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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF SUPPLY AND DEVELOPMENT.

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS.

REPORT No. 1949/104.
(Geol.Ser.71)

POSSIBLE UNDERGROUND EVAPORITE DEPOSITS IN WESTERN AUSTRALIA.

by

E.K. Sturmfels
Geologist.

CANBERRA. 28th October, 1949.

DEPARTMENT OF SUPPLY AND DEVELOPMENT.

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Report on a Reconnaissance Trip in September and October, 1949.

CONTENTS.

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I. SUMMARY.

No evaporites of economic value can be expected in the Tertiary to Recent sediments of the Fortescue River Area.

Two gypsum horizons occur in the Cretaceous of the North-West Basin, between Carnarvon and the Exmouth Gulf, but only the lower one could be connected with other evaporites at depth.

The origin of saline waters struck in two deep bores within probably Jurassic strata at Geraldton and Dongarra is not known.

The Permian of the Irwin River Area, north of Mingenew, contains primary gypsum over a thickness of sediments of several hundred feet, and is rich in salt crusts. Rock-salt and potash salts may occur, perhaps farther to the north, nearer the probable centre of the basin of deposition.

Gypsum occurs within sandy shales and shaly sandstones at several places in the North-West Basin, but these occurrences are of no importance. However, large amounts of primary gypsum extend over a thickness of several hundred feet of shale south of the Minilya River; similar gypseous beds and also salt crusts were found on the Gascoyne River; it is probable that both occurrences belong to the same formation. In these beds, there is a good chance of finding rock-salt and potash salts.

Only weak indications of the occurrence of evaporites are reported from the northern and north-eastern margin of the Permian in the Desert Basin.

The most promising geological formations for the occurrence of evaporite deposits are, in the following order:

(1) the Permian of the North-West Basin,

(2) the Permian of the Irwin River Area, and

(3) the Cretaceous of the North-West Basin.

These areas taken together, the chances of finding a rock-salt bed of economic value in Western Australia may be estimated to be 1 in 4, and the chances of finding potash salts to be 1 in 20.

Geology and structure of these several areas have to be studied in detail before any recommendations for appropriate sites for deep drilling can be given. Office work on air photos, mapping

in the field, and scout drilling are the three main stages of geological work which should be carried out before any deep drilling. Further information on the possible extent of underground evaporite deposits may be gained by analysing, and comparing the composition of, the salt crusts.

II. INTRODUCTION.

The possibilities of finding evaporite deposits in Western Australia were investigated by C.L. Knight and E.K. Sturmfels on a reconnaissance trip from 12th September until 14th October, 1949.

The localities in which primary gypsum beds or other indications of evaporites at depth were found or from which they are reported, are classified on the following pages according to the geological formations, and their position is shown on two accompanying maps.

III. POSSIBLE DEPOSITS OF TERTIARY TO PLEISTOCENE AGE.

In the Fortescue River Area, some 150 miles south of Port Hedland, lacustrine sediments of late Tertiary or Pleistocene age supply very saline water (Talbot, 1920). The beds were probably laid down in an old salt lake. It is possible that they embrace thin layers of salt. However, no salt deposits of economic value can be expected.

IV. POSSIBLE DEPOSITS OF CRETACEOUS AGE.

In the North-West Basin, Cretaceous strata unconformably overlie the Permian to the west and north. The Cretaceous beds are up to 2000 feet thick and consist in the upper part mainly of marls and chalk, in the lower part mainly of shales. The Cretaceous has generally flat dips and forms shallow synclines and anticlines.

Grey shales on Cardabia Station contain thin layers of horizontally bedded gypsum. Breakaways along Cardabia Creek, about 25 miles east of Cardabia Homestead, show flat lying shales of more than 15 feet thickness over a distance of at least 1 mile; the shales contain three or more gypsum layers which are horizontally bedded and between 1 and 3 inches thick. The big sheets of gypsum covering the slopes and sparkling in the sun are very impressive, but the shales contain actually less than 5 per cent gypsum. A sandy barite horizon on an average 4 inches thick forms apparently the base of the gypsum-bearing shales.

The same shales and the same sheets of gypsum were seen on the road from Cardabia Creek Outcamp to Cardabia Homestead, about 18 miles east of Cardabia Homestead and are reported by M.A. Condon, Senior Geologist of the Bureau of Mineral Resources, Melbourne, (personal communication) from the country east and north of Remarkable Hill, approximately 20 miles east-north-east of Cardabia Homestead.

These thin gypsum layers in the upper part of the Cretaceous are probably derived from primary gypsum which has been modified by recrystallization. However, the amount of gypsum is not large enough to be possibly connected with salt deposits at depth.

Brownish coloured primary gypsum has been encountered in several dams at Winning Station, and in an outcrop some twenty miles farther north. This gypsum belongs to the lower part of the Cretaceous, Raggatt's (1936) Winning Series.

In the excavation for a dam on Winning Station, about 2 miles south-west of Mount Forrest and approximately 8 miles east-north-east of Winning Homestead, gypsum rock was struck but not penetrated. The large quantities of lumps of gypsum which may be seen around the dam indicate that at least 2 or 3 feet of gypsum rock have been excavated. The gypsum is definitely of primary origin, but partly weathered. Small quantities of gypsum occurring together with marls were found around a dam 3 miles north-east of Winning Homestead. A larger proportion of gypsum than around this dam is reported by a local resident from a dam about 7 miles north-east of Winning Homestead. Big lumps of primary gypsum of about 1 foot in diameter were collected by another local resident on the boundary fence between Giralia and Marilla Stations, approximately 15 miles south-south-east of Giralia Homestead and approximately 23 miles north-north-west of Winning Homestead.

So far, the primary gypsum deposit in the lower part of the Cretaceous has been struck in artificial excavations in all but one occurrence, since the country is generally flat and not dissected by creeks or gullies. The primary gypsum has been proved over a distance of 20 miles, but the thickness of the gypsum-bearing strata generally and of the gypsum beds themselves could not be established. Thus, it is impossible to say whether this gypsum could possibly be connected with other evaporites like rock-salt or potash-salts.

V. POSSIBLE DEPOSITS OF JURASSIC AGE.

Saline artesian water was struck at 1400 feet in the Dongarra Bore on the mouth of the Irwin River (about 70 miles west of Mingenew), and subartesian water at 1531 feet in the bore on the Geraldton racecourse (Campbell, 1910). According to Teichert (1946), for all except the upper 140 feet the beds in the Dongarra Bore are probably of Jurassic age, whereas the lower part of the strata in the Geraldton Bore may be of Jurassic or of Permian age.

The origin of the saline waters is not known, and no other indications of evaporites have been reported from the Jurassic.

VI. POSSIBLE DEPOSITS OF PERMIAN AGE.

a. In the Irwin River Area.

The Permian succession in the Irwin River Area which unconformably overlies the Pre-Cambrian, is about 4000 feet thick, according to Dr. Fairbridge, lecturer at the University of Western Australia, Perth, (personal communication)(1). The Holmwood shale of about 1600 feet thickness begins approximately 800 feet above the base of the Permian sequence and consists mainly of dark shales with some calcareous layers in the lower part and increasing amounts of gypsum towards the top.

The Permian of the Irwin River occurs essentially in one big fault block which is tilted towards the east and divided from the Mesozoic strata to the west as well as from the Pre-Cambrian to the east by north-north-west striking faults. Thus, generally speaking, the higher Permian strata appear in the eastern part and the lower Permian strata in the western part of the area. However, the structure is complicated by numerous smaller faults which run parallel to the strike. The Permian is partly covered

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(1) A paper on the Irwin River Area by Clarke, Prendergast, Teichert and Fairbridge will be published shortly in the Proceedings of the Royal Society of Western Australia.

by a laterite and by Jurassic sandstones and conglomerates which form mesas. The outcrops of marine Permian in the Irwin River Area extend probably over an area of not more than 500 square miles. Holmwood Shale lies on or near the surface over perhaps one quarter of this area and is buried under younger sediments for about half the area.

Outcrops of primary gypsum are found in many places in the creeks south-west of the junction of the two headwater branches of the Irwin River, and in numerous deep gullies formed by soil erosion.

Beckett's Gully, about 13 miles north-north-east of Mingenew, gives a good section through the east dipping Holmwood Shale. Large quantities of primary gypsum were seen in the lower two thirds of the Upper Holmwood Shale, over a thickness of about 400 or 500 feet according to figures given by Fairbridge (personal communication). The gypsum in these beds has been attacked strongly by leaching. Most of the gypsum which was seen in the sections is distributed in the form of single crystals or agglomerates within the shales, probably due to the fact that a large percentage of the original gypsum content has been leached, but layers of hard brownish coarse-grained rock-gypsum are still common. Beds of 1 foot thickness each contained up to 50 per cent gypsum. However, no exact figure of the present or original content of gypsum in these strata can be given, since the outcrops are too poor and too much leaching has taken place.

The upper third of the Upper Holmwood Shale (about 200 to 300 feet thick) and the Lower Holmwood Shale (about 900 feet thick) apparently contain only secondary gypsum.

Primary gypsum has been found also along the head branches of Eagle Creek, between 1 and 2 miles south of the junction of North and South Irwin River, 15 to 16 miles north-north-east of Mingenew. The country just east of Eagle Creek particularly, which is dissected by numerous deep gullies, is rich in primary gypsum. In one of these gullies, a section of the Upper Holmwood Shale, of a thickness of 3 feet, contained six layers of rock-gypsum which though strongly leached still made up more than half of the section. Springs on top of the Upper Holmwood Shale are fairly saline, for instance a spring in the upper part of Beckett's Gully, a spring right at the beginning of the south-eastern branch of Eagle Creek, and springs in the valley of the North Irwin River between 1 and 2 miles above the junction. There, sandstones which overlie the Upper Holmwood Shale are often white with encrusted salt. White encrustations of salt are quite common within the Upper Holmwood Shale and are found in many other places, for instance in Beckett's Gully and in Eagle Creek. Salt crusts collected in the southern tributary of Eagle Creek were shown by spot tests to contain besides sodium chloride a high percentage of magnesium and sulphate.

No gypsum could be found about 3 miles north-east of Yandanooka (about 11 miles south-east of Mingenew) where shales probably of Holmwood age outcrop in a creek bed.

Summarizing, it can be stated that the Upper Holmwood Shale contains within a thickness of 400 or 500 feet large quantities of primary gypsum, and that salt crusts and saline springs are quite common. However, whether actual unleached rock-salt deposits occur at depth is not known. The high magnesium content of the salt crusts could indicate that the evaporation of the sea water in the Permian basin proceeded even beyond the stage of deposition of rock-salt and that perhaps some magnesium and potash salts were deposited. However, complete analyses of the salt crusts have to be made before any definite conclusions can be drawn. (see below)

Fairbridge (personal communication) supposes that the Permian of the Irwin River forms the south-south-eastern part of

a Permian geosyncline which extended probably for a great distance to the north-north-west in the direction of Shark Bay; but nearly all the area to the north-north-west is now covered by Mesozoic sediments. The centre of deposition, where the greatest thickness of evaporites and perhaps even potash salts may be expected, was situated probably in this area, to the north-north-west of the Irwin River. However, to date nothing is known about this hypothetical extent of the marine Permian of the Irwin River, nor is it known whether marine Permian occurs at depth between Mingenew and the Indian Ocean.

b. In the North-West Basin.

The Permian sequence on the Minilya River in the northern part of the North-West Basin is probably up to 10,000 feet thick, but only the upper 6,000 feet outcrop (Teichert, 1946). To the south, the Permian decreases in thickness; on the Gascoyne River, it is only 6,000 feet thick (Raggatt, 1936).

The gypsum-bearing Bulgadoo Shale which forms the base of the visible part of the Permian sequence on the Minilya River and its surroundings measures more than 2000 feet and is overlain by the Cundlego Sandstone (Teichert, 1946). The Byro Series on the Gascoyne River overlies 3000 feet of older Permian sediments; it also contains gypsum and is probably of the same age as the Bulgadoo Shale of the Minilya River.

The structure of the Permian in the North-West Basin is complicated by strong faulting and has as yet not been fully worked out. To the west, from about 10 miles west of Wandagee Homestead and from about 15 miles west of Gascoyne Junction, the Permian is unconformably overlain by Cretaceous and Tertiary.

The formation of shaly sandstones and grits which covers the south-western part of Williambury Station and which overlies probably the Bulgadoo Shale, carries gypsum at several horizons and over a total thickness of several hundred feet (Condon, personal communication). Shaly sandstones which were seen between 1 and 3 miles south of Donelly's Well on Williambury Station, contained thin layers of gypsum, none of them more than 1 inch thick. It may be assumed that this gypsum either represents the end phase of the deposition of evaporites in the Bulgadoo Shale or has been derived entirely from the Bulgadoo Shale itself by solution and redeposition.

Many gypsum occurrences were found on Wandagee Station within the Bulgadoo Shale. Sandy shales and shaly sandstones, which belong probably to the top of the Bulgadoo Shale, outcrop in Barrabiddy Creek, west of the junction of Quail-Quail Creek with Barrabiddy Creek and approximately 13 miles south-south-west of Wandagee Homestead. They dip gently to the west, and are divided in several blocks by north-south running faults. They contain many beds and layers of primary gypsum, especially in their lower eastern part. About ½ mile west of the junction of Quail-Quail Creek, a section through 200 feet of gypsum-bearing sandy shales and shaly sandstones contains on an average between 5 and 10 per cent gypsum, and one bed of shaly sandstone nearly 10 feet thick has about 25 or 30 per cent gypsum.

A sequence consisting mainly of grey shales and primary gypsum adjoins these sandy gypsum-bearing beds to the east, and is divided from them by a fault. Dr. Teichert, Melbourne, (personal communication) found that this sequence is many hundred feet in thickness and supposes that it is of Bulgadoo age. It forms apparently a north-south striking anticline of several miles in width. Only a few outcrops of grey shales were seen in Barrabiddy Creek, which crosses the anticline, but many outcrops of primary gypsum were found along Quail-Quail Creek which runs, in its upper part, more or less parallel to the strike of the west dipping shale and gypsum beds. Two outcrops near the junction

of Quail-Quail Creek with Barrabiddy Creek, representing together a thickness of more than 40 feet, contain between 30 and 50 per cent rock-gypsum although some of the gypsum has probably been dissolved by weathering; the gypsum beds occur together with grey shales and are up to 6 inches thick. Five other outcrops on Quail-Quail Creek, underneath Cretaceous wash, between ½ mile and 1½ mile about the junction with Barrabiddy Creek, show more than 50 per cent gypsum, but are only a few feet thick. The beds of primary gypsum extend to the south beyond the junction of the two headwater branches of Quail-Quail Creek as indicated by the occurrence of pieces of gypsum rock in the stream-beds.

These grey shales and primary gypsum beds extend over a considerable area, but outcrops are very poor. Most of the surface in the area is covered by Cretaceous wash or thick soil to a depth of at least 10 or 20 feet. Sections are more or less restricted to Quail-Quail Creek and show only a small part of the sequence.

However, it is known that the beds of primary gypsum extend to the north. Primary gypsum of the same appearance as in Quail-Quail Creek has been excavated on a dam-site about 5 miles south of Wandagee Homestead. Large amounts of gypsum occur also around a dam about 2½ miles north-west of the junction of Quail-Quail Creek with Barrabiddy Creek and on another dam about 5 miles west of the junction, according to a local resident. Teichert (personal communication) found much gypsum in joints and faults east of Wandagee Hill, between 6 and 7 miles south-west of Wandagee Homestead. The beds of primary gypsum probably extend even beyond the Minilya River to the north; a big piece of primary gypsum was found in the bed of a creek which joined the Minilya River from the north. Thus, this gypsum deposit on Wandagee Station extends from the north to the south over a distance of at least 20 miles.

A sequence of black bituminous shales which is reported by Teichert (personal communication) to be between 1000 and 2000 feet thick outcrops along the Minilya River between 5 miles west-north-west and 2 miles north-west of Wandagee Homestead, probably forming a flat syncline. The shales contain small amounts of fibrous gypsum, as thin and more or less horizontal layers, or along steeply dipping joints. The same shales are also found east of Wandagee Homestead. These black bituminous shales represent the bulk of the Bulgadoo Shale, according to Teichert, but their exact relationship to the grey shales with primary gypsum on Barrabiddy Creek and Quail-Quail Creek is not known.

Large amounts of primary gypsum were found within the Byro Series on the northern bank of the Gascoyne River, between 12 and 13 miles west of Gascoyne Junction. Greyish to greenish shales contain much primary gypsum; they are about 250 feet thick according to Raggatt (1936) and are underlain by about 150 feet of sandstone and sandy shale in which only a little secondary gypsum has been observed. White salt crusts on these sandstones may be found in several places along the Gascoyne River. Salt Gully which joins the Gascoyne River just opposite the above mentioned outcrops of greyish to greenish shales and primary gypsum (about 13 miles west of Gascoyne Junction) and which crosses the Permian shales in a northwesterly direction, shows unusual thick crusts of salt in its bed for many miles above the junction.

The extent of these beds of primary gypsum on the Gascoyne is not known. It is quite possible that they form the southern continuation of the primary gypsum beds which were found on Wandagee Station.

The middle part of the Permian in the North-West Basin has apparently been deposited in a restricted basin where water circulation was more or less absent, as shown by the deposition of large thicknesses of black bituminous shales. The high

percentages of gypsum found in many hundred feet of sediments in the Bulgadoo Series on Wandagee Station and in the Byro Series west of Gascoyne Junction prove that concentration and deposition of evaporites took place in the Permian of the North-West Basin during a considerable period. Salt crusts such as seen in Salt Gully show that besides gypsum some sodium and magnesium salts were deposited ~~xkxx~~. However, whether any rock-salt beds of greater thickness or potash-salt deposits of economic value occur at depth is not known. Also it is not known in which areas such deposits may be expected since structure and geology of the North-West Basin have not been studied in detail except for limited areas. It has been stressed by Raggatt (1936) and Teichert (1946) that generally the Permian in the North-West Basin decreases in thickness and becomes more sandy from the north to the south. Thus, chances of finding other valuable evaporite deposits exist rather in the northern part of the basin, north of the Minilya River, than in the south.

c. In the north-eastern part of the Desert Basin.

Gypseous beds are reported by Wade (unpublished report, 1936) to occur in the lower part of the Erskine Series in the Luck Range (nearly 200 miles south-east of Derby) and in the base of the Erskine Series in the Erskine Range (60 miles south-east of Derby). The Erskine Series which probably forms the top of the Permian sequence is of estuarine origin and consists mainly of conglomerates and sandstones. There is no possibility of finding evaporite deposits of economic value in estuarine beds of such a composition.

The Noonkanbah Shale in the upper part of the Permian in the Fitzroy River Area is about 1200 feet thick and is composed of dark carbonaceous and partly pyritic shales. Some gypsum has been struck in the Nerrima No.1 Bore (about 95 miles south-east of Derby), which intersects the lower 800 feet of the Noonkanbah Shale. Gypseous bands are reported by Wade from cuttings of two tanks in the neighbourhood of Upper Liveringa Homestead (between 70 and 85 miles south-east of Derby) and from places near Selection Homestead on Christmas Creek. Saline water is said to be commonly struck when drilling in the Noonkanbah Shale.

Gypsum has also been reported by H. Evans (letter of September 1949) from the north-eastern margin of the Desert Basin, south of the Pallotine Mission, some 400 miles south-east of Derby. There, within an anticlinal structure, black shales contain abundant vein gypsum.

However, the indications of evaporites sound so far in Permian shales along the northern and north-eastern margin of the Desert Basin are only slight. Teichert (1941) states that fossils occur throughout the Noonkanbah Shale; this suggests that this formation from which some gypsum is reported was never separated for any length of time from the open sea. From south of the Pallotine Mission, no primary but only fibrous gypsum has been described. Thus the chances of finding evaporites at depth were thought to be too small to warrant a trip into this remote area.

VII. RECOMMENDATIONS FOR FURTHER INVESTIGATIONS.

It has been shown above that there are chances of finding rock-salt and potash salts at depth in the Cretaceous as well as in the Permian strata of the Irwin River Area and of the North-West Basin. From field observations it may be estimated that the chances of finding a rock-salt bed of economic value are 1 in 4, and the chances of finding potash salts 1 in 20.

However, even if such deposits exist, it will be a difficult task to trace them within many ten thousand square

miles since they may be of only very limited size, perhaps only some ten or twenty miles in diameter. Thus, a systematic approach to the problem is necessary.

The investigations made so far in search of evaporites in Western Australia were of a purely preliminary nature. It has been stressed above that our knowledge of the geology and the structure of the two main areas in which evaporites may be expected, the Irwin River Area and the North-West Basin, is very limited. The geology of these areas in which evaporites may be expected should be carefully investigated before any deep drilling can be done. Only after proper studies and careful examination, deep drilling in search of evaporites may be undertaken.

From the point of view of finding rock-salt and potash salts the areas where the primary gypsum-bearing beds occur at a depth of between 500 and 2000 feet are most interesting. At these depths, even readily soluble salts would probably not be leached, and drilling and eventual later working of a deposit would not be too expensive. However, high-grade deposits could be exploited under favourable conditions to a depth of 5000 feet.

Much information can be gained from the study and interpretation of air photos in the office before any field work is begun. Air photos have been taken of most of the Irwin River Area and of the North-West Basin by the Royal Australian Air Force. Some strips may still have to be flown in order that all areas of interest will be covered by air photography.

Field work should start in the areas where the primary gypsum-bearing beds outcrop, and from there proceed to the areas where these beds are covered with between 500 and 2000 feet of younger sediments.

Gypsum and other evaporites usually occur in soft shales with poor outcrops. To get an idea of the composition and thickness of such strata, it is often necessary to do some shallow depth scout drilling. It may be advisable to use a small drilling outfit for depths up to about 300 feet. However, the drilling outfit should not be sent into the field together with the geologists, but some three or four months later, when the field geologists have collected enough information and designated appropriate sites for scout drilling.

Salt crusts are common in semiarid to arid regions. However, salt crusts within the Permian of the Irwin River Area and of the North-West Basin seem to be of greater extent, greater thickness, and different composition, than elsewhere. By analysing the salt crusts in different regions, and comparing their composition, further information on the possible occurrence and extent of underground evaporite deposits and perhaps even on the concentration of potassium salts at depth may be gained.

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28/10/49.

REFERENCES.

Clarke, E. de C., Prendergast, K.L., Teichert, C., and Fairbridge, R.W. (in Print) : Permian succession and structure in the northern part of the Irwin Basin, Western Australia. Proc.Roy.Soc.W.Austr.

Campbell, W.D., 1910 : The Irwin River Coalfield. Geol.Surv. W.Austr. Bull.No.38.

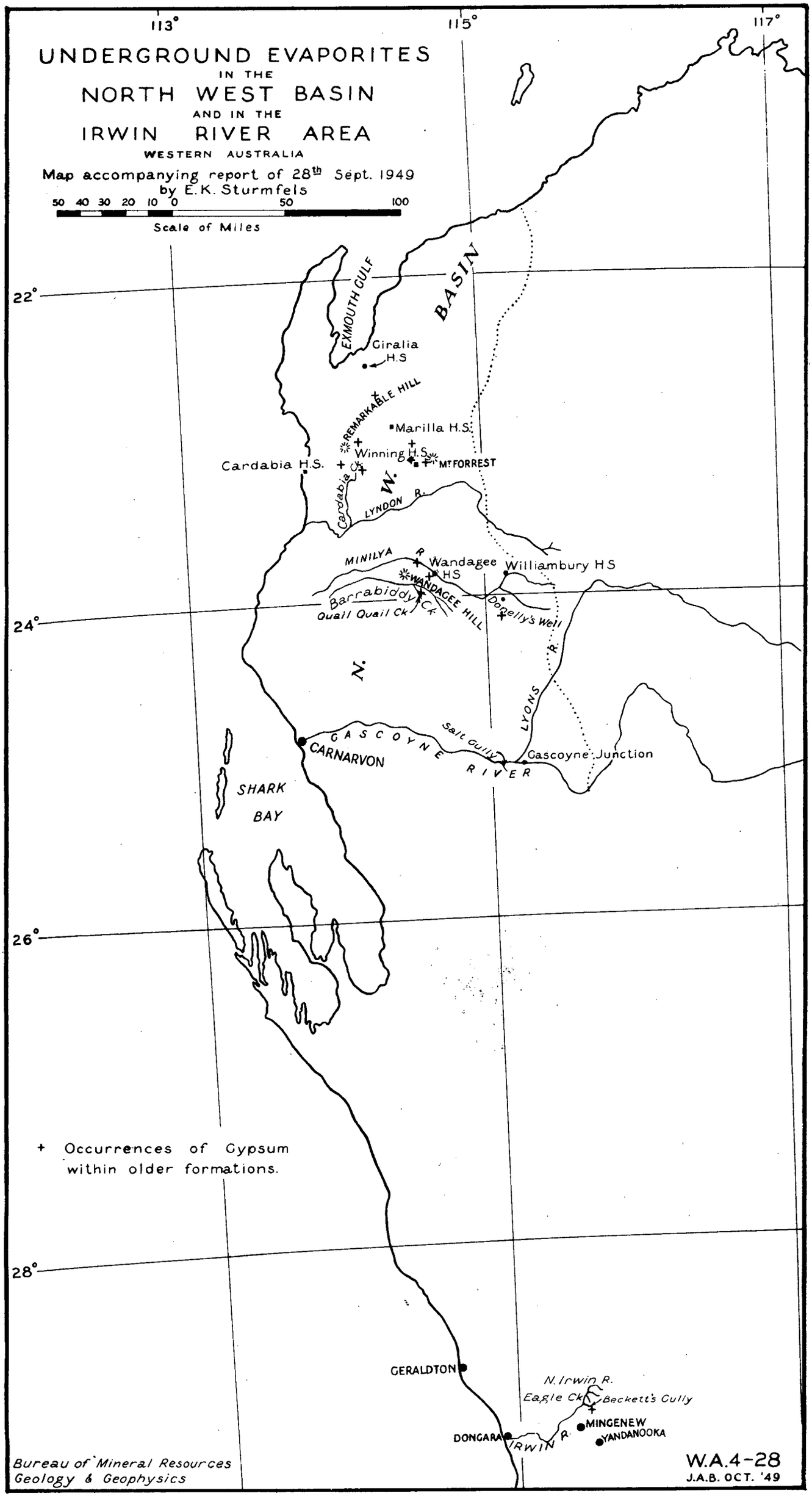
Raggatt, H.G., 1936 : Geology of North-West Basin, Western Australia, with particular reference to the stratigraphy of the Permo-Carboniferous. Journ. and Proc.Roy. Soc.N.S.W. Vol.70, pt.1, pp.100-174

Talbot, H.W.B., 1920 : The geology and mineral resources of the North-West, Central, and Eastern Divisions. Geol.Surv.W.Austr. Bull.No.83, pp.30-38

Teichert, C., 1941 : Upper Paleozoic of Western Australia : Correlation and Paleogeography. Bull. Amer.Assoc.Petrol.Geol. Vol.25, pp.371-415.

" 1946 : Stratigraphy of Western Australia. Journ. and Proc. Royal Soc. N.S.W. Vol. 80, pp.81-142.

Wade, A., 1936 : Report. Freney Kimberley Oil Company (1932) N.L. (Unpublished).


113°
115°
117°
UNDERGROUND EVAPORITES
IN THE
NORTH WEST BASIN
AND IN THE
IRWIN RIVER AREA
WESTERN AUSTRALIA
Map accompanying report of 28th Sept. 1949
by E.K. Sturmfels
50 40 30 20 10 0 50 100
Scale of Miles
22°
24°
26°
28°
EXMOUTH GULF
BASIN
Giralia H.S
REMARKABLE HILL
Marilla H.S.
Winning H.S.
Mt FORREST
Cardabia H.S.
Cardabia Ck
W.
LYNDON R.
MINILYA R.
Wandagee H.S
Williambury H.S
WANDAGEE HILL
Barrabiddy Ck
Quail Quail Ck
Dorelly's Well
N.
LYONS R.
Salt Gully
GASCOYNE RIVER
CARNARVON
Gascoyne Junction
SHARK BAY
+ Occurrences of Gypsum within older formations.
GERALDTON
N. Irwin R.
Eagle Ck
Beckett's Gully
DONGARA
IRWIN R.
MINGENEW
YANDANOOKA
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UNDERGROUND EVAPORITES IN WESTERN AUSTRALIA

Scale of Miles
0 50 100 150 200 250 300 350

Map accompanying report of 28th September, 1949
by E.K. Sturmfels

+ Occurrences of gypsum within older formations

124°
14°
20°
26°
32°
112°
118°
124°

Derby
Erskine Ra.
Upper Liveringa H.S.
Nerrima No1 Bore
Fitzroy River
Christmas Ck.
Christmas Ck. H.S.
Luck Ra
Pallotine Mission
Pt. Hedland
DESERT BASIN
Fortescue River
FOR ENLARGEMENT
N.W. BASIN
Minilya R
Gascoyne River
SEE MAP WA4-28
Geraldton
Irwin R
Mingenew
WESTERN AUSTRALIA
PERTH

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