			flat											
11982	G128	do. do.	0' to 0' 10". From	29·29	....	41·12	....	2·90	88·45	....	2·90	CaO 0·55	8·10
			lake flat											
11983	G129	do. do.	0' to 0' 10". From	24·64	....	34·38	....	3·65	73·95	....	3·65	CaO 0·6	21·80
			lake flat											
11984	G130	do. do.	0' to 1' 4". From lake	30·13	....	42·46	0·03	2·80	91·35	0·05	2·80	CaO 0·4	5·40
			flat											
11985	G131	do. do.	0' to 1' 0". From lake	28·91	....	41·26	0·03	2·85	88·60	0·05	2·85	.... ....	8·50
			flat											
11989	G135	Woolundra (<i>see Plan</i>)	0' to 1' 4". From	29·81	....	37·16	2·53	0·55	79·90	5·75	0·55	CaO 0·6	13·20
			kopi dune											
11990	G136	do. do.	0' to 1". From lake	23·32	....	32·76	0·02	2·55	70·40	0·05	2·55	CaO 0·4	26·60
			flat											
11991	G137	do. do.	0' to 2' 6". From	22·70	....	29·88	1·10	2·30	64·25	2·50	2·30	CaO 0·4	30·55
			kopi dune											

11992	G138	do.	do.	0' to 6'. From seed dune	15.71	....	23.10	0.04	0.40	48.10	0.10	0.40	SO ₃ 0.7	....	50.70
11993	G139	do.	do.	0' to 4'. From seed dune	23.91	....	34.25	0.03	0.50	73.30	0.05	0.50	SO ₃ 0.1	....	26.05
11994	G140	do.	do.	0' to 4' 6". From seed dune	24.52	....	34.65	0.01	0.30	74.50	trace	0.30	CaO 0.3	....	24.90
11995	G141	do.	do.	6" to 1' 10". From kopi dune	29.54	....	38.33	1.62	1.35	82.40	3.70	1.35	CaO 0.7	....	11.85
11996	G142	Kellerberrin Plan)	(see do.	0' to 2". From lake flat	30.09	....	43.25	0.02	0.55	93.00	0.03	0.55	SO ₃ 0.25	....	6.15
11997	G143	do.	do.	0' to 5'. From seed dune	26.69	....	37.92	0.05	0.45	81.55	0.10	0.45	CaO 0.15	....	17.75
<i>Lands Dept. Litho. 34/80.</i>															
11986	G132	15 miles north of Baandee (see Plan)	do.	0' to 0' 6". From lake flat	24.90	....	35.98	0.02	0.75	76.40	0.05	0.75	SO ₃ 0.4	....	22.40
11987	G133	do.	do.	0' to 5'. From seed dune	25.06	....	35.72	0.02	1.05	76.90	0.05	1.05	....	....	22.00
11988	G134	do.	do.	0' to 10'. From seed dune	31.26	....	43.54	0.02	0.60	93.70	0.05	0.60	CaO 0.8	....	4.85
<i>Lands Dept. Litho. 26/80.</i>															
11998	G144	4 miles east-north-east of Cunderdin (see Plan)	do.	0' to 2'. From lake bed	28.64	....	39.75	0.03	2.60	85.50	0.05	2.60	CaO 0.8	....	11.05
11999	G145	do.	do.	0' to 1' 6". From lake bed	30.76	....	42.90	0.02	1.65	92.30	0.05	1.65	CaO 0.75	....	5.25
12000	G146	do.	do.	0' to 5' 6". From kopi dune	22.23	....	29.27	0.45	1.55	62.95	1.00	1.55	CaO 1.2	....	33.30
12001	G147	4 miles east of Cunderdin (see Plan)	do.	0' to 1'. From lake bed	27.13	....	37.60	0.03	1.00	80.90	0.05	1.00	CaO 0.8	....	17.25
12004	G150	do.	do.	2' to 7'. From kopi dune	26.94	....	32.24	3.08	0.45	69.40	7.00	0.45	CaO 0.5	....	22.65
12002	G148	6 miles east-north-east of Cunderdin (see Plan)	do.	0' to 0' 6". From lake bed	30.88	....	42.03	0.04	0.40	90.40	0.10	0.40	CaO 1.45	....	7.65
12003	G149	do.	do.	0' to 3'. From kopi dune	30.35	....	41.81	0.07	1.80	90.00	0.15	1.80	CaO 1.05	....	7.00
12005	G151	Wyola. Approximately 6 chains south-east of south-west corner peg of Avon Location 7084 (M.L. 6 p.p.)		0' to 3'. From kopi bank	31.80	....	41.27	1.77	0.95	88.80	4.05	0.95	CaO 0.7	....	5.50

* Calculated in accordance with suggestions made in "Standard Methods of Testing Gypsum and Gypsum Products" (C26-50), A.S.T.M. Standards, 1950 Supplement, Part 3.

AREA No 3

COWCOWING LAKE.

General Information.

This deposit includes the surveyed M.C. 75H and the unsurveyed M.Cs. 72H, 73H, 157H, 158H. The area examined ranges from two miles to nine miles west of Nalkain siding on the Koorda railway line about 140 miles from Perth. Gypsum-bearing material is found on Avon Locations 20523, 299, 34, also Reserves 21541 and 9280. These are close to the main road.

Occurrence.

M.Cs. 72H, 157H, 158H are in a small clay pan on which there are small banks of seed running north-south. These are only a few feet in width and of negligible thickness. Odd banks of clay-kopi occur also and the lake bed does contain crystals in the clay. This patch was not sampled.

The main lake flat contains isolated clay pans and has a narrow water channel along its southern edge but is covered for the most part with gypsum-bearing material. Two discontinuous ridges of seed gypsum running slightly east of north can be seen on the plan. The more westerly ridge has an average crest height of 10 feet of which the top two feet is kopi. The other ridge to the east is slightly higher and has a similar kopi cap (two feet) over seed gypsum which was still present at a depth of 10 feet. The deposit is somewhat cavernous—cavities of three feet depth were encountered during sampling.

The lake flat is covered with a dirty compacted kopi up to three feet in depth. This kopi contains quite a large amount of clay impurity and sometimes overlies a bed of seed gypsum which is about two feet thick and contains a large amount of clay.

The deposit changes its character at M.C. 75H. The claim is pegged across the water channel and a kopi ridge. The kopi is five feet high in the centre of the ridge. The water channel has a layer of one-inch long crystals growing vertically from its bed in tightly packed clots. There is only a very small amount available. More equidimensional crystals are present in the western bank of the channel, where there is a narrow strip about one chain wide and 10 chains long and thickness of one foot, along the western boundary of M.C. 75H. There is a kopi cover of six inches.

Some crystals occur further to the west in a band which thins out after about five chains. These appear to be the product of crystallisation at a former water level.

Production.

There does not appear to have been any work done on any of the mineral claims.

Sampling.

Samples G52 to G63 were taken at this deposit (see plan for disposition of sampling and Table V. for analysis results). Logs of sample holes are as follows :—

G52	{ 0' 0" to 2' 6"	Kopi.
	{ 2' 6" to 10' 0"	small seed.
	{ 10' 0" to 10' 0"	small seed.
G53	{ 0' 0" to 0' 1"	red clay.
	{ 0' 1" to 1' 6"	loose kopi.
	{ 1' 6" to 1' 7"	hard band (limestone).
	{ 1' 7" to 9' 0"	small seed.
	{ 9' 0" to 10' 0"	seed and gastropods.
	{ 10' 0" to 9' 0"	seed and gastropods.
	{ 9' 0" to 9' 0"	water level.
G54	{ 0' 0" to 1' 0"	kopi.
	{ 1' 0" to 8' 0"	clay, kopi.
	{ 8' 0" to 9' 6"	grey clay.
	{ 9' 6" to 7' 0"	water level
G55	{ 0' 0" to 2' 0"	dirty kopi.
	{ 2' 0" to 4' 0"	dirty seed.
	{ 4' 0" to 4' 0"	red clay.
G56	{ 0' 0" to 3' 0"	kopi.
	{ 3' 0" to 3' 2"	limestone.
	{ 3' 2" to 5' 6"	kopi.
	{ 5' 6" to 5' 6"	loam.
G57	{ 0' 0" to 3' 0"	kopi.
	{ 3' 0" to 7' 0"	seed.
	{ 7' 0" to 7' 0"	seed.
G58	{ 0' 0" to 0' 6"	kopi.
	{ 0' 6" to 3' 0"	clay, kopi.
	{ 3' 0" to 5' 0"	seed.
	{ 5' 0" to 5' 0"	grey clay, water.
G59	0' 0" to 3' 0"	kopi, clay.
G60	3' 0" to 5' 0"	seed, clay.
	5' 0" to 5' 0"	grey clay, water.
G61	0' 0" to 0' 6"	kopi.
	0' 6" to 3' 0"	crystals.
	3' 0" to 3' 6"	crystals, clay.
	3' 6" to 3' 6"	sand.
	3' 0" to 3' 0"	water level.
G62	{ 0' 0" to 2' 0"	kopi.
	{ 2' 0" to 10' 0"	fine seed.
	{ 10' 0" to 10' 0"	fine seed.
G63	{ 0' 0" to 2' 0"	kopi.
	{ 2' 0" to 5' 0"	air space.
	{ 5' 0" to 10' 0"	kopi, seed.
	{ 10' 0" to 10' 0"	seed.

With the exception of G54, all of the samples show a gypsum content in excess of 70 per cent., while there are five which assay more than 90 per cent.

Reserves.

The five samples from the seed dunes indicate a deposit of 1,200,000 tons of 94 per cent. pure gypsum in the western ridge and some 1,550,000 tons of 95 per cent. pure gypsum in the eastern ridge.

There is also a minimum of 1,000,000 tons of seed and kopi in the lake bed in the vicinity of samples G58 to G60 (80 per cent. pure gypsum).

NALKAIN.

General Information.

The deposit includes M.C. 77H and M.C. 79H and is two miles north-west of Nalkain siding on the Koorda railway line. It is about 140 miles from Perth on Avon Location 215. Some shallow water is present in the lake in winter. A road passes the deposit.

Occurrence.

Varieties of gypsum present include kopi, seed, granular and crystalline gypsum.

The dune at the south-east corner of M.C. 77H is granular gypsum from one foot to seven feet depth at the crest. The top one foot is kopi and the deposit becomes sandy below seven feet depth.

The remainder of the deposit is a thin bed of crystals of average thickness two feet. This bed overlies a clay containing crystals and is covered in places by kopi, up to six inches in thickness.

A patch of seed gypsum occurs north of the claims. It is of variable thickness, averaging 1 foot, and contains some quartz grains. The seed is overlain by compacted kopi of average thickness one and a half feet and overlies clay containing some crystals.

Production.

Some small excavations have been made in the kopi of the dune but no production has been reported for these claims.

Sampling.

Samples G64, G65, G66, G67, G68 were taken from this deposit (see plan for location of sample and Table V. for analysis results). Logs of the sample holes are:—

G64	{ 0' 0" to 1' 0"	kopi.
	{ 1' 0" to 7' 0"	granular gypsum.
G65	7' 0"	becoming sandy.
	{ 0' 0" to 1' 0"	kopi
	{ 1' 0" to 2' 6"	crystals, clay.
	2' 6"	clay.
	2' 0"	water level.
G66	{ 0' 0" to 2' 6"	Kopi.
	{ 2' 6" to 4' 0"	seed.
	4' 0"	clay.
	3' 0"	water level.
G67	{ 0' 0" to 0' 6"	kopi.
	{ 0' 6" to 3' 0"	crystals, clay.
	{ 3' 0" to 3' 6"	clay, crystals.
	3' 6"	clay.
G68	3' 0"	water level.
	0' 0" to 0' 4"	Kopi.
	0' 4" to 3' 6"	crystals.
	3' 6"	clay.
	3' 0"	water level.

Reserves.

There are some 70,000 tons of crystals of gypsum, under a thin kopi cover, of 60 per cent. average grade.

Sample G66 (of kopi with seed) indicates a tonnage of 30,000 tons of 78 per cent. pure gypsum.

DUKIN.

General Information.

M.C. 29H is about three-quarters of a mile north of Dukin siding on the railway line to Koorda—distant about 150 miles from Perth. It is immediately adjacent to the railway line and includes a small embayment in the Cowcowing Lake—(see 1925, Feldtmann⁶).

Some surface water is present on the lake bed in winter but is very shallow.

Occurrence.

The deposit now consists of kopi over seed gypsum, with patches of crystals and much clay impurity, on the lake floor. Maximum depth of this material is four feet and its area is hard to determine. Most of the Cowcowing Lake is covered with a clayey kopi containing some seed. Low samphire covers this material.

⁶1925 Feldtmann, F. R. : The Gypsum Deposits at Dukin, Avon District, South-West Division. *G.S.W.A. Ann. Prog. Rep.* 1924, pp. 9-10.

A kopi dune near the railway line has been worked at some time but it is not known for what purpose.

The long thin strip of seed gypsum is negligible in quantity and represents the start of a seed deposit.

Production.

Four hundred and eighty-seven tons were won from this deposit in 1924. This was probably seed gypsum which was taken from a seed dune on the edge of the lake, where the new ridge is starting.

Sampling.

An analysis made in 1922, for Millar's Timber and Trading Co., showed the seed to be very pure.

Reference—Chem. Lab. File 90/49.

Locality—M.C. 29H.

<i>Analysis</i> (1922)—				%
Water soluble CaO	....	....	....	31.74
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	....	97.44
Acid soluble CaO	....	....	....	.26
equal to CaCO_3	....	....	....	.46
Insoluble in acids	....	....	....	.56
NaCl	....	....	....	.56

Remarks.—Seed gypsum suitable for all purposes—yields a quick-setting plaster of strong body and is pure white in colour.

Another analysis was made for A. Chick in the same year, probably from the same deposit.

Reference—Chem. Lab. File 90/49.

Location—Location 17454.

<i>Analysis</i> (1952)—				%
Insoluble in acids	....	....	....	2.32
NaCl	....	....	....	0.18
Water soluble CaO	....	....	....	31.80
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	....	97.63
Acid soluble CaO	....	....	....	.10
equal to CaCO_3	....	....	....	.18

Remarks.—This material, on calcining at 180° C., yields a high grade plaster of Paris which is pure white in colour, and quick-setting to a strong body. The prepared plaster is well suited for all kinds of modelling and building purposes.

Samples G59A, 60A, 61A were taken in 1952 and results of analyses are shown in Table V. Following are the logs of the sample holes:—

G59A	{	0' 0" to 0' 6"	kopi
	{	0' 6" to 1' 0"	clayey.
	{	1' 0" to 2' 0"	seed.
	{	2' 0" to 3' 0"	seed, clay.
	{	3' 0"	clay.
		2' 6"	water level.
G60A	{	0' 0" to 1' 0"	kopi.
	{	1' 0" to 3' 0"	small seed (dirty).
	{	3' 0" to 4' 0"	larger seed (pink).
	{	4' 0"	pink clay.
	{	3' 0"	water level.
G61A	{	0' 0" to 0' 6"	kopi.
	{	0' 6" to 4' 0"	seed, clay.
	{	2' 0"	water level.

Other holes showed there are small patches of crystals in clay but there is a negligible tonnage of these.

Reserves.

Some 300,000 tons of seed gypsum (with kopi) at 70 per cent. pure.

NORTH-WEST OF KOORDA.

General Information.

Reserve 23022, for gypsum, is 10 miles north-west of Koorda. Access to this lake can be gained by gravel and earth roads from Koorda (*see* Litho. 56/80). The lake itself does not contain much gypsum but there is a small deposit in one arm of the lake which juts into the north-west corner of Location 1143.

Water is five feet from the surface of the lake flat at this spot. Fresh water is probably obtainable at Badjerin Rock, three miles to the south.

Occurrence.

Compacted kopi, one foot thick, covers the bed of the lake in this locality. About seven chains north-east of the north-west corner peg of Location 1143, the kopi overlies four feet of seed gypsum (which gives way to clay and seed). Another hole, three chains north-east of here showed stiff pink clay directly under the kopi. The deposit is only a few chains wide.

Other patches of gypsum have been recorded from nearby. Location 1265 is four miles south-east of the reserve, at the end of this lake system. A dune of impure kopi, 10 chains long, two to three chains wide, and up to eight feet in height is located there. A sample from this locality was analysed in 1914.

Production.

There has been no gypsum production from this locality.

Sampling.

Reference—Govt. Chem. Labs. File 90/49.

Locality—Ninghan Location 1265.

Analysis (1914)—

	%
Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)	46.84
Calcite (CaCO_3)	1.71
Sodium chloride (NaCl)	0.61
Insoluble matter	40.00

Remarks.—This material is a mixture of gypsum and clay, in approximately equal proportions. In its present condition, it is of no economic value whatever. By washing or sifting, most of the clay could be removed and the purified gypsum would then be suitable for agricultural purposes. If the washing were carefully done, a gypsum suitable for plaster making could be obtained.

Reference—Govt. Chem. Labs. File 90/49.

Locality—Near Locations 181 and 681.

Determination (1933)—Finely crystalline gypsum.

Remarks.—The sample is too highly coloured and impure for value as a plaster or any other purpose.

Sample G62A was taken seven chains north-east of north-west peg of Location 1143. Sample included the material from 0' to 5'.

0' to 1' kopi.
1' to 5' seed gypsum.
5' + seed with clay, water.

On analysis, this sample gave the following result:—

Pure gypsum 88.3 per cent., lime carbonate 0.4 per cent., salt 1.9 per cent., sand, clay, etc., 9.25 per cent.

Reserves.

About 6,000 tons only of seed gypsum is available from Reserve 23022. The grade (indicated by one sample only) is 80 per cent. pure gypsum.

MARSHALL ROCK.

General Information.

This deposit consists of several small patches of gypsum associated with clay pans. Surveyed mineral claims include M.Cs. 132H, 133H, 134H, 135H, 145H, 151H, 153H, and the area concerned is covered by Reserves 17715, 12652, and Avon Location 14809. The deposit is almost immediately adjacent to Marshall Rock siding, on the Wyalkatchem-Bullfinch line, approximately 190 miles from Perth.

Occurrence.

The deposit consists of several small occurrences of seed gypsum, granular gypsum, and clay containing crystals.

M.C. 132H.—There is very little gypsum here. Several holes were bored in the claypan and the most promising hole showed

0' 0" to 0' 3" red clay.
0' 3" to 1' 0" small crystals with clay.
1' 0" sand and clay.

Some kopi, mixed with sand, occurs between M.C. 132H and the adjacent M.C. 134H.

M.C. 134H.—This claim encloses a small lake bed which is covered with a layer of seed gypsum over crystals in grey clay. Some gypsum has been removed from this claim (*see para. on production*). Near its western edge the deposit is 2½ feet thick—G63A—

0' 0" to 1' 9" seed gypsum.
1' 9" to 2' 6" crystals in grey clay.
2' 6" sandy clay, water level.

The deposit thins to nil on the east and north. A small dune of kopi on granular gypsum occurs on the south-east shore. The lake bed is studded with trees.

M.C. 133H.—There is a little granular gypsum over clay, containing crystals, on this claim. It occurs as a ridge 10 chains long, 1½ chains wide and average height two feet, between two flats.

M.C. 135H.—Contains a seed dune of crest height 6½ feet over clay with a little gypsum. Dune is one chain wide and five chains long. A kopi dune occurs near the claim along the south-east boundary.

Vegetation on the dunes is salmon gum, native pine and some scrub.

Location 14809.—Includes M.C.s 145H, 151H, 152H, 153H. M.C. 153H contains practically no gypsum. The other three claims are on clay containing crystals in the lake bed. The crystals persist to depths of three feet. M.C. 145H also includes a dune containing impure kopi (two feet), over seed (two feet), over clay with some crystals. Quartz sand is the main impurity in the kopi. A thin layer of crystals occurs in the clay pan on the southern boundary of M.C. 145H.

A dune runs along the eastern edge of the lake on Location 14809. The top cover on the dune is clay, kopi, or a mixture of both—up to depths of three feet. This overlies about four feet thickness of granular gypsum. The dune is about 10 chains wide. Some seed gypsum (two feet depth) was noted in the north-east corner of the lake bed.

Vegetation in the lake flat is a little samphire. Morrel, salmon gum and ti-tree grow on the dunes.

Production.

The only production recorded from this area was in 1946. A total of 267 tons was produced from M.C. 134H. (It is listed as "Welbungin" in the Production Table.)

Sampling.

Samples G63A to G68A, G69 to G71, G71A were taken from this area and analysis results are shown in Table V. The plan shows the sample locations and logs are listed below :—

G63A	0' 0" to 1' 9"	seed.
	1' 9" to 2' 6"	crystals, clay.
	2' 6"	sand, clay, water.
G64A	0' 0" to 1' 6"	granular gypsum.
	1' 6" to 3' 0"	clay, crystals.
	3' 0"	sand, clay.
G65A	0' 0" to 6' 6"	seed.
	6' 6"	clay.
G66A	0' 0" to 3' 0"	crystals, clay.
	3' 0"	clay.
G67A	0' 0" to 2' 0"	clay.
	2' 0" to 2' 6"	crystals, clay.
	2' 6" to 3' 3"	granular gypsum, clay.
	3' 3"	grey clay.
	3' 0"	water level.
G68A	0' 0" to 0' 4"	clay.
	0' 4" to 2' 0"	clay, crystals.
	2' 0" to 4' 0"	clay, crystals, some seed.
	4' 0"	clay.
	2' 0"	water level.
G69	0' 0" to 2' 0"	impure kopi.
	2' 0" to 4' 0"	seed.
	4' 0"	clay, some crystals.
G70	0' 0" to 2' 0"	loam.
	2' 0" to 6' 0"	granular gypsum, clay.
	6' 0"	clay.
G71	0' 0" to 3' 0"	kopi.
	3' 0" to 7' 6"	granular gypsum.
	7' 6"	clayey.
G71A	0' 0" to 2' 0"	seed.
	2' 0" to 2' 3"	crystals, clay.
	2' 3"	clay.

Only sample G65A (80 per cent.) showed a grade in excess of 65 per cent., while G70 was as low as 29 per cent.

Reserves.

M.C. 132H.—Nil.

M.C. 134H.—Some 46,000 tons of seed and crystals—grade 65 per cent. pure.

M.C. 133H.—2,500 tons of granular and crystalline gypsum—grade 34 per cent. pure.

M.C. 135H.—1,200 tons of seed—grade 80 per cent. pure.

Location 14809.—

146,000 tons of crystals—35 to 40 per cent. pure.

32,000 tons of seed—60 per cent. pure.

180,000 tons of kopi and granular gypsum—grade 48 per cent. pure.

LAKE BROWN.

General Information.

This deposit is about 155 miles east-north-east of Perth and about 12 miles north-east of Elabbin, the nearest railway siding. Elabbin is on the Wyalkatchem-Merredin railway, 20 miles from Merredin. The present leaseholders truck gypsum to the siding at Elabbin then load it on to railway trucks for Perth.

The numerous mineral claims on this lake are shown on the plan. Nearby locations are Avon Locations 14295, 14333, 14212.

Occurrence.

Seed gypsum is won from a large bank of gypsum along the eastern shore of Lake Brown. This bank is 18 inches in average thickness but is only one foot thick in places. Seed gypsum has been taken from this bank for many years but the dunes on the shore have been by-passed. These are considered too impure for plaster manufacture, by the leaseholders.

Some seed is present on the lake shore but the depth of this seed is generally less than four feet and grades into sand at depth. It forms a narrow dune system which is backed by kopi with granular gypsum and is contaminated with quartz sand in places.

The seed bank, which parallels the northern boundary of Location 14212, varies in thickness up to one foot and is contaminated with quartz grains.

Production.

Gypsum was first removed from this deposit in 1935 when 441 tons were produced. There was no production in the years 1936, 1937, 1942, 1943 but 46,629 tons have been produced since 1935. (see Production Table, p. 20). Average production for 1951 and 1952 was 8,000 tons approximately.

Sampling.

Reference.—Chem. Lab. File 90/49.

Locality.—Lake Brown.

Analyses (1948)—

	No. 1.	No. 2.
Insoluble in acid	1.22	0.32
Water sol. CaO	30.42	32.56
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	93.4	100.0
CaCO_3	Nil	Nil

Remarks.

No. 1—Seed gypsum from seven foot bank.

No. 2.—Big pieces of gypsum.

Both good for plaster.

Samples G72 to G82 were taken from Lake Brown and analysis results are shown in Table V. (see plan for location of samples).

Sample logs are as follows:—

G72	0' 0" to 4' 0"	seed.
	4' 0"	seed, sand.
G73	{ 0' 0" to 2' 0"	kopi.
	{ 2' 0" to 3' 0"	granular gypsum.
	{ 3' 0"	sand.
G74	0' 0" to 5' 0"	seed.
	5' 0"	sandy.
G75	0' 0" to 2' 0"	seed.
	2' 0"	clay.
G76	0' 0" to 7' 0"	kopi, seed.
	7' 0"	sand, seed.
G77	0' 0" to 2' 6"	seed.
	2' 6"	clay.
	2' 0"	water level.
G78	{ 0' 0" to 1' 0"	kopi.
	{ 1' 0" to 4' 0"	seed.
	{ 4' 0"	sand.
G79	0' 0" to 7' 0"	seed.
	7' 0"	seed.
G80	0' 0" to 1' 6"	seed.
	1' 6"	clay.
G81	0' 0" to 7' 0"	kopi, granular gypsum.
	7' 0"	kopi, granular gypsum.
G82	0' 0" to 3' 0"	silica, seed.
	3' 0"	clay.

Reserves.

Although the deposit contains about 1,100,000 tons of seed gypsum at a grade of 90 per cent. (or better), much of the deposit must be left on the floor of the lake to avoid the clay underneath.

CHANDLER.

General Information.

Chandler townsite is 170 miles north-east of Perth. Road distance, via Merredin, is 195 miles. The nearest siding is Weira on the Bonnie Rock line, a distance of seven miles.

The town was built to accommodate workers at the alunite works, which ceased operations in December, 1949. From October, 1950, to May, 1952, plaster was produced at the works by Australian Plaster Industry Pty., Ltd. There were very few people in the town in July, 1952.

Water is piped to Chandler from the Goldfields Pipeline at Burracoppin.

Occurrence.

The deposit worked is on the east shore of the northern-most lake of a series. M.C. 38 (Yilgarn) was taken out on the deposit but not surveyed.

Several patches of seed gypsum are shown on the plan. The seed worked is very coarse and of rather irregular grade. It occurs, as usual, on the east and south-east shores of the lake and is contaminated with silica sand in places. Some gypsum has also been removed from the south where small crystals were noticed in the clay beneath the seed. Here the seed occurs in a low bank but that to the north is in dunes of considerable height. A pit of 22 feet depth has been made there.

There is an unsurveyed M.C. 430H on a small clay pan some four miles south of Chandler. This clay pan has a line of dunes on each of its northern and southern banks. Both of these contain seed gypsum but the southern belt has a kopi cover. The northern belt ranges up to six feet crest height while that to the south is 10 feet in places. This claim has not been worked.

Production.

Fifty-nine thousand three hundred and seventeen tons of gypsum were produced from this deposit, yielding 29,099 tons of plaster. This was all exported to the Eastern States.

Sampling.

Several samples were analysed from this deposit over the years from 1922 to 1949. Only those giving a definite locality are reproduced below.

Reference—Chem. Lab. File 90/49.

Location—Junction of Locations 15895, 15896.

Analyses (1922)—

	1.	2.	3.
Water soluble CaO	32.26	31.61	24.87
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	99.04	97.04	87.46
Acid soluble CaO ....	.11	.38	1.70
equal to CaCO_3 ....	.19	.68	3.03
Insoluble in acids ....	.54	1.11	4.03
NaCl ....	.14	.20	2.06

Remarks.—Samples Nos. 1 and 2 are high grade seed gypsum which, when calcined at 180°C. , give a quick-setting pure white plaster which is suitable for all purposes.

Sample No. 3 is kopi—impure gypsum—with an appreciable amount of NaCl. Its plaster is of no value, being slow-setting, light grey in colour, and lacking in strength.

Reference—Chem. Lab. File 90/49.

Location—South end of big lake.

Analysis (1926)—

Insoluble in acid ....	.....	10.17
CaSO ₄ .2H ₂ O ....	.....	88.10
CaCO ₃ ....	.....	Nil
NaCl ....	.....	trace

Remarks.—Seed gypsum. Calcining at 180° C. gave a moderately slow-setting plaster of strong body and good white colour.

Samples Nos. G83-98 were taken from the Chandler deposits in 1952 (including G96-98 from the clay pan four miles south of Chandler). Analysis results are shown in Table V. and the samples are located on the plan. Logs of the samples are:—

G83	0' 0" to 12' 0"	seed.
G84	12' 0" to 21' 0"	seed.
	21' 0" to 22' 0"	seed.
	22' 0"	red clay.
G85	0' 0" to 5' 0"	clayey seed.
	5' 0"	clay.
G86	0' 0" to 5' 0"	kopi and granular gypsum.
	5' 0"	kopi and granular gypsum.
G87	{ 0' 0" to 2' 0"	kopi.
	{ 2' 0" to 7' 0"	granular gypsum.
	{ 7' 0"	granular gypsum.
G88	0' 0" to 5' 0"	seed.
	5' 0"	sand.
G89	0' 0" to 5' 0"	seed.
	5' 0"	seed.
G90	0' 0" to 3' 6"	seed.
	3' 6"	sand.
G91	0' 0" to 2' 6"	seed.
	2' 6" to 3' 0"	clay.
	3' 0" to 3' 6"	clay, crystals.
	3' 6"	sand.
G92	0' 0" to 6' 0"	granular gypsum.
	6' 0"	granular gypsum.
G93	{ 0' 0" to 2' 0"	kopi.
	{ 2' 0" to 5' 0"	granular gypsum.
	{ 5' 0"	granular gypsum.
G94	{ 0' 0" to 2' 0"	dirty seed.
	{ 2' 0" to 8' 0"	clean seed.
	{ 8' 0"	sand.
G95	0' 0" to 4' 0"	seed.
	4' 0"	sand.
G96	0' 0" to 6' 0"	seed.
	6' 0"	clay.
G97	0' 0" to 5' 0"	seed.
	5' 0"	sandy.
G98	0' 0" to 6' 0"	seed.
	6' 0"	clay, crystals.

Samples G83, 84, 90, 98 were the only ones which showed grade of 90 per cent. or better.

Reserves.

There is an estimated tonnage of 120,000 tons of seed gypsum of higher than 95 per cent. purity in the northern dune near samples G83, 84.

There is also 100,000 tons of 84 per cent. pure gypsum, in the form of seed, along the south-east shore of the main lake.

Some 30,000 tons of 75 per cent. pure gypsum can be won from the seed dune containing G94, 95 and some 60,000 tons of kopi and granular gypsum is available from the various kopi dunes. (Samples G86, 87, 92, 93 average 80 per cent.)

M.C. 430H contains a total of 40,000 tons of seed gypsum (with some kopi) at an average grade of 70 per cent. pure gypsum.

HINES HILL.

General Information.

This deposit was first examined in 1923 (*see* 1924, Feldtmann)⁷.

The gypsum occurs to the north of the townsite which is on the railway, road and pipe line to the Eastern Goldfields, about 156 miles east of Perth.

Surveyed mineral claims include M.C.s 27H, 28H, 34H, 35H, 63H.

Occurrence.

Gypsum occurs as seed, crystals and kopi and granular gypsum associated with clay pans (*see* plan).

P.A. 333PP.—Covers a small lake and some of the associated seed dune. Crystals, up to three inches long, occur as a layer on the surface of the dry lake. A sample hole in the crest of the dune (G121) showed :—

0' 0" to 3' 6"	seed.
3' 6" to 5' 6"	kopi.
5' 6" to 11' 0"	granular gypsum and kopi.
11' 0"	clay.

Vegetation of scrub, native pine and salmon gum on the dune.

M.C.s 34H, 35H.—Some crystals of gypsum are present on the lake surface in a thin layer and under two feet of seed at the north corner of M.C. 35H. The dune around the south-east edge has a cap of seed over kopi and granular gypsum. This overlies sand in the south-east corner and clay near the north end. Thickness of material varies, up to 11 feet.

M.C. 27H.—The gypsum is in the form of seed, contaminated with silica sand. A maximum depth of 10 feet occurs at two chains east of the east peg of M.C. 27H. Sand dunes occur east of here and at the western end of the lunar shaped seed dune. There is no gypsum on M.C. 27H. Native pines and gums comprise vegetation on the dune.

⁷1924 Feldtmann, F. R. : The Gypsum Deposits on Mineral Claims 27H and 28H, Hines Hill, Avon District, South-West Division. *G.S.W.A. Ann. Prog. Rep.* 1923, pp. 20-21,

M.C.s 28H, 63H, etc.—The round islands of seed here average about three feet in thickness and the dune has a maximum thickness of six feet to a sandy base. Average thickness of seed in the dune would be no more than three feet. Holes on M.C. 63H show :—

0' 0" to 0' 6" very dirty seed.
 0' 6" to 1' 6" sand and clay.
 1' 6" to 1' 8" crystals in clay.
 1' 8" clay.

Production.

Gypsum production from Hines Hill was revived in 1949, after a lapse of 20 years.

Year.	1924.	1925.	1926.	1927.	1928.	1949.	1950.	1951.	1952.	Total.
Tons	641	1,035	301	Nil	722	1,356	732	181	1,244	6,212

Sampling.

Two samples from this deposit were analysed in 1922.

Reference.—Chem. Lab. File 90/49.

Locality.—Half a mile from railway station.

Analyses (1922).—

	No. 1.	No. 2.
Water soluble CaO	28.96	28.83
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	88.91	88.51
Acid soluble CaO	Nil	0.05
equal to CaCO_3	Nil	0.09
Insols. in acid	9.67	9.84
NaCl	0.06	0.07

Remarks.—Both are seed gypsums and give a quick-setting, strong plaster.

No. 1—plaster is white with black specks.

No. 2—plaster is white and suited for all modelling purposes.

Samples G116 to G125 were taken in 1952 and analysis results are shown in Table V. Sample locations are shown on the plan and the logs are reproduced below :—

G116	0' 0" to 10' 0"	seed clay.
G117	0' 0" to 5' 0"	seed, sand. clay.
G118	{ 0' 0" to 6' 0" 6' 0" to 7' 0" 7' 0"	seed. seed, sand. sand.
G119	0' 0" to 3' 0" 3' 0" to 5' 0" 5' 0" to 8' 0" 8' 0"	seed. kopi, vegetable matter. kopi, granular gypsum. sand.

G120	0' 0" to 4' 6"	seed. sandy.
G121	{ 0' 0" to 3' 6" 3' 6" to 5' 6" 5' 6" to 11' 0" 11' 0"	seed. kopi. granular gypsum, kopi. clay.
G122	0' 0" to 2' 0" 2' 0" to 3' 0" 3' 0"	seed. crystals. sand, clay.
G123	{ 0' 0" to 2' 6" 2' 6" to 7' 0" 7' 0" to 8' 6" 8' 6"	seed. granular gypsum, kopi. seed. sand.
G124	{ 0' 0" to 5' 0" 5' 0" to 11' 0" 11' 0"	seed. kopi, granular gypsum. clay.
G125	0' 0" to 2' 6" 2' 6" to 4' 0" 4' 0"	kopi. granular gypsum. sand.

Samples G121, G123, G125 showed 95·8 per cent., 96·7 per cent., 94·1 per cent. respectively. G116, G117, G122 were below 80 per cent. gypsum.

Reserves.

P.A. 333PP—

700 tons of crystals (? 85 per cent.).

19,300 tons of seed and granular gypsum—grade 95 per cent.

M.C.s 34H, 35H—20,000 tons of seed with kopi, crystals, and granular gypsum—grade 71 per cent.

M.C. 27H.—16,000 tons of seed gypsum—grade 59 per cent.

Dune to east and south of M.C. 28H—14,500 tons of seed—85 per cent.

Four seed deposits west of M.C. 28H—some 20,000 tons of seed—grade of (? 80 per cent.).

At sample G125—3,000 tons of kopi and granular gypsum (94 per cent.).

BAANDEE.

General Information.

The deposit is on the bed of a lake three miles south-west of Baandee. Baandee is approximately 150 miles east of Perth on the Kalgoorlie line. Access to the workings is gained from the Doodlakine side of the lake (*see* Feldtmann, 1926³).

There are several mineral claims on the deposit but all are held by Perth Modelling Works Pty., Ltd. When railway transport is unavailable, gypsum is taken direct to Perth from here by motor trucks.

M.C. 74H on the lake to the north, contains little gypsum.

³1926 Feldtmann, F. R.: The Gypsum Deposits of the Avon District, South-West Division. *G.S.W.A. Ann. Prog. Rep.* 1925, pp. 2-9. (M.C. 30H, North Baandee; Baandee; Woolundra; M.C. 33H, near Cunderdin.)

Occurrence.

There is a low ridge of impure seed gypsum along the south-east shore of the lake. The seed gypsum being worked in the lake bed is never more than 16 inches deep and thins out to nothing in places. The base of the gypsum is clay and there is often a thin cover of kopi.

In wet weather, the lake is flooded and work has to be abandoned. There is a fresh water soak at the north end of the lake.

Vegetation consists of occasional scrub on the fringes of the lake. The rest of the surface is practically free of vegetation.

Production.

The gypsum is shovelled into skips on light rails running out into the lake. It is then trucked back to the north-west shore where it is washed to remove any clay, kopi and fine seed. The washed seed is a high grade gypsum suitable for surgical plaster.

Production began in 1924 and the deposit has been worked every year since then. The deposit was worked for several years by Millars' Timber and Trading Co., as well as the present lessees. Tonnage of gypsum removed to the end of 1952 is 83,939 tons (*see* Production Table).

Sampling.

Reference—G.S.W.A. File 135/01.

Locality—M.C. 31H.

Analyses (1925)—

No. 1—"Black mud" overlying gypsum, M.C. 31H—

	%
Gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	44.55
Magnesium sulphate, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	1.70
Magnesium chloride, $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	5.59
Sodium chloride, NaCl	12.40
Free Sulphur, S} .....	.22
Carbon, C.4.15, equal to humus	7.14
Insoluble in water	25.13
Moisture	3.87
	<hr/> 100.60

Remarks.—A fine-grained mixture of gypsum, salt, sand, clay and finely divided organic matter.

No. 2—Typical sample of gypsum, M.C. 31H— %

Insoluble in acid	0.31
Acid soluble lime, CaO	0.06
equal to calcite, CaCO_3	0.11
Water soluble lime, CaO	32.42
equal to gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	99.53
Salt, NaCl	traces

Remarks.—The sample consisted of rather coarse crystals of gypsum (seed gypsum) slightly tinted. Yields a slow-setting plaster of paris (setting time 25 minutes), white in colour but containing a number of minute black specks, due to the presence of organic matter. This gypsum could, however, be used for plaster making.

In 1923, Mr. J. Saunders submitted some impure gypsum for determination. It contained too much NaCl for agriculture and was too discoloured for plaster. However, a sample from M.C. 74H was analysed in 1925 and gave good results. This claim has already been referred to above.

Reference—G.S.W.A. File 135/01.

Locality—M.C. 74H.

Analysis (1925)—

	%
Insoluble in acid	2.94
Acid soluble CaO	0.40
equal to CaCO_3	0.71
Water soluble CaO	31.46
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	96.59
Salt, NaCl	traces

Remarks.—Rather fine prismatic crystals of gypsum (seed gypsum) very white and clean looking. Yields a rather slow-setting (20 minutes) plaster of paris, pure white in colour and of strong body. This is an excellent sample of gypsum for plaster making or other purposes.

Samples G126-131 were taken in 1952 and analysis results are shown in Table V. The samples are located on the plan and the logs are shown below:—

G126	0' 0" to 1' 0"	seed.
	1' 0"	clay.
	0' 4"	water level.
G127	0' 0" to 0' 8"	seed.
	0' 8"	clay.
G128	0' 0" to 0' 10"	seed.
	0' 10"	clay.
G129	0' 0" to 0' 10"	seed.
	0' 10"	clay.
G130	0' 0" to 1' 4"	seed.
	1' 4"	grey clay.
	1' 0"	water level.
G131	0' 0" to 1' 0"	seed.
	1' 0"	grey clay.
	0' 9"	water level.

Samples G127, 130 showed a grade better than 90 per cent., while G129 was only 74 per cent. pure.

Reserves.

Although it is not all recoverable, there is a tonnage of some 500,000 tons of seed gypsum in this lake flat. The average grade is about 85 per cent. pure gypsum.

15 MILES NORTH OF BAANDEE.

General Information.

The deposit is practically enclosed by M.C. 110H on Avon Location 22818. Access is by track from a good road $1\frac{1}{2}$ miles to the south (see Feldtmann, 1926)⁹.

Occurrence.

Seed is the principal variety of gypsum here, with odd patches of kopi east of the dune and also within the dune itself. The maximum crest height of the dune is 12 feet and consists, at this point, of more than 10 feet of seed and kopi. The clay surface of the lake is practically clear of gypsum except against the dune in the south-east corner. Here the dune occupies only half the width of seed, the inner part being a layer of seed one foot in thickness, on the lake surface.

Production.

None recorded.

Sampling.

Reference—G.S.W.A. File 135/01.

Locality—From dune on M.C. 30H (= M.C. 110H).

Analysis (1925)—

	%
Insoluble in acid	4.28
Acid soluble CaO	0.94
equal to CaCO ₃	1.68
Water soluble CaO	30.36
equal to CaSO ₄ .2H ₂ O	93.21
NaCl	traces

Remarks.—A rather coarsely crystalline gypsum which yields a good white plaster with a strong body (setting time 25 minutes). Is of good commercial grade.

Samples G132, 133, 134 were taken from this deposit in 1952 and analysis results are shown in Table V. The locations of the samples are shown on the plan and logs of the sample holes are shown below:—

G132	0' 0" to 0' 6"	seed.
	0' 6"	clay.
G133	0' 0" to 5' 0"	seed.
	5' 0" to 6' 0"	seed.
	6' 0"	clay.
G134	0' 0" to 2' 6"	seed.
	2' 6" to 3' 6"	kopi.
	3' 6" to 6' 0"	seed.
	6' 0" to 7' 0"	kopi.
	7' 0" to 10' 0"	fine seed.
	10' 0"	fine seed.

G132, 133 were 76 per cent. pure gypsum and G134 was 94 per cent.

⁹1926 Feldtmann, F. R.: The Gypsum Deposits of the Avon District, South-West Division. G.S.W.A. Ann. Prog. Rep. 1925, pp. 2-9. (M.C. 30H, North Baandee; Baandee; Woolundra; M.C. 33H, near Cunderdin.)

Reserves.

There is an estimated tonnage of 20,000 tons of seed gypsum of better than 90 per cent. grade and a further 2,500 tons of 76 per cent. grade seed gypsum in the lake flat and the dune around samples G132, 133.

WOOLUNDRA.

General Information.

There are several small claims in an area about one and a half miles south of Woolundra siding. The siding is 127 miles east of Perth on the Kalgoorlie railway line and pipeline. Access can be gained to most of the deposits from the road down the centre of the area (see Feldtmann, 1926¹⁰).

Occurrence.

There is very little gypsum in this locality. The seed deposits were worked out long ago.

M.L. 6PP.—Two dunes occur on this lease. The more westerly one is composed of layers of seed and granular gypsum to a depth of four and a half feet at the crest, with a cover of gums, bull oak and a little scrub. The east dune is mostly of granular gypsum with a thin veneer of seed. Maximum depth of gypsum is six feet. Vegetation of gums and ti-tree on dune. The small kopi dune just south-east of the lease is a mixture of kopi and granular gypsum with patches of clay impurity.

M.C.s 410H, 293H.—These claims are over kopi dunes. The dune on M.C. 410H is composed of kopi and has a thickness of two and a half feet. On M.C. 293H, the deposit is kopi (one and a half feet) over granular gypsum (more than two and a half feet). These deposits have been worked by Mr. Ripper for the cement producers.

M.C. 123H.—The deposit here consists of seed with a thin layer of kopi on top and with crystals at its base. Total thickness of gypsum is one foot.

M.C. 32H.—Is a worked out deposit which was composed of seed on the lake surface.

M.C.s 24H, 183H.—Both claims contain a kopi dune (two feet of kopi over four feet of granular gypsum). This dune is in a cleared paddock. M.C. 24H also contains M.C. 121H, which is pegged around a patch of seed gypsum in the lake. Average thickness of the seed is about one foot. Some clayey kopi occurs east of this lake.

M.C.s 84H, 120H.—Worked out lake bed deposits. The greatest thickness of seed crystals present now is two inches. A small dune to the south-east has a six inch layer of dirty seed on its western edge.

M.C.s 83H, 116H, 122H.—A deposit of seed gypsum (now worked out) was contained by M.C. 116H and the northern half of M.C. 83H. A small kopi dune runs down into M.C. 122H, but is of little consequence.

¹⁰ 1926 Feldtmann, F. R.: The Gypsum Deposits of the Avon District, South-West Division G.S.W.A. *Ann. Prog. Rep.* 1925, pp. 2-9. (M.C. 30H, North Baandee; Baandee. Woolundra; M.C. 33H, near Cunderdin.)

Production.

Gypsum has been produced from this locality since 1924. No Production was recorded in 1931. A total of 53,114 tons were produced to the end of 1952 (see Production Table) and material for the cement industry is still available. The gypsum worked in earlier years was the seed which was used in the plaster industry.

Sampling.

Samples G135 to G141 were taken from the various small deposits in this area. Analysis results are shown in Table V., sample localities are shown on the plan and sample logs are shown below:—

G135	0' 0" to 1' 4"	kopi. granular gypsum and kopi. sand.
	1' 4" to 4' 0"	
	4' 0"	
G136	{ 0' 0" to 0' 3" 0' 3" to 0' 11" 0' 11" to 1' 0" 1' 0"	kopi, fine seed. dirty seed. crystals. clay.
G137	{ 0' 0" to 1' 0" 1' 0" to 2' 6" 2' 6"	kopi (white). kopi (grey). clay.
G138	{ 0' 0" to 0' 9" 0' 9" to 6' 0" 6' 0"	seed. granular gypsum. sand.
G139	{ 0' 0" to 0' 5" 0' 5" to 4' 0" 4' 0"	seed. granular gypsum. sand.
G140	{ 0' 0" to 0' 2" 0' 2" to 2' 6" 2' 6" to 4' 0" 4' 0" to 4' 6" 4' 6" 0' 0" to 0' 6"	seed. granular gypsum. seed. granular gypsum. clay, sand. clay.
G141	0' 6" to 1' 10" 1' 10" to 6' 0" 6' 0"	kopi. granular gypsum. clay.

All of these samples contained less than 80 per cent. gypsum.

Reserves.

M.L. 6PP.—12,000 tons of seed and granular gypsum, grade at 65 per cent. pure.

M.C. 410H.—3,000 tons of kopi—grade 64 per cent. pure.

M.C. 293H.—3,000 tons of kopi—grade 79 per cent. pure.

M.C. 123H.—5,000 tons of seed and crystals—grade 70 per cent. pure.

M.C. 32H.—Nil.

M.C. 24H.—(See M.C.s 183H, 121H, below.)

M.C. 183H.—12,000 tons of kopi and granular gypsum—grade 82 per cent. pure.

M.C. 121H.—4,000 tons of seed—probable grade 70 per cent.

KELLERBERRIN.

General Information.

The deposit is five miles south of the townsite which is 133 miles from Perth on the Kalgoorlie railway line. Access is gained from a south-running road two miles to the west. The track from the east is somewhat boggy in the wet weather but the other should be accessible all the year round. M.C. 366H (unsurveyed) is the mineral claim on the deposit, Avon Location 18975.

Occurrence.

The layer of crystals shown on the surface of the lake forms a hard buckled mat two inches thick. The mat also contains a considerable quantity of crystallised salt.

The seed on the dune is only one foot thick and overlies kopi and granular gypsum. The dune becomes sandy at a depth of five feet below the crest. Some fairly large gums grow on the dune.

In July, 1952, water was six inches deep in the lake.

Production.

The gypsum crystals were removed on a skip then trucked away. Seven tons of gypsum were produced from here in 1947 by the Ajax Plaster Co., but no other production has been recorded.

Sampling.

Samples G142, G143 were taken from the lake and the dune respectively. Results of analysis are shown in Table V.

Reserves.

There is an estimated 1,000 tons of gypsum crystals of 93 per cent. purity and 6,400 tons of seed (81 per cent. pure).

WYOLA.

General Information.

The deposit is about 30 chains north of the Kalgoorlie railway line, 114 miles east of Perth, on Avon Location 8761, M.L. 6PP.

Occurrence.

The deposit consists of a circular bank of pink coloured compacted kopi, of average thickness two feet, covering an area of five acres in a clay pan. Some samphire grows on the bank.

Production.

Nil.

Sampling.

Sample G151, taken as a random sample showed the surprisingly high gypsum content of 89 per cent. (Table V.)

Reserves.

Tonnage estimate of compacted kopi is 10,000 tons.

CUNDERDIN, FOUR MILES EAST.

General Information.

This deposit is on M.C. 33H, Avon Location 13052, just north of the Kalgoorlie railway line. Cunderdin is 104 miles east of Perth. Access from the Great Eastern Highway can be gained by a track which crosses the railway line at the Rabbit Proof Fence one and a half miles west of the deposit (*see* Feldtmann, 1923¹¹).

Occurrence.

Most of the lake surface is covered with crystals which vary in size from one-third of an inch to two inches in length. The crystals are densely packed in some places but are rather loose in others. Thickness of the crystal layer varies from three inches to 18 inches, average nine inches.

The crystals are quite pink due to impurities of iron and some clay. There is also clay associated with the crystals. There was water in the lake at the time of inspection.

A kopi dune is present near the south-east shore but this is heavily covered with sand.

Production.

None recorded.

Sampling.

Reference.—Chem. Lab. File 90/49.

Location.—M.C. 33H.

Analyses (1924).—

	No. 1.	No. 2.
	%	%
Insoluble in acids	20.48	5.54
Water soluble CaO	24.00	29.70
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	73.68	91.18
Acid soluble CaO	2.02	.88
equal to CaCO_3	3.60	1.58

Remarks.—No. 1—Sandy kopi—no use for plaster—good for agriculture.

No. 2—Coarsely crystalline—too discoloured with iron compounds (even after washing) for plaster. Needs grinding for agriculture.

Reference.—G.S.W.A. File 135/01.

Locality.—M.C. 33H.

Analysis (1925).—

	%
Insoluble in acid	1.74
Acid soluble CaO	1.10
equal to CaCO_3	1.96
Water soluble CaO	31.00
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	95.18
NaCl	traces

¹¹1926 Feldtmann, F. R.: The Gypsum Deposits of the Avon District, South-West Division. *G.S.W.A. Ann. Prog. Rep.* 1925, pp. 2-9. (M.C. 30H, North Baandee; Baandee: Woolundra; M.C. 33H, near Cunderdin.)

Remarks.—The sample was a compact mass of large iron-stained gypsum crystals. It was discoloured with ferruginous clay and gave a pink powder on fine grinding. Yielded a slow-setting (35 minutes) plaster of good body but too cream coloured to be of any commercial value except as a land dressing.

Washing crystals with water would remove a large proportion of the iron and improve the colour.

Samples G147, G150 were taken from this deposit (Table V.).

Sample G147 was from the layer of crystals which were washed while sampling as they occur in water.

Reserves.

About 7,000 tons of crystals are present (80 per cent.).

There are also a few tons of 69 per cent. pure kopi, under a two feet thick cover of sand.

CUNDERDIN, SIX MILES EAST-NORTH-EAST.

General Information.

The deposit is on Avon Location 20630, five chains south of the south-west corner peg of Location 17599. Access is gained by one mile of sand track from a road heading north from the railway line, just west of Wyola siding.

Occurrence.

Immediately south-east of the water in a small clay pan is a patch of seed gypsum overlain by crystals. The crystals form a thin layer about one inch thick and the average thickness of the seed is six inches.

The two kopi dunes are rather impure and somewhat compacted. The average depth of kopi would be less than two feet.

Production.

G148 was taken from the six inch thick layer of seed gypsum which overlies clay and water.

G149 was taken from the kopi ridge immediately adjacent to the seed. Material below the sample is also impure kopi for two feet.

Reserves.

About 1,400 tons of seed gypsum at 90 per cent. purity and a similar tonnage (1,500 tons) of kopi at 90 per cent.

CUNDERDIN, FOUR MILES EAST-NORTH-EAST.

General Information.

The deposit is enclosed by P.A. 231PP on Avon Location 20630, 20 chains north-east of the north-east corner peg of Location 15840. It can be reached by a track running through the adjacent Location 19342, from the Rabbit Proof Fence.

Occurrence.

The gypsum occurs mainly as fine seed on the floor of a small clay pan. Water is present in the pan. Average depth of this seed, which contains some clay and vegetable matter, is one foot six inches. There is no living vegetation on the deposit.

There is a small kopi dune to the south-east of the pan. Here two and a half feet of kopi overlies a further three feet of granular gypsum on a sandy base.

Production.

There is a small pit in the dune but there is no record of any gypsum production from this area.

Sampling.

Samples G144, G145 and G146 were taken from this deposit (see Table V. for analyses). Logs of sample holes are:—

G144	{	0' 0" to 1' 6"	clean seed.
		1' 6"	water.
	{	1' 6" to 2' 0"	dirty seed (clay).
		2' 0"	dirty seed (clay).
G145		0' 0" to 1' 6"	seed.
		1' 6"	clay, water.
G146	{	0' 0" to 2' 6"	kopi.
		2' 6" to 5' 6"	granular gypsum.
		5' 6"	sand.

The dirty seed, included in sample G144, reduced the grade seven per cent. as compared with G145.

Reserves.

The tonnage of seed gypsum in the lake is estimated at 24,000 tons of 89 per cent. pure gypsum.

The amount of kopi and granular gypsum (63 per cent. pure) is negligible.

TABLE VI.—SAMPLE ANALYSES—AREA No. 4.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*				
				Acid Soluble.		SO ₃ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ ·2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO. SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.
				CaO.	MgO.								
1952.				%	%	%	%	%	%	%	%		%
14317	G164	<i>Lands Dept. Litho. 36/80.</i> Southern Cross (see Plan)	0' to 2' 4". From lake flat	26.88	....	37.45	0.02	0.95	80.60	0.05	0.95	CaO 0.65	17.75
14318	G165	do. do.	0' to 5'. From seed dune	24.97	....	35.08	0.04	0.25	75.45	0.10	0.25	CaO 0.4	23.80
14319	G166	<i>Lands Dept. Litho. 24/300.</i> Lake Seabrook (see Plan)	0' to 5'. From seed dune	32.84	....	46.00	0.05	0.20	99.00	0.10	0.20	CaO 0.65	0.05
14320	G167	do. do.	0' to 3'. From seed bank	32.81	....	45.87	0.05	0.60	98.65	0.10	0.60	CaO 0.65	....
14321	G168	do. do.	0' to 1'. From lake bed	27.23	trace	38.31	....	2.60	82.40	....	2.60	CaO 0.45	14.55
14322	G169	do. do.	0' to 1'. From lake bed	28.07	trace	39.69	0.05	3.15	85.40	0.10	3.15	CaO 0.3	11.05
14323	G170	do. do.	5' to 16'. From seed dune. Channel	32.98	....	46.25	....	0.25	99.45	....	0.25	CaO 0.3	....
14324	G171	do. do.	0' to 2' 6". From seed sample dune. Channel sample	32.56	....	45.67	0.02	1.25	98.20	0.05	1.25	CaO 0.5	....

TABLE VI.—continued.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*				
				Acid Soluble.		SO ₂ .	CO ₂ .	Chlorides as NaCl.	Gypsum CaSO ₄ ·2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.
				CaO.	MgO.								
1952 14325	G172	<i>Lands Dept. Litho.</i> 19/300. Mt. Palmer (see Plan)	0' to 1' 10". From seed bank. Channel sample	31·22	....	43·54	0·10	1·70	93·70	0·25	1·70	CaO 0·65	3·70
14326	G173	do. do.	0' to 3'. From seed bank. Channel sample	31·91	....	44·58	0·02	1·35	95·90	0·05	1·35	CaO 0·75	1·95
14327	G174	do. do.	0' to 2'. From seed bank. Channel sample	29·41	....	41·55	0·05	0·65	89·40	0·10	0·65	CaO 0·3	9·55
14328	G175	do. do.	0' to 2'. From seed bank. Channel sample	32·14	....	45·32	0·04	0·15	97·50	0·10	0·15	CaO 0·45	1·80
14329	G176	<i>Lands Dept. Litho.</i> 23/80. Moorine Rock (see Plan)	0' to 4' 6". From lake flat	24·56	....	34·90	0·04	0·85	75·05	0·10	0·85	CaO 0·1	23·90
14330	G177	do. do.	0' to 5'. From lake flat	25·81	....	36·67	0·03	1·70	78·85	0·05	1·70	CaO 0·15	19·25
14331	G178	do. do.	0' to 3'. From lake flat	25·02	....	35·62	0·08	1·15	76·60	0·20	1·15	....	22·05
14332	G179	do. do.	0' to 2' 6". From kopi dune. Channel sample	23·32	....	38·49	0·37	0·30	82·80	0·85	0·30	CaO 0·95	15·10
14333	G180	do. do.	0' to 2'. From lake flat. Channel sample	30·21	....	41·97	0·04	0·05	90·25	0·10	0·05	CaO 0·85	8·75

* Calculated in accordance with suggestions made in " Standard Methods of Testing Gypsum and Gypsum Products " (C26-50), A.S.T.M. Standards, 1950 Supplement, Part 3.

Government Chemical Laboratories, Perth.

AREA No 4.

SOUTHERN CROSS.

General Information.

The deposit is mostly on Lot 75, 100 chains north-east of Southern Cross railway station. It is on the eastern side of the block, while the town rubbish tip is on the west. Roads run fairly close to the deposit on the west, north, and east sides.

There was a little water on the surface of the lake in August, 1952. Scheme water is available at Southern Cross.

Occurrence.

Three varieties of gypsum are present—small crystals, seed, and kopi. All of these are dirty, and the occurrence is a small one. All of Lot 75 is low lying but occasional water is now restricted to the narrow clay flat.

A small seed dune, with clay impurity, occurs at the south-east corner of the flat. The centre of the dune has an average height of four feet and average width is about 90 feet. Sand with clay occurs "outside" this dune and along the east shore of the flat.

A small patch of dirty crystals occurs on the west side of the flat. This varies in thickness from six inches at its northern end to two feet four inches at sample G164. The crystals overlie clay and they occasionally have a two-inch cover of dirty compacted kopi.

The ground to the west is slightly higher and is composed of dirty compacted kopi (three feet) over clay.

The kopi flat is covered with small samphire bushes, while the crystals have no cover of vegetation. Vegetation on the seed dune is low scrub with occasional gums.

Production.

There has been no production from this deposit.

Sampling.

Three samples from this deposit were determined for Mr. J. H. Gratwick in 1922.

Reference—Govt. Chem. Labs. File 90/49.

Locality—Location 16597, blocks 74, 75—Government reserve for sanitary purposes.

Analyses—

No. 1.—From surface: Seed gypsum with clay, iron hydrates, and vegetable matter; 0.4 per cent. NaCl.

No. 2.—From surface: Crystal gypsum and seed gypsum with clay and iron hydrates; 1.46 per cent. NaCl.

No. 3.—Taken out of lake: Crystal gypsum with clay and iron hydrates: 1.31 per cent. NaCl.

Remarks.—All three are too highly-coloured and too impure for plaster.

Holes from which the samples G164, 165 were taken show:—

G164—0' 0" to 2' 4".

0' 0" to 0' 2" compacted kopi.
0' 2" to 2' 4" dirty crystals.
2' 4" — grey clay and water.

G165—0' 0" to 5' 0".

0' 0" to 5' 0" seed gypsum with clay impurity.
5' 0" — red clay.

Results of analysis are shown in Table VI.

Reserves.

Assuming all of the layer of gypsum crystals to be of the same grade, there are 10,000 tons of crystals at 80 per cent. purity.

There are also some 9,000 tons of seed gypsum at 75 per cent. purity.

LAKE SEABROOK.

General Information.

The deposit is on a long peninsular near the eastern shore of Lake Seabrook. It is 22 miles north of Yellowdine by a good gravel road. Yellowdine is 254 miles east of Perth by road and rail (see 1921, Crabb¹²).

There are 13 mineral claims on the deposit. M.Cs. 9, 22-29 are held by Perth Modelling Works Pty., Ltd., and M.Cs. 30-32, 37 are held by Ajax Plaster Co., Ltd.

Salt water is present in the lake bed at shallow depth. Nearest scheme water is at Yellowdine (Goldfields pipe line).

Occurrence.

Three varieties of gypsum are present at this deposit—seed, kopi, and crystals. The deposit is one of the largest in the State and is being worked by both of the companies mentioned above. The leases cover nearly all of the seed dunes but the kopi and crystals are untouched.

The area of seed dunes extends over three miles in length and varies in width. The height of the dunes is also variable. They occur on the western edge of a peninsular which extends northwards into the lake. The deposit can be split into three for the purpose of description. The southern portion is 90 chains long with an average width of 25 chains. It is in the form of windblown hummocks of seed, ranging from one foot to six feet in height, with an average thickness overall of three feet.

The central portion of the deposit is a narrow dune 100 chains long and five chains wide. Height of the crest above lake level varies between eight feet and 20 feet.

¹²1921 Crabb, J.: Note re Lake Seabrook Deposit. *Ann. Rep. of the Dept. of Mines. W.A.* 1920, p. 33.

Vegetation on this portion, and that to the south, consists of fairly closely spaced bull oak and native pine trees up to 20 feet in height. There are occasional gums on the high dune.

The remainder of the deposit is just over 20 chains wide above the central portion but pinches out to nothing at its northern limit. This portion is 60 chains long with an average width of 10 chains and thickness of one and a-half feet. The gypsum overlies sand in some places (clay in others) and contains some sand impurity. Vegetation here is mostly samphire scrub with odd bull oak.

Kopi occurrences are shown on the plan. The kopi is not very clean and the large area to the south is about one foot thick.

Crystals of gypsum (thumbnail size) form a solidly packed layer one foot thick on the surface of the lake bed. Water level is close to the surface and the samples were partly washed during extraction. The bed of crystals overlies densely packed seed and crystals, and grey clay of unknown thickness. Grey clay impurity is also present in the layer of crystals and on the surface. Area of lake surface occupied by crystals is a minimum of three square miles.

Production.

Total tonnage of gypsum removed from Lake Seabrook to the end of 1952 was 74,961 tons. Operations were first started in 1926.

At the time of inspection (August, 1952) Ajax Plaster Co., Ltd., were working on M.C. 32, shovelling the seed into an elevator. Perth Modelling Works were quarrying from the high dune on M.C. 9. The gypsum was rilled on to motor trucks through a chute.

The gypsum was dumped from the motor trucks at Yellow-dine siding then reloaded into railway trucks for Perth at a later date.

Only the seed gypsum was being taken from the deposit and the only treatment afforded this material is washing with fresh water at the works in Perth.

Sampling.

Details of analysis of six samples made prior to this survey are reproduced below.

Reference—G.S.W.A. File 135/01.

Locality—

No detailed locality for Nos. 1 and 2.

No. 3. 0" to 18". South-east shore of Lake Seabrook. Seven miles south-east of Condenser Rocks. 300-400 yards wide, three miles long.

No. 4. Pot hole 0' to 2' 6". Shore of lake west of No. 3.

No. 5. Surface. South-east side of No. 3. Ridges of powdery gypsum.

(*Note:* Samples 3-5 were collected at a different time from Nos. 1, 2—possibly by another person.)

Analyses (1920)—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	%	%	%	%	%
Insoluble in acids	1.88	5.24	0.44	8.19	2.93
Water soluble CaO	31.37	30.11	31.04	26.34	25.79
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	96.31	92.44	95.29	80.86	79.18
Acid soluble CaO	1.50	0.78	2.49	4.23	4.55
equal to CaCO_3	2.68	1.39	4.44	7.55	8.12

Remarks.—No. 1.—A high grade seed gypsum which gives a light bluish-white plaster which is quick-setting to a strong body. Well suited for all kinds of modelling and building purposes.

No. 2.—A coarsely crystalline gypsum which gives a light greyish-white plaster which sets quickly to a strong body. Colour limits its range of uses.

No. 3.—A high grade seed gypsum which gives a pure white plaster which is quick-setting to strong body. Well suited for all purposes.

No. 4.—Seed gypsum which yields a moderately quick-setting plaster of fair strength. Its use would be somewhat restricted owing to its light greyish-white colour.

No. 5.—Crystallised gypsum which gives a cement-coloured plaster. It is very slow-setting and devoid of strength. Of no value as a source of plaster.

Reference—Chem. Lab. File 90/49.

Locality—Lake Seabrook.

Analysis (1926)—

	%
Insolubles	0.22
Water soluble CaO	32.32
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	99.22
Acid soluble CaO	0.28
equal to CaCO_3	0.50

Burning test 20.8 per cent. loss in 1 hour.

Setting time—15 minutes.

Colour—White.

Strength—Good.

Remarks.—This is a high grade gypsum for plaster.

A further 6 samples (G166-171) were taken by the authors in 1952. Details of analysis of these are given in Table VI. (see plan for location of samples). Logs of sample holes are given below:—

G166	0' 0" to 5' 0"	seed.
	5' 0"	seed.
G167	0' 0" to 3' 0"	seed.
	3' 0"	sand.

G168	0' 0"	to	1' 0"	small crystals.
	1' 0"	to	1' 3"	larger crystals, seed.
	1' 3"			clay.
	0' 6"			water level.
G169	0' 0"	to	1' 0"	crystals, fine seed.
	1' 0"	to	1' 3"	larger crystals, seed.
	1' 3"			clay.
	0' 6"			water level.
G170	0' 0"	to	5' 0"	seed, organic matter.
	5' 0"	to	16' 0"	seed.
G171	16' 0"			seed.
	0' 0"	to	2' 6"	seed.
	2' 6"			seed.
	3' 0"			water level.

Samples G166, 167, 170, 171 showed a grade higher than 98 per cent. These were from the seed dunes. Both of the samples taken from the lake flat show a grade in excess of 82 per cent. pure gypsum.

Reserves.

Some 1,020,000 tons of seed gypsum of high grade (95 per cent. and better) was still available from this deposit at the end of 1952.

The authors established a minimum tonnage of 3,100,000 tons of crystals, in the lake flat west of the seed deposit, of better than 80 per cent. gypsum.

The kopi was not tested or assessed.

MT. PALMER.

General Information.

This deposit is on the east shore of a salt lake, running roughly south on the east side of Mt. Palmer. It is 3 miles south by east from the mine—nearly four miles by track. The deposit is taken in by M.Cs. 1, 2, 3, 4 (unsurveyed).

Water is present, six inches below the lake bed to the west of the deposit. Scheme water is piped to Mt. Palmer.

Occurrence.

The seed gypsum deposit is more than 100 chains long and is 16 chains across at its widest point. Average thickness is somewhat less than two feet. A patch of dirty kopi runs down the east side of the seed. This kopi is as much as two feet thick but is sometimes only two inches, over dirty seed. The whole deposit has a higher clay content at its northern end and overlies clay.

Samphire is the only vegetation on the deposit. Old native pines, which once grew there, are now only rotten wood. Large trees grow on the sand dunes further east.

Production.

No production recorded.

Sampling.

Previous samples were analysed in 1913 and 1951 for the Geological Survey. Seven samples were also analysed for Mr. J. K. Dixon in 1951.

Reference—G.S.W.A. Bull. 63.

Locality—Eleven miles south of Yellowdine. From large quantities of seed gypsum in the form of dunes. Depth three feet.

Analyses (1913)—

	Top 1ft. %	Middle 1ft. %	Bottom 1ft. %
Gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	97.24	95.90	94.80
Calcite, CaCO_3	0.74	1.56	1.16
Salt, NaCl	0.05	0.27	0.72
Insolubles	1.28	1.42	1.98
Iron oxide, moisture, etc.	0.69	0.85	1.34
	100.00	100.00	100.00

Remarks.—These are all seed gypsums, yielding quick-setting plasters. The top sample is almost pure white and could be used for practically all purposes. The other two are slightly cream-coloured—could be used for ordinary wall plaster.

The first two gypsums are well suited for agricultural purposes. The third contains a rather too large percentage of salt to be used on other than well drained samples.

The following three analyses were made on samples from Mt. Palmer, in May, 1951. The sampler was Mr. J. K. Dixon.

Reference—Govt. Chem. Labs. File 90/49.

Locality—Three miles south of Mt. Palmer at south-east end of lake.

Analysis (May, 1951)—

	Surface to 12". %	Surface. %	2' Deep. %
Water soluble CaO	27.96	29.86	30.90
equivalent to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	85.8	91.7	94.85

Remarks.—The water insoluble residue from the three materials was mainly quartz and clay matter, stained with iron oxide.

A further four samples were submitted by Mr. Dixon in August, 1951.

Reference—Govt. Chem. Labs. File 90/49.

Locality—East side of lake, three miles south of Mt. Palmer.

Analysis (August, 1951)—

No. 1 contains too much organic matter.

	No. 2.	No. 3.	No. 4.
	%	%	%
Gypsum	96·31	97·60	72·73
Insoluble (mainly quartz sand)	3·04	1·95	2·55
Colour of prepared plaster	Good white	Good white	Slightly brownish

Remarks.—Colour tests on samples prepared from washed material. Numbers 2 and 3 produced good plasters.

A representative sample from this deposit was submitted by the Government Geologist in August, 1951.

Reference.—G.S.W.A. File 135/01.

Locality.—Three miles south of Mt. Palmer.

Analysis (August, 1951).—

	Per cent.
Water soluble CaO	31·74
equivalent to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	97·44
Insolubles	1·75
Salt, NaCl	0·21

Sieve Analysis.—

Mesher/linear inch.	Cumulative percentage refusing.
12	3·20
30	35·58
50	81·54
70	91·84
100	94·22

Plaster Test.—The uncrushed sample was washed, which removed a very small amount of organic matter. No clay matter was present. The ground, washed, material was calcined at a temperature of 150°C ., re-ground, and pats cast from the plaster. The pats, after drying out, were of good white colour and good strength.

Remarks.—This is a good grade seed gypsum. The proportion of material passing 100 mesh is rather high and, on calcining, some loss by dusting is to be expected.

Samples taken on this survey (1952) include G172 to G175. The average grade of the samples taken (not weighted average of the deposit) was 94 cent. Results of analysis are shown in Table VI. and the sample holes are located on the plan. Logs of the sample holes were :—

G172	0' 0" to 1' 10"	seed. clay.
G173	{ 0' 0" to 2' 0" 2' 0" to 3' 0" 3' 0"	kopi. seed. clay.
G174	0' 0" to 2' 0"	seed. grey clay.
G175	0' 0" to 2' 0"	seed. clay.

Reserves.

There are some 310,000 tons of seed gypsum in this deposit (with some kopi cover in places) of a grade better than 90 per cent. pure gypsum.

There is also a tonnage of about 100,000 tons of dirty kopi (with some dirty seed) in the area to the east of the northern half of the seed deposit (probably 50 per cent. pure).

MOORINE ROCK.

General Information.

M.C. 21 (not surveyed) is six miles south of Moorine Rock railway station, on Locations 70, 75 and 76. A good gravel road from Moorine Rock, runs down the west boundary of Location 76.

Water was not found at the deposit but should be present at about five feet depth. Fresh water is available at Moorine Rock, from the Goldfields pipe line.

Occurrence.

The deposit is in an old dry lake flat. It consists of crystals ranging from $\frac{1}{4}$ inch to two inches in length, in the southern part of the flat, and seed in the northern part. There is some clay amongst the crystals and the seed. The deposit is covered with about six inches of dirty compacted kopi. The deposit is very patchy and overlies grey clay. Gypsum is five feet thick in the middle of the flat—grading to nothing at the edges.

The kopi dune on the east edge of the flat rises to 10 feet high at its southern end but is only three to four feet high for the most part. It consists of a two feet cover of kopi, with patches of red clay, over reddish granular gypsum.

The vegetation on the deposit consists of ti-tree with occasional gums in the southern half. Samphire is the only vegetation north of G177. Large salmon gums and blackbutt grown on the higher ground round the flat.

Production.

None has been recorded.

Sampling.

Samples G176, G177, G178, G180 were taken from the lake flat (see Plan) and G179 from the kopi dune. Logs of the sample holes are :—

G176	{ 0' 0" to 0' 6" 0' 6" to 4' 6"	compacted kopi. seed, some clay.
G177	{ 0' 0" to 0' 6" 0' 6" to 5' 0" 5' 0"	kopi. small crystals. clay.
G178	0' 0" to 3' 0" 3' 0"	small crystals, clay. clay.
G179	{ 0' 0" to 2' 0" 2' 0" to 2' 6" 2' 6"	white kopi. granular gypsum with red clay. as above.
G180	0' 0" to 2' 0" 2' 0"	crystals. crystals.

Table VI. shows results of analyses. Sample G180 did not contain any of the kopi which covers most of the deposit.

Reserves.

Some 298,000 tons of crystals (with seed and kopi) of 77 per cent. pure gypsum are contained in the lake flat.

There are about 7,500 tons of kopi and granular gypsum in the dune (grade = 82.8 per cent. for one sample).

TABLE VII.—SAMPLE ANALYSES—AREA No. 5.

Lab. No.	Field No.	Locality.	Occurrence.	Analysis.					Calculated Composition.*				
				Acid Soluble.		Sor.	Cor.	Chlorides as NaCl.	Gypsum CaSO ₄ ·2H ₂ O.	CaCO ₃ .	NaCl.	Excess CaO, SO ₃ or other constituents.	Sand Clay and other constituents not determined by difference.
				CaO.	MgO.								
1952		<i>Lands Dept. Litho. 25/300.</i>		%	%	%	%	%	%	%	%		%
14305	G152	Kanowna (<i>see Plan</i>)....	0' to 7'. From kopi dune	28.77	....	39.80	0.23	0.25	85.60	0.50	0.25	CaO 0.65	13.00
14306	G153	do. do.	0' to 3' 6". From kopi dune. Channel	31.71	....	44.24	0.07	1.55	95.20	0.15	1.55	CaO 0.7	2.40
14307	G154	Gidji Siding (<i>see Plan</i>)	0' to 2' 6". From kopi dune sample	29.19	....	39.69	0.46	0.25	85.40	1.05	0.25	CaO 0.85	12.45
14308	G155	Lakewood (<i>see Plan</i>)	0' to 1' 6". From island of crystals	20.64	....	29.27	0.03	0.25	62.95	0.05	0.25	CaO 0.15	36.60
14309	G156	Kopai Lake. Approx. 7 miles north-west of Kurrawang	0' to 3' 6". From kopi dune	29.69	....	39.35	1.18	0.05	84.65	2.70	0.05	CaO 0.7	11.90
		<i>Lands Dept. Litho. 350/80.</i>											
14310	G157	Lake Cowan (<i>see Plan</i>)	0' to 6'. From seed dune. Channel	32.79	....	45.99	0.03	0.05	98.95	0.05	0.05	CaO 0.6	0.35
14311	G158	do. do.	9" to 2' 0". From lake flat sample	32.40	....	45.57	0.01	0.85	98.00	trace	0.85	CaO 0.55	0.60
14312	G159	do. do.	0' to 3'. From seed dune. Channel	32.83	....	46.17	0.03	0.10	99.35	0.05	0.10	CaO 0.5	....
14313	G160	do. do.	0' to 4'. From seed dune	33.02	....	46.22	0.08	0.05	99.15	0.20	0.05	CaO 0.6	....
14314	G161	do. do.	0' to 5'. From seed dune	33.28	....	46.03	0.05	0.05	99.00	0.10	0.05	CaO 0.85	....
	G162	do. do.	0' to 5'. From kopi dune	31.04	....	43.54	0.03	1.60	93.70	0.05	1.60	CaO 0.55	4.10
14315	G163	do. do.	0' to 5' 6". From kopi dune	32.20	....	43.54	0.83	1.10	93.70	1.90	1.10	CaO 0.7	2.60

* Calculated in accordance with suggestions made in "Standard Methods of Testing Gypsum and Gypsum Products" (C26-50), A.S.T.M. Standards, 1950 Supplement, Part 3. Government Chemical Laboratories, Perth.

AREA No. 5.

KANOWNNA.

General Information.

The deposit sampled is five miles north-east of Kanownna on the Kanownna-Kurnalpi road. The road cuts through the deposit. The closest railway siding is Parkeston.

A little salt water was present in the clay pans in August but there is no local fresh water supply. Water has to be carted from Parkeston to Kanownna.

Occurrence.

The gypsum occurs in a dune about 100 chains long in the form of kopi and seed (see plan). The dune is 16 chains across, at its widest point, and has an average height of six feet above lake level. It rises up to 12 feet in places. The average thickness of gypsum over the area of the dune is about three feet—grading out into red clay or sand.

The gypsum is very patchy and discoloured with red clay.

Vegetation on the dune consists of occasional low scrub and samphire with a few blackbutts and native pines near its western extremity.

Further kopi dunes among the lakes to the north were not investigated.

Production.

A few tons of kopi have been quarried from the locality of Sample G153. This material has been used for road surfacing.

Sampling.

Two samples analysed for Mr. J. Ellis, in 1925, showed:—

Reference—Govt. Chem. Labs. File 90/49.

Locality—Six miles from Kanownna on the road to Kurnalpi.

Analyses—

	Flour.	Granular.
	%	%
Insoluble in acid	2.20	5.32
Water soluble CaO	31.70	28.56
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	97.32	87.68
Acid soluble CaO	trace	3.16
equal to CaCO_3	trace	5.64
NaCl	0.023	0.020
Iron	trace	fair amount

Remarks.—Samples are too highly coloured for plaster but are suitable for agriculture.

Sample G152.—Two chains north of five-mile peg on road—was taken over 0' to 7' depth. Material encountered in the hole was:—

0' 0" to 0' 6"	red clay.
0' 6" to 2' 0"	kopi.
2' 0" to 5' 0"	seed and clay.
5' 0" to 7' 0"	kopi.
7' 0" +	red clay.

Sample G153.—One chain north of where road enters the lake flat (see plan)—is a channel sample from a quarry bank, 0' to 3' 6".

0' 0" to 3' 6"	kopi.
3' 6" +	seed with quartz grains, pebbles of limonite, and red clay.

These samples were analysed with the following results:—

G152 = 85.6 per cent. gypsum.

G153 = 95.2 per cent. gypsum.

Reserves.

Some 28,000 tons of kopi (containing some seed and clay) is available at this deposit. The average grade may be somewhere in the vicinity of 90 per cent. pure gypsum.

GIDJI SIDING.

General Information.

This deposit contains an unsurveyed mineral claim (M.C. 3E), one mile west of the siding and 1½ miles west of the bitumen road from Kalgoorlie to Broad Arrow. The location of the siding is 10 miles north of Kalgoorlie. A track runs to the deposit from the bitumen road.

There was no water in the lake flat but the deposit is not far from the Broad Arrow pipe-line.

Occurrence.

The gypsum occurs in ridges, and patches of kopi amongst sand. The ridges are on the east shore of a clay pan and the patches extend to the railway line. The kopi is patchy in the ridges—mixed with red clay—but some of it is fairly white. Average thickness of kopi is 2' to 2' 6" and it overlies a red clay soil.

Odd trees on the deposit are native pines.

Production.

There does not appear to have been any production from this deposit.

Sampling.

One sample only was taken from this deposit (G154). Its location is shown on the plan. Analysis results are shown in Table VII.

Reserves.

Some 10,000 tons of kopi are available from this deposit, of 85 per cent. purity (according to sample G154).

LAKEWOOD.

General Information.

The deposit is $1\frac{1}{2}$ miles south-east of the townsite and is reached by a track along an old timber tram track. The west corner peg of G.M.L. 6176E is in the centre of the claypan.

Nearest fresh water is at Lakewood.

Occurrence.

Gypsum crystals occur on an island in the middle of a claypan and kopi is present as a dune to the south-east of the pan.

The crystals are somewhat stained and are mixed with some red clay to a depth of 1' 6". This gives way, in depth, to a sticky grey clay with some crystals of gypsum. A red mixture of kopi and clay covers about 10 per cent. of the island with little dunes up to four feet high. Native pines and low scrub are the vegetation here.

The kopi dune at the edge of the lake is very dirty. It contains clay and grains of limonite and a lot of hard limey cap. Large blackbutts and salmon gums grow in this old dune.

Production.

Nil.

Sampling.

A sample submitted, in 1924, by Mr. A. Duke is believed to have come from this deposit.

Reference—Govt. Chem. Lab. File 90/49.

Location—Five miles south of Boulder, on Crown land.

Analysis—

Water soluble CaO	.....	.....	.....	.....	30.92
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	.....	.....	.....	.....	94.92
Acid soluble CaO	.....	.....	.....	.....	0.75
equal to CaCO_3	.....	.....	.....	.....	1.34
Insolubles	.....	.....	.....	.....	2.09

Remarks.—On calcining at 180° C., yields with a quick-setting plaster—slightly creamy white colour and strong.

Sample G155 (see plan), 0' to 1' 6", gave an analysis—63 per cent. gypsum.

Reserves.

Two thousand tons of crystalline gypsum, 63 per cent. pure.

KOPAI LAKE.

General Information.

Kopai Lake is about seven miles north-west of Kurrawang on an old track. It is surrounded by small lakes of similar type.

Nearest fresh water would be at Kurrawang on the Gold-fields Pipe Line. There was some salt water in the lake (August).

Occurrence.

A deposit of kopi, with red clay patches, occurs as a dune on the east bank of the lake. The dune is about 80 chains long, five chains wide and rises to 15 feet above the lake. Average thickness of kopi is probably a little less than three feet.

A small lake nearly three miles south of here showed a dune of kopi (2') over granular gypsum (2' to 3' 6" +). There are probably many such deposits.

Vegetation on the dune at Kopai Lake includes quondong, bull oak, pepper tree, sandalwood, scrub and saltbush, with occasional gums. It is fairly closely wooded.

Production.

Nil.

Sampling.

A sample, probably from this locality, was analysed in 1925—

Reference—Govt. Chem. Lab. File 90/49.

Locality—5½ miles from Kurrawang, on wood line.

Analysis—

	%
Water soluble CaO	25.56
equal to CaSO ₄ .2H ₂ O	78.47
Acid soluble CaO	5.10
equal to CaCO ₃	9.10
Insoluble in acid	11.58

Remarks.—Is red in colour—contains iron. Suitable for agriculture.

Sample G156 was taken from the dune at Kopai Lake. It represents a depth of three feet six inches which overlay granular gypsum with red clay. The sample contained 84 per cent. gypsum (see Table VII.).

Reserves.

There is an estimated 50,000 tons of kopi at this deposit (84 per cent.) overlying some clayey granular gypsum of lower grade (probably 50,000 tons). There are other low grade dunes further south.

LAKE COWAN.

General Information.

The deposit is on the southern portion of Lake Cowan, immediately west of Norseman. Norseman is on the Perth-Coolgardie-Esperance road and railway ; also the Perth-Kalgoorlie-Esperance air service. The Norseman aerodrome is on the lake containing the deposit.

There are two tracks crossing the lake but the one which runs east-west, across the middle of the lake, is most unreliable. Tracks run round the lake—up to a mile distant from the lake flat.

Fresh water is obtainable from the town supply (Goldfields Scheme) and there is plenty of salt water below the lake bed. Original supply for Norseman was condensed water from this lake. Sumps and drains were dug on water rights in the lake. Water at three feet depth.

Surveyed mineral claims on the lake include M.C.s 1, 2, 3, 8 (4), 9 (5), 10 (6) and 12. M.L.s 7 and 8 are also surveyed.

Occurrence.

Gypsum is present as crystals, seed and kopi. The crystals occur in the clay in the lake bed and are exposed in drains on Water Rights. The crystals are naturally dirty and somewhat stained.

The clay bed is overlain by varying thicknesses of seed gypsum and compacted kopi. Towards the northern end of the deposit, the layer of seed is a few inches thick but a pit on M.C. 12 exposes six feet of clean seed gypsum. The average height of dunes on this island is three to four feet—tapering to a few inches at the edges. There is a two feet thickness of wet seed (with grey clay and kopi) in the lake flats. The compacted kopi is generally thicker on the eastern side of this island.

Seed dunes on the south-east shore of the lake have a cover of kopi, up to three feet thick in places. The long islands just off shore are of seed with 18 inches of kopi on top. The flat in between the islands and the shore contains compacted kopi with a little seed. It has a samphire cover. A few small islands of seed occur a little further out in the lake from here.

Dunes along the east shore, to the north of the gypsum dunes, are of yellow sand. Cherry Island, and the rocks on the shore immediately west, are pillow lavas.

Production.

Production from this deposit has been small—mainly owing to its distance from Perth.

Year.	1935.	1936.	1946.	1947.	1949.	1951.	1952.	Total.
Tons	706	695	212	376	10	7	21	2,027

Sampling.

*Reference.—G.S.W.A. File 135/01.

Locality.—Two miles west of Norseman (M.C. 1 or M.C. 2).

<i>Analysis</i> (1920).—				%
Water soluble CaO	....	....	....	32.22
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	....	98.92
Acid soluble CaO	....	....	....	.08
equal to CaCO_3	....	....	....	.15
Insoluble in acids	....	....	....	.46

Remarks.—A high grade gypsum yielding a pure white quick-setting plaster which is suitable for all purposes.

*Reference.—Chem. Lab. File 90/49.

Locality.—Lake Cowan.

<i>Analysis</i> (1950).—				%
Water Soluble CaO	....	....	....	32.40
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	....	99.51
Insoluble in water	....	....	....	0.25

Some crystals from the lake bed were analysed in considerable detail in 1921.

Reference.—G.S.W.A. File 135/01.

Locality.—(M.C. 1 or M.C. 2).

<i>Analysis</i> (1921).—				%
Insoluble in acids	....	....	....	11.27
Water soluble CaO	....	....	....	26.31
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	....	80.77
Acid soluble CaO	....	....	....	3.08
equal to CaCO_3	....	....	....	5.49

Remarks.—Sample consisted of large wedge shaped crystals, up to three inches in length, impregnated with a ferruginous clay. Washing did not remove much of the clay.

Burning at 180°C . gave a moderately quick-setting plaster of strong body—light creamy white in colour. This plaster appears to be suitable for most building purposes.

* These were probably seed gypsum.

Sample was crushed to about quarter inch mesh and washed with water to remove fines and clay.

Coarse gypsum	....	....	....	....	%
					80.50
Fine gypsum and clay (rejected)	....				19.50

The washed coarse material was ground and burnt at 180°C. The resulting plaster was quick-setting to a strong body of ivory white colour. This was a high grade plaster suitable for all purposes.

Samples G157 to G163 were taken from this deposit and analyses results (Table VII) show that they were all of better than 93 per cent. grade while only two (G162, G163) were below 93 per cent. The samples are located on the plan and logs of the holes are shown below :—

G157	0' 0" to 6' 0"	seed.
	6' 0"	seed.
	0' 0" to 0' 9"	kopi, fine seed.
G158	0' 9" to 2' 0"	seed.
	2' 0"	grey clay, water.
G159	0' 0" to 3' 0"	seed.
	3' 0"	seed.
G160	0' 0" to 4' 0"	seed.
	4' 0"	seed.
G161	0' 0" to 5' 0"	seed.
	5' 0"	seed.
G162	{ 0' 0" to 1' 6"	kopi.
	{ 1' 6" to 5' 0"	granular gypsum.
	{ 5' 0"	granular gypsum.
G163	{ 0' 0" to 3' 0"	kopi.
	{ 3' 0" to 5' 6"	granular gypsum.
	{ 5' 6"	granular gypsum.

Reserves.

The long seed banks contain some 2,000,000 tons of high grade gypsum (four samples all above 93 per cent.). A further 1,000,000 tons of seed (probably 90 per cent. pure) is available from the lake flat while some 900,000 tons of kopi and granular gypsum are available from the dunes (two samples showed 93 per cent. pure).

CHAPTER III.

LOCALITIES NOT SAMPLED.

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AREA No. 1.

Young's Siding.

The siding is approximately 23 miles by rail or bitumen road west of Albany. Gypsum crystals are scattered through a blue-grey clay and can be seen in drains. Gypsum is exposed in a drain running along the west boundary of Plantagenet Location 1016—also in the drain crossing the road at the siding.

A sample submitted by Mr. L. J. Chamberlain of 236 Albany Highway, Albany, gave the following result:—

Reference—Govt. Chem. Labs. File 90/49.

Locality—Three miles north of Young's Siding.

Analysis (1947)—

	%
Insoluble in acid	4.22
Water soluble CaO	31.25
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	95.94
Acid soluble CaO	0.04
equal to CaCO_3	0.07

Remarks.—Good for plaster, if washed.

As this analysis was probably made on crystals which had been hand-picked from the clay, the deposit is not considered worthwhile.

South of Lake Grace.

Some minor deposits of seed gypsum and dirty kopi were observed on lakes between Lake Grace townsite and Pingrup. The kopi was mixed with clay in small dunes near clay pans, and ridges containing some tens of tons of seed gypsum were located. The seed was fairly free from clay and other impurities.

Lakes were mostly dry at time of inspection.

Lake Chidnup.

Lake Chidnup is approximately 18 miles north-west of Ravensthorpe on the Perth road. Reserve 18461, for gypsum, takes in Lake Chidnup and a narrow strip of land (of the order of 2+ chains) around its circumference. There is virtually no gypsum on this reserve. Specimens only of seed and clay-kopi were located.

Lake was dry.

Lake Kurrenkutten.

This lake is situated approximately eight miles by road east of Bilbarin Siding, which is on the Narrogin-Bruce Rock railway line. The lake constitutes Gypsum Reserve 12886.

A small amount of seed and some clay-kopi banks were seen on the eastern shores of this lake, but quantity was too small to warrant sampling. Lake was dry.

East of Narembeen.

A clay pan, nine miles east by north from Narembeen, showed a few gypsum crystals on the surface—no importance.

A series of samples from five miles east of Narembeen, sent for analysis by Mr. A. Foster, in 1925, gave:—

Reference—Govt. Chem. Labs. File 90/49.

Locality—Location 18161.

Analyses—

(1) 18" down; (2) 3' down; (3) 4' down; (4) top of ground.

	1. %	1. %	3. %	4. %
Insoluble in acid	16.44	48.28	55.84	5.72
Iron and aluminium oxides (chiefly iron)	0.28	0.76	0.68	0.40
Water soluble CaO	26.12	14.76	11.24	28.53
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	80.19	45.31	34.51	87.58
Acid soluble CaO	0.92	0.84	0.76	2.31
equal to CaCO_3	1.64	1.50	1.36	4.12
Combined water and un- determined	1.45	4.15	7.61	2.18

Remarks.—Samples have no economic value.

AREA No. 2.

East of Marchagee.

Fifteen miles east of Marchagee is the location given for a sample sent in to the Government Chemical Laboratories in 1950. It *probably* came from a salt lake about 15 miles east by south from Marchagee and one mile south of Charcono Hill. The lake is 14 miles east of Gunyidi on a gravel road. Gunyidi is 153 miles from Perth on the Geraldton Highway.

The gypsum here is in the form of kopi, with clay impurities, in low banks about six inches thick.

Reference—Govt. Chem. Lab. File 90/49.

Locality—Fifteen miles east of Marchagee.

<i>Analysis</i> —						%
Insoluble in water	....	....	....	....	....	8.50
Gypsum	....	....	....	....	....	90.00

Remarks.—Reasonable plaster.

West of Marchagee.

Marchagee is 160 miles from Perth on the Geraldton Highway. Mr. Eric E. Rendle submitted a sample of kopi in 1943.

Reference—Govt. Chem. Labs. File 90/49.

Locality—Ten miles west of Marchagee (Locations 5866, 3256).

<i>Analysis</i> —						%
Water soluble CaO	....	....	....	....	....	30.22
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	....	....	....	92.78
Acid soluble CaO	....	....	....	....	....	1.24
equal to CaCO_3	....	....	....	....	....	2.21
Insolubles	....	....	....	....	....	1.31

Remarks.—Kopi with a little quartz—of no value for plaster.

Crystals of gypsum occur in clay beneath bentonite and clay (1' to 2') in this locality. Deposits are in clay pans and very small.

Mingenew.

A specimen of crystalline gypsum was sent to the Government Chemical Laboratories by the late Mr. J. V. Newton. The gypsum came from 12 miles north of Mingeneu where it occurs as thin seams in Permian shales. It is the variety satin-spar. The seams are rarely more than half-an-inch in thickness, limited in extent, and rather widely spaced. They outcrop in several parts of the Irwin River valley near the junction of the North Irwin and the South Irwin.

Lake Austin.

This lake crosses the Great Northern Highway between Mt. Magnet and Cue—about 390 road miles from Perth.

Both crystalline gypsum and kopi occur there but no samples were taken during this survey. Heavy rainfall in the area made investigation impossible.

Mr. H. P. Woodward, Assistant Government Geologist, 1912, submitted a sample from Lake Austin. Analysis showed—

Reference—G.S.W.A. File 135/01; Govt. Chem. Labs. File 90/49.

Locality—The Island, Lake Austin, near road.

<i>Analysis</i> —						%
Gypsum	....	....	....	....	....	91.54
CaCO ₃	....	....	....	....	....	1.60
Total CaO	....	....	....	....	....	30.72
NaCl	....	....	....	....	....	1.94
MgO	....	....	....	....	....	Nil

Remarks.—High grade gypsum for agricultural purposes but the two per cent. salt renders it unsuitable in country which does not have a fair average rainfall and is not fairly well drained.

In submitting the sample, Mr. Woodward said:—

“ in quantity it is practically unlimited, is crossed by the railway line, and could be worked under the same system as ballast pits.”

A specimen of gypsum, from two miles north of Lake Austin on the Mt. Magnet-Cue road, was submitted for determination in 1952.

The gypsum deposit at Lake Austin may well be of workable size but it seems doubtful whether it could be worked for a profit.

Elphin Siding.

The siding is five miles north of Wongan Hills station on the Wongan Hills-Mullewa railway line. Reserve No. 17542 for gypsum is five miles west of the siding.

There is no gypsum on this reserve.

AREA No. 3.

Koorda.

Gypsum was worked on M.L. 280H during the years 1921-29. The mineral lease was on Reserve 22198 which is two miles south-west of Koorda townsite. Access is gained by travelling half a mile, down the east boundary of Location 22128, from the road which runs along its northern boundary. Location 22128 is a ploughed field (*see* 1924, Maitland and Montgomery¹³).

The gypsum occurs as crystals on the bed of the lake, which had two to three inches of water at the time of inspection (June, 1952). Bed of the lake is of clay. A small amount of seed gypsum occurs on the east bank of the lake.

The crystals are about two inches long, half an inch wide and one-eighth of an inch thick. They grow perpendicular from the clay floor and have tapering roots.

Production.

This was the only source of gypsum in W.A. in the years 1921-22. No gypsum was worked in 1923 and other centres did not start producing till 1924.

It is apparent, from the disused machinery at the lake, that the crystals were shovelled into a rotary sieve and washed to remove clay—giving a pure gypsum product.

Year	1921	1922	1923	1924	1925	1926	1927.	1928	1929
Production (Tons)	644	63	Nil	1,234	444	1,261	1,784	278	834

In all, a total of 6,559 long tons of washed crystals were taken from the lease. Some hundred or more tons still remain but the deposit can be considered as virtually worked out.

Mollerin.

The Amery-Bonnie Rock railway line passes Lake Mollerin on its north side. A narrow bank of kopi runs, discontinuously, around the southern and south-eastern edges of the lake. The bank varies in width up to one chain and maximum depth is six feet. The kopi is pure white in some places but pink and reddish in others. Fairly large eucalypts grown in the bank which also gives way to sand in places.

Hines Hill (North).

M.C. 440H, for gypsum, is an unsurveyed claim on Avon Location 22260, nine miles north of Hines Hill. It is on a small clay pan which has a very small bank of impure seed gypsum at its south-east edge. Impurities are clay and quartz sand.

Waeel.

M.C. 137H, for gypsum, is a surveyed claim on Avon Location 3386. It is two miles north-east of Waeel Siding and half a mile east of a north-bound road. The claim encloses a clay pan which is entirely devoid of gypsum of any variety.

¹³1924 Maitland, A. G., and Montgomery, A. : The Geology and Mineral Industry of Western Australia. *G.S.W.A. Bull.* 89, p. 81. (Koorda.)

AREA No. 4.

Bodallin.

A specimen of kopi was sent into the Government Chemical Laboratories for determination by Mr. R. A. Price, in 1950. The specimen came from Location 632 which is about 12 miles north by east from Bodallin.

The kopi was dug from a low ridge on the south-east edge of an old clay pan. (The clay pan is now covered with grass.) The kopi occurs in very small patches on the ridge which is mostly composed of sand with a little red clay.

Lake Deborah.

Gypsum crystals are present in the bed of this lake just north of Baladjie Siding. Patches of crystals occur in layers (about one inch thick) in the sand and clay under the salt crust. The crystals are as long as three inches but usually have grit and clay embedded in them.

A rock floor of decomposed granite underlies the clay bed of the lake.

AREA No. 5.

Hannan Lake.

The country immediately south and east of Hannan Lake is made up of clay pans and dunes. This lake is about seven miles south by east from Kalgoorlie. There is a large amount of kopi in the dunes—together with red clay—but its occurrence is very irregular, between clay pans. Some of the clay flats, especially those nearer Home Rule Swamp, contain crystals of iron-stained gypsum. These crystals are useless as a source for plaster.

A sample of kopi from this area (1928) gave the following result on analysis:—

Reference.—Govt. Chem. Labs. File 90/49.

Locality.—Twelve miles south of Kalgoorlie.

Analysis.—

Water soluble CaO	....	....	....	29.63 %
equal to CaSO ₄ .2H ₂ O	....	....	....	91.12 %

Remarks.—Impure powdery gypsum.

Lake Lefroy.

An island in Lake Lefroy, about 17 miles north-east of Widgiemooltha was seen to contain a few thousand tons of gypseous material. Access was gained by travelling three miles south from Widgiemooltha, thence 10 miles east (along Paris Gold Mining road), thence 15 miles north (past St. Ives), then walking across the salt crusted lake floor for one and a half miles.

The deposit is on the north-west corner of the island and consists of seed gypsum and kopi with limey "crusts." The gypsum is stained pink to red and is intimately mixed with red clay and quartz sand. Some small stained crystals also occur in patches in the gypsum dunes.

Gypsum crystals occur in clay below the salt crust of the lake. A sample of these was submitted for analysis and plaster tests by Geologist E. de C. Clarke in 1921.

Reference.—G.S.W.A. Bull. 90, p. 9; G.S.W.A. File 135/01.

Locality.—Bed of Lake Lefroy—one mile north of Orchin Group leases.

<i>Analysis</i>			%
Water soluble CaO	....	....	26.11
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	80.16
Acid soluble CaO	....	....	1.44
equal to CaCO_3	....	....	2.57
Insoluble in acids	....	....	14.40

Remarks.—Sample was coarsely crystalline gypsum.

On burning at a temperature of 180°C ., the plaster formed was quick setting to a moderately strong body of dirty white colour.

Owing to the unsatisfactory colour of the plaster obtained by burning the gypsum in its natural state, a further test was carried out after crushing the material to a quarter-inch mesh and washing with water to remove the clay and fines. The figures obtained were:—

		%
Coarse gypsum	....	70.3
Fine gypsum and clay (rejected)	....	29.7

The washed coarse material was ground and burnt at a temperature of 180°C ., and the resulting plaster was quick setting to a strong body of an ivory white colour.

This sample in its original condition is of no value for the production of plaster of paris. After crushing and removing the clay by washing, it forms a plaster almost pure white in colour, and of high grade and suitable for all purposes.

Lake Dundas.

Gypsum has been reported from Lake Dundas but, as the east side of the lake is inaccessible, even in summer, the authors made no attempt to prospect the lake (August, 1952).

AREA No. 6.

This area is very small and of little importance. It includes the Swan Coastal Plain, south of Perth. The gypsum occurs in clay in the swampy parts of the area.

Exposures of gypsum crystals in blue clay can be seen in many drains on the Peel Estate—also near Cookernup—but the crystals are very scattered. Some of the lakes between Pinjarra and Mandurah have some very minor amounts of kopi on their eastern edges.

A specimen from Cookernup was analysed for Mr. C. W. Waltham in 1923, with the following result:—

Reference.—Govt. Chem. Labs. File 90/49.

Locality.—Crown Land, three miles west of Cookernup Siding.

<i>Analysis.</i> —				%
Insoluble in acid	....	....	....	1.00
Water soluble CaO	....	....	....	32.00
equal to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	....	....	....	98.24
Acid soluble CaO	....	....	....	0.46
equal to CaCO_3	....	....	....	0.82
NaCl	....	....	....	0.09

Remarks.—Gypsum crystals, up to three inches long, stained with a small amount of clayey material.

Calcining at 180°C . yields a pure white plaster which is quick setting to a strong body.

(Cookernup is 81 miles south of Perth via the Bunbury Highway.)

The specimen represented washed crystals from a clay belt, two and a half to three miles west of Cookernup Siding, running north and south. Scattered flakes and crystals—about thumb-nail size—are common. Such exposures probably continue, discontinuously, as far north as the Peel Estate and to Harvey in the south.

No samples were taken.

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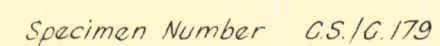
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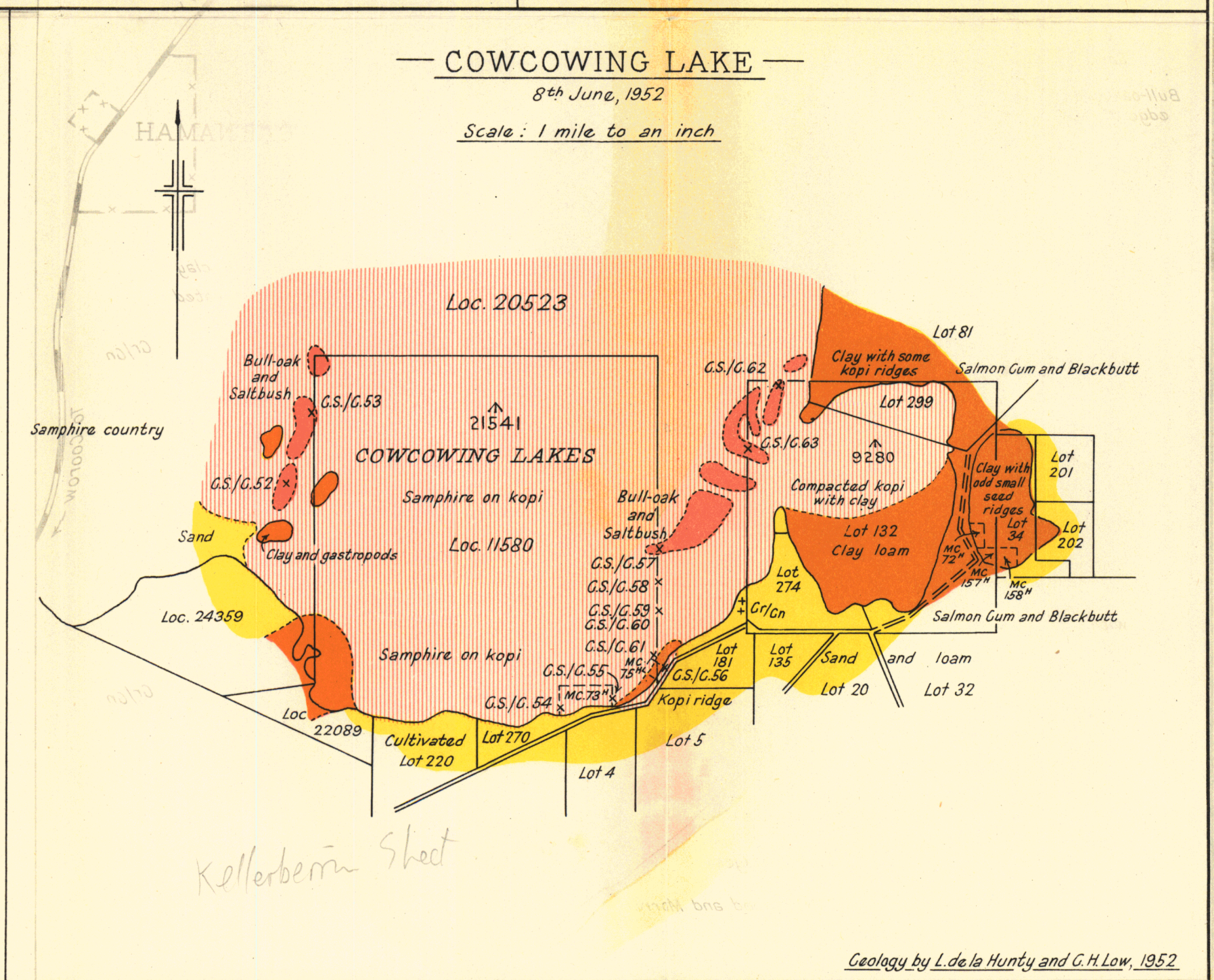
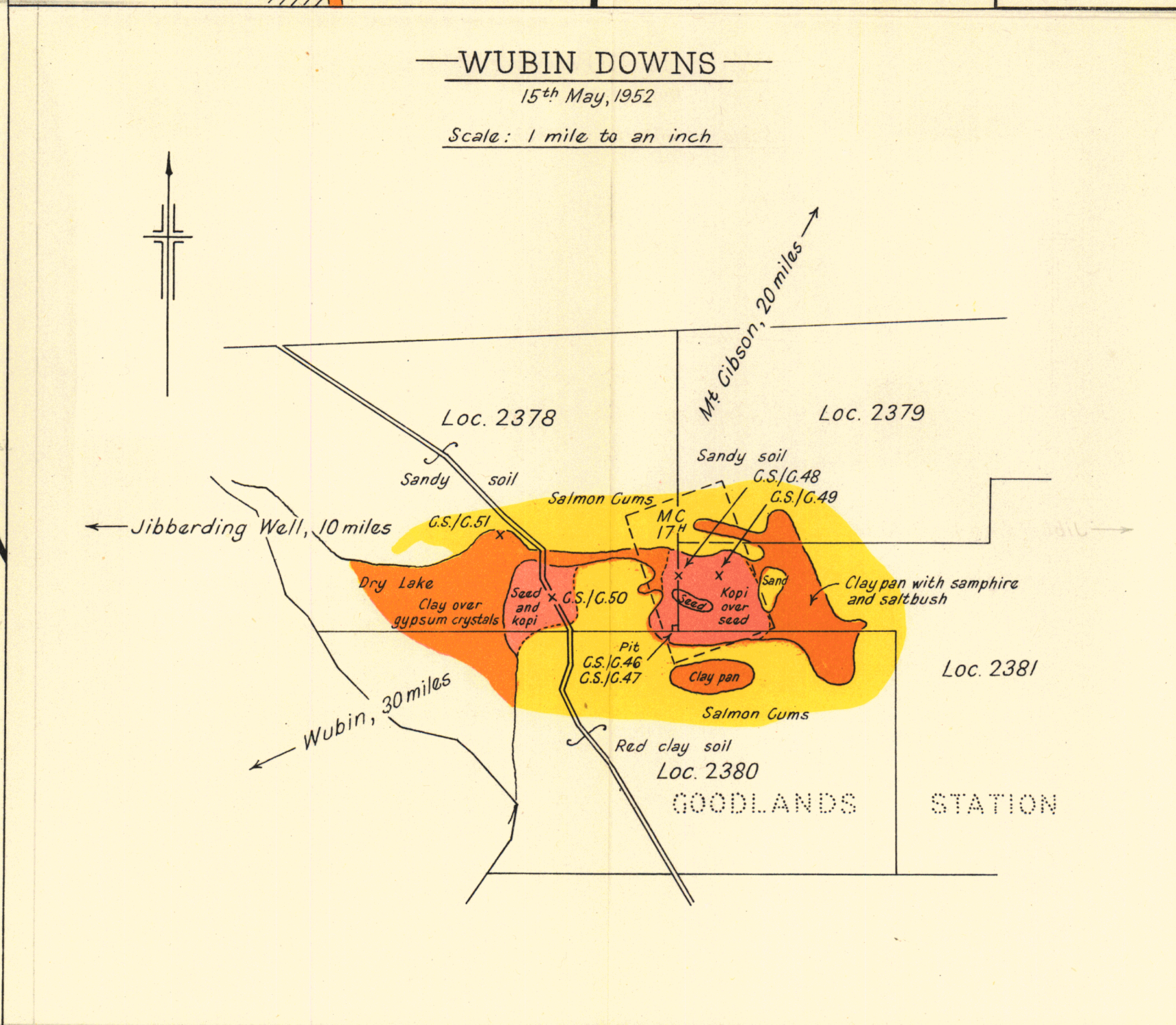
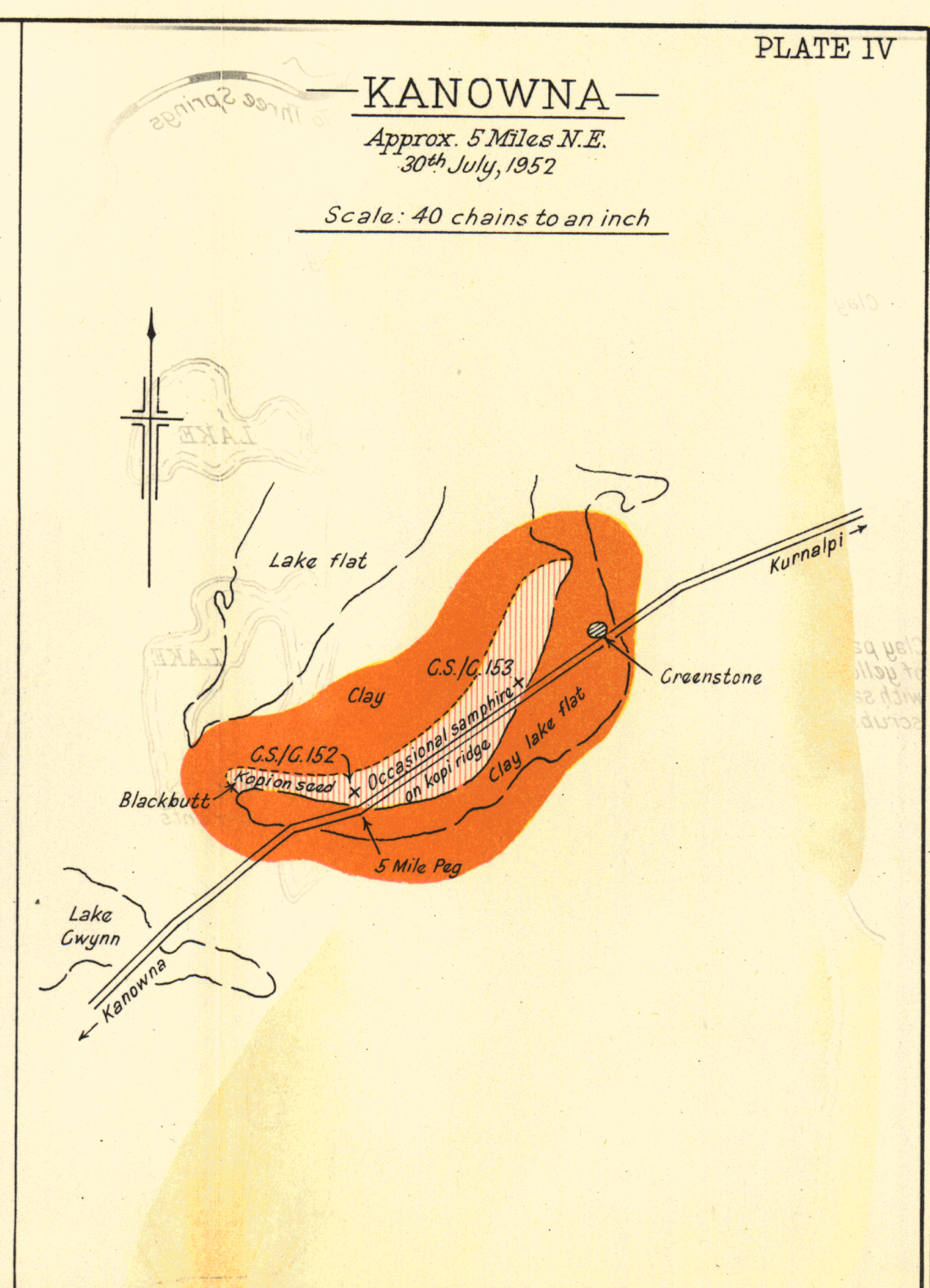
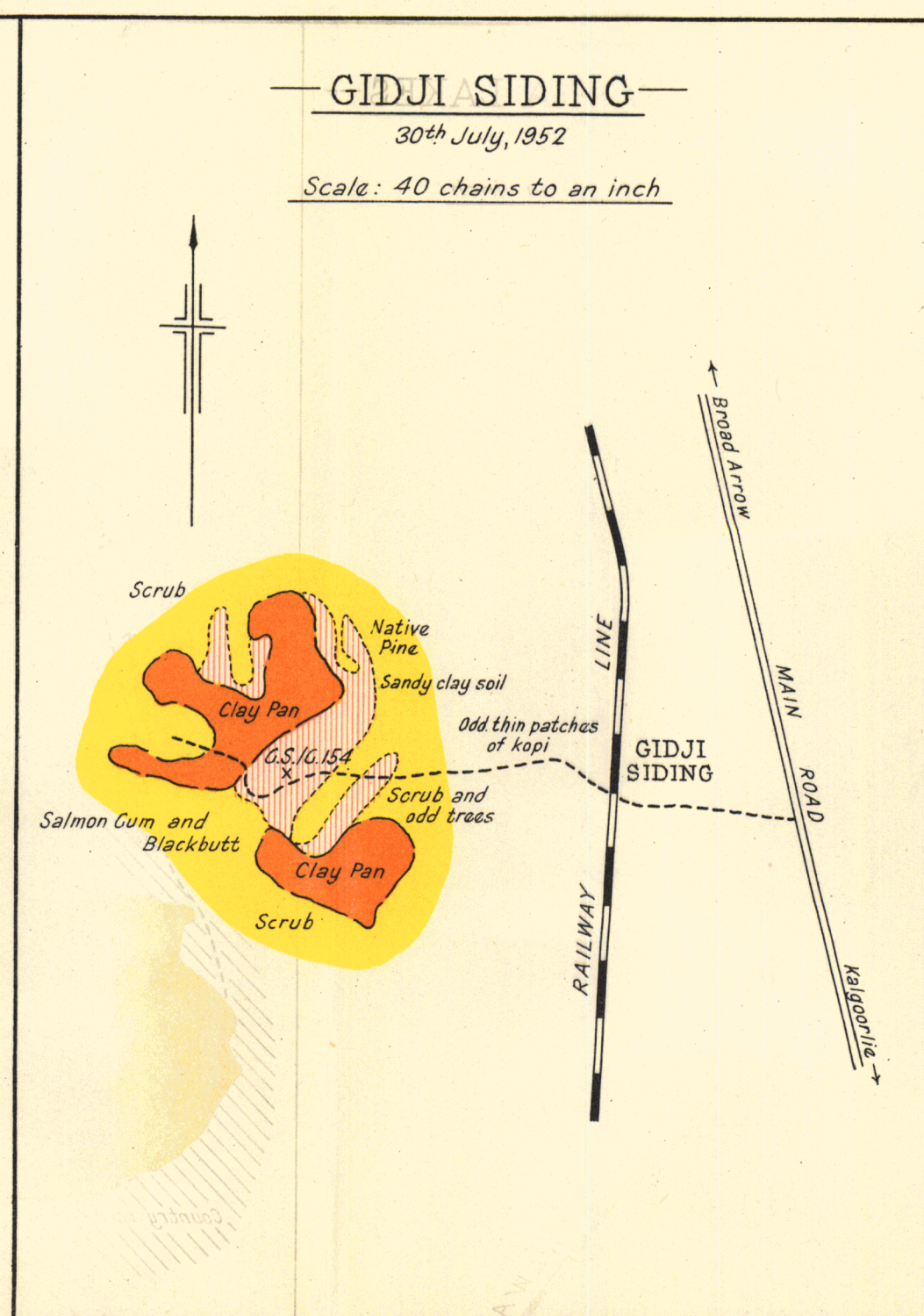
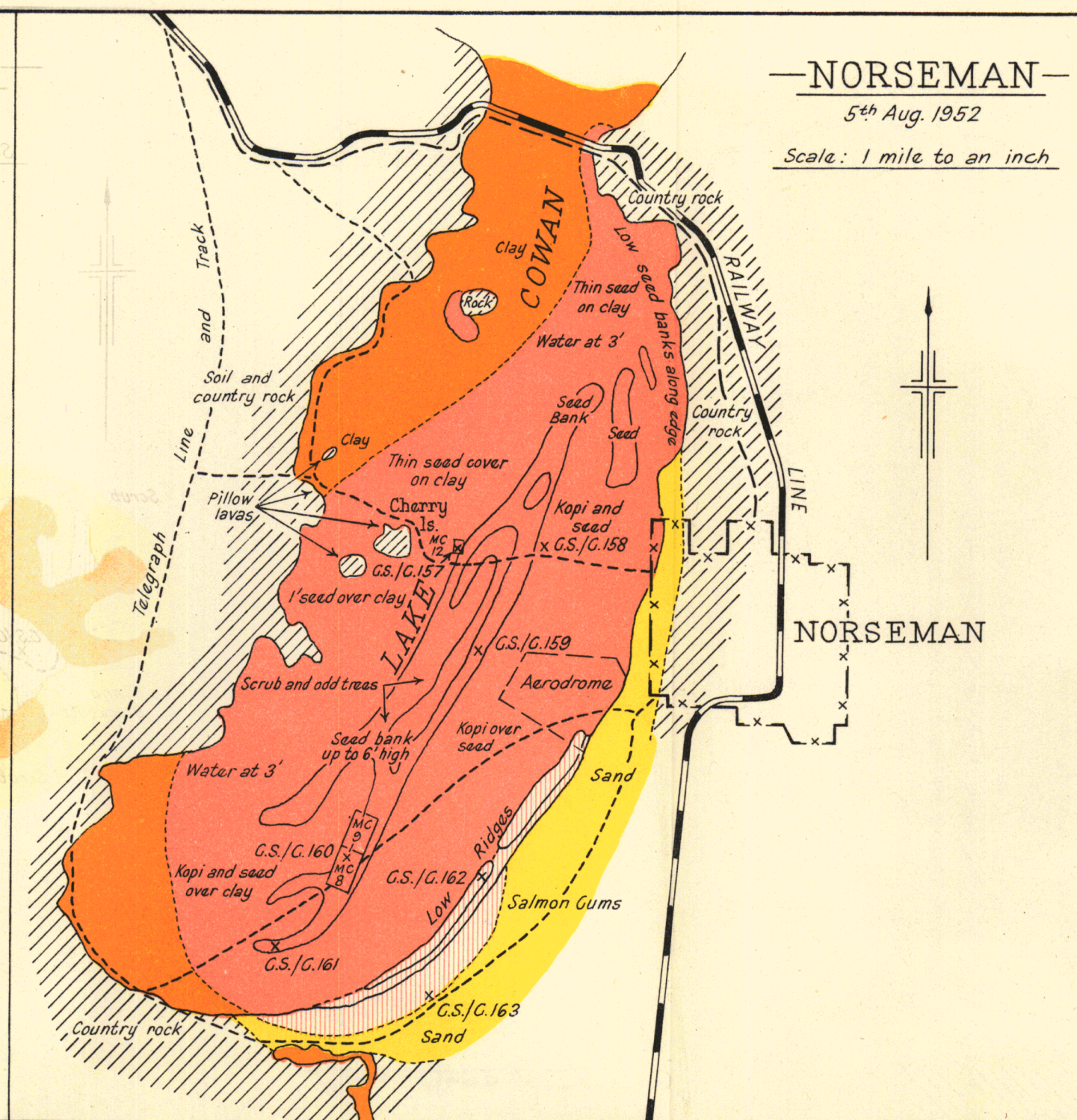
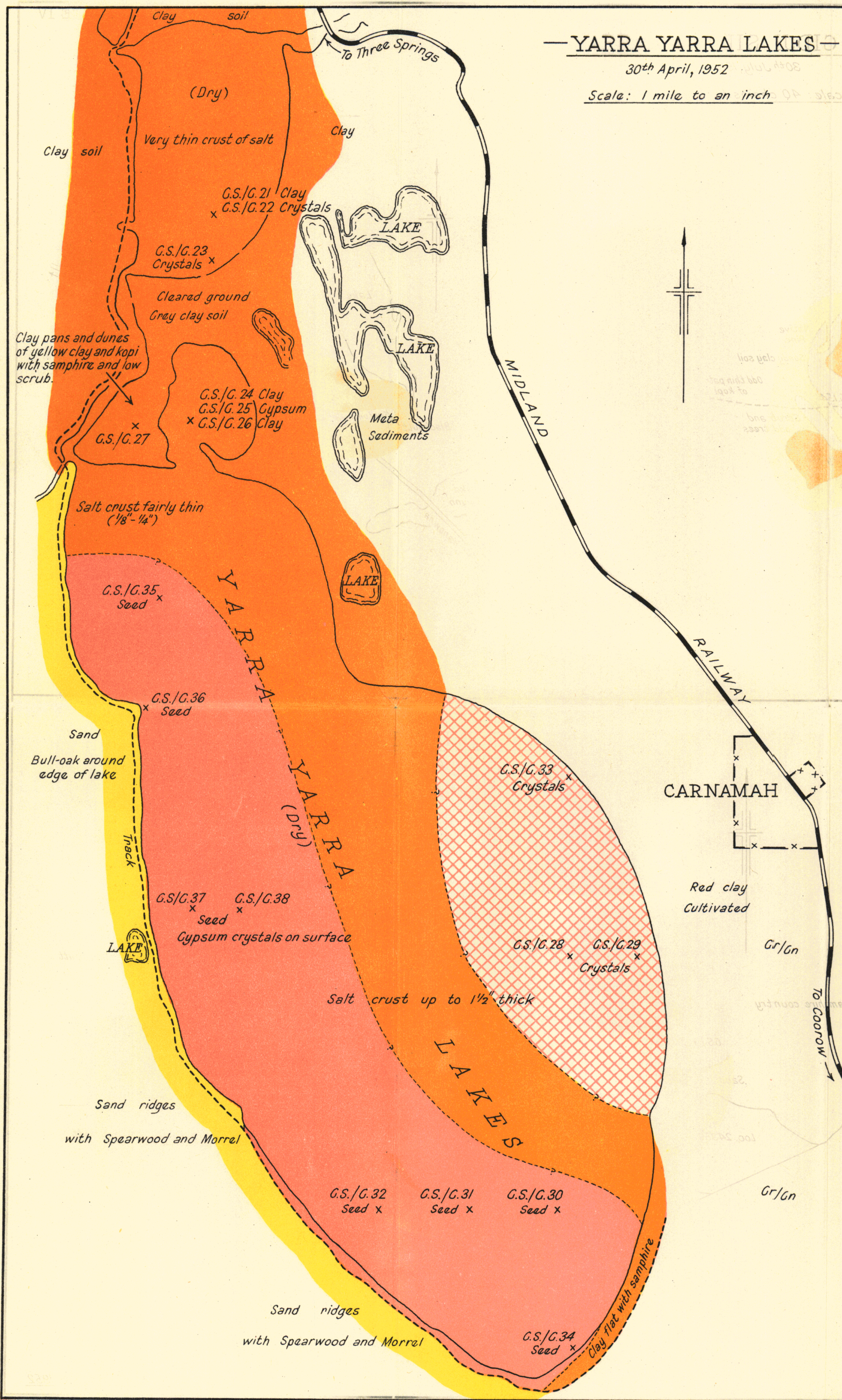
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16th June, 1952

Scale: 20 chains to an inch



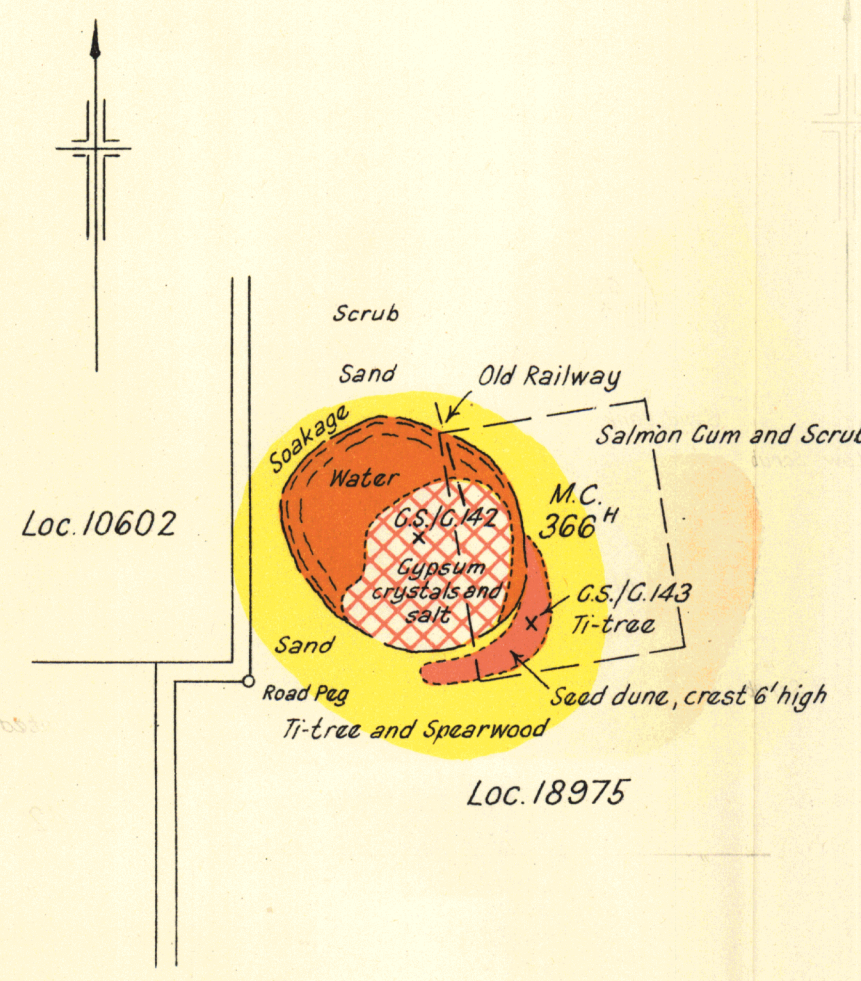


Sand
 Clay
 Gypsum Crystals
 Seed Gypsum
 Kopi
 Country Rock
 Specimen Number G.S./G.159

—KELLERBERRIN—

Approx. 5 Miles South (M.C. 366^H)
14th July, 1952

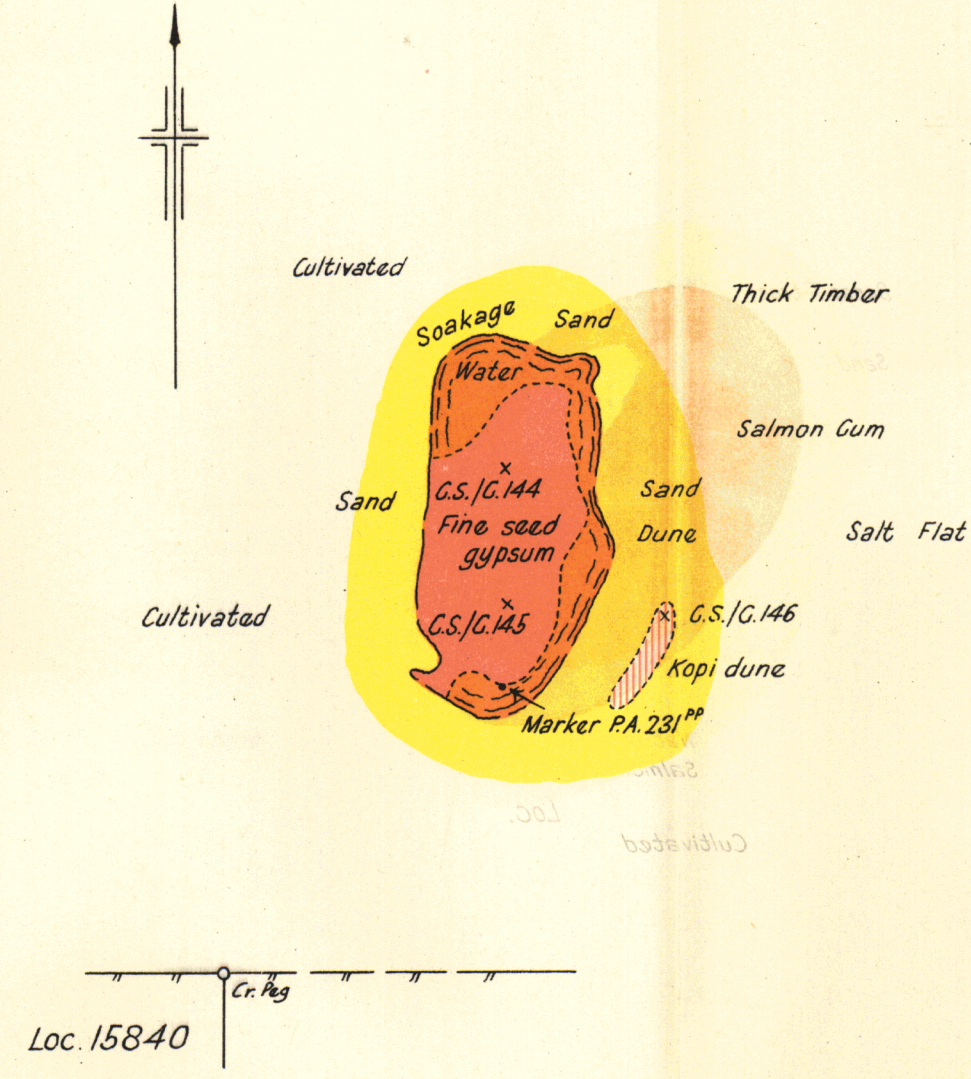
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—CUNDERDIN—

4 Miles E.N.E. (P.A. 231^{PP} Northam)
15th July, 1952

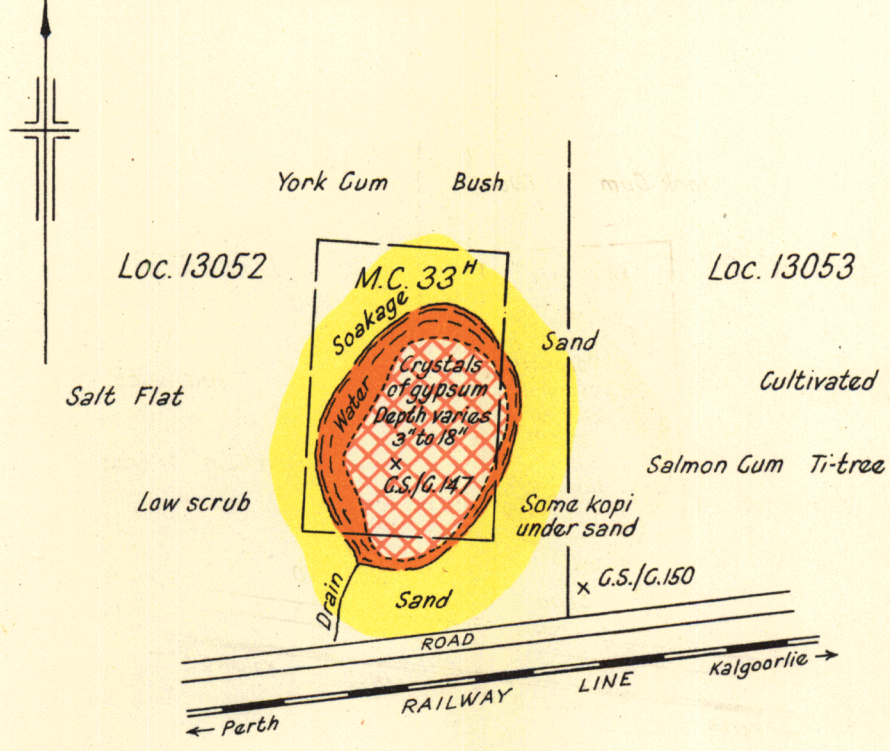
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—CUNDERDIN—

Approx. 4 Miles East (M.C. 33^H)
15th July, 1952

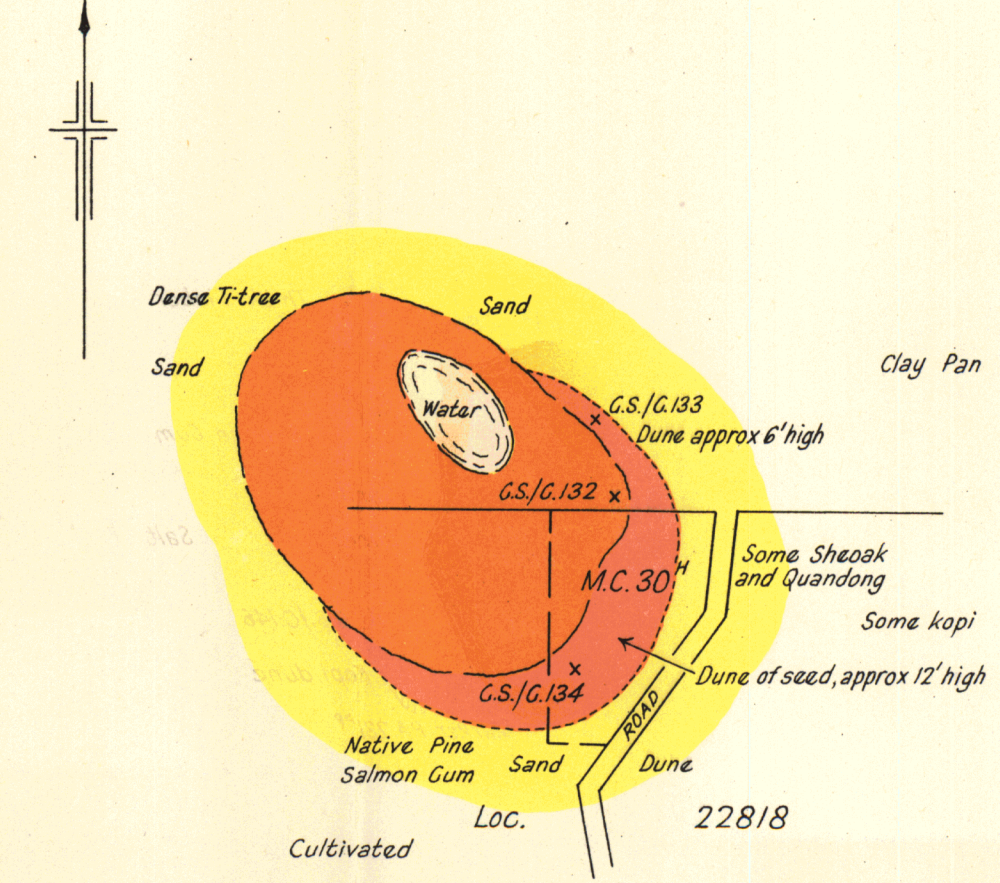
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—BAANDEE—

Approx. 13 Miles North (M.C. 30^H)
6th July, 1952

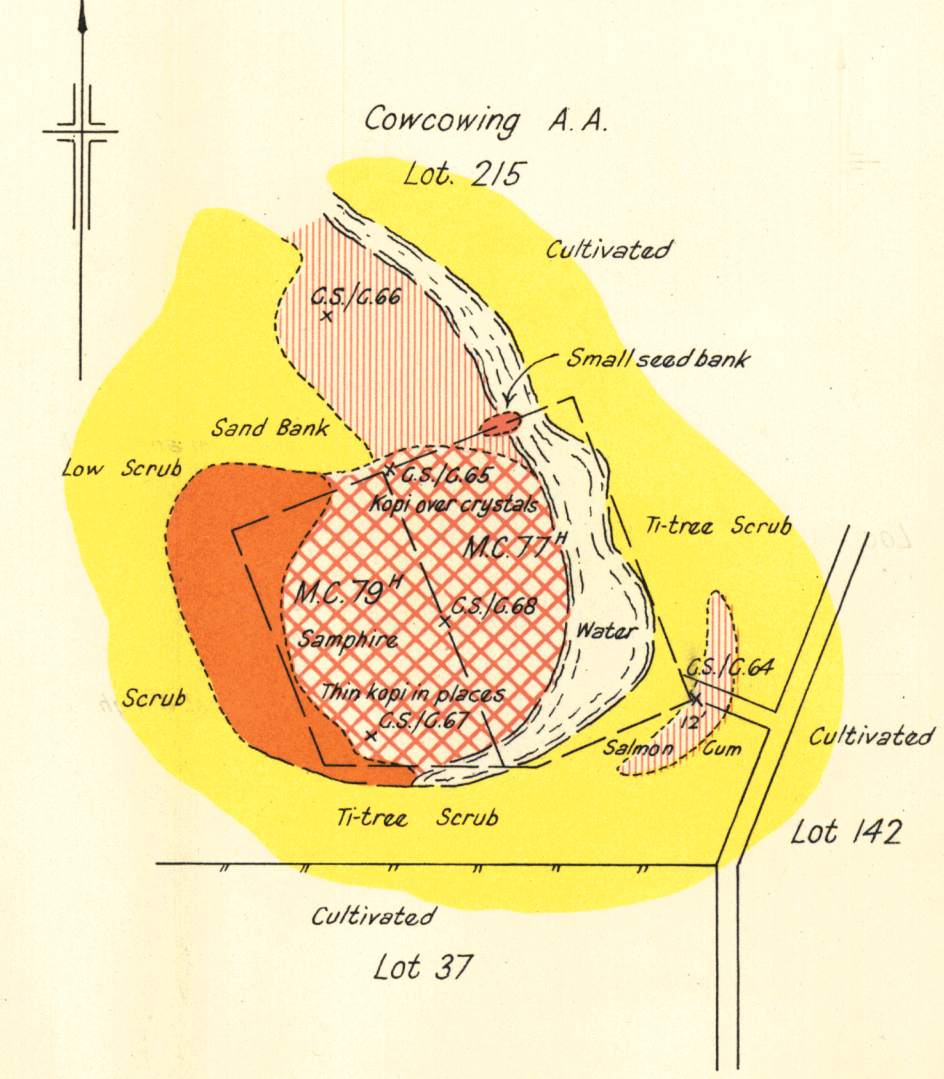
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—NALKAIN—

8th June, 1952

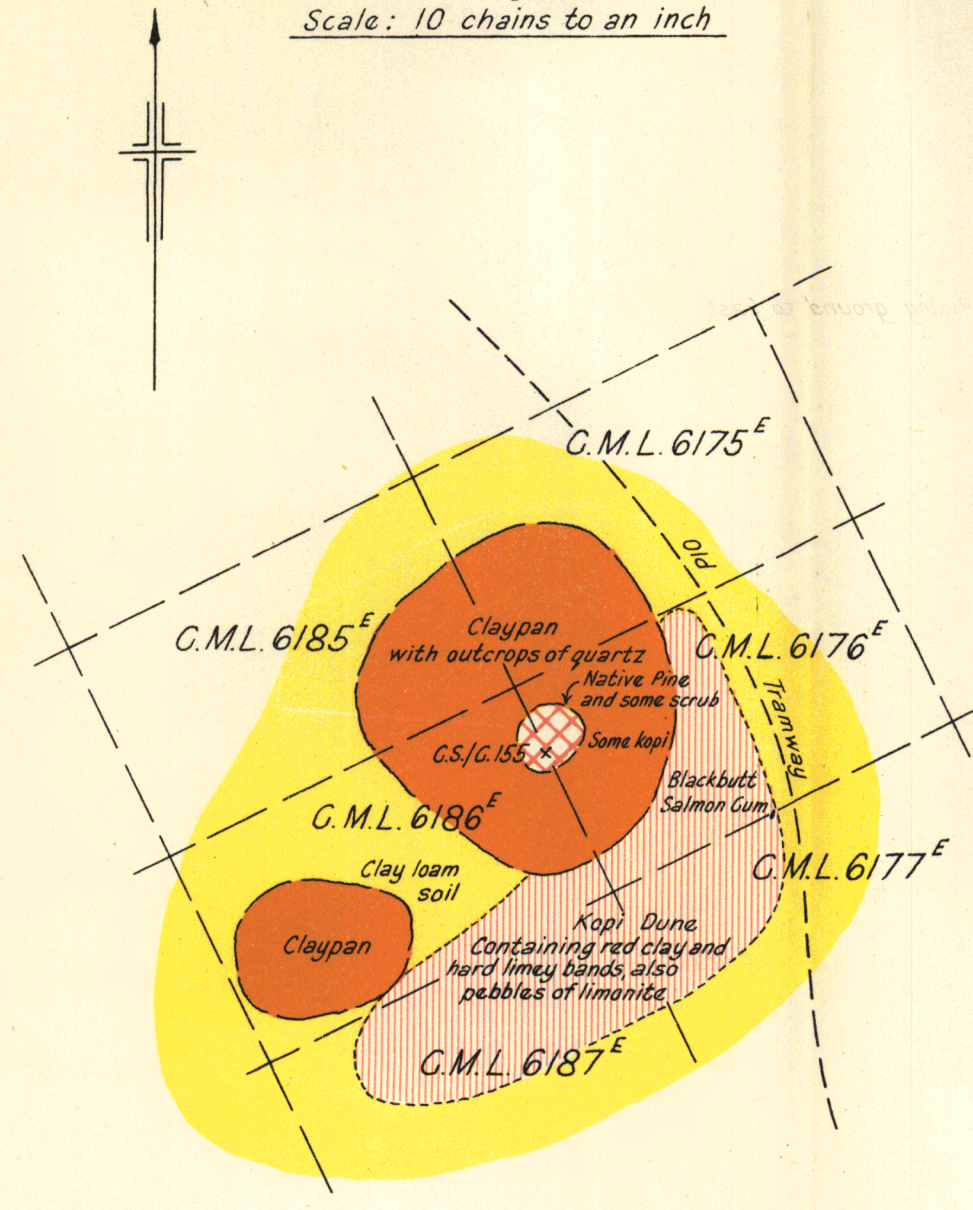
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—LAKEWOOD—

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29th July, 1952

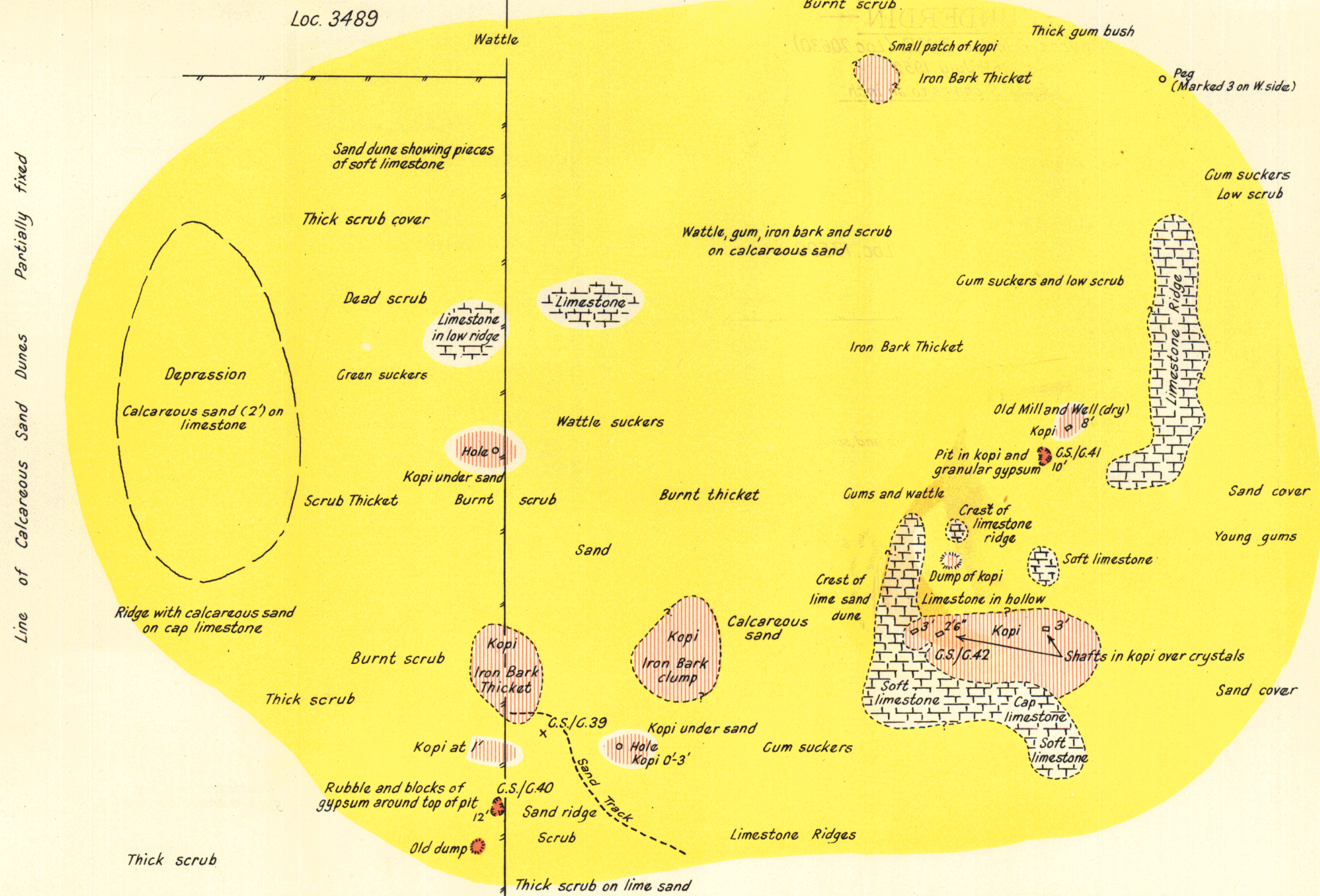
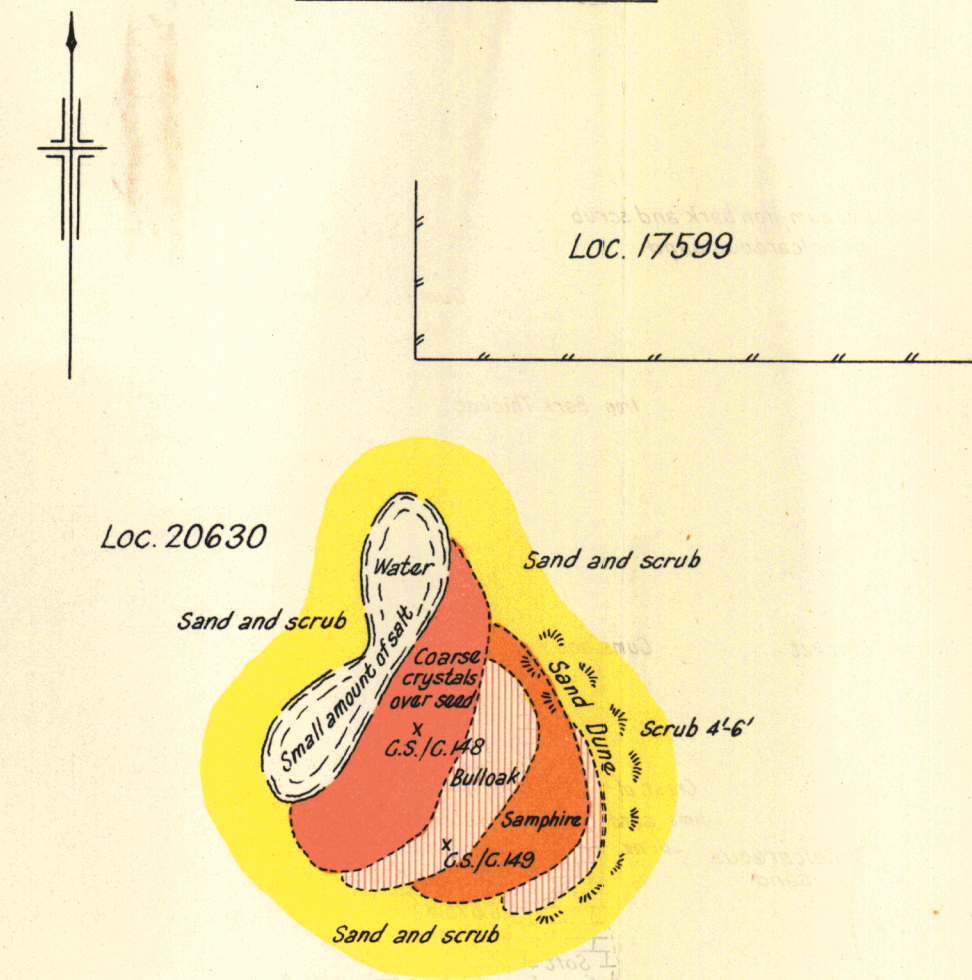
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—CUNDERDIN—

Approx. 6 Miles E.N.E. (Loc. 20630)
16th July, 1952

Scale: 5 chains to an inch

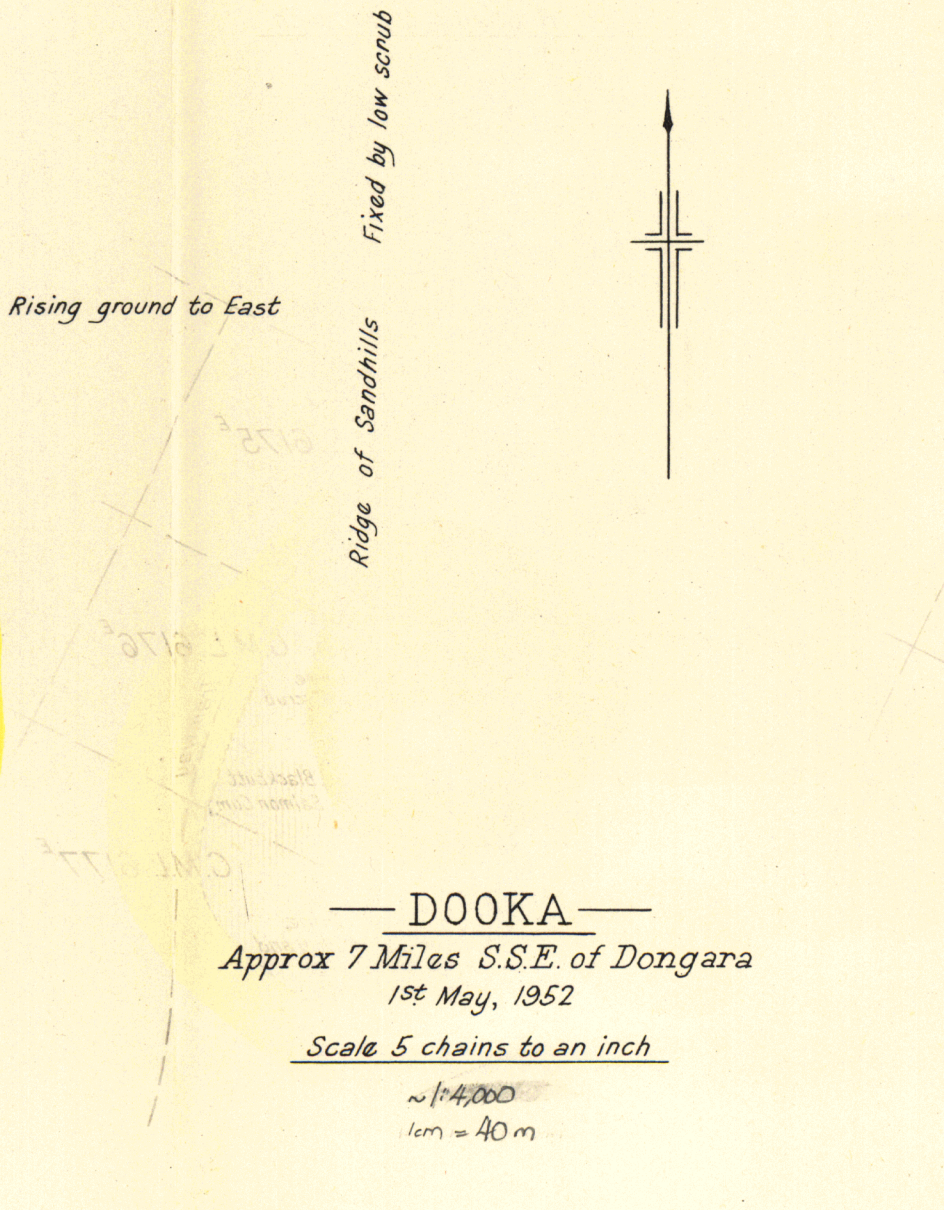


—DOOKA—

Approx 7 Miles S.E. of Dongara
1st May, 1952

Scale: 5 chains to an inch

1:4,000
1cm = 40 m



Sand Clay Gypsum Crystals Seed Gypsum Kopi Limestone

Specimen Number G.S./G.39