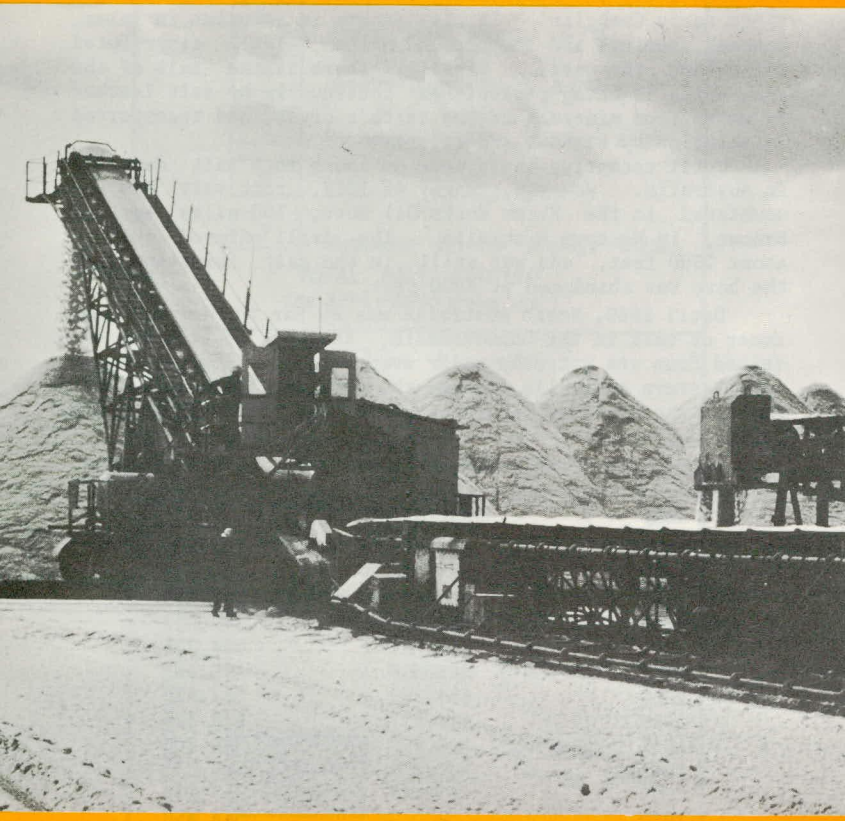
SALT in South Australia

S.A. Department of Mines and Geological Survey



MINERAL INFORMATION SERIES

Salt has been invested with symbolic meaning by mankind since earliest times. To various peoples it has been the symbol of friendship, fidelity, purity, hospitality, permanence and destiny. It has been used as a currency; has had religious significance; has been a source of political power; has been a traditional source of tax revenue, and has been the cause of wars. The many popular expressions and beliefs involving salt are evidence of the importance attributed to it. ("Ye are the salt of the earth." Matthew V; 13.).

The first usage of salt is lost in antiquity. Since the human body has a relatively constant requirement for salt, its first use must have been as a food, and since earliest times, as a food seasoning and preservative. Many ancient civilisations had well developed salt industries. To-day, salt is one of the major pillars of the chemical industry.

Salt - sodium chloride - is one of the most common and widely distributed mineral materials. It occurs in solid form as the mineral Halite or "rock salt" in bedded deposits and as salt domes or plugs. Rock salt occurs widespread and abundantly in sedimentary rocks of all geological ages since early Cambrian. It also occurs in solution in lakes, lagoons, springs and underground brines, widely distributed throughout the world. Finally, there is the salt of the sea, which is being replenished continually by salt leached by water from minerals of the earth's crust, and transported in solution by streams and rivers.

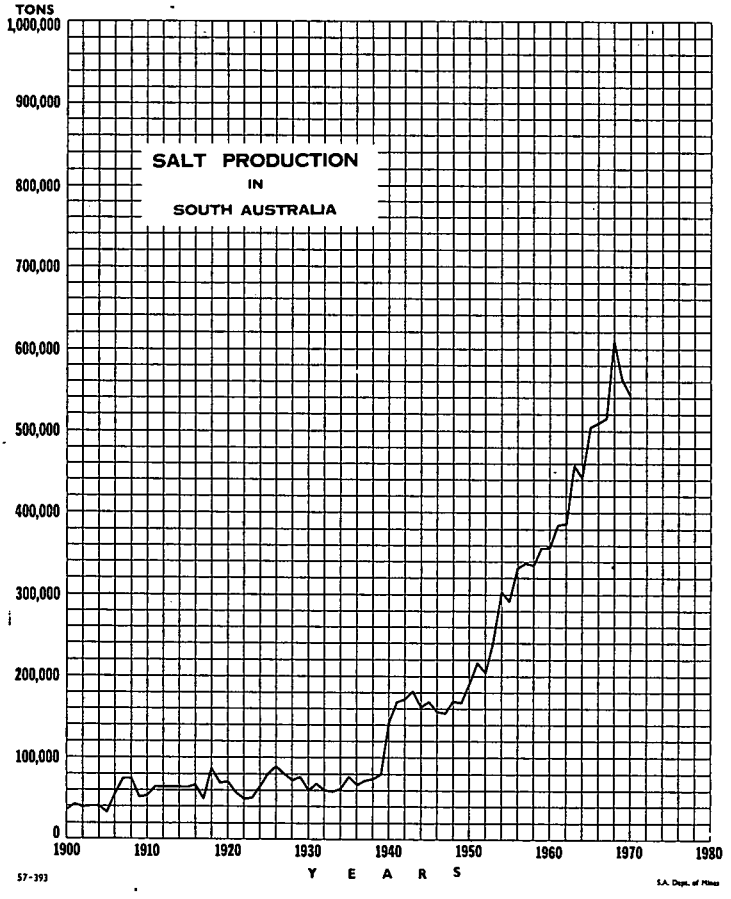
Until recently, there were no known rock salt deposits in Australia. However, early in 1959, rock salt was encountered in the Frome Rocks Oil Bore, 100 miles east of Broome, in Western Australia. The drill entered salt at about 2500 feet, and was still in the salt formation when the bore was abandoned at 4000 feet.

Until 1969, South Australia was by far the largest producer of salt in the Commonwealth, the bulk of it being obtained from sea water by solar evaporation. However, during 1969, Western Australia became the greatest producer of salt, due to the development of new ports and new markets with Japan.

Production of salt in recent years has been as follows:

Year	Australia	TONS South Australia
1959	467,532	357,802
1960	463,296	359,027
1961	508,657	387,433
1962	536,019	389,597
1963	582,787	459,005
1964	545,500	440,332
1965	654,280	512,852
1966	644,817	519,623
1967	703,157	516,166
1968	899,704	610,827
1969	1,653,478	563,442
1970	-	543,550

The first recorded production of salt in this State was in 1829, seven years before the establishment of the colony, when 20 tons of salt were garnered on Kangaroo Island. This was harvested from natural lake deposits, probably in the Hundred of Haines, near the present site of operations by



the Colonial Sugar Refining Company working a gypsum deposit. Salt was gathered on a small scale for strictly local requirements from a number of localities for many years. It was not until 1891, when 7505 tons were produced, that the scale of production became notable. From this time on, a number of companies were interested in salt production, both from saline lakes, and from the sea.

The very great advantages offered by the indented coastline of Spencer and St. Vincent Gulfs for the production of salt by the evaporation of sea water were recognised some 40 years ago. The availability of sites close to the cheap sea transport, combined with high net evaporation and abnormal salinity of sea water led to the establishment of solar salt works at the head of Spencers Gulf, near Port Augusta and at Whyalla; at Price on the eastern shore of Yorke Peninsula; and, in 1940, at Dry Creek near Adelaide. In addition, several operators recover salt from shallow salt lakes on Yorke Peninsula and elsewhere.

At the present time, the principal solar salt operations are at Dry Creek (I.C.I. Alkali (Aust.) Pty. Ltd.) and Price (Ocean Salt (Extended) Pty. Ltd.). At Whyalla, B.H.P. Co. Ltd. are expanding their solar salt operations. At Pt.

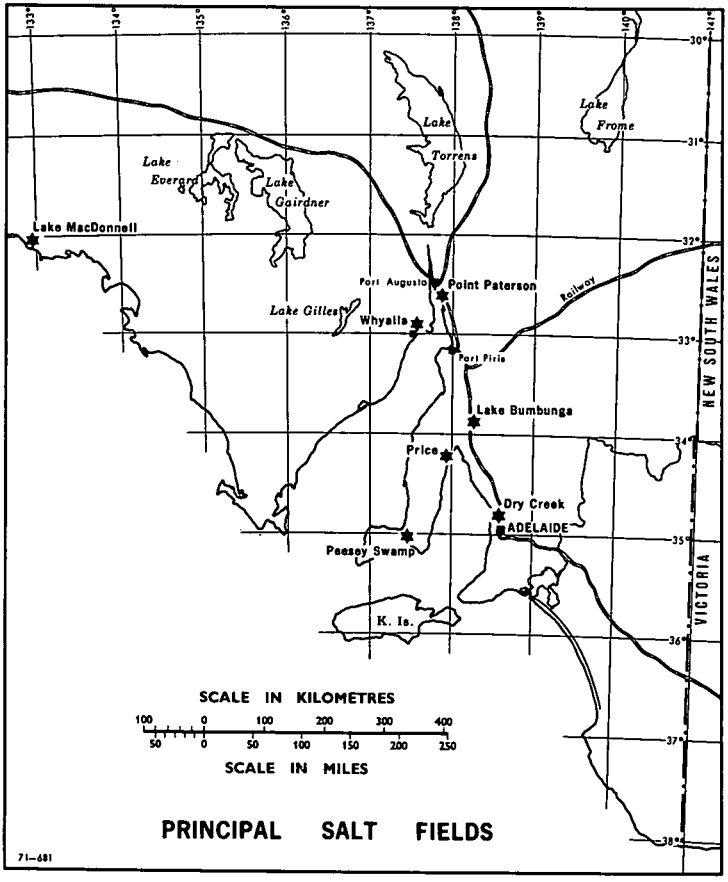
Paterson, investigations are being carried out for potential solar salt deposits.

Salt lake deposits are being worked at Lake Bumbunga, near Lochiel (Australian Salt Co. Ltd.) and Lake MacDonnell (Waratah Gypsum Pty. Ltd.). Highly saline groundwater brines are utilised as a source of solar salt by Olsson Industries Pty. Ltd. at Peesey Swamp near Warooka.

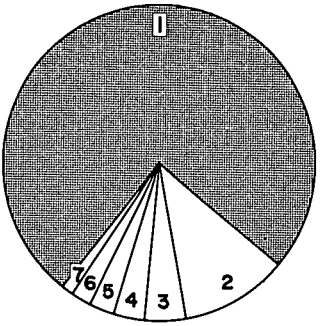
The source of all salt deposits is ultimately the sea. Much of the salt deposited in inland lakes on Yorke Peninsula and elsewhere is considered to have originated from this source as "cyclic" salt. This has been transported as sea spray evaporated to dryness as dust.

Sea water contains an average of 3.5% dissolved saline matter, or 35,000 parts per million. The average composition of the salts in sea water is given in the accompanying diagram.

Although sodium chloride, or common salt is the largest single component of these salts, it is not the first to be dropped from solution. The formation of the great bedded rock salt deposits of Europe and North America resulted from the fact that the various salts are crystallised out at definite concentrations, as the water is removed by evaporation. Thus iron oxides, calcium carbonate and gypsum are all re-

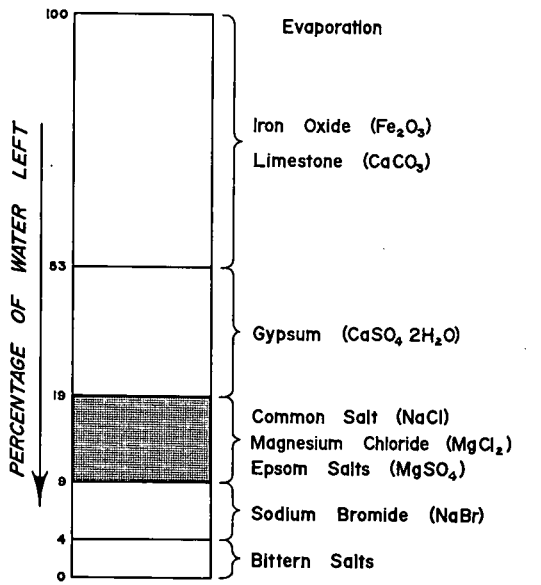


SEA WATER



1	Common Salt ($NaCl$)	77%
2	Magnesium Chloride ($MgCl_2$)	11%
3	Epsom Salts ($MgSO_4$)	4·7%
4	Gypsum ($CaSO_4\ 2H_2O$)	3·6%
5	Potassium Sulphate (K_2SO_4)	2·5%
6	Limestone ($CaCO_3$)	0·3%
7	Magnesium Bromide ($MgBr_2$)	0·2%

TOTAL SALT CONTENT
(Av. 3·5% = 2500 grains gall.)



DEPOSITION OF SALTS BY EVAPORATION

71–680

moved before sodium chloride begins to crystallise out. This does not occur until the bulk of the sea water has been reduced to about one tenth of its original volume. Salt continues to crystallise out until the volume has reduced to about one twentyfifth of the original sea water. Beyond this point, the extremely soluble salts, known as the bitterns, remain. These include a large number of salts occurring in very small quantity. For thick deposits of common salt to form in this way, special conditions were necessary within a large lake or inland sea, so that sodium chloride could be deposited in a pure state, free of either gypsum or bittern salts. Such conditions were evidently almost unknown in Australia's geological history.

Saline deposits in natural salt lakes may contain some of these bittern salts - not always desirable in industries using common salt. In inland lakes, with brines differing in composition from sea water, the proportion of bitterns is often much less. In fact, no significant quantity of bromine salts have been recorded in South Australian groundwaters, or in the waters of Spencer and St. Vincent Gulf.

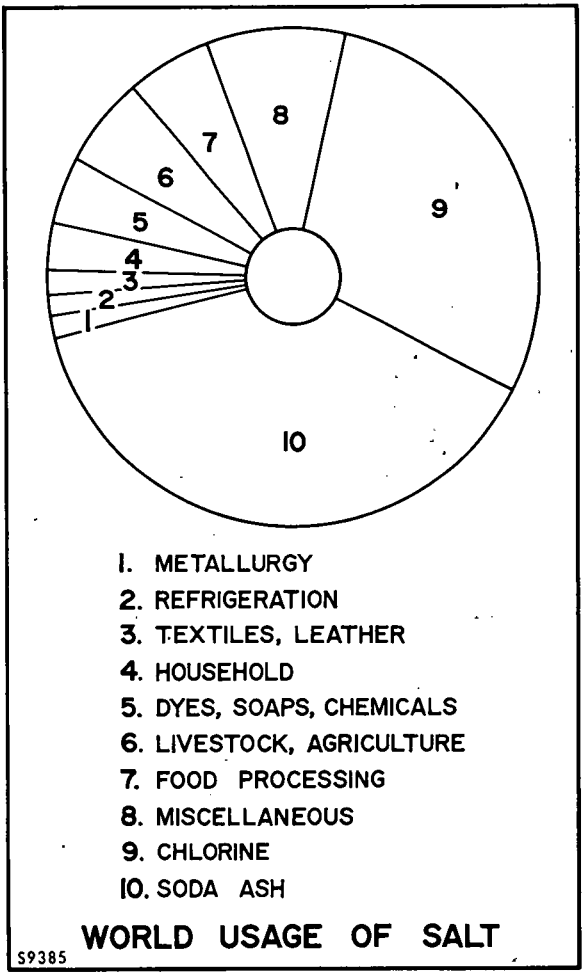
Production of salt in South Australia ranges from the small operation of gathering up the thin crust of lake salt from the surface of inland salinas, to the mammoth solar salt operations of I.C.I. Alkali (Aust.) Pty. Ltd. at Dry Creek, near Adelaide.

Salt lake harvesting can, and has, been accomplished with the simplest of equipment. In the early days, horses were used to draw scoops on Lake Bumbunga; nowadays a light railway, or motorised equipment is used to pick up the salt crust, rarely exceeding one inch in thickness. The average yield from salt lake harvesting is about 25 tons per acre, though with addition of brines from groundwater sources, this can be increased up to 100 tons or more per acre annually.

Present day uses of salt are so diverse, and the demand so great, that salt lake production can meet only a small proportion of requirements. The largest single user of salt in Australia is the alkali industry; the ammonia-soda (Solvay) works at Osborne, South Australia - where most of Australia's alkalis are produced, - uses over 250,000 tons of common salt (Sodium Chloride) annually.

Salt production at the I.C.I. saltfields at Dry Creek, and at three other centres in South Australia, is by solar evaporation of sea water. The process makes use of natural evaporation, and its application depends largely on an adequate supply of solar energy.

Solar evaporation is really a means of speeding up the natural process by which salt beds have been deposited in geological formations in various parts of the world. In South Australia it finds application in certain coastal areas of Spencer and St. Vincent Gulfs where climate and terrain are suitable. Sea water is pumped or run by tidal action, so as to flow in series through a number of shallow ponds where evaporation progressively concentrates the solution until certain salts are deposited. Calcium carbonate and gypsum (calcium sulphate) are the first to separate, but the chief one to crystallize out is sodium chloride or common salt. Usually it is only the sodium chloride which is recovered for commercial purposes.



A suitable climate is one in which the rate of evaporation is high and the rainfall is low. An arid climate is best, when salt-making may go on throughout the year, but the requirements can frequently be met even in areas with moderate rainfall, particularly when the rain is mainly confined to the winter season. Salt-making under these conditions is likely to be seasonal with effective salt deposition restricted to the hot, dry part of the year.

A suitable terrain for saltfields is a flat, lowlying coastal area consisting of relatively impervious clay sediments. Embankments are built to divide it from the sea and to form a chain of shallow ponds constituting the evaporation system.

The evaporation system consists of two main parts - a first and much more extensive part called the "concentrating" area, in which the initial sea water is concentrated up to the point where it just becomes saturated with sodium chloride (the "Salting Point"), and a second, smaller part called

the "crystallizing" area, where further concentration causes the deposition of crystalline sodium chloride. The process is usually stopped at a stage when most of the sodium chloride which has entered in the initial sea water has been recovered but before the remaining solutes - principally magnesium and potassium salts - have begun to separate, so as to obtain a single, relatively pure product. The residual liquor, or "bittern" which remains after the deposition of the sodium chloride, and containing the unwanted solutes, is finally run to waste.

An interesting modern development in the age-old solar evaporation process is the use of an organic dye-stuff in the brine of the crystallizing ponds to improve the absorption of the sun's rays, so to increase the evaporation rate, and hence the output of salt, by some 20 per cent.

The salt crust reaches a thickness of 6 inches at the end of a salt-making season, and then between March and May this crust is gathered up ("harvested") by machines from the now-drained crystallizing ponds. At the Dry Creek salt fields, harvesting machines pick up a strip of salt 14 ft. wide and deliver the broken-up, granular material on to an 800 foot conveyor belt along which it is carried to the stacking bays and piled in large conical heaps. During the harvest, work continues for 10 hours per day, 6 days per week A salt harvest occupies 10-12 weeks and starts on approximately 15th March. By way of example, the gross tonnage harvested in 1960 was 377,000 tons. The harvesting operation in other South Australian saltfields is somewhat similar, though on a smaller scale than at Dry Creek.

Some interesting facts about solar salt production include the following:

1. 40 tons sea water contain approximately one ton of salt. Because of various losses in the solar salt process due to seepage from ponds, salt lost in bitterns etc., it requires approximately
2. 100 tons sea water to produce one ton of salt.
3. Annual Rainfall - Dry Creek - 18 inches.
   Annual Evaporation " " - 80 inches.
4. Proportion of Concentrating area to crystallising area — 10 : 1
5. Depth of Concentrating ponds - 1 to 2 feet.
6. Depth of Crystallising ponds - 6 inches over the salt crust.
7. Thickness of salt deposited in crystallisers each season - up to 6 inches.
8. Rate of harvesting salt (Dry Creek) - 1000 tons per hour.

Address:

Department of Mines, 169 Rundle Street, Adelaide, South Australia, 5000

COVER PHOTO: SALT HARVESTING
I.C.I. Saltfields, Dry Creek.

Prepared for lithography by the Drafting Branch, S.A. Department of Mines
Printed by H. J. Wall, Government Photolithographer, Adelaide

SALT
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MINERAL INFORMATION SERIES

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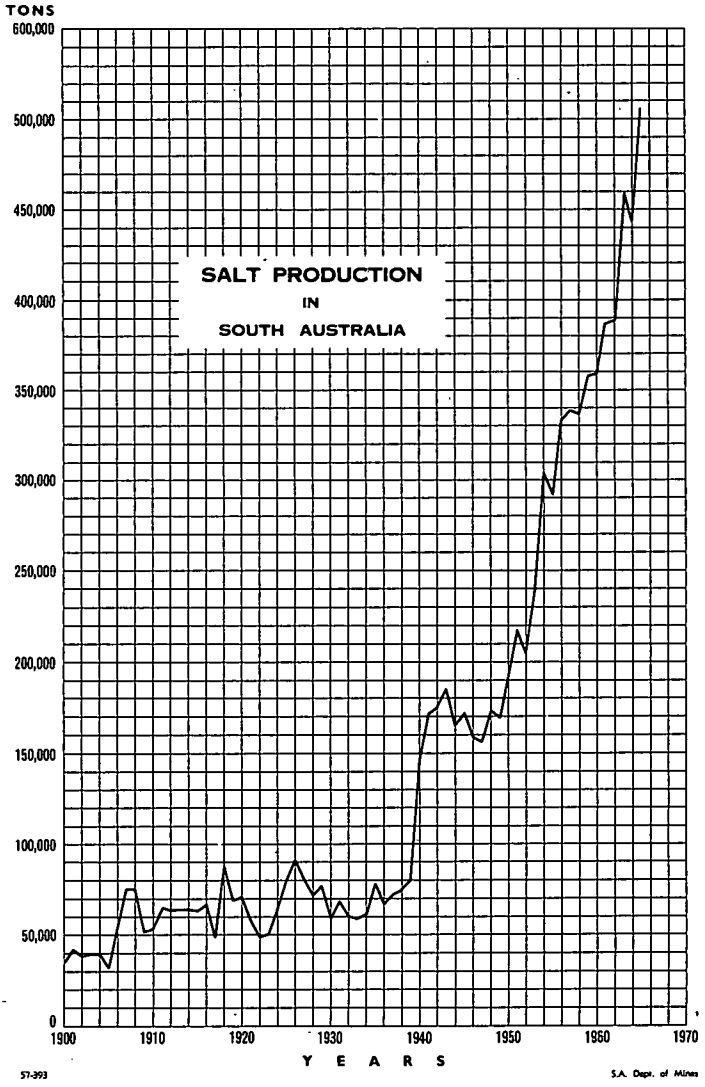


Salt - sodium chloride - is one of the most common and widely distributed mineral materials. It occurs in solid form as the mineral Halite or "rock salt" in bedded deposits and as salt domes or plugs. Rock salt occurs widespread and abundantly in sedimentary rocks of all geological ages since early Cambrian. It also occurs in solution in lakes, lagoons, springs and underground brines, widely distributed throughout the world. Finally, there is the salt of the sea, which is being replenished continually by salt leached by water from minerals of the earth's crust, and transported in solution by streams and rivers.

Until recently, there were no known rock salt deposits in Australia. However, early in 1959, rock salt was encountered in the Frome Rocks Oil Bore, 100 miles east of Broome, in Western Australia. The drill entered salt at about 2500 feet, and was still in the salt formation when the bore was abandoned at 4000 feet.

South Australia is by far the largest producer of salt in the Commonwealth, the bulk of it being obtained from sea water by solar evaporation.

Production of salt in recent years has been as follows:

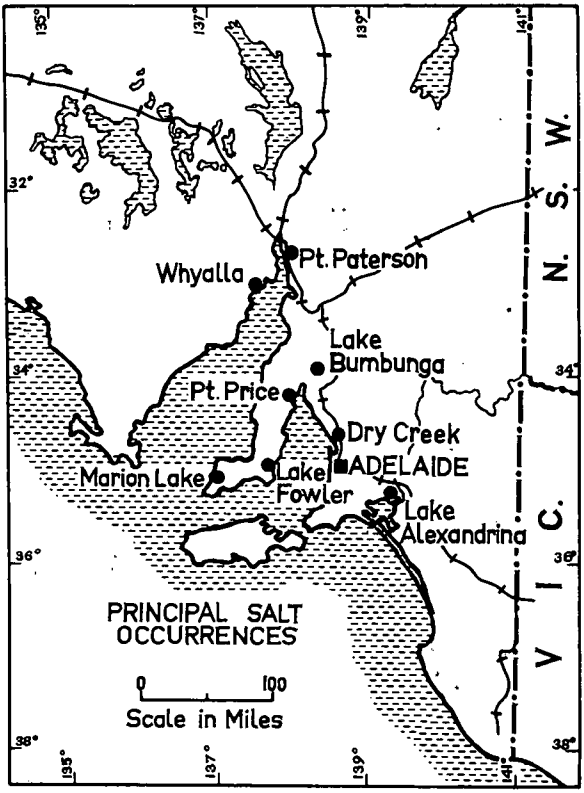
Year	Australia	South Australia
1955	363,323	291,323
1956	408,689	331,965
1957	427,600	339,396
1958	429,534	336,247
1959	467,532	357,802
1960	463,296	359,027
1961	508,657	387,433
1962	536,019	389,597
1963	582,787	459,005
1964	545,500	440,332
1965	654,280	512,852

The first recorded production of salt in this State was in 1829, seven years before the establishment of the colony, when 20 tons of salt were garnered on Kangaroo Island. This was harvested from natural lake deposits, probably in the Hundred of Haines, near the present site of operations by the Colonial Sugar Refining Company working a gypsum deposit. Salt was gathered on a small scale for strictly local requirements from a number of localities for many years. It was not until 1891, when 7505 tons were produced, that the scale of production became notable. From this time on, a number of companies were interested in salt production, both from saline lakes, and from the sea.

The very great advantages offered by the indented coastline of Spencer and St. Vincent Gulfs for the production of salt by the evaporation of sea water were recognised some 40 years ago. The availability of sites close to the cheap sea transport, combined with high net evaporation and abnormal salinity of sea water led to the establishment of solar salt works at the head of Spencers Gulf, near Port Augusta and at Whyalla; at Price on the eastern shore of Yorke Peninsula; and in 1940 at Dry Creek near Adelaide. In addition several operators recover salt from shallow salt lakes on Yorke Peninsula and elswwhere.

At the present time, the principal solar salt operations are at Dry Creek (I.C.I. Alkali (Aust.) Pty. Ltd.); Price (Ocean Salt (Extended) Pty. Ltd.); Whyalla (B.H.P. Co. Pty. Ltd.); Port Patterson (Augusta Salt Ltd.). The Australian Salt Co. Ltd. is the major operator in a number of salt lake deposits, including Lake Fowler, Lake MacDonnell, Lake Bumbunga (near Lochiel) and others. Waratah Gypsum Pty. Ltd. operates on Marion Lake, at Stenhouse Bay, while Olsson Industries salt works are based near Warooka, both utilising highly saline groundwater brines as a source of solar salt.

The source of all salt deposits is ultimately the sea. Much of the salt deposited in inland lakes on Yorke Peninsula and elsewhere is considered to have originated from this source as "cyclic" salt. This has been transported as sea spray evaporated to dryness as dust.



Sea water contains an average of 3.5% dissolved saline matter, or 35,000 parts per million. The average composition of the salts in sea water is given in the accompanying diagram.

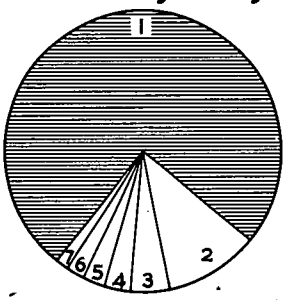
Although sodium chloride, or common salt is the largest single component of these salts, it is not the first to be dropped from solution. The formation of the great bedded rock salt deposits of Europe and North America resulted from the fact that the various salts are crystallised out at definite concentrations, as the water is removed by evaporation. Thus iron oxides, calcium carbonate and gypsum are all removed before sodium chloride begins to crystallise out. This does not occur until the bulk of the sea water has been reduced to about one tenth of its original volume. Salt continues to crystallise out until the volume has reduced to about one twentyfifth of the original sea water. Beyond this point, the extremely soluble salts, known as the bitterns, remain. These include a large number of salts occurring in very small quantity. For thick deposits of common salt to form in this way, special conditions were necessary within a large lake or inland sea, so that sodium chloride could be deposited in a pure state, free of either gypsum or bittern salts. Such conditions were evidently almost unknown in Australia's geological history.

Saline deposits in natural salt lakes may contain some of these bittern salts - not always desirable in industries using common salt. In inland lakes, with brines differing in composition from sea water, the proportion of bitterns is often much less. In fact, no significant quantity of bromine salts have been recorded in South Australian groundwaters, or in the waters of Spencer and St. Vincent's Gulf.

Production of salt in South Australia ranges from the small operation of gathering up the thin crust of lake salt from the surface of inland salinas, to the mammoth solar salt operations of I.C.I. Alkali (Aust.) Pty. Ltd. at Dry Creek, near Adelaide.

SEA WATER

TOTAL SALT CONTENT
(Av. 3·5% = 2500 grains gal.)



1	Common Salt	$(NaCl)$ 77%
2	Magnesium Chloride	$(MgCl_2)$ 11%
3	Epsom Salts	$(MgSO_4)$ 4·7%
4	Gypsum	$(CaSO_4.2H_2O)$ 3·6%
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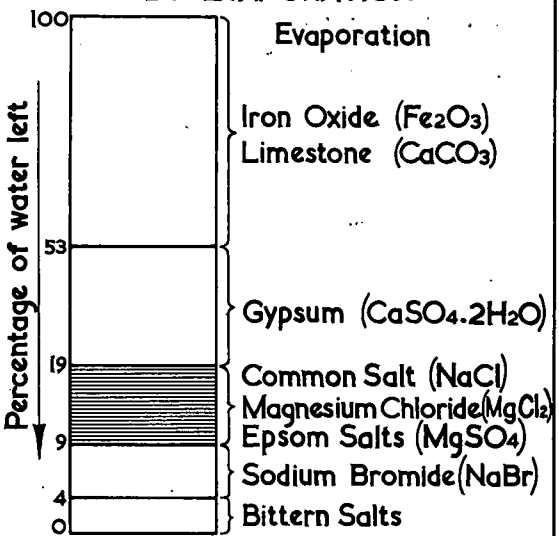
SEA WATER

DEPOSITION OF SALTS BY EVAPORATION



Salt lake harvesting can, and has, been accomplished with the simplest of equipment. In the early days horses were used to draw scoops on Lake Bumbunga; nowadays a light railway, or motorised equipment is used to pick up the salt crust, rarely exceeding one inch in thickness. The average yield from salt lake harvesting is about 25 tons per acre, though with addition of brines from groundwater sources, this can be increased up to 100 tons or more per acre annually.

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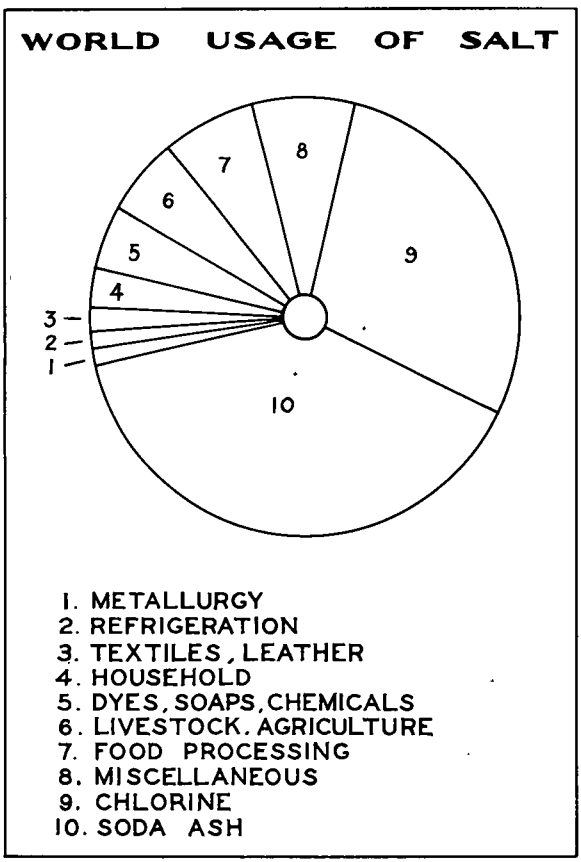

Salt production at the I.C.I. saltfields at Dry Creek, and at three other centres in South Australia, is by solar evaporation of sea water. The process makes use of natural evaporation, and its application depends largely on an adequate supply of solar energy.

Solar evaporation is really a means of speeding up the natural process by which salt beds have been deposited in geological formations in various parts of the world. In South Australia it finds application in certain coastal areas of Spencer and St. Vincent Gulfs where climate and terrain are suitable. Sea water is pumped or run by tidal action, so as to flow in series through a number of shallow ponds where evaporation progressively concentrates the solution until certain salts are deposited. Calcium carbonate and gypsum (calcium.sulphate) are the first to separate, but

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A suitable terrain for saltfields is a flat, lowlying coastal area consisting of relatively impervious clay sediments. Embankments are built to divide it from the sea and to form a chain of shallow ponds constituting the evaporation system.

The evaporation system consists of two main parts - a first and much more extensive part called the "concentrating" area, in which the initial sea water is concentrated up to the point where it just becomes saturated with sodium chloride (the "Salting Point"), and a second, smaller part called the "crystallizing" area, where further concentration causes the deposition of crystalline sodium chloride. The process is usually stopped at a stage when most of the sodium chloride which has entered in the initial sea water has been recovered but before the remaining solutes - principally magnesium and potassium salts - have begun to separate, so as to obtain a single, relatively pure product. The residual liquor, or "bittern" which remains after the deposition of the sodium chloride, and containing the unwanted solutes, is finally run to waste.

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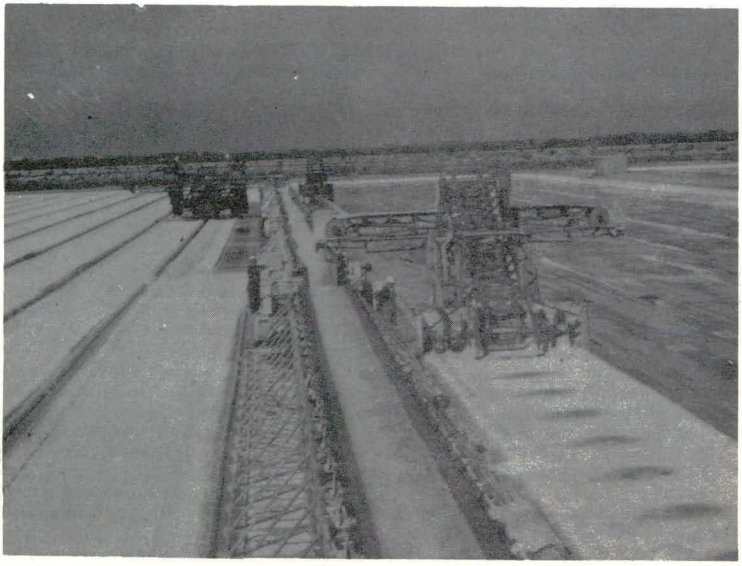
The salt crust reaches a thickness of 6 inches at the end of a salt-making season, and then between March and May this crust is gathered up ("harvested") by machines from the now-drained crystallizing ponds. At the Dry Creek salt fields, harvesting machines pick up a strip of salt 14 ft. wide and deliver the broken-up, granular material on to an 800 foot conveyor belt along which it is carried to the stacking bays and piled in large conical heaps. During the harvest work continues for 10 hours per day, 6 days per week.



Salt harvesting, I.C.I. Saltfields, Dry Creek

A salt harvest occupies 10-12 weeks and starts on approximately 15th March. By way of example, the gross tonnage harvested in 1960 was 377,000 tons. The harvesting operation in other South Australian saltfields is somewhat similar, though on a smaller scale than at Dry Creek.

Some interesting facts about solar salt production include the following:

1. 50 tons sea water contain approximately one ton of salt. Because of various losses in the solar salt process due to seepage from ponds, salt lost in bitterns etc., it requires approximately
2. 100 tons sea water to produce one ton of salt.
3. Annual Rainfall - Dry Creek - 18 inches.
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4. Proportion of Concentrating area to crystallising area - 10 : 1.
5. Depth of Concentrating ponds - 1 to 2 feet.
6. Depth of Crystallising ponds - 6 inches over the salt crust.
7. Thickness of salt deposited in crystallisers each season - up to 6 inches.
8. Rate of harvesting salt (Dry Creek) - 1000 tons per hour.

Loading Salt, B.H.P. Saltfield, Whyalla.

COVER PHOTO: SALT STACKER, I.C.I. SALTFIELDS, DRY CREEK.

Address: *Department of Mines, 169 Rundle Street, Adelaide South Australia*

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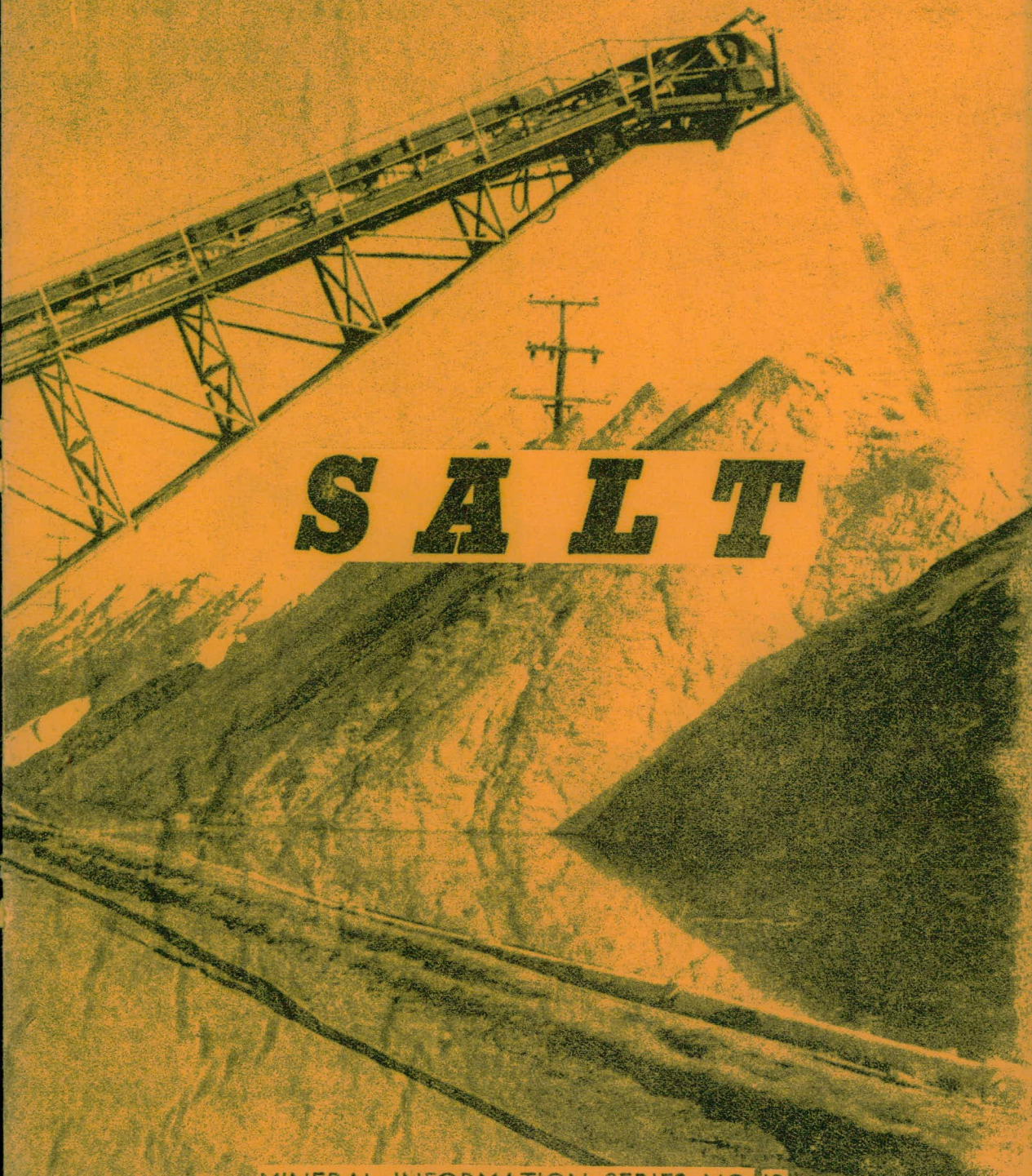

SALT

S A L T

in

SOUTH AUSTRALIA

Salt has been invested with symbolic meaning by mankind since earliest times. To various peoples it has been the symbol of friendship; fidelity, purity, hospitality, permanence and destiny. It has been used as a currency; has had religious significance; has been a source of political power; has been a traditional source of tax revenue; and has been the cause of wars. The many popular expressions and beliefs involving salt are evidence of the importance attributed to it. ("Ye are the salt of the earth." Matthew V; 13.)

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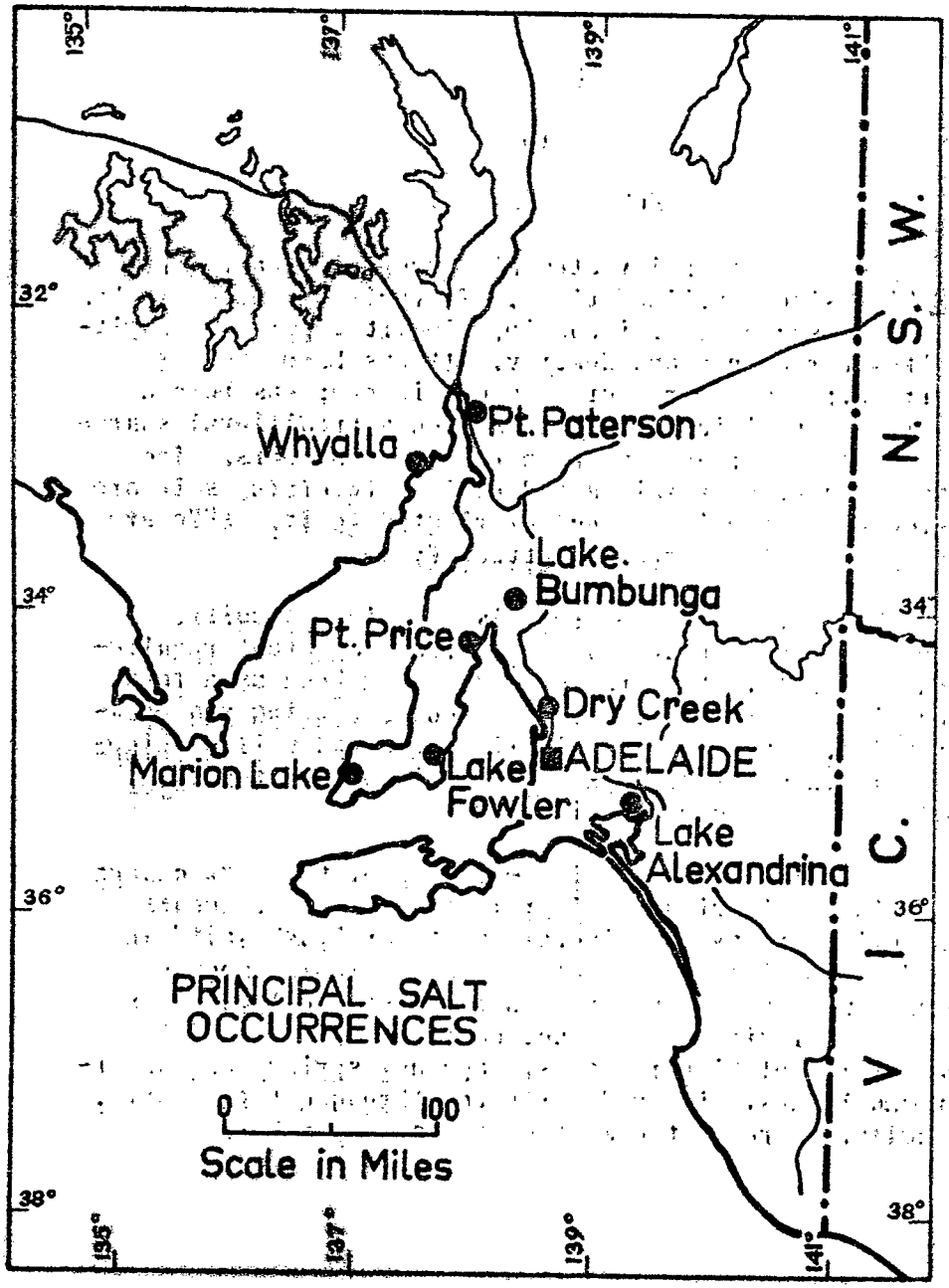

135°
137°
139°
141°
32°
34°
36°
38°
Whyalla
Pt. Paterson
Lake.
Bumbunga
Pt. Price
Dry Creek
ADELAIDE
Marion Lake
Lake
Fowler
Lake
Alexandrina
S. A.
N. S. W.
V I C.
PRINCIPAL SALT
OCCURRENCES
0
100
Scale in Miles

replenished continually by salt leached from minerals of the earth's crust by water, and transported in solution by streams and rivers.

Until recently, there were no known rock salt deposits in Australia. However, early in 1959, rock salt was encountered in the Frome Rocks Oil Bore, 100 miles east of Broome, in Western Australia. The drill entered salt at about 2500 feet, and was still in the salt formation when the bore was abandoned at 4000 feet. Highly saline brines, possibly originating from rock salt, have been encountered in South Australia, notably at Wilkatana, north of Port Augusta.

South Australia is by far the largest producer of salt in the Commonwealth, the bulk of it being obtained from sea water by solar evaporation.

Production of salt in recent years has been as follows

Year	Australia	South Australia
1945		171,067
1955	363,323	291,323
1956	408,689	331,965
1957	427,600	339,396
1958	429,534	336,241
1959	N.A.	357,802

The value of South Australian salt production in 1959 was £715,604.

The first recorded production of salt in this State was in 1829, seven years before the establishment of the colony when 20 tons of salt was obtained from Kangaroo Island. This was harvested from natural lake deposits, probably in the Hundred of Haines, near the

present site of operations by the Colonial Sugar Refining Company working a gypsum deposit. Salt was gathered on a small scale for strictly local requirements from a number of localities for many years. It was not until 1891, when 7505 tons were produced, that the scale of production became notable. From this time on, a number of companies were interested in salt production, both from saline lakes, and from the sea.

The very great advantages offered by the indented coastline of Spencer and St. Vincent Gulfs for the production of salt by the evaporation of sea water were recognised some 40 years ago. The availability of sites close to the cheap sea transport, combined with high net evaporation and abnormal salinity of sea water led to the establishment of solar salt works at the head of Spencers Gulf, near Port Augusta and at Whyalla; at Price on the eastern shore of Yorke Peninsula; and in 1940 at Dry Creek near Adelaide. In addition several operators recover salt from shallow salt lakes on Yorke Peninsula and elsewhere.

At the present time, the principal solar salt operations are at Dry Creek (I.C.I. Alkali (Aust.) Pty. Ltd.); Price (Ocean Salt (Extended) Pty. Ltd.); Whyalla (B.H.P. Co. Pty. Ltd.); Port Patterson (Solar Salt Ltd.). The Australian Salt Co. Ltd. is the major operator in a number of salt lake deposits, including Lake Fowler, Lake MacDonnell, Lake Bumbunga (near Lochiel) and others. Waratah Gypsum Pty. Ltd. operates on Marion Lake, at Stenhouse Bay, while Olsson Industries salt works are based near Warooka, both utilising highly saline groundwater brines as a source of solar salt.

The source of all salt deposits is ultimately the sea. Much of the salt deposited in inland lakes in Yorke Peninsula and elsewhere is considered to have

originated from this source as "cyclic" salt. This has been transported as sea spray evaporated to dryness as dust.

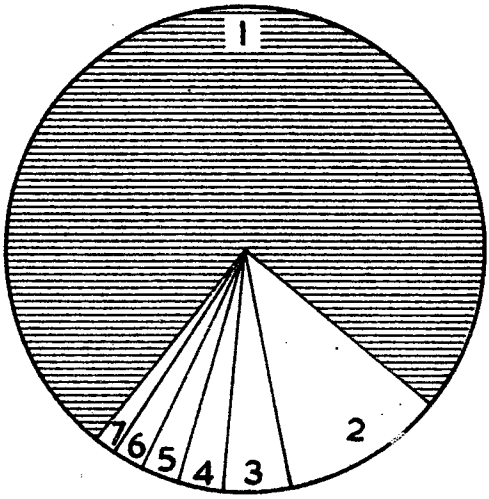
Sea water contains an average of 3.5% dissolved saline matter, amounting to about 2500 grains per gallon. The average composition of the salts in sea water is given in the accompanying diagram.

Although sodium chloride, or common salt is the largest single component of these salts, it is not the first to be dropped from solution. The formation of the great bedded rock salt deposits of Europe and North America resulted from the fact that the various salts are crystallised out at definite concentrations, as the water is removed by evaporation. Thus iron oxides, calcium carbonate and gypsum are all removed before salt begins to crystallise out. This does not occur until the bulk of the sea water has been reduced to about one tenth of its original volume. Salt continues to crystallise out until the volume has reduced to about one twenty fifth of the original sea water. Beyond this point, the extremely soluble salts, known as the bitterns, remain. These include a large number of salts occurring in very small quantity. For thick deposits of salt to form in this way, special conditions were necessary within a large lake or inland sea, so that sodium chloride could be deposited in a pure state, free of either gypsum or bittern salts. Such conditions were evidently almost unknown in Australia's geological history.

Salt deposits in natural salt lakes may contain some of these bittern salts - not always desirable in industries using common salt. In inland lakes, with brines differing in composition from sea water, the proportion of bitterns is often much less. In fact,

SEA WATER

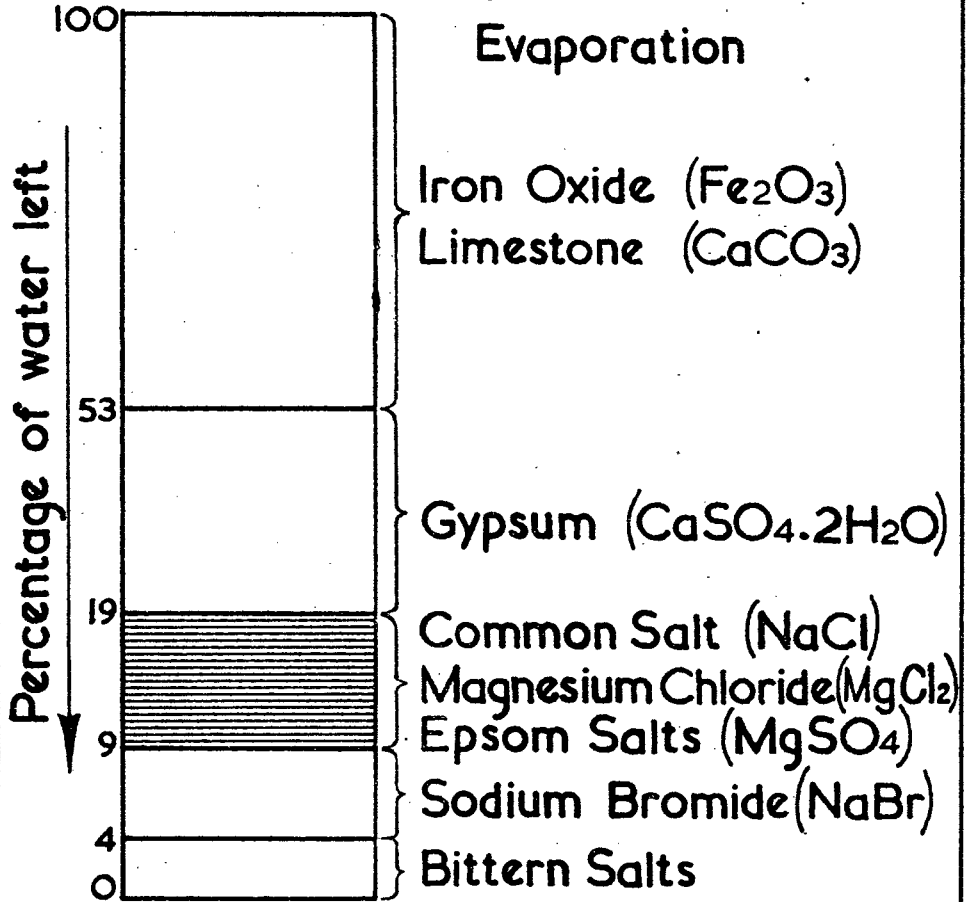
TOTAL SALT CONTENT
(Av. 3·5% = 2500 grains gal.)



1	Common Salt	($NaCl$) 77%
2	Magnesium Chloride	($MgCl_2$) 11%
3	Epsom Salts	($MgSO_4$) 4·7%
4	Gypsum	($CaSO_4.2H_2O$) 3·6%
5	Potassium Sulphate	(K_2SO_4) 2·5%
6	Limestone	($CaCO_3$) 0·3%
7	Magnesium Bromide	($MgBr_2$) 0·2%

SEA WATER

DEPOSITION OF SALTS BY EVAPORATION



no significant quantity bromide salts have been recorded in South Australian groundwaters, or in the waters of Spencer and St. Vincent's Gulf.

Production of salt in South Australia ranges from the small operation of gathering up the thin crust of lake salt from the surface of inland salinas, to the mammoth solar salt operations of I.C.I. Alkali (Aust.) Ltd. at Dry Creek.

Salt lake harvesting can, and has, been accomplished with the simplest of equipment. In the early days horses were used to draw scoops on Lake Bumbunga; nowadays a light railway, or motorised equipment is used to pick up the salt crust, rarely exceeding one inch in thickness. The average yield from salt lake harvesting is about 25 tons per acre, though with addition of brines from groundwater sources, this can be increased up to 100 tons or more per acre annually.

Present day uses of salt are so diverse, and the demand so great, that salt lake production can meet only a small proportion of requirements. The largest single user of salt in Australia is the alkali industry; the ammonia-soda (Solvay) works at Osborne, South Australia - where most of Australia's alkalis are produced, - uses over 200,000 tons of common salt (Sodium Chloride) annually.

Salt production at the I.C.I. saltfields at Dry Creek, and at three other centres in South Australia, is by solar evaporation of sea water. The process makes use of natural evaporation, and its application depends largely on an adequate supply of solar energy.

Solar evaporation is really a means of speeding up the natural process by which salt beds have been depos-

ited in geological formations in various parts of the world. In South Australia it finds application in certain coastal areas of Spencer and St. Vincent Gulfs where climate and terrain are suitable. Sea water is pumped or run by tidal action, so as to flow in series through a number of shallow ponds where evaporation progressively concentrates the solution until certain salts are deposited. Calcium carbonate and gypsum (calcium sulphate) are the first to separate, but the chief one to crystallize out is sodium chlorideoon common salt. Usually it is only the sodium chloride that is recovered for commercial purposes.

A suitable climate is one in which the rate of evaporation is high and the rainfall is low. An arid climate is best, when salt-making may go on throughout the year; but the requirements can frequently be met even in areas with moderate rainfall, particularly when the rain is mainly confined to the cold season. Salt-making under these conditions is likely to be seasonal with effective salt deposition restricted to the hot, dry part of the year.

A suitable terrain for saltfields is a flat, low-lying coastal area consisting of relatively impervious clay sediments. Embankments are built to divide it from the sea and to form a chain of shallow ponds constituting the evaporation system.

The evaporation system consists of two main parts - a first and much more extensive part called the "concentrating" area, in which the initial sea water is concentrated up to the point where it just becomes saturated with sodium chloride (the "Salting Point"), and a second, smaller part called the "crystallizing" area, where further concentration causes the deposition of crystalline sodium chloride. The process is usually stopped at

a stage when most of the sodium chloride which has entered in the initial sea water has been recovered but before the remaining solutes - principally magnesium and potassium salts - have begun to separate, so as to obtain a single, relatively pure product. The residual liquor, or "bittern" which remains after the deposition of the sodium chloride, and containing the unwanted solutes, is finally run to waste.

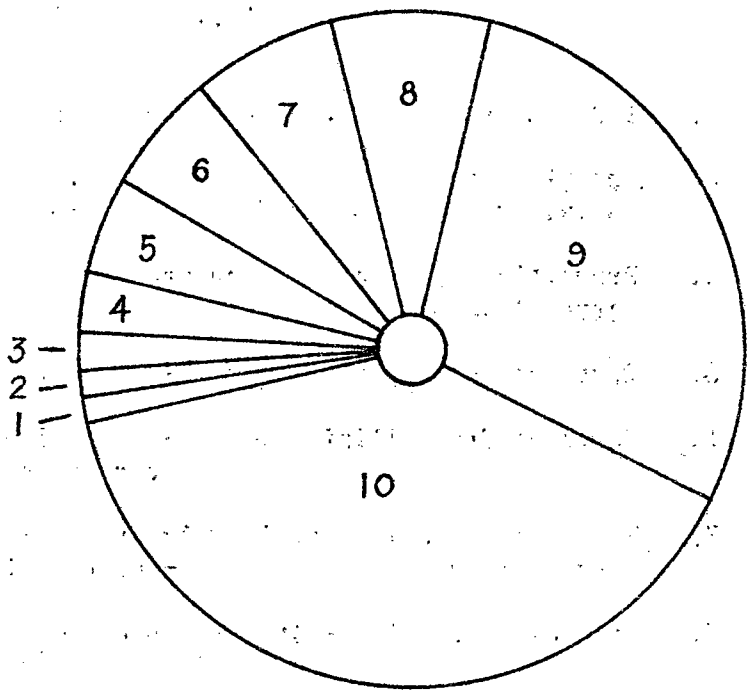
An interesting modern development in the age-old solar evaporation process is the use of an organic dyestuff in the brine of the crystallizing ponds to improve the absorption of the sun's rays, so to increase the evaporation rate, and hence the output of salt, by some 20 per cent.

The salt crust reaches a thickness of 6 inches at the end of a salt-making season, and then between March and May this crust is gathered up ("harvested") by machines from the now-drained crystallizing ponds. At the Dry Creek salt fields, harvesting machines pick up a strip of salt 14 ft. wide and deliver the broken-up, granular material on to an 800 foot conveyor belt along which it is carried to the stacking bays and piled in large conical heaps. During the harvest work continues for 10 hours per day, 6 days per week. A salt harvest occupies 10-12 weeks and starts on approximately 15th March. By way of example, the gross tonnage harvested in 1957 was 284,000 tons. The harvesting operation in other South Australian saltfields is somewhat similar, though on a smaller scale than at Dry Creek.

Some interesting facts about solar salt production include the following.

1. 50 tons sea water contain approximately one ton of salt. Because of various losses in the solar

WORLD USAGE OF SALT



1. METALLURGY
2. REFRIGERATION
3. TEXTILES, LEATHER
4. HOUSEHOLD
5. DYES, SOAPS, CHEMICALS
6. LIVESTOCK. AGRICULTURE
7. FOOD PROCESSING
8. MISCELLANEOUS
9. CHLORINE
10. SODA ASH

salt process due to seepage from ponds, salt lost in bitterns etc., it requires approximately

2. 100 tons sea water to produce one ton of salt.

3. Annual Rainfall - Dry Creek - 18 inches.
Annual Evaporation " - 80 inches.

4. Proportion of Concentrating area to crystallising area - 10 : 1

5. Depth of Concentrating ponds - 1 to 2 feet

6. Depth of Crystallising ponds - 6 inches over the salt crust

7. Thickness of salt deposited in crystallisers, each season. - up to 6 inches.

8. Rate of harvesting salt (Dry Creek) - 1000 tons per hour

27/9/60

GEOLOGICAL SURVEY SOUTH AUSTRALIA