REPT.BK.NO. 72/143

EVALUATION OF LIGHTWEIGHT AGGREGATE RAW MATERIALS ADELAIDE AREA

Department of Mines
South Australia

DEPARTMENT OF MINES
SOUTH AUSTRALIA

EVALUATION OF

LIGHTWEIGHT AGGREGATE RAW MATERIALS

ADELAIDE AREA

by

DOUGLAS NICHOL
GEOLOGIST
NON-METALLICS SECTION

1st August, 1972

Rept.Bk.No. 72/143
G.S. No. 4909
D.M. No. 290/66

DEPARTMENT OF MINES
SOUTH AUSTRALIA

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EVALUATION OF LIGHTWEIGHT AGGREGATE RAW MATERIALS ADELAIDE AREA

ABSTRACT

Forty-five samples of clay, shale and slate, collected within the Adelaide metropolitan area and elsewhere in South Australia were submitted for firing tests to determine their suitability for the manufacture of lightweight aggregate.

Four samples, from Cherry Gardens, Eagle Quarry, Mintaro Slate Works and Gilburn Brick Works, displayed excellent bloating ability and were submitted for compressive strength tests to determine their suitability for lightweight concrete.

The shale or slate material from Eagle Quarry, Mintaro Slate Works and Gilburn Brick Works gave very promising results. Reserves of these materials are probably large.

Untreated fly-ash from Port Augusta power station is unsuitable for lightweight aggregate production.

Other bloating clays and shales in South Australia are listed.

INTRODUCTION

Lightweight aggregate is generally defined as any solid material included within a concrete mix weighing less than the conventional sand, gravel or crushed stone. The three major types of lightweight aggregate are natural, byproduct and manufactured. Natural lightweight aggregates are those derived from naturally occurring materials such as pumice and volcanic ash. Byproduct lightweight aggregates are principally derived from combustion processes involving coal or coke and include foamed blast-furnace slag, cinders and coke breeze. The third class of lightweight aggregate is manufactured and includes expanded

vermicultite, perlite, clay, shale and slate. The scope of this report is limited to manufactured lightweight aggregate and in particular to expanded clay, shale and slate.

When certain argillaceous rocks are heated to incipient fusion, gases are liberated which become trapped in the semi-fused or pyro-plastic mass, causing it to expand and giving it a cellular structure. This phenomenon is known as bloating and has always been a bane to manufacturers of ceramic products, who must ensure that bloating of their ware does not take place during firing. For bloating to occur, some mineral or combination of minerals must be present that will dissociate or react to liberate a gas at the moment when the mass of clay or shale has fused to a melt sufficiently viscous to prevent the escape of the gas. By no means all clays and shales possess the chemical and physical properties necessary to fulfil this condition. A fuller discussion of bloating is given by Riley (1951).

Investigations on manufactured lightweight aggregate have been carried out by the Department of Mines and the Australian Mineral Development Laboratories since 1959 (Hosking et al., 1960; Oliver, 1961; Madigan, 1963, 1964, 1966, 1967 and 1968). These investigations have been summarised by Nichol (1970).

The purpose of the present report is to describe results obtained after further sampling of possible raw-material sources for manufactured lightweight aggregate mainly from within the Adelaide metropolitan area.

Samples were collected intermittently by the writer between October, 1970 and November, 1971. Laboratory testing of clay and shale samples was carried out by D.R. Ashworth and D.R. Jones, Materials Technology Section, The Australian Mineral Development Laboratories. The results of laboratory testing (Ashworth et al., 1971) are presented in this report. Investigations to determine the effect of lightweight aggregate on the compressive strength of the concrete cylinders

was carried out by W.R. Ridgway, School of Civil Engineering - Materials Testing Laboratory, The South Australian Institute of Technology. The results of the concrete cylinder strength tests are also presented in this report.

SAMPLING AND RESULTS

Preliminary

A reconnaissance sampling programme was devised to compliment an earlier programme reported on by Olliver (1961). The combined programmes test the main argillaceous elements in the stratigraphic sequence in the Adelaide area. In addition and wherever possible samples were collected from existing and operating quarries. Sample locations are given in Table I (Plan No. 72-263) and shown along with the sample locations from the earlier survey (Olliver op cit) on plan No. 71-181. Rock samples were chipped from quarry faces and occasionally from natural outcrops and wherever possible unweathered and representative samples were obtained. Clay samples were collected by channel sampling from quarry and roadcutting faces except for one sample, A214/70, Cherry Gardens black clay, which was taken directly from a clay stockpile. A sample of fly-ash from the coal-burning power generating station at Port Augusta was provided by the Adelaide Cement Co. Ltd.

The following is the procedure used by AMDEL for testing the bloating properties of the samples:-

"The clay samples were dried in an oven set at 105°C to zero moisture content, jaw crushed to approximately ¼-inch size and pulverised to approximately 30 mesh (BSS). Representative samples were moistened with water and 3/8 to ½-inch pellets were hand formed. The pellets were thoroughly dried before flash firing. The shale and slate samples were jaw crushed and specimens of each material passing ½-inch and retained on 3/8-inch screens were used for flash firing.

"Initially 38 samples were flash fired for 15 minutes at 1 200°C in an oil-fired muffle kiln (see plate No. 22109) and sorted in preparation for further testing. Samples of those materials which had just started to bloat or had not bloated, were flash fired for a further 15 minutes at 1 250°C, while those which bloated satisfactorily or over bloated at 1 200°C were put aside for further testing. After visual observations of the bloated materials, further firings of selected samples were made at temperatures in the range of 1 120° - 1 280°C to determine bloating temperature limits and range. The remainder of the samples were only flash fired for 15 minutes at 1 250°C as experience has shown that materials which do not bloat or show signs of bloating at 1 250°C either do not bloat or do not produce a satisfactory lightweight aggregate. In addition it was found that information on bloating temperatures and in particular optimum bloating temperatures obtained from flash firing, bore only minimal resemblance to those required to produce a satisfactory product in later operations".

Table I (plan No. 72-263) shows the results of the above firings. Of the 45 samples tested, 8 bloated sufficiently to warrant further investigation. However, two samples A211/70 and A212/70 are both from Eagle Quarry and therefore may be considered together. Sample A236/70 was omitted from further testing because the sample location lies close to Para Wirra National Park. It is mentioned here in the event that exploration reveals the same material in a more acceptable location. Sample A1112/70 was omitted from further testing because the sample location lies in the Tapley Hill shale which has already been thoroughly examined in previous investigations (Olliver, 1961, Madigan, 1963, 1964, 1966, 1967 and 1968). Sample A1112/70 was the only sample to bloat out of 8 collected in the area of Linwood Quarry (A213-222/70 and A1110-113/71).

Secondary

Of the five deposits shown by the preliminary trials to be potential sources of material for the manufacture of lightweight aggregate, three were selected for secondary testing. Seven samples, A1099-1105/70 were collected at regular intervals along the shale face exposed on the approach road to Eagle Quarry. Four samples, A1106-1109/70 were collected at regular intervals across the quarry face at Gilburn Brick Works. Five samples A1114-1118/70 were collected at regular intervals across the quarry face at Mount Lofty Quarry. These 16 representative samples were processed in the same way as the preliminary trial samples and flash fired for 15 minutes at 1 250°C.

Table II (plan No. 72-264) shows the results of the above firings. At Eagle Quarry, the acceptable material is limited to the hard, blue-grey shale, of which there appears to be large reserves exposed to the east of the weighbridge. At the Mount Lofty Quarry the material is highly variable and when fired yields a barely acceptable product. This locality was therefore omitted from further testing.

The primary and secondary trials thus indicated four localities from which bloating materials could be obtained in a commercial operation.

Tertiary

For the tertiary trials, bulk samples each of about 1 tonne were collected from the four localities indicated by the primary and secondary trials.

The materials for pilot production were processed by AMDEL in the following manner:-

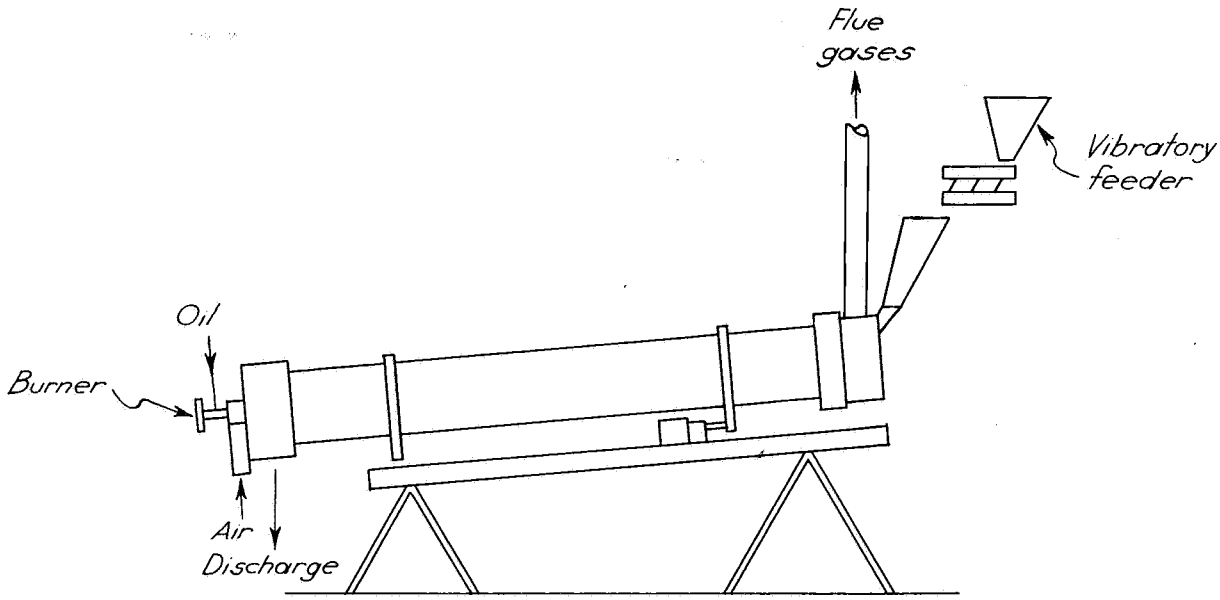
"The clay sample, A47/71, was dried, jaw crushed, pulverised to approximately 30 mesh (BSS) and then pelletised to give a range of sizes from approximately 3/16 to 3/4-inch, using a revolving inclined disc with a water spray attachment.

The pellets were dried. The shale samples A44/71, A46/71 and A48/71 were jaw crushed to approximately 5/8-inch and screened with the aid of a screen shaker to give two sizings, minus ½ plus 3/8-inch and minus 3/8 plus 5/16-inch. The fines were stored.

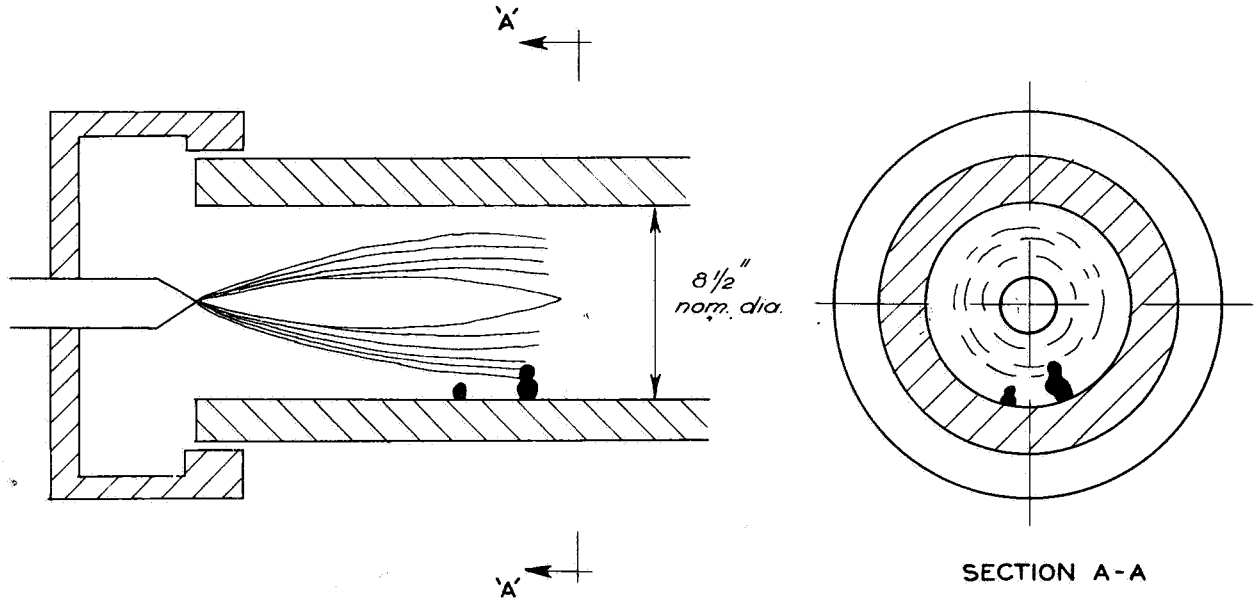
"Pilot production was carried out in a rotary calciner, a schematic diagram of which is shown on plan No. S.9828 and plate No. 22110. The calciner consists essentially of a steel cylinder (18 inches (0.46 metres) O.D., 8½ inches (0.22 metres) I.D.)) 11 feet (3.35 metres) long, lined internally with refractory bricks. The speed of rotation could be varied between 3 and 10 r.p.m. by means of a motor driven gear train. The angle of the cylinder could be altered between 0 and 5 degrees by an adjustable support. The burner was of the "Nu-way" type (Model No. 4) and was equipped with primary and secondary compressed air supplies. The oil (distillate) was injected by gravity feed from a constant head tank. The aggregate was fed into the input end of the calciner by means of a vibratory hopper which could be adjusted to give different feed rates. During the production of bloated aggregate the temperature of the hot zone was measured with an optical pyrometer (Optix-Pyro-Weck, GmbH, Hannover).

"In order to minimise clinkering and ringing (see plan No. S9829), sand was introduced with the shale aggregate into the kiln. It was found that only a small amount of sand adhered to the bloated product. The residue was easily removed by screening on a ¼-inch mesh sieve".

Table III (plan No. 72-265) shows the results of the pilot production trials. The four samples gave satisfactory products and no difficulties were experienced in processing the materials. The pelletised clay, A47/71 formed an excellent product having a bulk density of 1.02 gcm^{-3} and was strong. Of the shales, sample A48/71 and the minus 3/8, plus 5/16-fraction of sample A44/71 gave the best products being well rounded and light. The remaining samples bloated well but the



ROTARY CALCINER



SECTION A-A

STICKING AND CLINKERING OF AGGREGATE

DEPARTMENT OF MINES — SOUTH AUSTRALIA

Compiled: D. Nichol
Drn: T.S. Ckd: R.H.

LIGHTWEIGHT AGGREGATE PROJECT
DIAGRAMS OF ROTARY CALCINER AND
STICKING & CLINKERING OF AGGREGATE

Scale:
Date: 16 May 1972
Drg. No. S 9828
Ha

bulk ensity might be too high (1.17 - 1.24 gcm^{-3}) when compared with the acceptable values given by the Building Research Station (1970), (0.33 - 0.96 gcm^{-3}).

CONCRETE CYLINDER TESTS

Having established that satisfactory lightweight aggregate can be produced, the investigation was extended to determine the compressive strength of concrete cylinders made from the lightweight aggregate formed. In order to compare the results with those obtained by Madigan (1967), the same ratio of coarse to fine aggregate and the ratio of water to cement was used throughout the investigation.

The Australian Standard A168-1971 gives values of grading for coarse (3/4-inch) aggregate (see Table IV).

TABLE IV GRADING FOR COARSE AGGREGATE (3/4") AND SIZED AGGREGATE (½") - AUSTRALIAN STANDARD A168-1972

B.S. Mesh Size and Number	Graded Aggregate (3/4") Percentage by Weight Passing	Sized Aggregate (-3/4"+3/8") Percentage by Weight Passing
1½"	-	-
1 "	100	-
3/4"	85 - 100	100
½ "	-	90 - 100
3/8"	25 - 55	0 - 45
3/16"	0 - 10	0 - 10
No. 7	0 - 5	0 - 5
No. 200	0 - 5	0 - 5

No Australian specification is available yet for the grading of fine lightweight aggregate. The grading and proportion of coarse and fine aggregate was therefore prepared according to previous work (Madigan, 1967) as set out in Table V.

TABLE V GRADING AND PROPORTIONS OF COARSE AND FINE AGGREGATE USED IN CONCRETE TEST PIECES

Coarse Aggregate	-1"	to	+3/8"	75%
	-3/8"	to	+3/16"	25%
Fine Aggregate	-3/16"	to	+16 Mesh	45%
	-16 Mesh	to	+52 Mesh	40%
	-52 Mesh	to	+100 Mesh	10%
	-100 Mesh			5%
Sized Aggregate	-3/4"	to	+3/8"	100%

The grading of the coarse aggregate was prepared by using a vibratory sieve (-1 inch to +3/8 inch, -3/8 inch to +3/16 inch). The remaining coarse aggregate was then jaw crushed and the fine fraction (-3/16 inch to +100 mesh) prepared by sieving in the same manner.

Australian Standard A168-1971 specifies the maximum dry loose weight (lb/ft^3) for coarse, fine and combined fine and coarse aggregate as shown in Table VI using the equipment laid down in the Standard. Accordingly, the necessary metal cylinder having about one cubic foot volume was constructed and calibrated in the prescribed manner and the unit weight for each fraction measured, the results being given in Table VI. The combined coarse and fine fraction weight

could not be carried out due to special processing required before mixing of the aggregate.

TABLE VI COMPARISON OF UNIT WEIGHT OF SAMPLES WITH STANDARD

	Dry Loose Weight in lb/ft^3					
	Maximum as per					
	A168-1971	A211/70	A214/70 (single size)	A214/70	A226/70	A229/70
Fine Aggregate	70	48		36	64	64
Coarse Aggregate	55	46	35	34	46	52
Combined Fine and Coarse Aggregate	60					

The proportion of Portland cement, fine aggregate, coarse aggregate and the water/cement ratio used in this investigation and as previously employed by Madigan (1967) are given in Table VII.

TABLE VII PROPORTIONS OF PORTLAND CEMENT, FINE AND COARSE AGGREGATE AND WATER/CEMENT RATIO

	By Volume (Cubic Yard)	By Weight (lb)
Portland Cement	1.00	1.23
Fine Aggregate	1.82	1.06) ratio of fine to
Coarse Aggregate	2.75	1.00) coarse 2:3 by volume

Water to cement ratio = 0.57 (weight basis).

The method of mixing of the concrete was such that the coarse aggregate was mixed with water until just damp. The fines and cement were then mixed dry and added to the damp coarse material. Water was then added in the specified amount. In contrast with Madigan (1967) it was found that difficulty was encountered in obtaining a homogenous mix as the coarse and fine aggregate tended to segregate in the moulds, which led to a considerable spread in compressive strength values for some of the aggregate tested.

The cylinders were cast in three layers and rodded by hand with fifty strokes per layer except for sample A47/71, coarse aggregate only, where 25 strokes per layer were sufficient for the very mobile mix. Cylinders were stripped from moulds 24 hours after casting and were cured in a fog-room. Sulphur compound was used for capping.

The measurements of slump, density and compressive strength after seven and twenty-eight days aging are given in Table VIII.

TABLE VIII: PROPERTIES OF LIGHTWEIGHT AGGREGATE CONCRETE

Sample	Compressive Strength (lbf/in^2)		Density (lb/ft^3)	Slump
	7 day	28 day		
A44/71	1 850	1 300 3 250	102	Nil
A47/71	700	900 450 600	75	Nil
A47/71 (Single Size)	500	650 800 550	65	8"
A48/71	2 550	1 850 2 900 2 800	98	Nil
A46/71	1 950	2 550 2 000 3 000	105	Nil

The maximum compressive strength values determined were about the same found for previous tests and agree well with published values obtained for natural aggregate. The results also show a wide spread of compressive strength values for the individual materials. An examination of the test cylinders reveals that segregation of the fine and coarse aggregate often occurred and the lower values appear to be associated with poor mixing. The cylinders which gave high compressive strengths show much less evidence of segregation and these values are considered as being typical and indicate the potential strength which may be attained if precautions are taken with mixing and prevention of segregation.

The lightweight aggregate produced from the clay (sample A47/71) gave unexpectedly low compressive strengths and examination of the concrete cylinders indicated the presence of holes and poor packing, presumably due to the spherical nature of the coarse aggregate.

Table IX shows the concrete strengths obtained from test cylinders cast in the same manner and with the same mix as above but substituting 'standard' natural aggregate for the lightweight material.

TABLE IX: COMPRESSIVE STRENGTH OF 'STANDARD' AGGREGATE CONCRETE

Sample	Age (days)	Compressive Strength (lbf/in^2)	Density (lb/ft^2)
(STANDARD AGGREGATE)	7	4 050	146
	28	5 350	
	28	5 300	
	28	5 300	

For further comparison Table X shows the range of values obtained from tests on various expanded clay and shale aggregates published in the Building Research Station Digest (1970).

TABLE X: COMPARATIVE VALUES

Aggregate	Typical Density Range	Dry Density of Concrete	Compressive Strength
Expand clay/shale	20-60 lb/ft^3	45-1 100 lb/ft^3	290-9 000 lbf/in^2

It can be seen that there is a wide range of values obtainable, but the values for both clay and shales tested in this project fall well within this range.

Further work would be required to determine such factors as sulphate content and water absorption, and the effects of water to cement ratio on compressive strength.

THE DEPOSITS

Cherry Gardens (see plate 22111)

Supplies of clay and "shale" for roofing tile production are obtained from pits established at Cherry Gardens, 21 kilometres south-southeast of Adelaide. The quarry is operated by W. Benbow and Sons Ltd. for Wunderlich Ltd.

The plastic black clay which was tested in the present investigation was taken from a stockpile built up by the operator alongside the shale workings. This black clay is an alluvial clay, up to 7 metres thick which occurs along the valley floors and creek beds in the vicinity of Cherry Gardens. Drilling of the clay deposit on sections 783 and 786, Hundred of Noarlunga is described by Russ (1968). The quarry operator reports that he has been unable to locate further supplies of this clay for his own use.

Eagle Quarry (see plate No. 22112)

Quartzite used as natural aggregate is obtained at Eagle Quarry, 12 kilometres south-east of Adelaide on Sections 922, 935 and 946, Hundred of Adelaide. The property is bounded on the north by the Princes Highway. The quarry is operated by Quarry Industries Ltd.

The Undulya Quartzite (formerly Stonyfell Quartzite), which is the unit being quarried is cut to the north and northwest by an east-northeast, west-southwest trending portion of the Clarendon-Ochre Cove Fault. Across the fault and juxtaposed against the Stonyfell Quartzite, are phyllitic argillites of Sturtian age. The latter material was sampled and the hard blue-grey shale which outcrops near the weighbridge on the quarry access road found to be suitable for lightweight aggregate manufacture. Reserves of this material are unknown but can be seen to be large. The quarry operator has indicated that, in time, the blue-grey shale will be quarried as waste material to permit access to large reserves of quartzite rock.

Mintaro Slate Works

(see plate No. 22113)

High-quality slate, once used for Adelaide city pavements and now used in the manufacture of billiard tables has been produced at Mintaro since 1891. The workings are located 1.6 kilometres west of Mintaro, about 110 kilometres north-northeast of Adelaide on Sections 178 and 307 Hundred of Clare. The quarry is operated by the Mintaro Slate and Flagstone Co. Ltd.

The Mintaro Slate is a bluish-grey fluvio-glacial siltstone of Sturtian age and belonging to the Burra Group of sediments. Reserves are enormous and large supplies of waste and off-cut material already exist in the spoil heaps at the Mintaro Slate Works.

Gilburn Brick Works

(see plate No. 22114)

Highly weathered phyllite shales used in a clay blend for brickmaking are obtained at Magill Brick Works, 8 kilometres east of Adelaide on Section 849, Hundred of Adelaide. The quarry is operated by Gilburn Brick Co. Ltd.

The weathered shales of Torrensian age are yellow-brown in colour. Reserves are uncertain but probably large.

SINTERING OF FLY-ASH

A sample of fly-ash from the Port Augusta power station was examined to establish its potential as a source of material for lightweight aggregate manufacture. Initial experiments were carried out on pellets produced by moistening the fly-ash powder, all of which was less than 300 mesh, to obtain a semi-plastic body and rolling by hand to form ¼-½ inch pellets. These were dried at 105°C and fired at different temperatures between 1 000 and 1 200°C in 50°C increments with a 15 minute soak at each temperature.

Examination of the fired pellets indicated that they were hard and strong. In all cases a brown exudation was present after firing which appeared to originate from the interior of the pellet leaving a hollow lightweight sphere. The fly-ash does not produce a lightweight aggregate as a result of the normal bloating mechanism.

A more detailed investigation of this material to determine a method of beneficiation for the production of lightweight aggregate may be worthwhile (cf. Boux, 1970; Morris, 1970; Brzakovic, 1970). However, this is not considered to be warranted at the present time because Adelaide Cement Co. Ltd. are using present available supplies of the fly-ash as an additive in their produce.

OTHER BLOATING CLAYS AND SHALES IN SOUTH AUSTRALIA

A thorough perusal of departmental published and unpublished files has revealed that other bloating clays and shales occur in South Australia. They have been listed in Table XI (see plan No. 72-266). Where appropriate, a reference source has been cited. The National Clay Register referred to in the table is an unpublished compendium, compiled by the Australian Mineral Development Laboratories, of Australian clays which have been examined for their physical, chemical and ceramic properties.

The materials listed on Table XI (plan No. 72-266) are noted only for their ability to bloat. Their potential as sources of material for lightweight aggregate manufacture is unknown. In addition the nature and extent of reserves are unknown.

SUMMARY AND CONCLUSIONS

Bloated clay, shale and slate is of value in the construction industry as lightweight aggregate in a concrete mix.

Test firing of forty five clay shale and slate samples from the Adelaide metropolitan area and elsewhere in South Australia has permitted the selection of four potential sources of raw material for lightweight aggregate manufacture.

Black alluvial clay of Recent age from Cherry Gardens produces an excellent bloated product on firing. However the bloated material appears to be fairly weak in a concrete mix and is therefore of limited value. Reserves of black clay in the Cherry Gardens area are uncertain though probably small.

Adelaidean shale or slate from Eagle Quarry, Mintaro Slate Works and Gilburn Brick Works produces well bloated products on firing. The bloated materials are fairly strong in a concrete mix giving compressive strength values of about 3 000 lb.f/in^2 as compared with about 5 300 lb.f/in^2 for a similar concrete mix

employing conventional natural aggregate. These bloated materials produced concrete having densities in the range 98-105 lb/ft^3 as compared with 146 lb/ft^3 for a similar concrete mix employing conventional natural aggregate. Reserves of all three materials are large. At Eagle Quarry the blue shale will be quarried as overburden in future intended quarry development. At Mintaro Slate Works large quantities of waste slate are available in present stockpiles. At Gilburn Brick Works bloating shale can be obtained from the operating quarry.

The rock formations sampled are extensive in the Adelaide area and likely to provide many sources of lightweight aggregate raw material in addition to those outlined in the present report.

Fly-ash from Port Augusta power station would not produce suitable lightweight aggregate without costly benefication.

Other clays and shales in South Australia which are known to bloat are recorded.

Douglas Nichol

1st August, 1972
DN:IA

DOUGLAS NICHOL
GEOLOGIST
NON-METALLICS SECTION

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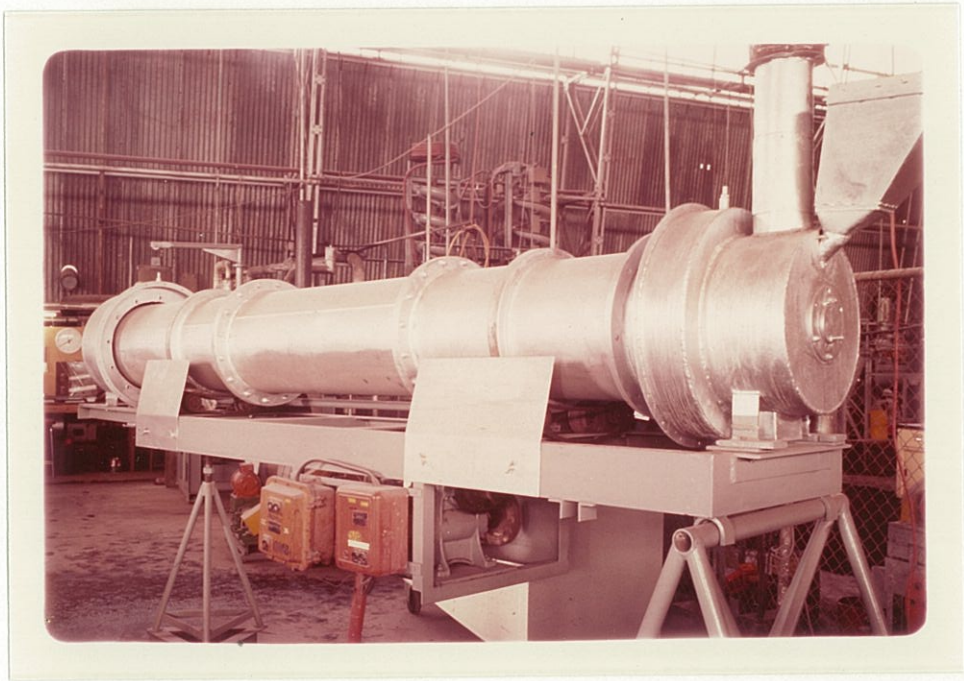
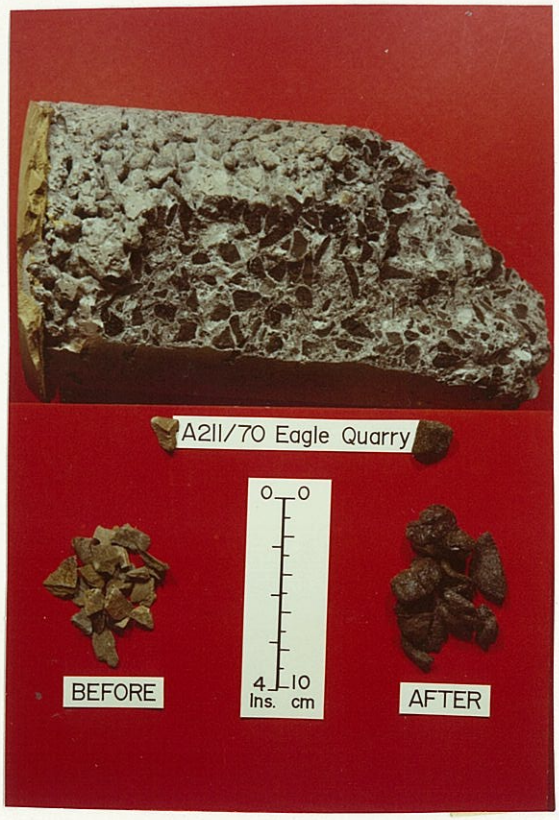
PLATES

22109 Lightweight Aggregate Project. Oil-fired Muffle Kiln. AMDEL.



22110 Lightweight Aggregate Project. Rotary Calciner. AMDEL.

22111 Lightweight Aggregate Project. Sample A214/70, Cherry Gardens Black Clay.



22112 Lightweight Aggregate Project. Sample A211/70, Eagle Quarry.

22113 Lightweight Aggregate Project Sample A226/70, Mintaro Slate Works.

22114 Lightweight Aggregate Project. Sample A229/70, Gilburn Brick Works.

N

Co. GAWLER

Co. LIGHT

Co. ST. VINCENT

Co. STURT

Co. HINDMARSH

GAWLER

GAWLER RIVER

NORTH PARA RIVER

A228/70

BAROSSA RESERVOIR

SOUTH PARA RIVER

A236/70
A235/70
A223-224/70
A225/70

WARREN RESERVOIR

Smithfield

ELIZABETH

St. Kilda

A237/70

LITTLE PARA RIVER

Salisbury

Outer Harbor

Torrens Island

A234/70

A207/70
A208/70

Largs

Semaphore

Port Adelaide

Modbury

Tea Tree Gully

A232-233/70

MILLBROOK RESERVOIR

Gumeracha

Birdwood

DRY CREEK

A231/70
A230/70

HOPE VALLEY RESERVOIR

Woodville

Enfield

A206/70

Mt. Torrens

A209/70
A210/70

Henley Beach

RIVER TORRENS

ADELAIDE

Norwood

A229/70
A1106-1109/70
A46/71

Norton Summit

A151-153/71

Burnside

Lobethal

Charleston

Glen Osmond

Summertown

A213/70
A1114-1118/70

MT. LOFTY

A211/70
A212/70
A1099-1105/70
A44/71

Crafers

Stirling

Balhannah

Glenelg

Brighton

Blackwood

Kingston Park

A1113/70

A218-222/70
A1110-1111/70

A1112/70

RIVER STURT

HAPPY VALLEY RESERVOIR

Cherry Gardens

A214-218/70
A47/71

Hallett Cove

Reynella

Clarendon

Echunga

RIVER

MT. BOLD RESERVOIR

Pt. Noarlunga

ONKAPARINGA

Noarlunga

McLaren Vale

Willunga

A238/70

Sellicks Hill

LEGEND

× Sample locality of previous survey (Olliver, 1961).

• A44/71 Sample locality of present survey with sample number.

SCALE

MILES 2 1 0 2 4 6 8 10 MILES

KILOMETRES 5 0 5 10 15 KILOMETRES

DEPARTMENT OF MINES — SOUTH AUSTRALIA

LIGHTWEIGHT AGGREGATE PROJECT
COUNTY ADELAIDE
SAMPLE LOCATION PLAN

MINERAL RESOURCES DIVISION

Director of Mines

GEOLOGIST

Compiled D. Nichol

SUP. GEOLOGIST

Drn. R.H.

Chkd. LVW.

Scale: As shown

Date: 25 Feb 1971

Drg. No. 71-181

Ha

DEPT. SAMPLE NUMBER	LAB. SAMPLE NUMBER	LOCALITY INFORMATION			FLASH FIRING AT 1200°C FOR 15 MINUTES	FLASH FIRING AT 1250°C FOR 15 MINUTES	FIRING IN THE RANGE 1120 - 1280°C			COMMENTS	REJECTED or ACCEPTED	RECOMMENDATION
		HUNDRED	SECTION	OTHER			BLOATING TEMP. LIMITS (°C)	TEMP. RANGE (C°)	OPTIMUM FIRING TEMP. (°C)			
A204/70	CE 3802	Macclesfield	4883, 4884, 5009	Hallett's Quarry: Littlehampton	Not bloated	Not bloated					Rejected	
A205/70	CE 3803	Macclesfield	4883, 4884, 5009	Hallett's Quarry: Littlehampton	Not bloated	Not bloated					Rejected	
A206/70	CE 3804	Talunga	55	Road cutting: Tungkillo - Mount Torrens Road	Not bloated	Not bloated					Rejected	
A207/70	CE 3805	Talunga	6397	Newbold's clay: Birdwood Quarry	Not bloated	Not bloated					Rejected	
A208/70	CE 3806	Talunga	6397	Readymix clay: Birdwood Quarry	Not bloated	Not bloated					Rejected	
A209/70	CE 3807	Onkaparinga	190	Onkaparinga Brick Co.: Clay Pit	Not bloated	Not bloated					Rejected	
A210/70	CE 3808	Onkaparinga	191	Onkaparinga Brick Co.: Rock	Not bloated	—	1200	—	—	Sample fired at 1200°C - whole sample disintegrated on standing in air	Rejected	
A211/70	CE 3809	Adelaide	922	Eagle Quarry: Crafers	Just starting to bloat	Poorly bloated and starting to flow	1200 - 1280	80	1250	Good sample: long range	Accepted	Recommended for detailed testing - A1099 - 1105/70*, and pilot production run A44/71†
A212/70	CE 3810	Adelaide	922	Eagle Quarry: Crafers	Just starting to bloat	Poorly bloated and starting to flow	1200 - 1280	80	1250	Good sample: long range	Accepted	Recommended for detailed testing - A1099 - 1105/70*, and pilot production run A44/71†
A213/70	CE 3811	Adelaide	1172	Mount Lofty Quarry: (Gilburn Brick Co. Ltd)	Just starting to bloat	—	1210 - 1240	30	1220 - 1230	Good sample: short range	Accepted	Recommended for detailed testing - A1114 - 1118/70*
A214/70	CE 3812	Noarlunga	782, 785	Cherry Gardens Quarry	Bloated - good product	Bloated	1120 - 1220	100	1170	Excellent sample: long range but required thorough drying and preheating	Accepted	Recommended for pilot production run - A47/71†
A215/70	CE 3813	Noarlunga	782, 785	Cherry Gardens Quarry	Not bloated	Not bloated					Rejected	
A216/70	CE 3814	Noarlunga	782, 785	Cherry Gardens Quarry	Not bloated	Not bloated					Rejected	
A217/70	CE 3815	Noarlunga	782, 785	Cherry Gardens Quarry	Not bloated	Not bloated					Rejected	
A218/70	CE 3816	Noarlunga	215	Linwood Quarry: Marion	Some specimens bloated - mixed sample	—	1160 - 1200	40	1180	Mixed sample: starting to flow at 1200°C	Rejected	
A219/70	CE 3817	Noarlunga	215	Linwood Quarry: Marion	Some specimens bloated - mixed sample	—	1160 - 1200	40	1180	Mixed sample: some material not bloated at 1160°C, some over bloated at 1200°C	Rejected	
A220/70	CE 3818	Noarlunga	215	Linwood Quarry: Marion	Just starting to bloat	Little change from 1200°C firing: poor product and fusing	1260 - 1280	20	—	Starting to bloat at 1260°C: melting at 1280°C	Rejected	
A221/70	CE 3819	Noarlunga	215	Linwood Quarry: Marion	Some specimens bloated or disintegrated - mixed sample	—	1170 - 1200	30	—	Mixed: some specimens disintegrated on standing in air	Rejected	
A222/70	CE 3820	Noarlunga	215	Linwood Quarry: Marion	Some specimens bloated or disintegrated - mixed sample	—	1160 - 1190	30	—	Mixed: some specimens disintegrated on standing in air	Rejected	
A223/70	CE 3821	Yatala	5459	George Dentons Quarry: Golden Grove	Not bloated	Not bloated					Rejected	
A224/70	CE 3822	Yatala	5459	George Dentons Quarry: Golden Grove	Not bloated	Not bloated					Rejected	
A225/70	CE 3823	Yatala	5466	Dreckows Pit, Golden Grove	Not bloated	Not bloated					Rejected	
A226/70	CE 3824	Clare	178, 307	Mintaro Slate Works: Mintaro	Very well bloated	—	1140 - 1180	40	1160	Reasonable sample - good product	Accepted	Recommended for pilot production run - A48/71†
A227/70	CE 3825	Jellicoe	401	S.A. Portland Cement Quarry: Truro	Not bloated	Not bloated					Rejected	
A228/70	CE 3826	Nuriootpa	3	Abandoned Shale Quarry: Gawler	Just starting to bloat	Bloated	1230 - 1270	40	1250	Not well bloated: sticking at 1250°C	Rejected	
A229/70	CE 3827	Adelaide	849	Gilburn Brick Works: Magill Road	Starting to bloat	Bloated	1210 - 1260	50	1230	Reasonable product and fair range	Accepted	Recommended for detailed testing - A1106 - 1109/70*, and pilot production run A46/71†
A230/70	CE 3828	Yatala	514	Ansteys Hill Clay Pit	Not bloated	Not bloated					Rejected	
A231/70	CE 3829	Yatala	5512	Shale Workings: 1½ km. north of Ansteys Hill	Not bloated	Not bloated					Rejected	
A232/70	CE 3830	Yatala	5633, 5634	Quarry Industries Plant N°9: Tea Tree Gully	Just starting to bloat	Poorly bloated and starting to flow	1220 - 1250	30	1230	Starting to flow at 1250°C: not well bloated	Rejected	
A233/70	CE 3831	Yatala	5633, 5634	Quarry Industries Plant N°9: Tea Tree Gully	Just starting to bloat	Poorly bloated and starting to flow	1250 - 1270	20	—	Starting to flow at 1250°C: melting at 1280°C	Rejected	
A234/70	CE 3832	Yatala	5449	Poltons Pit: One Tree Hill	Not bloated	Not bloated					Rejected	
A235/70	CE 3833	Munno Para	3262	One Tree Hill Clay Pit (Abandoned)	Not bloated	Not bloated					Rejected	
A236/70	CE 3834	Munno Para	1646	Roadside cutting near Para Wirra National Park	Just starting to bloat	Bloated	1220 - 1300	80	1260	Reasonable product: long range: tending to stick a little	Accepted	Rejected due to closeness to Para Wirra National Park
A237/70	CE 3835	Munno Para	5276, 3263A	Quarry Industries Plant N°7: Salisbury	Just starting to bloat	Poorly bloated and starting to flow	1220 - 1290	40		Not a good bloated product	Rejected	
A238/70	CE 3836	Willunga	1008	Willunga Slate Quarry: Willunga	Well bloated	—	1150 - 1180	30	1170	Reasonable appearance but lacking in strength	Rejected	
A247/70	CE 3846		—	Tregolana Pit: 10 miles north of Whyalla	Not bloated	Not bloated					Rejected	
A248/70	CE 3847	Moorooroo	284	Roadside cutting: Maculta Township	Not bloated	Not bloated					Rejected	
A249/70	CE 3848	Nuriootpa	682	Copper - Clay - Talc Prospect Quarry	Not bloated	Not bloated					Rejected	
A1110/70	CE 3891	Noarlunga	215	Linwood Quarry: Marion		Not bloated, mixed, white fraction very refactory					Rejected	
A1111/70	CE 3892	Noarlunga	215	Linwood Quarry: Marion		Mixed sample, some just bloated, could take higher temp.					Rejected	
A1112/70	CE 3893	Noarlunga	196	Roadside cutting: West O'Halloran Hill		Bloated, good texture, strong, lightly adhering					Accepted	Not recommended for further testing. Tapley Hill shale (see text)
A1113/70	CE 3894	Noarlunga	190	Roadside cutting: East O'Halloran Hill		Over bloated, large cells, squatting, adhering					Rejected	
A151/71	CE 3940	Adelaide	1050A, 1057, 905	Stonyfell Quarry (Quarry Industries)		Poorly bloated, glassified, flowing, adhering					Rejected	
A152/71	CE 3941	Adelaide	1050A, 1057, 905	Stonyfell Quarry (Quarry Industries)		Poorly bloated, glassified, flowing, adhering					Rejected	
A153/71	CE 3942	Adelaide	1050A, 1057, 905	Stonyfell Quarry (Quarry Industries)		Poorly bloated, glassified, flowing, adhering					Rejected	

TABLE I

* Detailed testing sample numbers - see TABLE II

† Bulk sample numbers - for pilot production run - see TABLE III

DEPARTMENT OF MINES - SOUTH AUSTRALIA

Compiled: D. Nichol | Drn. T.S. | Ckd. R.N.

LIGHTWEIGHT AGGREGATE PROJECT
COUNTY ADELAIDE
RESULTS OF PRELIMINARY TRIALS

Date: 10 May 1972.

Drg. No. 72-263 Ha

DEPT. SAMPLE NUMBER	LAB. SAMPLE NUMBER	LOCALITY INFORMATION			FLASH FIRING AT 1250°C FOR 15 MINUTES	REJECTED or ACCEPTED	RECOMMENDATION
		HUNDRED	SECTION	OTHER			
A1099/70	CE 3880	Adelaide	922	Eagle Quarry : Crafers	Bloated, lightly adhering, strong, good texture, good product	Accepted	Recommended for pilot production run A44/71†
A1100/70	CE 3881	Adelaide	922	Eagle Quarry : Crafers	Bloated, lightly adhering, strong, good texture, good product	Accepted	Recommended for pilot production run A44/71†
A1101/70	CE 3882	Adelaide	922	Eagle Quarry : Crafers	Bloated, lightly adhering, fairly good product	Rejected	—
A1102/70	CE 3883	Adelaide	922	Eagle Quarry : Crafers	Bloated, lightly adhering, fairly good product	Rejected	—
A1103/70	CE 3884	Adelaide	922	Eagle Quarry : Crafers	Bloated, lightly adhering, very fine texture, fair product	Rejected	—
A1104/70	CE 3885	Adelaide	922	Eagle Quarry : Crafers	Completely fused, glassified, flowing	Rejected	—
A1105/70	CE 3886	Adelaide	922	Eagle Quarry : Crafers	Not bloated	Rejected	—
A1106/70	CE 3887	Adelaide	849	Gilburn Brick Works : Magill Rd.	Bloated, good texture, good product	Accepted	Recommended for pilot production run A46/71†
A1107/70	CE 3888	Adelaide	849	Gilburn Brick Works : Magill Rd.	Bloated, very fine texture, strong, good product, lightly adhering	Accepted	Recommended for pilot production run A46/71†
A1108/70	CE 3889	Adelaide	849	Gilburn Brick Works : Magill Rd.	Bloated, good texture, strong, good product, lightly adhering	Accepted	Recommended for pilot production run A46/71†
A1109/70	CE 3890	Adelaide	849	Gilburn Brick Works : Magill Rd	Bloated, fine texture, good product	Accepted	Recommended for pilot production run A46/71†
A1114/70	CE 3895	Adelaide	1172	Mount Lofty Quarry : (Gilburn Brick Co. Ltd.)	Mixed sample, some just bloated, could take higher temp.	Accepted	—
A1115/70	CE 3896	Adelaide	1172	Mount Lofty Quarry : (Gilburn Brick Co. Ltd.)	Bloating, just starting to bloat	Accepted	—
A1116/70	CE 3897	Adelaide	1172	Mount Lofty Quarry : (Gilburn Brick Co. Ltd.)	Not bloated	Rejected	—
A1117/70	CE 3898	Adelaide	1172	Mount Lofty Quarry : (Gilburn Brick Co. Ltd.)	Not bloated	Rejected	—
A1118/70	CE 3899	Adelaide	1172	Mount Lofty Quarry : (Gilburn Brick Co. Ltd.)	Mixed sample, some just bloated, could take higher temp.	Rejected	—

† Bulk sample number for pilot production run; see TABLE III

TABLE II

DEPARTMENT OF MINES – SOUTH AUSTRALIA

Compiled: D. Nichol

Drn. T.S. | Ckd. R.H.

LIGHTWEIGHT AGGREGATE PROJECT
COUNTY ADELAIDE
RESULTS OF SECONDARY TRIALS

Scale:

Date: 11 May 1972

Drg. No. 72-264 Ha

IM–2.70 A1811

DEPT. SAMPLE NUMBER	LAB. SAMPLE NUMBER	LOCALITY INFORMATION			SIZE FRACTION (inch)	TEMP (°C)	BULK DENSITY (gcm^{-3})	REMARKS
		HUNDRED	SECTION	OTHER				
A44/71	CE 3809	Adelaide	922	Eagle Quarry : Crafers	-1/2 to +3/8	1250 - 1270	1·17	Sand injection, good product
					-3/8 to +5/16	1270 - 1280	1·09	Sand injection, good product
A47/71	CE 3812	Noarlunga	782, 785	Cherry Gardens Quarry	-1/4 to +5/8	1160 - 1200	1·02	Excellent product
A48/71	CE 3824	Clare	178, 307	Mintaro Slate Works : Mintaro	-1/2 to +3/8	1230 - 1240	1·09	Sand injection, very good product
					-3/8 to +5/16	1260 - 1270	1·08	Sand injection, very good product
A46/71	CE 3827	Adelaide	849	Gilburn Brick Works : Magill Rd.	-1/2 to +3/8	1280 - 1300	1·24	Sand injection, good product
					-3/8 to +5/16	1190 - 1200	1·19	Sand injection, good product

TABLE III

DEPARTMENT OF MINES — SOUTH AUSTRALIA

Compiled: D. Nichol

Drn. T.S. | Ckd. R.N.

LIGHTWEIGHT AGGREGATE PROJECT
COUNTY ADELAIDE
RESULTS OF TERTIARY TRIALS

Scale:

Date: 12 May 1972

Drg. No. 72-265 Ha

IM-2.10 A1R11

DEPT. SAMPLE NUMBER	LOCALITY INFORMATION			COMMENTS	REFERENCE
	HUNDRED	SECTION	OTHER		
A1443/60	Yatala	2106	5 km. S.E. of Salisbury	bloated	
A1049/61	Noarlunga	79	Noarlunga	well bloated	Olliver (1961). Madigan (1965, 1966)
A1113/61	Port Adelaide	1012	Wingfield, Little Para area	well bloated	Olliver (1961)
A3455/61	Yatala	104	Grange	bloated	Madigan (1962, 1963)
A3458/61	Port Adelaide	3070	Wingfield, Little Para area	bloated	Madigan (1962, 1963)
A2028/67	Hallett	489	Railway cutting	poorly bloated	———
A2285/67	———	———	1 km. west of Pandurra H.S.	poorly bloated	———
A818/68	Paringa	232	Bank of River Murray	bloated	Clay Register Serial N° 582
A819/68	Murtho	17	Cliff face on River Murray	bloated	Clay Register Serial N° 583
A821/68	———	———	County Hamley: shore of Lake Werta West	severely bloated	Clay Register Serial N° 585
A1075/68	Blyth	468	Railway reserve	well bloated	———
A586/69	Milne	3000, 3001	Roadside cutting between two sections	severely bloated	———
P115/70	Yatala	845	Christies Sand Pty. Ltd. Sample from settling pit	bloated	Jones (1971)
P120/70	Willunga	403	Snapper Point: sea cliff in recreation reserve	bloated	Jones (1971)
A198/71	Ramsay	95, 96	Surveyor Point: Yorke Peninsula	well bloated	Nichol (1971)
A264/71	Willunga	381	Cliff face at Blanche Point	well bloated	Clay Register Serial N° 621
A266/71	———	———	Anabama Hill, bore A.R.40, 20'-37'	bloated	Clay Register Serial No 623

TABLE XI

	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale:
Compiled: D. Nichol	LIGHTWEIGHT AGGREGATE PROJECT BLOATING CLAYS AND SHALES IN SOUTH AUSTRALIA	Date: 17 May 1972
Drn. T.S. Ckd. D.N.		Drg. No. 72-266 994·2

1M–2.70 A1811