

DEPARTMENT OF MINES
SOUTH AUSTRALIA

SUPPLEMENTARY REPORT

ON

LIMESTONE DEPOSITS - LABORATORY TESTING

SECTIONS 671, 672 HA. DAVENPORT

(Augusta Salt Ltd.)

by

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GEOLOGICAL SURVEY

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Salt Field.

MAPS ACCOMPANYING THE REPORT

No.	Title	Scale
64.63	Geological Map Limestone deposit Sections 671-672, Hd. Davenport.	1" = 100'

G.S. 2887

H.O. 58/142

D.M. 810/64

P.P. 28

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SECTIONS 671, 672 HD, DAVENPORT

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ABSTRACT

Results of laboratory testing of selected drill core samples, carried out by the Highways and Local Government Department, are presented. These support an earlier recommendation for trial pits.

INTRODUCTION

Large quantities of stone, some of up to one ton size, are required for construction projects associated with a proposed expansion of the works of Augusta Salt Ltd. near Port Augusta.

Results of diamond drilling and tonnage estimates were presented in a previous report. (Hiern 1964). A sufficient volume of stone was proved but doubts were expressed as to whether blocks of the required dimensions could be won and whether the rock could physically resist the action of sea water, particularly under tidal conditions.

Selected sections of drill core from ten diamond drill holes were sent to the Highways and Local Government Department Test Laboratory for the following tests.

1. Los Angeles Abrasion
2. Sulphate soundness
3. Weathering test with sea water
4. Atterberg limit determinations on the fine fractions.

Results of this work are now to hand and are reproduced fully in the Appendix.

SAMPLE DETAILS AND RESULTS

The deposit is divided vertically into three zones, each with distinctive physical properties.

Overburden - consists of sand, kunkar limestone and marl in varying proportions and will find uses in construction of roads and minor banks. No samples of this material were sent for testing.

Limestone Bed grades from hard clean rock in the upper part to hard but pitted material with frequent clay seams and pockets in the lower section. The gradation between these two types is rapid with the result that two zones, each with a fairly constant physical appearance, occur. Samples from these two zones were submitted as follows and when considered collectively may be regarded as typical of the deposit.

Bore No.	Upper zone of Mainly clean rock	Lower zone of rock with clay seams.
DD 12	13'0" - 37'3"	37'3" - 46'9"
DD 15	14'8" - 41'6"	
DD 24	15'6" - 41'8"	41'8" - 47'3"
DD 25	18'0" - 30'0"	
DD 28	18'11" - 35'	
DD 32	14'7" - 26'	33'0" - 49'2"
DD 33	19'6" - 48'6"	

Samples of the lower zone from individual holes were too small for testing and were combined to form one sample.

Mottled Orange-brown and grey sandy clay underlies the limestone and will not be used in construction.

A summary of the test results, extracted from the laboratory report, is as follows.

"All samples showed reasonable resistance to abrasion as determined by the Los Angeles Abrasion test, the losses due to abrasion ranging from 28.3 to 42.8 per cent. These figures compare favourably with those obtained from aggregates being

used as base material in road construction, where the specified limits range from 25 to 50 and occasionally higher.

The resistance of these limestones to disintegration as determined by the sodium sulphate soundness test showed that in general the material closer to the surface had greater resistance to disintegration than material obtained from greater depths.

The weathering tests indicated that some disintegration of aggregate could occur due to repeated soaking in salt water and subsequent drying. However there was a considerable improvement in the Atterberg Limits obtained from the fine fraction produced during this disintegration".

SUMMARY & CONCLUSIONS.

Laboratory testing confirms the opinion that the rock may not be sufficiently durable for its intended use and indicates a need for more rigorous testing.

Uncertainties also exist on the ability of the formation to produce large blocks and on groundwater conditions which will be encountered during quarrying.

Excavation of trial pits will resolve the latter two doubts as well as providing in situ samples for further materials testing. The earlier recommendation for trial pitting is re-affirmed.

MNH:AVK:MHR
1/6/1964

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Reference:

Hiern, M.N. 1964. Limestone Deposit, Sections 671, 672,
Hd. Davenport. Dept. Mines Report 58/33 -
unpublished.

APPENDIX.

Highways and Local Government Department

LABORATORY TESTS ON DRILL CORES - Augusta Salt Field

Ten samples of drill core from a limestone deposit at the Augusta Salt Field were submitted by the Department of Mines for the following tests -

1. Los Angeles Abrasion
2. Sulphate soundness
3. Weathering test with sea water
4. Atterberg limit determinations on the fine fractions

Details of the samples submitted are shown in the following table:

Sample No. (Laboratory)	Hole	Depth of Hole	Weight of Sample Submitted (lb.)
634-A-2089	D.D. 12	13'0" - 37'3"	29.8
2090	D.D. 12	37'3" - 46'9"	9.3 *
2091	D.D. 15	14'8" - 41'6"	29.0
2092	D.D. 24	15'6" - 41'8"	28.9
2093	D.D. 24	41'8" - 47'3"	4.2. *
2094	D.D. 25	18'0" - 30'0"	15.0
2095	D.D. 28	18'11" - 35'0"	20.9
2096	D.D. 32	14'7" - 26'0"	13.3
2097	D.D. 32	33'0" - 49'2"	14.1 *
2098	D.D. 33	19'6" - 48'6"	34.6

- These samples were inadequate for all the tests requested and as directed (vide D.M. 794/62 - 6th February, 1964) the samples were mixed to give one composite sample on which the Los Angeles and weathering tests were conducted. The Atterberg Limits and sodium sulphate loss were determined on the individual samples.

The Los Angeles Abrasion loss on each sample was determined using material in the range $1\frac{1}{2}$ inch to $\frac{3}{4}$ inch.

Sodium sulphate soundness was determined on material in the range $\frac{1}{4}$ inch to $\frac{3}{4}$ inch. All samples indicated early breakdown to a fine sand after one cycle of the five cycle soaking and drying test. The sodium sulphate loss ranged from 15.6 to 77.1 per cent, the highest losses being obtained from samples at greatest depth (D.D. 12, D.D. 24 and D.D. 32). Weathering tests were conducted according to the D.M.R. (N.S.W.) method of Accelerated Weathering Treatment. Sea-water was used for each of the ten wetting and soaking cycles. The sea water was obtained from Outer Harbour and may contain less salinity than the water to be encountered at the Augusta Salt Field.

Comparing the sizing analyses of each sample before weathering, and after weathering and compaction (Post Weathering) it is evident that degradation of the aggregate did occur. However the most important aspect shown by the weathering test results was the pronounced lowering of the liquid limit after weathering. There is considerable evidence to show that the salt concentration was the principal factor responsible for the reduced liquid limits. As can be seen from the results no linear shrinkage values were obtained from any of the materials tested for Atterberg Limits after weathering and compaction. The original fines (pre weathering) resulted in comparatively high liquid limits and linear shrinkage values.

Conclusions.

The results of tests conducted on limestones from the Augusta Salt Field may be summarised as follows:-

1. All samples showed reasonable resistance to abrasion as determined by the Los Angeles Abrasion test, the losses due to abrasion ranging from 28.3 to 42.8 per cent. These figures compare favourably with those obtained from aggregates being used as base material in road construction where the specified limits range from 25 to 50 and

occasionally higher.

2. The resistance of these limestones to disintegration as determined by the sodium sulphate soundness test, showed that in general the material closer to the surface had greater resistance to disintegration than material obtained from greater depths.
3. The weathering tests indicated that some disintegration of aggregate could occur due to repeated soaking in salt water and subsequent drying. However there was a considerable improvement in the Atterberg Limits obtained from the fine fraction produced during this disintegration.

16/4/64

G.R. Sandman
TESTING OFFICER.

LABORATORY SAMPLE NO. 674-A-2089 B.D. 12 13'0" to 37'3"

LOS ANGELES ABRASION LOSS: 28.3%

SODIUM SULPHATE LOSS: 15.6%

WEATHERING TEST RESULTS:

<u>Sieve Size</u>	<u>Sizing Analyses:</u> <u>Pre Weathering</u>	<u>Per cent passing</u> <u>Post Weathering</u>
4 inch	100.0	100.0
6 "	89.8	91.4
10 "	66.5	72.6
20 "	48.7	56.3
40 "	28.4	39.1
3/16 "	21.8	32.0
7 mesh	12.2	20.8
14 "	7.4	14.4
25 "	4.8	10.9
36 "	3.8	9.6
52 "	3.3	8.9
100 "	2.8	7.9
200 "	2.3	7.0

ATTERBERG LIMITS:

	<u>Pre Weathering</u>	<u>Post Weathering</u>
Liquid Limit	26.8	17.9
Plastic Limit	14.1	14.0
Plasticity Index	12.7	3.9
Linear Shrinkage	4.5	None obtained

LABORATORY SAMPLE No. 634-A-2090 : D.D. 12 - 37'3" to 46'9"
 634-A-2093 : D.D. 24 - 41'8" to 47'3"
 634-A-2097 : D.D. 32 - 33'0" to 49'2"

LOS ANGELES ABRASION LOSS: (Determined on combined samples)

634-A-2090	}	- 42.8%
634-A-2093		
634-A-2097		

SODIUM SULPHATE LOSS: (Determined on individual samples)

634-A-2090	77.1%
634-A-2093	48.0%
634-A-2097	61.2%

*WEATHERING TEST RESULTS: (Determined on combined samples)

<u>Sieve Size</u>	<u>Sizing analyses - Per cent passing</u>	
	<u>Pre weathering</u>	<u>Post weathering and compaction</u>
$\frac{3}{8}$ "	100.0	100.0
$\frac{1}{2}$ "	73.5	78.2
3/16"	59.9	66.0
7 mesh	42.9	45.9
14 "	34.4	36.7
25 "	29.3	31.2
36 "	26.9	29.6
52 "	24.9	25.3
100 "	21.3	23.7
200 "	17.2	19.1

- * The only material available for the weathering test on these samples was reconstituted material from the Los Angeles test, which was finer than $\frac{3}{4}$ " instead of $\frac{1}{2}$ " as specified by D.M.R.

ATTEBERGT LIMITS:

	<u>PRE WEATHERING</u>			<u>POST WEATHERING AND COMPACTION</u>		
	<u>SAMPLES 634-A-</u>			<u>Combined samples</u>		
	<u>2090</u>	<u>2093</u>	<u>2097</u>	<u>2090</u>	<u>2093</u>	<u>2097</u>
Liquid Limit	45.2	66.3	46.4	23.3		
Plastic Limit	17.0	17.7	16.4	13.6		
Plasticity Index	28.2	48.6	30.0	11.7		
Linear Shrinkage	13.8	17.5	11.7	None obtained		

LABORATORY SAMPLE No. 634-A-2091 D.D. 15 14'8" to 41'6"

LOS ANGELES ABRASION LOSS: 36.0%

SODIUM SULPHATE LOSS: 31.8%

WEATHERING TEST RESULTS:

<u>Sieve Size</u>	<u>Sizing Analyses; Per cent passing</u>	
	<u>Pre Weathering</u>	<u>Post Weathering.</u>
3/4 inch	100.0	100.0
1/2 "	91.0	95.6
3/8 "	64.2	75.6
1/4 "	51.1	61.0
3/16 "	31.0	43.4
7 mesh	23.6	35.6
14 "	15.0	23.9
25 "	9.6	15.8
36 "	6.4	11.0
52 "	5.2	9.1
100 "	4.6	7.7
200 "	3.9	5.9
	3.2	4.2

ATTERBERG LIMITS:

	<u>Pre Weathering</u>	<u>Post Weathering</u>
Liquid Limit	48.0	21.0
Plastic Limit	14.8	14.3
Plasticity Index	33.2	6.7
Linear shrinkage	12.8	None obtained

LABORATORY SAMPLE No. 634-A-2092 D.D. 24 15'6" to 41'8"

LOS ANGELES ABRASION LOSS: 36.0%

SODIUM SULPHATE LOSS: 26.4%

WEATHERING TEST RESULTS:

<u>Sieve Size</u>	<u>Sizing Analyses:</u>	
	<u>Pre Weathering</u>	<u>Post Weathering</u>
$\frac{3}{4}$ inch	100.0	100.0
$\frac{5}{8}$ "	92.8	94.3
$\frac{3}{4}$ "	73.0	77.7
$\frac{1}{2}$ "	57.8	63.7
$\frac{1}{4}$ "	34.6	45.1
3/16 "	25.7	35.7
7 mesh	13.9	23.3
14 "	9.0	16.1
25 "	5.7	12.4
36 "	4.5	11.1
52 "	4.0	10.4
100 "	3.4	9.4
200 "	2.8	8.2

ATTERBERG LIMITS:

	<u>Pre Weathering</u>	<u>Post Weathering</u>
Liquid Limit	53.6	23.7
Plastic Limit	15.0	15.0
Plasticity Index	38.6	8.7
Linear Shrinkage	13.1	None obtained

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LABORATORY SAMPLE No. 634-A-2094 D.D. 25 18'0" to 30'0"

LOS ANGELES ABRASION LOSS: 31.0%

SODIUM SULPHATE LOSS: 18.9%

WEATHERING TEST RESULTS:

<u>Sieve Size</u>	<u>Sizing Analyses; Pre Weathering</u>	<u>Per cent passing Post Weathering</u>
$\frac{3}{8}$ inch	100.0	100.0
$\frac{1}{2}$ "	89.5	90.7
$\frac{3}{4}$ "	77.4	79.1
2 "	66.4	69.8
4 "	38.7	47.3
3/16 "	26.1	35.3
7 mesh	13.4	20.3
14 "	6.5	12.8
25 "	3.2	9.3
36 "	1.8	8.0
52 "	1.6	7.4
100 "	1.4	6.8
200 "	1.1	6.1

ATTERBERG LIMITS:

	<u>Pre Weathering</u>	<u>Post Weathering</u>
Liquid Limit	30.5	19.9
Plastic Limit	15.2	15.3
Plasticity Index	15.3	4.4
Linear Shrinkage	6.5	None obtained

LABORATORY SAMPLE No. 634-A-2095 D.D. 28 18'11" to 35'0"

LOS ANGELES ABRASION LOSS: 39.7%

SODIUM SULPHATE LOSS: 68.4%

WEATHERING TEST RESULTS:

<u>Sieve Size</u>	<u>Sizing Analyses; Pre Weathering</u>	<u>Per cent Passing Post Weathering</u>
1/2 inch	100.0	100.0
3/4 "	92.1	92.1
1 "	75.7	79.8
1 1/2 "	65.7	69.9
2 "	41.3	52.2
3/16 "	31.3	43.3
7 mesh	16.8	29.6
14 "	11.1	23.0
25 "	7.7	18.9
36 "	6.2	17.2
52 "	3.6	16.1
100 "	4.3	14.5
200 "	3.2	12.7

ATTABERG LIMITS:

	<u>Pre Weathering</u>	<u>Post Weathering</u>
Liquid Limit	36.3	27.7
Plastic Limit	17.3	14.5
Plasticity Index	19.0	13.2
Linear Shrinkage	10.0	None obtained

LABORATORY SAMPLE NO. 634-A-2096 DD. 14'7" to 26'0"

LOS ANGELES ABRASION LOSS: 33.8%

SODIUM SULPHATE LOSS: 19.0%

WEATHERING TEST RESULTS:

<u>Sieve Size</u>	<u>Sizing Analyses:</u> <u>Pre Weathering</u>	<u>Per cent passing</u> <u>Post Weathering</u>
4 inch	100.0	100.0
6 "	92.3	92.8
10 "	79.5	81.3
20 "	69.0	72.9
40 "	40.9	50.6
9/16 "	27.8	39.2
7 mesh	10.6	20.5
14 "	3.9	12.1
25 "	2.8	9.8
36 "	2.1	8.8
52 "	1.9	8.3
100 "	1.6	7.5
200 "	1.3	6.7

ATTERBERG LIMITS:

	<u>Pre Weathering</u>	<u>Post Weathering</u>
Liquid Limit	37.9	21.0
Plastic Limit	16.4	16.8
Plasticity Index	21.5	4.2
Linear Shrinkage	7.6	None obtained

LABORATORY SAMPLE No. 634-A-2098 D.D. 33 19'6" to 48'6"

LOS ANGELES ABRASION LOSS: 41.95

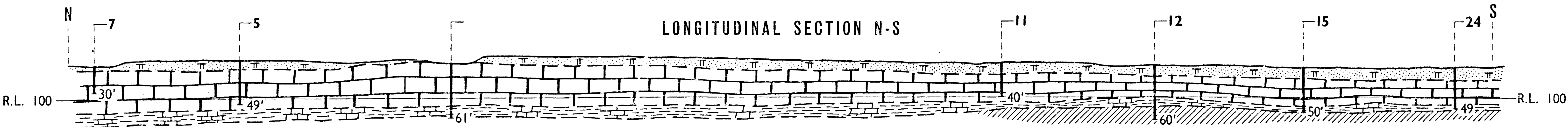
SODIUM SULPHATE LOSS: 56.68

WEATHERING TEST RESULTS:

<u>Sieve Size</u>	<u>Sizing Analyses:</u> <u>Pre Weathering</u>	<u>Per cent Passing</u> <u>Post Weathering</u>
4 inch	100.0	100.0
6 "	91.7	93.9
10 "	71.6	76.6
20 "	55.7	63.4
40 "	37.5	47.2
3/16 "	29.6	39.6
7 mesh	19.9	28.9
14 "	14.5	24.2
25 "	11.1	21.0
36 "	9.6	19.6
52 "	8.5	18.5
100 "	6.5	16.6
200 "	4.4	14.5

ATTERBERG LIMITS:

	<u>Pre Weathering</u>	<u>Post Weathering</u>
Liquid Limit	46.9	28.0
Plastic Limit	19.9	16.0
Plasticity Index	27.0	12.0
Linear Shrinkage	12.0	None obtained



LEGEND FOR SECTION

- Sand, kunkar and marl
- Hard limestone
- Limestone with soft clay seams and pockets
- Brown and grey mottled clay limy in parts

