DEPARTMENT OF MINES
SOUTH AUSTRALIA

SALT

SOUTH AUSTRALIA

by

R.K. JOHNS

CHIEF GEOLOGIST

31st October, 1973

Rept.Bk.No. 73/258
G.S. No. 5260
D.M. No. 715/72

CONTENTS PAGE

INTRODUCTION	1
LAKE SALT AND BRINES	2
Lake Fowler	3
Lake Bumbunga	3
Kangaroo Island Lakes	4
Mulgundawa Lakes	4
Marion and Snow Lakes	4
Peesey Swamp	5
Lake MacDonnell	6
Lakes of the Interior	6
SOLAR EVAPORATION OF SEAWATER	8
Port Price	9
Dry Creek	9
Pt. Paterson	10
Whyalla	10
REFERENCES	11

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. 73/258
G.S. No. 5260
D.M. No. 715/72

SALT

SOUTH AUSTRALIA

INTRODUCTION

Salt production in South Australia has shown a steady expansion since inception of the industry in 1891 until it now (1971) exceeds 700 000 tonnes annually (valued at $2.75 million).

Until 1966, over 80% of Australian production came from this State. However, proportion of the output derived from South Australia had fallen to 68% of the total in 1968 and to 35% in 1969 as a result of major developments in solar salt production in Western Australia.

The local salt industry was based initially on lake deposits of a magnitude, purity and accessibility that were unrivalled in Australia and so situated climatically that the conditions for solar evaporation were exceptional. The numerous salt lakes of southern Yorke Peninsula were the principal sources of supply to the turn of the century. There, a comparatively high winter rainfall combined with dry, hot summers produced salt crusts ranging up to 10 cm thick on the lake surfaces. By 1900 a number of companies were operating and production amounted to about 40 000 tonnes per year which, dependent upon seasonal fluctuation in output, represented the natural potential capacity of the district.

Pre-eminence was later maintained through the establishment of artificial evaporating ponds based on seawater of higher than normal

salinity and the introduction of mechanical harvesters. The first artificial salt fields were developed at Port Price during World War I. In 1940 I.C.I. Alkali (Australia) Pty. Ltd. commenced production of salt for the alkali industry at Dry Creek, 10 kilometres north of Adelaide, with the result that the State's output was more than doubled from 80 000 tonnes in 1939 to 171 000 tonnes in 1941. Expansion of these and other highly efficient fields has ensured a steady growth of the industry. The major producers are I.C.I. Australia Ltd. at Dry Creek, Ocean Salt Ltd. at Port Price, The Broken Hill Pty. Co. Ltd. at Whyalla and Waratah Gypsum Pty. Ltd. at Lake MacDonnell.

Further developments have been foreshadowed in connection with a petrochemical industry which will be based on ethane and salt as raw feed stocks in the Port Augusta area. Elsewhere, in the more remote areas of the State there are large untapped reserves of salt in lake crusts and brines.

LAKE SALT AND BRINES

The source of salt in natural lakes and other aspects of occurrence and production have been discussed in detail by Jack (1921). He presented evidence to support the identity of cyclic origin of salt in the waters of inland lakes. There, seasonal accretions of sodium chloride which are derived by the evaporation of waters impounded in internal drainage basins are desiccated and retained by impervious lake floors.

Salinas which are located near the coast and where transport costs to markets are not prohibitively high have been harvested regularly until many have been exploited to the point of near exhaustion.

In addition to the deposits described below there are a number of small producers throughout the State which yield insignificant amounts. These include lakes in the Lower North (Mundoora, Barunga, Tippara and Dublin), the South East (Robe, Bray, Santo), Eyre Peninsula (Ulipa) and on southern Yorke Peninsula.

Lake Fowler

This is the largest saline lake on southern Yorke Peninsula, 1 000 hectares in area. Crude salt was formerly harvested by Australian Salt Co. and trucked to Edithburgh for refining and overseas shipment.

Production fluctuated greatly from year to year and approximated 10 000 tonnes annually during the 1950's but salt deposits that were once resident in Lake Fowler have been harvested to a point of virtual extinction and no salt has been harvested during the past decade.

Lake Bumbunga

The Australian Salt Co. began operations in 1913 on leases totalling 2 000 hectares near Lochiel, 120 kilometres north of Adelaide. Evaporating pans and crystallisers were constructed adjacent to the southern shores of Lake Bumbunga. Harvesting is mechanised and the product is stockpiled at the lake margin prior to refining and transport to markets.

Though the average annual production for the ten years prior to 1950 was 28 000 tonnes (Betheras, 1951), it has since dwindled to less than 10 000 tonnes during the years since 1966.

Kangaroo Island Lakes

There are several salt lakes on Kangaroo Island suitable for exploitation. Australian Salt Co. Ltd. harvested from a lake of 270 hectares prior to 1961. The product was treated in a refinery to yield coarse washed grades.

As weather conditions are generally less favourable than on the mainland the output was variable.

Mulgundawa Lakes

Several small lakes situated near Lake Alexandrina, 75 kilometres southeast of Adelaide, yield small output. Production by Australian Paper Manufacturers Ltd. averages about 2 000 tonnes per year.

Marion and Snow Lakes

Waratah Gypsum Pty. Ltd. harvested salt intermittently for many years on southern Yorke Peninsula with yields ranging from 3 000 to 12 000 tonnes per year.

A channel almost one kilometre long was cut to connect Snow Lake with the coast to make it possible for seawater to gravitate along this channel at high tide. This proved to be unsuccessful and the brine effluent from drainage of the gypsum mining operations on Marion Lake was pumped to crystallisers on Snow Lake. Salt was harvested mechanically and transported by tramway to Stenhouse Bay for shipment interstate. There has been no production since 1969.

Peesey Swamp

Peesey Swamp, 2 800 hectares in area and 0.6 to 2.1 m above sea level, occupies a broad depression delimiting a former marine strait that connected Hardwicke Bay across the southern end of Yorke Peninsula to Investigator Strait. The swamp is underlain by sand of the Pleistocene Glanville Formation 10 m thick that constitutes a highly saline brine aquifer. The sands are shelly at the base and rest on an impervious floor provided by Permian clays.

Several operators recover salt by solar evaporation of brines pumped from wells 3 m deep. The output of crude salt has varied from 5 000 to 10 000 tonnes per year during the past decade.

During the period 1968 to 1972 Geosurveys of Australia Pty. Ltd. investigated the salt potential of the region. The project was based on an integrated use of Peesey Swamps brines, augmented by sea-water pumped from Hardwicke Bay and by interstitial brines derived from Cambrian dolomite reservoirs (Sprigg, 1968; Sprigg and Johnson, 1970). Production of 1 million tonnes of salt per year was planned from initial concentration in ponds on Peesey Swamp and final crystallisation in Lake Fowler for shipment at Port Giles. Based on an average brine reservoir thickness of 10 m, an average porosity of 25 to 30 per cent and an average salinity of brines of 9 per cent it was estimated that 12 million tonnes of salt were available under Peesey Swamp (Johnson and Laws, 1969). Geological geophysical and topographic surveys and feasibility studies were undertaken before the project was abandoned.

Lake MacDonnell

Leases totalling 1 100 hectares are held over Lake MacDonnell by Waratah Gypsum Pty. Ltd. Salt is produced from brines that are pumped from the adjacent gypsum workings and have a salinity two to three times that of seawater. The high quality product is railed 117 kilometres by rail to Thevenard for shipment.

Operations have been fully mechanised and greatly expanded since the present company began operations in 1967 and annual production now exceeds 120 000 tonnes.

Lakes of the Interior

Attempts have been made to harvest salt from the surfaces of several large lakes in proximity to the transcontinental railway but the ready availability of solar evaporation sites near centres of consumption or harbour facilities, elsewhere, have rendered these projects uneconomic.

Salt leases were taken out in 1913 at Lake Hart, 225 kilometres west of Port Augusta, in anticipation of the construction of the railway and, during the period 1919 to 1931, production amounted to 30 000 tonnes. A crust of salt averaging 4 cm in thickness has accumulated over the surface of the lake which is 160 square kilometres in area. Crystallising ponds were constructed adjacent to the southern shore. Jack (1921) estimated that the lake contained over 12 million tonnes of salt.

During the period 1918 to 1920 salt was harvested at Lake Dutton, 100 kilometres northwest of Port Augusta, from a crystalliser constructed across the channel connecting the lake to Ironstone Lagoon; recorded production totalled 5 000 tonnes.

Experimental work was conducted at Pernatty Lagoon to recover salt from the lake brines but production during the years 1919-20 amounted to only 225 tonnes.

Island Lagoon, occupying an area of over 500 square kilometres has a crust of salt covering most of its surface. Patterson (1950) determined that the crust thickens from 0.75 cm at the margins to 60 cm at a distance of 3 kilometres from the shore and is constant thereafter in the central part of the lagoon. He estimated that 3 million tonnes of salt were present over the surface.

There is no salt on the surface of Lake Torrens. Lake brines are of uniform composition and show little departure from the following: NaCl, 94%; $MgCl_2$, 2.5%; $MgSO_4$, 2%; $CaSO_4$, 1 to 5% (Johns, 1968 Salts brought into this large basin are removed by subsurface movement of brines along the Port Augusta "corridor" to the head of Spencer Gulf. The possibility of recovery of salt, by evaporation of brines pumped from Cambrian carbonate reservoirs underlying this tract, was investigated in 1967 but there was no development. However, the availability of brines from the Lake Torrens Sunklands is again (1973) being assessed in connection with a proposed petrochemical industry based at Port Patterson.

Lake Gairdner is encrusted by a crust of salt of variable thickness, dependent on extent of flooding and prevailing winds during the crystallisation phase, and a thickness of almost 0.5 m has been recorded (Johns, 1968). Lake brines contain 30% to 32% dissolved solids consisting of NaCl, 75% to 95%; $CaCl_2$, 0.2% to 0.9% and $MgCl_2$, 2.9% to 22.2%. This lake contains a reserve of natural salt second only to that of Lake Eyre.

Lake Eyre is the largest of the lakes of the interior and is the repository of salts leached from a drainage area occupying 1/6th of the continent. Tilting of the lake floor to the south has resulted in the accumulation of a crust of salt over much of the surfaces of Belt Bay and Madigan Gulf which are estimated to contain 400 million tonnes of salt (Bonython, 1956). Chemical analyses of brines collected during boring operations in Madigan Gulf show NaCl, 90 to 95%; $MgSO_4$, 5 to 7%; $MgCl_2$, to 4%; and $CaSO_4$, up to 2.5% (Johns, 1963).

A study of the brines of the lakes of the interior of the State has disclosed that they are all chloride waters of more or less constant composition, regardless of whether taken from the surface or at depth, and independent of the location and size of the lakes and of the rocks underlying their catchment areas (Johns, 1963). The crustal salt and brines of Lake Frome have not been investigated but they are expected to be similar in nature and composition to those of the other major salinas.

SOLAR EVAPORATION OF SEAWATER

Over 80% of present salt production in South Australia is derived from the solar evaporation of seawater in areas of high net evaporation. Further expansion of facilities along the shores of St. Vincent Gulf, north of St. Kilda, and adjacent to the shores of northern Spencer Gulf are expected to result in significant increases in output of salt for the chemical and petrochemical industries in the next few years. There, an extensive coastal fringe of more or less flat samphire swamps, which are underlain by impervious marine and estuarine muds of the St. Kilda Formation constitute favourable sites for concentration of evaporating pans and crystallisers.

In this process seawater is pumped into broad, flat, and impervious evaporating ponds and moved in stages from one pan to the next so that by the time it reaches the crystallisers the iron salts, calcium carbonate and gypsum have been deposited and the brine is saturated with respect to sodium chloride. Common salt is allowed to crystallise to the stage where the residual liquor (bittern) is saturated with magnesium sulphate and magnesium chloride. The bittern is then withdrawn and returned to the sea and the accumulated salt is harvested. Throughout, a close control is maintained on the density of the brine in the crystallisers to maximise both yield and purity of the product.

Port Price

Solar salt production began at Port Price on the estuary of Wills Creek in 1919. The present operator, Ocean Salt Pty. Ltd. acquired leases totalling 670 hectares in 1930, developed evaporating ponds and crystallisers and erected a refinery, based on seawater having a salinity 30% higher than normal oceanic seawater.

Production now amounts to 100 000 tonnes per year.

Dry Creek

I.C.I. Alkali (Australia) Ltd. established an alkali industry in South Australia in 1940, based on salt produced at the Dry Creek works, 10 kilometres north of Adelaide, and limestone obtained from Angaston. The company is at present producing salt at the rate of over 350 000 tonnes per year.

A completely mechanised harvesting plant includes track-mounted loaders which pick up salt from the pans and discharge it onto conveyor belts for stacking. The salt in the stacks is dissolved in fresh water and pumped to an alkali plant at Osborne, a distance of 8 kilometres, where it is consumed in the manufacture of soda ash, bicarbonate of soda, caustic soda and calcium chloride using the Solway ammonia-soda process.

A proportion of the output is exported.

Pt. Paterson

Salt was recovered from pans constructed at the northernmost extremity of Spencer Gulf, 6 kilometres north of Port Augusta, during the period 1915 to 1930 from water which was 50% more saline than oceanic water but encroachment of windblown sand forced closure of the operations.

In 1951, embankments were constructed and pumps were installed for development of a solar salt field 12 kilometres south-south-east of Port Augusta at Port Paterson where feed water is about 20% more saline than normal seawater. Annual production to 1963 averaged 10 000 tonnes when operations were suspended.

Since that time several proposals for large scale development have been considered. Drilling has been undertaken to establish permeability of the substratum, to secure materials for embankments and for construction of a causeway and berth for bulk loading installations.

Whyalla

During 1946 the Broken Hill Pty. Co. Ltd. investigated the possibility of salt production at Whyalla on solar evaporation of

seawater. Permeability testing of tidal land and foreshore swamps and pilot embankments proved successful for trial production has since been achieved and during the past ten years the annual output has averaged 50 000 tonnes.

31st October, 1973
RKJ:IA

R.K. JOHNS
CHIEF GEOLOGIST

REFERENCES

Betheras, F.N., 1951. Salt industry in South Australia. Min. Rev., Adelaide, 91: 187-199.

_____ , 1956. Salt industry - Whyalla. Min. Rev., Adelaide, 99: 199-200.

Bonython, C.W., 1956. The Salt of Lake Eyre - its occurrence in Madigan Gulf and its possible origin. Trans. Roy. Soc. S. Aust., 79: 66-92.

Jack, R.L., 1921. The salt and gypsum resources of South Australia. Geol. Surv. S. Aust. Bull. 8: 13-82.

Johns, R.K., 1963. Investigation of Lake Eyre. Pt. I. Geol. Surv. S. Aust. Rept. Inv. 24: 69 p.

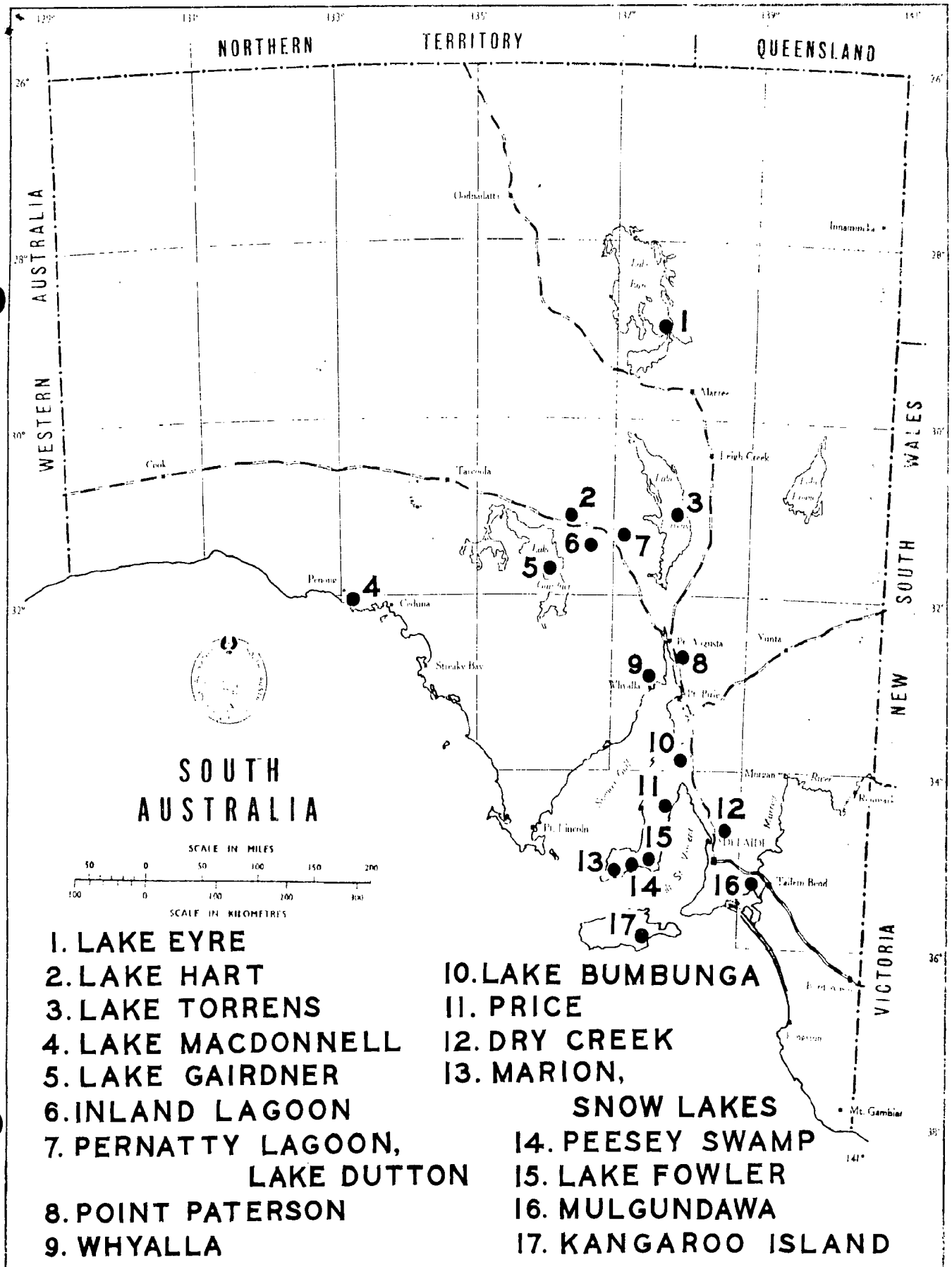
_____ , 1968. Investigation of Lakes Torrens and Gairdner. Geol. Surv. S. Aust. Rept. Inv. 31: 90 p.

Johnson, J.L. and Laws, R.A., 1969. Completion of Phase I of the Peesey Swamp project. Report to Geosurveys of Australia Pty. Ltd.; Dept. of Mines Env. 1127 (unpublished).

Patterson, G.W., 1950. Investigation of salt lakes. Min. Rev., Adelaide, 90: 9-10.

Sprigg, R.C., 1968. Stansbury brines project, SML No. 187. Report to Geosurveys of Australia Pty. Ltd. Dept. of Mines Env. 945 (unpublished).

_____, and Johnson, J.E., 1970. SML 187A, Southern Yorke Peninsula. Report to Geosurveys of Australia Pty. Ltd.; Dept. of Mines Env. 1430 (unpublished).



1. LAKE EYRE
2. LAKE HART
3. LAKE TORRENS
4. LAKE MACDONNELL
5. LAKE GAIRDNER
6. INLAND LAGOON
7. PERNATTY LAGOON, LAKE DUTTON
8. POINT PATERSON
9. WHYALLA
10. LAKE BUMBUNGA
11. PRICE
12. DRY CREEK
13. MARION, SNOW LAKES
14. PEESEY SWAMP
15. LAKE FOWLER
16. MULGUNDAWA
17. KANGAROO ISLAND

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale:
Compiled:		Date: 30 - 11 - 73
Drn: B.T. Ckd:	SALT	Drg. No. 994·2
		S10603/1