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Record 1973/82

MINOR NON-METALLIC MINERALS IN THE

NORTHERN TERRITORY

1. Evaporites in Central Australia by A.T. Wells

2. Magnesite by C.E. Prichard

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EVAPORITES IN CENTRAL AUSTRALIA

by A.T. Wells (Bureau of Mineral Resources)

Major salt accumulations in the Northern Territory occur in evaporites in the Upper Proterozoic-Lower Palaeozoic Amadeus Basin sequence in central Australia, particularly in the Bitter Springs Formation, and also accumulations on the beds of seasonal lakes in the same general area, e.g. on Lake Amadeus and Lake MacDonald.

Some is produced to meet local requirements from tidal salt pans in the Roper River and Wearyan River areas of the Gulf of Carpentaria, and until about 1965 from tidal salt pans in the Shoal Bay area, about 15 km northeast of Darwin.

EVAPORITES IN CENTRAL AUSTRALIA

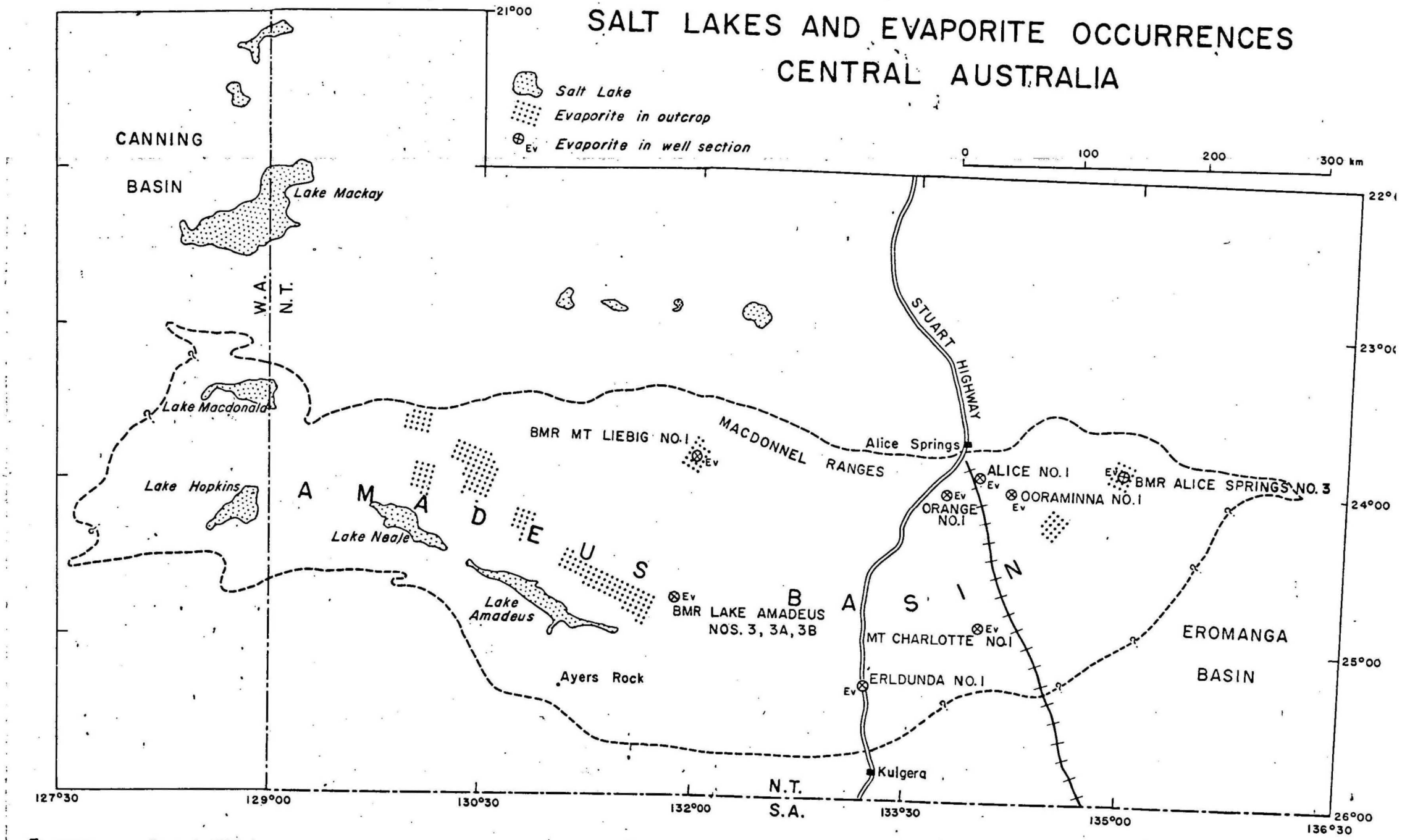
Thin surface accumulations of evaporite in playa lakes in central Australia have been known for several decades; but subsurface bedded deposits were discovered only recently, during exploration by government regional mapping parties (Wells et al., 1970; Ranford et al., 1965) and drilling by petroleum exploration companies. Five deep wells have intersected bedded basinal deposits and three shallow stratigraphic holes have been drilled to investigate the deposits in outcrop. An Australia-wide review of evaporite deposits has been compiled by Wells (MS).

CAINOZOIC PLAYA DEPOSITS

The playa lake deposits are in areas of subdued topography and internal drainage; the largest are in the southwestern part of the Northern Territory principally along the Western Australian border (Fig. 1). They include Lakes Amadeus, Mackay, Macdonald, Dennis, White, Bennett, Eaton, Hopkins, Neale, and Hazlett, and several unnamed salt lakes 200 to 300 km northwest of Alice Springs. The total area covered by the playas is about 6500 km^2.

The salt-lake evaporites generally consist of a surface crust of halite a fraction of a centimetre thick underlain by grey and black brine-saturated silt, sand, and clay which contain abundant large crystals of gypsum. In some places the sodium sulphate content is high and could indicate a source rock of particular composition. Thin thenardite-bearing evaporite deposits are known from the isolated salt lakes east of Lake Amadeus between Ayers Rock and Erldunda, and from small lakes east of Lake Mackay.

SALT LAKES AND EVAPORITE OCCURRENCES CENTRAL AUSTRALIA



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BASIN DEPOSITS

Extensive bedded evaporites occur in the Amadeus Basin in the Precambrian Bitter Springs Formation and the Lower Cambrian Chandler Limestone (Wells et al., 1967). Other formations in the basin show evidence of evaporitic conditions, but no interbedded evaporite minerals are known. Figure 1 illustrates the occurrences of evaporites in both formations in outcrop and in wells.

Bitter Springs Formation

Evaporites of the Bitter Springs Formation underlie an area of about 140 000 km^2 - practically the whole of the Amadeus Basin. The maximum known thickness of halite is about 200 m in BMR Mount Liebig No. 1 well, although this may not be a true stratigraphic thickness (Wells & Kennewell, 1972).

The distribution of gypsum outcrops in the formation suggests that this mineral occurs throughout the basin. Halite intersections in drill holes can be circumscribed in plan by a circle which lies in the central part of the basin and embraces an area of about 47 000 km^2. However, it is most likely that the halite has a much wider distribution and may also occur over most of the basin.

The less soluble parts of this evaporite sequence, mainly gypsum, are exposed in the cores of eroded anticlines and diapiric structures, and in a few isolated outcrops in sand-plains. The gypsum is mainly recrystallized and compact where freshly exposed, even though the texture commonly indicates it has been brecciated or tightly folded. In many places large blocks of dolomite are embedded in the incompetent gypsum.

The gypsum outcrops occur mainly in an east-southeast trending zone in the northwestern part of the basin, terminating a few kilometres northeast of Ayers Rock. The only known exceptions are outcrops in the Gardiner Range, at the Ringwood Dome, and immediately south of Santa Teresa Mission in the Phillipson Pound. Three of the surface gypsum occurrences have been drilled to 300 m by the Bureau of Mineral Resources by BMR Alice Springs No. 3 (Ringwood Dome), BMR Mount Liebig No. 1 (Gardiner Range), and BMR Lake Amadeus No. 3 (northeast of Ayers Rock).

Alice Springs No. 3 (Stewart, 1969) and Lake Amadeus No. 3 (Wells & Kennewell, 1972) intersected somewhat similar sequences of strongly folded, and in part brecciated, gypsum, anhydrite, and dolomite. The proportion of anhydrite increases with depth; it first appears at

about 100 m in each hole. The sequence penetrated in Mount Liebig No. 1 (Wells & Kennewell, 1972) consists of 100 m of brecciated mixed evaporite rocks underlain by 210 m of white, pink and red halite with minor impurities. The mixed evaporite rocks contain anhydrite, gypsum, dolomite, and euhedral quartz in various proportions, and are lithologically similar to salt-dome cap-rocks.

It is possible that Lake Amadeus could in part owe its presence to partial solution of underlying Bitter Springs evaporites. However, the only hole drilled to test this hypothesis was sited by a company near the eastern end of the lake and penetrated about 60 m of limestone, dolomite, and sandstone of the Bitter Springs Formation.

Halite-bearing sequences in the Bitter Springs Formation were also penetrated in the Ooraminna No. 1, Erldunda No. 1, and Mount Charlotte No. 1 petroleum exploration wells (Table 1).

Chandler Limestone

The area underlain by the Chandler Limestone evaporites is about 40 000 km^2, in the northeastern part of the Amadeus Basin. The maximum known thickness is about 225 m of halite in the Transoil Mount Charlotte No. 1 well; sections in this and the Orange No. 1 and Alice No. 1 wells are given in Table 1.

The evaporites do not crop out but they could be present near the surface.

NGALIA BASIN

In the Ngalia Basin gypsum and small amounts of other salts are commonly encrusted on outcrops of the Treuer Member of the Vaughan Springs Quartzite, and indicate the possible presence of evaporites at depth (Wells et al., 1968; Evans & Glikson, 1969). Supporting evidence includes the characteristic incompetent folding of the member, which also contains chert nodules with indistinct cubic pseudomorphs which could be after halite.

ECONOMIC ASPECTS

The subsurface intersections of evaporites in the Amadeus Basin are predominantly halite and contain relatively little anhydrite or gypsum, in contrast to the surface occurrences which are dominantly composed of these minerals. No bittern salts have been reported in the subsurface

sequences or in outcrops. The source of any unusual salts in outcrops, such as sodium nitrate, can generally be traced to decaying leached organic surface debris. The only evaporite deposit that has been exploited is the thin crust of halite from the eastern end of Lake Amadeus, which is used locally.

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TABLE 1

THICKNESS OF THE BITTER SPRINGS FORMATION, CHANDLER LIMESTONE, AND CONTAINED EVAPORITES IN PETROLEUM EXPLORATION WELLS

WELL NAME	FORMATION INTERVAL	LITHOLOGY	EVAPORITE INTERVAL
Exoil Alice No. 1	Chandler Limestone	Halite	2065-2089 m (24 m)
TD2292 m	2017-2176 m (159 m)	"	2095-2129 m (34 m)
		"	2149-2182 m (33 m)
Exoil Ooraminna No. 1	Bitter Springs Fm 1300-1858 m (558 m)		
TD1858 m			
	Gillen Member 1609-1858 m (249 m)	Halite, claystone and coarse anhydrite	1804-1858 m (54 m)
Exoil Erldunda No. 1	Bitter Springs Fm 1311-1665 m (354 m)		
TD1665 m			
	Gillen Member 1448-1665 m (217 m)	Coarsely crystalline halite	1619-1665 m (46 m)
Transoil Mount Charlotte No. 1	Chandler Limestone 711-936 m (225 m)	Coarsely crystalline halite	711-936 m (225 m)
TD2116 m			

WELL NAME	FORMATION INTERVAL	LITHOLOGY	EVAPORITE INTERVAL
	Bitter Springs Fm 1423-2116 m (693 m)		
	Gillen Member 1555-2116 m (561 m)	Halite	1863-1904 m (41 m)
Magellan Orange No. 1 TD2641 m	Chandler Limestone 2274-2502 m (228 m)	Halite with some inter-bedded carbonate rock, anhydrite and shale.	2315-2502 m (187 m)

MAGNESITE

by C.E. Prichard (Bureau of Mineral Resources)

Magnesite occurrences have been noted from several localities in the Katherine-Darwin region, including Rum Jungle, Stapleton, Brocks Creek, Katherine and the Alligator Rivers area.

The occurrences appear to be variously derived from intrusive amphibolite and dolerite, from basic lavas of the Antrim Plateau Volcanics, from dolomite in the Lower Proterozoic Celia, Coomalie, Golden Dyke and Koolpin Formations and from magnesian limestones in the Cambrian Daly River Group. However, on present indications, only those in the Celia and Coomalie Dolomite Formations at Rum Jungle and the Koolpin Formation in the Alligator Rivers area appear to be of possible economic significance.

RUM JUNGLE AREA

In the Rum Jungle Area, about 100 km south of Darwin, magnesite was first noted at the Mt. Fitch uranium prospect in 1968. Reconnaissance sampling from the same formation (Coomalie Dolomite) and a lower formation (Celia Dolomite) has since shown that magnesite occurs in both formations at various localities in the district.

The two dolomitic units are part of the Lower Proterozoic Batchelor Group which consists of four formations unconformably overlying the crystalline Archean Rum Jungle Complex.

Coomalie Dolomite	magnesite, dolomite, lutite
Crater Formation	mostly arenite
Celia Dolomite	magnesite, dolomite, lutite
Beestons Formation	arenite.
Rum Jungle Complex	mainly granite and granite-gneiss.

The two "dolomite" units crop out poorly and only a few percent of the area they occupy is represented by carbonate rock outcrop. Subsurface information is available from opencut uranium mines and diamond drilling for the Coomalie Dolomite only.

Initial sampling was undertaken from diamond drill holes in the Coomalie Dolomite south-west of the Complex and from outcrops of both Celia and Coomalie Dolomite south of the Complex. X-ray diffraction examination identified magnesite as a major constituent in 9 of our 20 drill core samples and 14 of 17 outcrop samples. It is apparent that magnesite occurs widely in both formations. Outcropping carbonate rock is more likely to be magnesite than subsurface carbonate rock but nevertheless determinations on drill core showed magnesite present to over 300 m (at Whites and Dysons) and to more than 100 m at other localities (Mt. Fitch, Mt. Burton and Triangle South).

Three localities of outcropping carbonate rock were samples in more detail. These are:-

Zeta area

Huandot Magnesite area

Celia Fossil area

The Zeta Area is about six kilometres north-west of Batchelor. About 30 percent of an area 300 m by 200 m consists of low outcrop of irregularly intermingled fine grained and coarse grained carbonate rock of the Coomalie Dolomite. Twenty samples were collected. Only three contained more than 90 percent MgCO3, two were dolomite and the rest were magnesian dolomite with 55-75 percent MgCO3.

At the Huandot Magnesite Area, two to three kilometres north-west from the junction of the Batchelor road with the Stuart Highway, partial outcrop of the Coomalie Dolomite occurs over an area about 1500 m by 700 m. Only about 15 percent of the area is carbonate outcrop. Twenty-five samples, mostly from crystalline dolomite, were collected. One of these was dolomite, and nearly all the others contained over 80 percent $MgCO_3$. Thirteen of the samples from an outcrop of about 50,000 m^2 in the north west of the area average 88.8 percent $MgCO_3$ and less than 1 percent $CaCO_3$. As this indicated the possibility of 150,000 tonnes per vertical metre a composite chip sample was tested by Australian Mineral Development Laboratories, Adelaide (AMDEL), (ASTM Designation C24-56) to the limit of available equipment. They obtained "greater than cone 41 (1970°C)" which result indicated the refractory nature of the sample.

Celia Fossil Area. Eight kilometres north-east of Batchelor the Celia Dolomite outcrops as a number of irregular upstanding masses separated by soil. The individual masses range from about one metre to nearly 10 metres in height and occur within an area about 300 m by 200 m.

Silicification is variable and is most prominent in beds rich in "Collenia".

Twenty one samples were collected. Analysis confirmed that all the carbonate was magnesite. Two samples from silicified "Collenia" contained respectively 24.1 and 33.4 percent $MgCO_3$, the remainder being chiefly silica. The other 19 samples ranged from 79.0 to 95.5 percent $MgCO_3$ and from 0.57 to 0.98 percent $CaCO_3$, averaging 90 percent $MgCO_3$, and less than 1 percent $CaCO_3$.

A composite chip sample submitted to AMDEL for Pyrometric Cone Equivalent testing resulted in "greater than cone 41 (1970°C)".

In summary, testing of carbonate outcrops from the Lower Proterozoic Coomalie Dolomite and Celia Dolomite in the Rum Jungle District has therefore shown that magnesite crops out intermittently over a strike length of about 30 km.

Testing of drill core has shown that dolomite is more common at depth, but magnesite occurs below 100 m depth at a number of localities and to at least 300 m depth in the Coomalie Dolomite.

Analyses indicate significant areas in both formations averaging about 90 percent $MgCO_3$ and less than 1 percent $CaCO_3$.

ALLIGATOR RIVERS AREA

In the Alligator Rivers area, 200 km east of Darwin, magnesite has been noted in the Koolpin Formation in a geological setting which in many ways resembles that of the Rum Jungle occurrences. However, at the time of writing (March 1973) few data on grades or tonnages of individual occurances are available.