DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT.BK.NO. 83/90
LOW ALKALI SHALE INVESTIGATION
RAPID BAY - DELAMERE AREA.
RESULTS OF AUGER DRILLING 1983.
-Adelaide Brighton Cement Ltd. -

GEOLOGICAL SURVEY

by

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DEPARTMENT OF MINES AND ENERGY
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LOW ALKALI SHALE INVESTIGATION RAPID BAY - DELAMERE AREA RESULTS OF AUGER DRILLING 1983. - ADELAIDE BRIGHTON CEMENT LTD. -

ABSTRACT

During January to March 1983, an area within 10 km radius of Rapid Bay limestone quarry, 80 km south-southwest of Adelaide, was investigated for low alkali argillaceous rock suitable for use in the manufacture of low alkali cement clinker.

Geology comprises folded sandstone, siltstone, limestone and greywacke of late Proterozoic to Cambrian age in places overlain by thin cover of fluvio glacial sediments of Permian age or ironstone gravel of Tertiary age.

Reconnaissance sampling followed by 30 auger holes drilled on the verges of public roads have outlined areas of weathered silty shale and greywacke meeting low alkali specifications.

It is recommended that an exploration licence be taken out over prospective areas. Further drilling is required to prove a site suitable for mining.

INTRODUCTION

In September 1981, Adelaide Brighton Cement Ltd. (ABC Ltd.) sought assistance in locating a source of low alkali shale suitable for manufacture of low alkali cement clinker.

A deposit within 10 km of Rapid Bay limestone quarry was required with total alkali content less than 1.5 per cent.

Investigations were integrated with mapping at Rapid Bay quarry commencing in early 1983.

On 5 and 6 January 1983, 13 clay samples were collected from road cuttings and dam excavations during a reconnaissance survey with A.J. Smith (Field Assistant) and J. Cawley (Student Geologist).

An area of potential low alkali shale was outlined and during February to March 1983, 30 auger holes were drilled on the verges of public roads using a Diahatsu-mounted auger rig operated by B.W. Atterton (Field Assistant) and A.J. Smith.

LOCATION AND ACCESS

Rapid Bay is located on the eastern shore of Gulf Saint Vincent, 80 km south-southwest of Adelaide (Fig. 1).

The area of interest is within 10 km radius of Rapid Bay quarry (see Figs. 1 & 2) covering approximately 150 sq. km in hundreds Yankalilla and Waitpinga, County Hindmarsh in the District Council of Yankalilla, part of the Outer Metropolitan Planning Area.

Access from Adelaide is via sealed highway to Cape Jervis. Within the area of investigation, access varies from a few minor tracks west of the highway to graded roads and forest tracks providing good access southeast of the highway.

TOPOGRAPHY AND LAND USE

The area divides into two distinct environmental associations (Laut et. al., 1977).

East of the highway, shown as predominantly undifferentiated sediments in Figure 2, is undulating to hilly dissected plateau comprising mottled lateritic soil with ironstone gravel. Land is used primarily for either forest plantation or grazing with well maintained grazing blocks bounded by long straight pine windbreaks interspersed with areas of remnant stringybark forest.

Towards the coast, the land is more deeply dissected exposing rocky outcrops beneath shallow soils and terminating in steep cliffs along the coastline. The land has been extensively cleared for sheep and cattle grazing and sheet erosion and local gullying are common.

Mean annual rainfall varies from 550 to 900 mm.

Small community centres are established at Cape Jervis, Delamere, Rapid Bay and Second Valley.

SPECIFICATIONS

ABC Ltd. require low alkali argillaceous rock which meets the chemical specifications in Table 1.

Table 1: Chemical specifications

	Ideal	Widest Limits
Na_2O	<0.4%	1% maximum
K_2O	<1.5%	2.2% maximum
MgO	<2%	5% maximum
CaO	<5%	30% maximum
Cl	as low as possible	0.2% maximum
SO_3	<0.5%	1% maximum
$\frac{SiO_2}{Al_2O_3 + Fe_2O_3}$	2.5-3.0	1.5-4.0
$\frac{Al_2O_3}{Fe_2O_3}$	0.5-1.2	0.5-4.0
$Na_2O + 0.658\ K_2O$	<1.1%	1.5% maximum if mostly K_2O

Cartage costs restrict economic deposits to within 10 km of Rapid Bay loading facilities.

On advice of ABC Ltd., distance from Rapid Bay also determines the percentage of CaO which can be tolerated. Low alkali rock with higher than 5 per cent CaO must be located closer than 10 km.

Handling properties are important and ideally rock should be compatible with crushing, screening and loading equipment in use at Rapid Bay quarry.

The low alkali rock is to be used in manufacture of low alkali cement clinker at Birkenhead Cement Works. High cost of sea transportation is to some extent offset by excess carrying capacity on Accolade II.

Low alkali cement clinker is produced currently at Birkenhead using weathered shale from Baker Gully south of Clarendon (Keeling 1983) and at Angaston Cement Works using shale from a quarry near Moculta.

REGIONAL GEOLOGY

Published geological maps of the area include BARKER (Thomson and Horwitz, 1962) and Jervis (Campana and Wilson, 1954).

Since 1962, the stratigraphy has been revised by Daily (1963), Daily and Milnes (1972 and 1973), Mancktelow (1979) and Priess (1982). Stratigraphic table and regional geology (Fig. 2) are based largely on Mancktelow (1979).

Gneiss and schist of Archean to early Proterozoic age crop out south of Normanville as basement inliers overlain by weakly metamorphosed rocks of late Proterozoic to early Cambrian age. These are folded about northeasterly - southwesterly trending axes.

The older rocks are in part covered by a veneer of younger sediments including fluvio-glacial clay, silt and fine sand of Permian age, residual ironstone gravel and ferruginous sand of Tertiary age and outwashed clayey gravel and soil of Holocene age.

Deep weathering during pre Cainozoic or early Tertiary times resulted in mineralogical changes and altered chemical composition of older rocks. Much of this weathered profile has been removed by subsequent erosion but remnants are preserved below thin Tertiary cover (see Fig. 2).

Of particular interest to this investigation are weathered argillaceous rocks of Brachina Formation and greywacke of Cambrian age, in particular Carrickalinga Head Formation, Backstairs Passage Formation and Tapanappa Formation (greywacke facies).

Descriptions of relatively fresh outcrops, summarised below from Mancktelow (1979) show high feldspar content contributing to the relatively high clay content in weathered equivalents of these formations.

Brachina Formation - predominantly well laminated, grey siltstone with interbedded feldspathic sandstone, quartzite and silty shale.

Carrickalinga Head Formation - in type section, this unit is dominantly massive, medium grained, grey to dark grey, feldspathic greywacke 1 to 2 m thick interbedded with siltstone or phyllite up to 0.5 m thick. The upper part is silty with minor limestone beds.

Backstairs Passage Formation - predominantly light coloured, well laminated arkose beds 0.15 m to 2 m thick separated by thin well laminated, grey siltstone or phyllite. Greywacke beds are common near the top of the formation.

Tapanappa Formation (greywacke facies) - a repetitious sequence comprising coarse basal greywacke overlain by finer grained greywacke grading into siltstone. Dominant lithology is grey, medium grained greywacke.

RECONNAISSANCE SAMPLING

On 5 and 6 January 1983, 13 samples of moderately to highly weathered argillaceous rock were collected from road cuttings and dam excavations.

Approximately 3 kg of sample from each site was submitted to Australian Mineral Development Laboratories (AMDEL) for silicate analyses by atomic emission spectroscopy.

Sample locations are shown on Figure 2 and results of analyses are summarised in Table 2 from the full report in Appendix B.

None of the samples met ideal chemical specifications, but RBS 6 was within widest limits.

Samples RBS 6 to RBS 9 and RBS 13 were relatively low in total alkalis, considerably lower than RBS 1 to RBS 4 and RBS 12.

The results of reconnaissance survey suggested:-

- Only highly weathered argillaceous rocks would meet low alkali specifications, although these were generally low in iron.
- Highly weathered profiles were restricted to the plateau area east and south of Delamere township, generally above RL 300.

Table 2: Reconnaissance samples - chemical analyses

SAMPLE No.	RBS1	RBS2	RBS3	RBS4	RBS5	RBS6	RBS7	RBS8	RBS9	RBS10	RBS11	RBS12	RBS13
ASSAY No.	A17/83	A18/83	A19/83	A20/83	A21/83	A22/83	A23/83	A24/83	A25/83	A26/83	A27/83	A28/83	A29/83
*Type of sample	A/H (2.1m)	RC-CS (90m)	RC-CS (35m)	RC-CS (33m)	RC-CS (20m)	RC-CS (38m)	DE-SS (3m)	DE-SS (2m)	DE-SS (2m)	DE-SS (4m)	RC-CS (47m)	RC-CS (4m)	RC-CS (42m)
+Stratigraphy	ADE. Shale	ADE. Shale	ADE. Shale	ADE. Shale	ADE. Shale	ADE. Shale	CAM. G/wke	CAM. G/wke	CAM. G/wke	CAM. G/wke	CAM. G/wke	PER. Clay	CAM. G/wacke
Na_2O(%)	0.74	1.01	0.97	1.40	0.37	0.15	0.16	0.09	0.07	0.23	0.31	0.16	0.10
K_2O (%)	5.33	4.98	3.46	3.16	1.78	1.57	1.49	1.84	0.98	2.02	1.83	2.92	1.36
MgO (%)	3.89	3.41	3.08	3.16	0.33	0.29	0.27	0.34	0.21	0.23	0.30	0.77	0.27
CaO (%)	0.24	0.34	0.39	0.87	0.12	0.32	0.06	0.05	0.04	0.03	0.13	0.33	0.04
$\frac{SiO_2}{Al_2O_3 + Fe_2O_3}$	2.45	2.93	2.16	2.21	2.35	2.58	2.33	3.26	3.16	2.24	1.71	3.09	2.38
$\frac{Al_2O_3}{Fe_2O_3}$	2.14	2.27	2.06	1.92	5.95	3.06	7.09	8.86	8.26	2.80	1.39	19.9	7.75
$Na_2O + 0.658\ K_2O$	4.25	4.29	3.25	3.48	1.54	1.18	1.14	1.30	0.71	1.56	1.51	2.08	0.99

*Type of sample - A/H (2.1 m) - auger hole and depth, RC-CS (90 m) - road cutting, chip sample and width, DE-SS (3m) - dam excavation, selected sample and depth of dam excavation.

+Stratigraphy - ADE - Adelaidean, CAM - Cambrian, PER - Permian.

- Only a relatively small area of Brachina Formation between RBS 5 and RBS 6 was prospective, and Cambrian greywacke and silty shale below thin Tertiary gravel was the prime target.
- Permian clay is highly variable in both distribution and silt content and is unlikely to produce suitable low alkali raw material.
- Almost half the prospective plateau area is State Forest Reserve, exempt land under Section 9(1)(bb) of the Mining Act 1971-1982.

DRILLING

Between 28 February to 10 March 1983, 30 holes (RBA 1 to RBA 30) totalling 378 m were drilled using a Diahatsu-mounted auger fitted with flights 1.5 m long by 60 mm diameter. Sufficient flights were carried to drill 13.5 m.

Holes were drilled on the verges of public roads at 0.5 to 1 km intervals on the plateau area east and south of Delamere township within 10 km radius of Rapid Bay quarry.

Cuttings were logged on site and representative samples for each 1 m of drilling retained and stored at Glenside Core Library.

Drillhole locations are shown on Figure 2 and logs of holes are given in Appendix A.

In order to check change in alkali content with depth, two bulk samples for chemical analyses were taken from each hole. Intervals sampled were selected in the field based on half hole depth modified by any significant colour change or change of rocktype.

Overburden from 0 to 4 m thick comprises soil, sand, rounded gravel and gravelly shale.

Auger drilling in weathered, dry, fine grained rock presented few problems although progress was slow where quartz veins were encountered or fine cuttings jammed the flights.

Average depth penetrated was 12.6 m.

Groundwater was cut at 13 m in RBA 15.

CHEMICAL ANALYSES

Sixty four bulk samples from drilling were analysed by ABC Ltd. Results are given in Appendix B and average analyses for each hole are summarised in Table 3.

Thirteen samples were selected for check analyses at AMDEL and these are shown in Table 3 from full analyses in Appendix B.

In general AMDEL determinations agreed closely with those of ABC Ltd., although AMDEL recorded, an average 0.17 per cent higher total alkalis. The higher K_2O value is supported by detailed analyses of selected drillholes by R. Bourman (Senior Lecturer, S.A. College of Advanced Education), (Appendix B).

The greatest discrepency was in RBA 14, 2-7 m where AMDEL reported 1.62 per cent K_2O compared with ABC's determination of 0.56 per cent.

Chlorine and total sulphur percentages were determined for holes RBA 8 and RBA 14. Results are well below maximum limits given in specifications (see Appendix B).

ASSESSMENT OF RESULTS

Results of chemical analyses are summarised in Table 4.

Eleven drillholes intersected weathered argillaceous rock meeting ideal low alkali specifications. Of these, three are outside the widest limits for alumina/iron ratio and none meet ideal alumina/iron specifications. The addition of small amounts of iron would upgrade most samples to ideal specifications.

A further 14 holes are within the wider limit of 1.5 per cent total alkalis.

The distribution of low alkali rock is dependent on the chemistry of the original rocktype and the degree of weathering during which K_2O is released and leached downwards. Plotting total alkali content against elevation (Fig. 3) confirms a general trend of decreasing alkali content with higher elevation.

Using these data, and assuming

- constant depth of weathering
- subdued topography during time of weathering,

prospective areas with high potential for more than 10 m thickness of low alkali shale have been defined. These areas of

Table 3 :
DRILLHOLE SAMPLES - CHEMICAL ANALYSES

HOLE	RBA1	RBA2	RBA3	RBA4	RBA5	RBA6	RBA7	RBA8	RBA9	RBA10	RBA11
ELEVATION	315	330	330	330	335	342	335	345	350	342	340
SAMPLE INTERVAL(m)	2-9	2-13	0-10	3-12	2-13	3-13.5	2-13.5	3-12	2-13.5	2-12.5	2-13.5
Na_2O(%)	0.12	0.06 (0.7) [0.12]	0.10	0.10	0.10 (0.08)	0.07	0.52	0.11 (0.08)	0.12 [0.13]	0.26	0.14 (0.15) [0.17]
K_2O (%)	1.62	1.21 (1.40) [1.54]	1.01	1.53	1.54 (1.79)	1.44	2.49	1.38 (1.46)	1.23 [1.47]	1.86	1.31 (1.54) [1.62]
MgO (%)	0.4	0.2 (0.2) [0.3]	0.3	0.3	0.7 (0.8)	0.6	1.5	0.6 (0.6)	0.2 [0.2]	0.3	0.3 (0.3) [0.03]
CaO (%)	0.2	0.1 (0.02) [0.04]	0.2	0.2	0.1 (0.08)	0.2	0.3	0.9 (0.02)	0.2 [0.05]	0.02	0.02 (0.04) [0.11]
$\frac{SiO_2}{*R_2O_3}$	3.4	2.6 (2.3) [2.6]	2.2	2.7	3.5 (3.4)	2.9	2.8	2.9 (2.9)	2.6 [3.0]	2.0	2.7 (2.4) [2.5]
$\frac{Al_2O_3}{Fe_2O_3}$	2.7	2.9 (2.6) [2.9]	3.3	3.6	3.9 (4.0)	3.0	2.1	3.4 (3.3)	11.7 [16.0]	3.0	3.3 (3.1) [3.2]
Na_2O + 0.658 K_2O	1.19	0.86 (0.99) [1.13]	0.76	1.11	1.11 (1.26)	1.02	2.16	1.02 (1.04)	0.93 [1.09]	1.48	1.00 (1.16) [1.26]

Note - results in '( )' brackets are for check samples analysed at AMDEL and in '[ ]' brackets are calculated from results by R. Bourman.

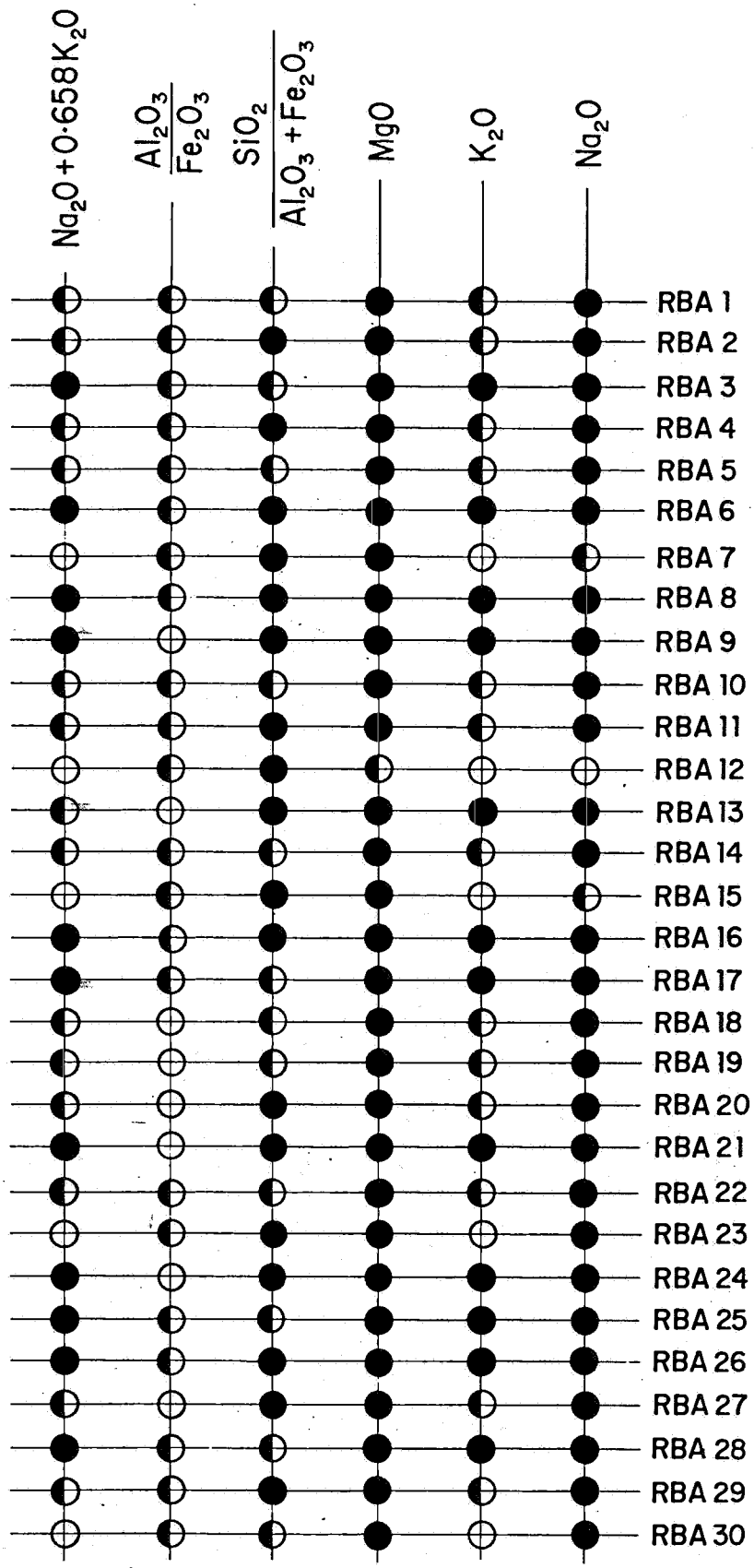
* $R_2O_3 = Al_2O_3 + Fe_2O_3$

Table 3 :
DRILLHOLE SAMPLES - CHEMICAL ANALYSES

HOLE	RBA12	RBA13	RBA14	RBA15	RBA16	RBA17	RBA18	RBA19	RBA20	RBA21	RBA22	RBA23	RBA24
ELEVATION	300	342	348	312	323	328	318	325	330	323	280	300	325
SAMPLE INTERVAL (m)	0-10	2-13.5	2-13.5	2-13.5	2-13.5	2-13.5	2-8.5	2-13.5	4-12	2-13.5	2-13.5	0-13.5	2-13.5
Na_2O (%)	1.29	0.19	0.11 (0.11) [0.20]	0.44	0.05	0.10	0.27	0.24	0.14 [0.14]	0.05	0.22	0.16	0.04 (0.05)
K_2O (%)	3.32	1.38	0.77 (1.53) [1.57]	2.65	1.24	1.01	1.70	1.50	1.42 [1.64]	1.01	1.88	2.27	0.95 (1.20)
MgO (%)	2.2	0.3	0.2 (0.2) [0.2]	1.9	0.3	0.2	0.3	0.3	0.7 [0.6]	0.2	1.0	1.4	0.2 (0.2)
CaO (%)	0.8	0.2	0.2 (0.1) [0.03]	0.4	0.2	0.1	0.3	0.2	0.1 [0.04]	0.1	0.2	0.2	0.1 (0.01)
$\underline{SiO_2}$	2.7	2.6	2.0 (1.9) [2.0]	2.7	3.0	2.2	2.1	2.4	2.8 [2.8]	3.0	2.3	2.6	2.6 (2.7)
$\underline{Al_2O_3}$ Fe_2O_3	2.8	7.2	2.1 (2.2) [2.4]	2.8	3.4	2.0	5.8	4.9	3.8 [4.2]	5.7	2.3	2.6	4.9 (5.9)
Na_2O + 0.658 K_2O	3.47	1.10	0.62 (1.12) [1.22]	2.18	0.87	0.76	1.39	1.23	1.07 [1.34]	0.71	1.46	1.65	0.67 (0.84)

Table 3 :
DRILLHOLE SAMPLES - CHEMICAL ANALYSES

HOLE	RBA25	RBA26	RBA27	RBA28	RBA29	RBA30
ELEVATION	329	342	322	332	330	322
SAMPLE INTERVAL (m)	0-13.5	2-13.5	2-10	4-12	2-13.5	2-13.5
Na_2O (%)	0.05	0.07	0.1	0.03 (0.03)	0.07 [0.06]	0.16
K_2O (%)	0.56	1.33	1.81	0.76 (0.72)	1.29 [1.63]	2.27
MgO (%)	0.2	0.3	0.7	0.2 (0.2)	0.2 [0.3]	1.2
CaO (%)	0.2	0.2	0.02	0.6 (0.2)	0.2 [0.03]	0.1
$\frac{SiO_2}{}$	3.3	2.9	2.7	3.2 (2.7)	2.3 [2.6]	2.4
$\frac{Al_2O_3}{Fe_2O_3}$	3.7	3.2	4.5	3.7 (2.6)	1.9 [2.2]	2.5
$Na_2O + 0.658\ K_2O$	0.42	0.95	1.29	0.53 (0.50)	0.92 [1.17]	1.65



●_____Within ideal specifications

◐_____Within widest limits

○_____Outside widest limits

NOTE: Where duplicate results are available the highest value for total alkalis has been used.

Table 4

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RAPID BAY – DELAMERE AREA
LOW ALKALI SHALE INVESTIGATION
COMPARISON OF DRILLHOLE ANALYSIS WITH CHEMICAL SPECIFICATIONS

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weathered Adelaidean and Cambrian rocks above 320 m elevation are outlined on Figure 5.

This simplified model is unlikely to apply over the whole area, but will aid in limiting exploration to more prospective areas.

Analyses by R. Bourman enable the distribution of alkalis within the weathered profile to be examined in greater detail.

As shown in Figure 5, alkali content is generally low in the upper few metres of the drillhole followed by a zone enriched in alkalis below which alkali content decreases initially then increases with depth.

Results were consistent with several periods of weathering of varying intensities and development of a zone variably enriched in alkalis. This will need to be considered when proving and developing a deposit.

Overburden comprising soil, ironstone gravel, indurated clayey gravel or sand varies from 0 to 4 m in thickness, averaging 2 m.

Highly weathered clayey siltstone or greywacke would be easily ripped and dug by bulldozer, excavator or elevating scraper but would be sticky when wet. Workings will need to be drained during winter, or annual requirements mined and stockpiled during summer months. Mining method employed should take into account the need to blend weathered rock from zones of high and low alkali content.

Weathered rock will break down on exposure and handling, producing a high proportion of fines which will be difficult to process using comminution plant at Rapid Bay quarry. Oversized lumps of vein quartz and indurated rock might be rejected on site using a mobile screening plant.

Access within the areas outlined in Figure 5 is generally good with graded or bitumen roads nearby for transport to Rapid Bay.

Visual impact of a future quarry site could be reduced by a perimeter pine plantation which would blend with current land development.

SUMMARY AND RECOMMENDATIONS

During January to March 1983, an area of approximately 150 sq km within 10 km radius of Rapid Bay limestone quarry was investigated for low alkali shale at the request of Adelaide Brighton Cement Ltd.

Reconnaissance sampling showed most prospective areas to be south and east of Delamere township where highly weathered argillaceous rocks of Adelaidean and Cambrian age are preserved below soil and thin residual or outwashed ironstone gravel deposits of Tertiary to Holocene age.

Thirty auger holes were drilled on the verges of public roads of which 25 intersected low alkali silty shale or greywacke.

The following further work is recommended:-

- ABC Ltd. acquire an exploration licence covering areas of potential low alkali shale and greywacke as outlined by drilling.
- using results of chemical analyses of drillhole cuttings, select sites for further testing.
- test potential deposits by drilling on a 50 m grid to a depth of 10 to 15 m.

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APPENDIX A

Logs of drillholes

Low alkali shale investigation - logs of drillholes

Drillhole No.	Depth Interval (m)	Description	Sample Interval (m)	Alkali Content (Na_2O + 0.658 K_2O)	Comment
RBA 1	0-1	SOIL, clayey with ironstone gravel, pale brown.			Holocene-colluvium.
	1-6	CLAY, silty with minor quartz veins micaceous, yellow to pale orange.	2-6	1.06	Cambrian-weathered silty shale.
	6-9	CLAY, micaceous, pale brown.	6-9	1.35	
	E.O.H. 9 m	Logged JLK 28.2.83			
RBA 2	0-0.5	GRAVEL, rounded ironstone red brown, slightly clayey.			Tertiary - outwashed gravel.
	0.5-1.5	CLAY, slightly indurated, white to light brown.			Cambrian - highly weathered silty shale.
	1.5-5	CLAY, slightly silty mottled white and pink to pale pink.	2-6	0.85	
	5-13	CLAY, moderately plastic, red brown to pale red purple with white patches.	6-13	0.86	
	E.O.H. 13 m	Logged JLK 28.2.83			
RBA 3	0-1	GRAVEL, ironstone with indurated shale fragments.	0-5	0.35	Tertiary - outwashed gravel.
	1-2	CLAY, partly indurated orange brown.			Cambrian - highly weathered shale or greywacke.

RBA 3 cont.	2-5	CLAY, red and white, indurated in part.	5-10	1.17	
	5-10.5	CLAY, slightly silty, very pale orange to 8 m then red brown.			
	E.O.H. 10.5 m	Logged JLK 28.2.83			
RBA 4	0-1	SOIL, clayey ironstone gravel over mottled yellow brown silty clay.			Thin Tertiary gravel on indurated bedrock.
	1-3	CLAY, indurated yellow brown to red.	3-7	0.70	
	3-7	CLAY, white, silty, dry and powdery with bands and pockets of red brown clay.	7-12	1.44	Cambrian - highly weathered greywacke.
	7-12	CLAY, silty, micaceous, yellow brown to red brown.			
	E.O.H. 12.0 m	Logged JLK 1.3.83			
RBA 5	0-2	GRAVEL, ironstone gravel with indurated white and red clay.			Tertiary - outwashed gravel.
	2-5	CLAY, moderately silty, powdery white to orange.	2-6	0.57	Cambrian - highly to moderately weathered greywacke.
	5-11	CLAY, silty, micaceous yellow brown to brown.	6-13	1.42	
	11-13.5	CLAY, micaceous, silty, grey.			
	E.O.H. 13.5 m	Logged JLK 1.3.83			

RBA 6	0-1	GRAVEL, ironstone with slightly indurated yellow brown clay.			Tertiary - outwashed gravel.
	1-3	CLAY, yellow brown to red and white indurated in part.			Cambrian - highly weathered greywacke.
	3-7	CLAY, silty, micaceous white to pale orange.	3-7	0.82	
	7-13.5	CLAY, micaceous red brown to brown-	7-13.5	1.15	
	E.O.H. 13.5 m	Logged JLK 1.3.83			
RBA 7	0-1	SOIL, clayey, minor ironstone gravel.			Holocene - colluvium
	1-2	GRAVEL, ironstone with clay yellow brown to white.			
	2-5	CLAY, micaceous, red and white to yellow brown.	2-5	0.87	Cambrian - highly to moderately greywacke.
	5-13.5	CLAY, silty, micaceous, light brown.	5-13.5	2.62	
	E.O.H. 13.5 m	Logged JLK 1.3.83			
RBA 8	0-1	SOIL, orange brown with iron rich patches.			
	1-4	CLAY, red brown and white slightly plastic, silty.			Cambrian - indurated capping over highly weathered silty shale.
	4-7	CLAY, white, powdery.	3-7	0.67	
	7-9	CLAY, light brown, silty.	7-12	1.30	

RBA 8 Cont.	9-12	CLAY, light brown to pale yellow silty non-plastic.			
	E.O.H. 12.0 m	Logged JLK 2.3.83			
RBA 9	0-2	SOIL, orange to red brown partly indurated.			
	2-3	CLAY, red brown to white.	2-3	0.40	
	3-12	CLAY, white to pale brown sligthly silty, non plastic.	3-13.5	0.98	Cambrian - highly weathered silty shale.
	12-13.5	CLAY, purple.			
	E.O.H. 13.5 m	Logged JLK 2.3.83			
RBA10	0-1	SOIL, clayey red brown with minor ironstone gravel.			Tertiary-residual deposits.
	1-3	CLAY, red brown and white with indurated iron rich patches.			
	3-8	CLAY, pale grey to pale red, 5 cm thick quartz vein at 8 m.	2-8	1.53	Cambrian - highly eathered silty shale.
	8-12.5	CLAY, red brown, micaceous minor quartz veins.	8-12.5	1.45	
	E.O.H. 12.5 m	Logged JLK 2.3.83.			
RBA11	0-2	CLAY, white and yellow brown with indurated patches.			Adelaidean? - highly weathered shale.
	2-6	CLAY, white and red brown.	2-6	0.98	

RBA11 Cont.	6-13.5	CLAY, silty red brown	6-13.5	1.01	
	E.O.H. 13.5 m	Logged JLK 2.3.83			
RBA12	0-10	CLAY, yellow to grey, micaceous, silty. Hard drilling below 9 m.	0-5	3.64	Adelaidean? - weathered shale.
			5-10	3.30	
	E.O.H. 10 m	Logged JLK 2.3.83			
RBA13	0-1	CLAY, yellow brown with ironstone gravel.			Holocene - colluvium.
	1-5	CLAY, slightly silty, slightly plastic, red brown mottled white.	2-4	0.29	Cambrian - weathered shale.
	5-11	CLAY, white to pale pink slightly plastic, minor silt.	4-9	1.1	
	11-13.5	CLAY, yellow to yellow brown sticky.	9-13.5	1.44	
	E.O.H. 13.5 m	Logged JLK 4.3.83			
RBA14	0-2	SOIL, yellow brown mottled clay over red and black ironstone gravel in mottled red and white clay.			Tertiary - residual deposits.
	2-9	CLAY, slightly plastic, mottled red and white with few iron indurated patches and quartz veins.	2-7	0.55	Cambrian - weathered shale.
	9-13.5	CLAY, red brown moderately plastic.	7-13.5	0.67	
	E.O.H. 13.5 m	Logged JLK 4.3.83.			
RBA15	0-1	CLAY, orange brown with minor ironstone gravel and quartz.			Holocene - colluvium.
	1-3	CLAY, micaceous, brown.	2-6	1.98	Cambrian - moderately weathered

RBA15 Cont.	3-13.5	CLAY, micaceous, grey to brown with thin quartz veins. (Water cut 13.0 m).	6-13.5	2.30	greywacke.
	E.O.H. 13.5 m	Logged JLK 4.3.83.			
RBA16	0-1	SOIL, yellow brown with ironstone gravel.			Holocene - colluvium.
	1-3	CLAY, yellow brown to red brown and white, quartz between 2-3 m.	2-9	0.96	Cambrian - highly weathered greywacke.
RBA16 cont.	3-9	CLAY, mottled red brown, purple and white. Some indurate iron patches	9-13.5	0.73	
	9-13.5	CLAY, yellow brown to brown, slightly silty.			
	E.O.H. 13.5 m	Logged JLK 7.3.83			
RBA17	0-2	CLAY, yellow brown to red brown with ironstone gravel and iron indurated bands.			Tertiary - residual deposits.
	2-7	CLAY, mottled red and white slightly silty, indurated in upper section.	2-7	0.66	Cambrian - highly weathered silty shale.
	7-10	CLAY, orange to yellow brown with red brown patches, slightly silty.	7-13.5	0.85	
	10-13.5	CLAY, red brown.			
	E.O.H. 13.5 m	Logged JLK 7.3.83			
RBA18	0-2	CLAY, red brown to yellow brown with strongly cemented ironstone patches and minor gravel.			Tertiary - residual deposits.

RBA18 Cont.	2-5	CLAY, pale pink to pale brown with white patches.	2-5	1.49	Cambrian - moderately weathered shale.
	5-8.5	CLAY, pale brown, quartz veins at 8 m.	5-8.5	1.30	
	E.O.H. 8.5 m	Logged JLK 7.3.83			
RBA19	0-1	SOIL, yellow brown to red brown, partly indurated by iron.			Tertiary - residual deposits.
	1-4	CLAY, slightly silty, slightly plastic red brown to pale brown.	2-5	0.28	Cambrian - highly weathered silty shale.
	4-9	CLAY, white to pale brown becoming yellow below 8 m.	5-9	1.60	
	9-12	CLAY, red brown.	9-13.5	1.53	
	12-13.5	CLAY, orange			
	E.O.H. 13.5 m	Logged JLK 7.3.83			
RBA20	0-2	CLAY, slightly SANDY yellow to orange indurated in part.	2-4	0.06	Tertiary - clayey sand.
	2-3.7	SAND, very fine to medium grained slightly clayey, orange.			
	3.7-6	CLAY, white to pale pink moderately plastic.	4-7	0.94	Cambrian - highly weathered greywacke.
	6-7	CLAY, as above, purple.			
	7-12	CLAY, slightly silty, yellow brown to green yellow.	7-12	1.16	
	E.O.H. 12.0 m	Logged JLK 7.3.83			

RBA21	0-1	SOIL, red brown slightly sandy clay with ironstone gravel.			Holocene - colluvium.
	1-2	CLAY, red brown and white with iron indurated patches.	2-6	0.56	Cambrian - highly weathered greywacke.
	2-6	CLAY, pink to pale red, mottled.			
	6-11	CLAY, silty, yellow brown to pale brown.	6-13.5	0.81	
	11-13.5	CLAY, red brown to red.			
	E.O.H. 13.5 m	Logged JLK 8.3.83			
RBA22	0-0.3	SOIL, dark brown,organic.			
	0.3-2.0	CLAY, orange brown, slightly plastic.			
	2-4	CLAY, red to orange slightly plastic, mottled grey and yellow brown.	2-4	0.75	Cambrian - highly moderately weathered greywacke.
	4-13.5	CLAY, slightly silty, non plastic yellow brown to greenish yellow.	4-13.5	1.61	
	E.O.H. 13.5 m	Logged JLK 8.3.83.			
RBA23	0-4	CLAY, slightly silty non plastic, pale orange.			
	4-8	CLAY, slightly silty, micaceous pale yellow - orange to yellow green.	0-6 6-13.5	1.53 1.76	Cambrian - moderately weathered greywacke.
	8-13.5	CLAY, micaceous, yellow green.			
	E.O.H. 13.5 m	Logged JLK 8.3.83			

RBA24	0-1	SOIL, clay, yellow brown with ironstone gravel.			Holocene - colluvium.
	1-2	CLAY, pink to brown partly indurated.			Cambrian - highly weathered greywacke.
	2-11	CLAY, pink to pale red, micaceous, slightly silty, non plastic, white patches.	2-6	0.64	
	11-13.5	CLAY, pink to brown, silty, micaceous.	6-13.5	0.69	
	E.O.H. 13.5	Logged JLK 8.3.83			
RBA25	0-2	CLAY, slightly sandy, orange to red, indurated in part.	0-3	0.18	Cambrian - highly weathered greywacke.
	2-3	CLAY, slightly silty brown and white.			
	3-5	CLAY, pale orange to pale pink.	3-7	0.35	
	5-6	CLAY, white, slightly silty.			
	6-12	CLAY, slightly silty, slightly plastic red brown to brown.	7-13.5	0.57	
	12-13.5	CLAY, yellow green.			
	E.O.H. 13.5 m	Logged JLK 8.3.83			
RBA26	0-1	CLAY, yellow brown, indurated in part by iron.			Cambrian - highly weathered greywacke.
	1-4	CLAY, mottled white and red with pale brown patches.	2-6	0.92	
	4-6	CLAY, white to pale brown.			

RBA26 Cont.	6-11	CLAY, red brown, silty, non plastic	6-13.5	0.95	
	11-13.5	CLAY, orange brown, moist at 13.0 m			
	E.O.H. 13.5 m	Logged JLK 9.3.83.			
RBA27	0-1	CLAY, dark brown to yellow brown, slightly indurated.			Cambrian - moderately weathered silty shale.
	1-2	CLAY, pink to pale brown.			
	2-5	CLAY, white to pale yellow brown, silty, non plastic	2-6	1.38	
	5-10	CLAY, silty, slightly plastic, yellow brown. Moist below 8.0 m.	6-10	1.20	
	E.O.H. 10.0 m	Logged JLK 9.3.83			
RBA28	0-1	CLAY, yellow brown with ironstone gravel.			Holocene - colluvium.
	1-2	CLAY, silty, orange, indurated in part.			Cambrian - highly weathered silty shale.
	2-7	CLAY, silty, non plastic, light brown to pale purple.	4-7	0.45	
	7-12	CLAY, silty, pale purple, moist.	7-12	0.58	
	E.O.H. 12.0 m	Logged JLK 9.3.83.			
RBA29	0-1	CLAY, dark brown to orange brown, indurated iron patches.			Cambrian - highly weathered greywacke.
	1-8	CLAY, silty, non plastic, pink to pale red mottled white.	2-7	0.97	
			7-13.5	0.89	

RBA29 Cont.	8-13.5	CLAY, red brown to purple brown, non plastic, moist.			
	E.O.H. 13.5 m	Logged JLK 10.3.83			
RBA30	0-1	CLAY, red brown with indurated iron patches.			Cambrian - moderately weathered greywacke.
	1-3	CLAY, orange, non plastic, silty	2-7	1.34	
	3-4	CLAY, red brown.			
	4-7	CLAY, orange, non plastic.	7-13.5	1.89	
	7-13.5	CLAY, yellow green to green grey, micaceous.			
	E.O.H. 13.5 m	Logged JLK 10.3.83.			

APPENDIX B

Chemical Analyses

B1 - B2	-	Reconnaissance samples RBS1 - RBS 13 Extracted from AMDEL report AC 3759/83 by D.K. Rowley
B3 - B4	-	Auger drill hole samples RBA1 - RBA30 by Adelaide Brighton Cement Ltd.
B5 - B8	-	Check samples from RBA2, 5, 8, 11, 14, 24, and 28, and sulphur and chlorine analysis. Extracted from AMDEL report AC5629/83 by D.K. Rowley.
B9 - B11	-	Detailed analysis of auger holes RBA2, 9, 11, 14, 20 and 29 by R. Bourman S.A. College of Advanced Education.

ANALYSIS
%

SAMPLE MARK	*A17/83* RBS1	*A18/83* RBS2	*A19/83* RBS3	*A20/83* RBS4	*A21/83* RBS5	*A22/83* RBS6	*A23/83* RBS7
SiO_2 *Silica*	60.5	64.2	59.1	59.0	61.8	64.9	61.5
TiO_2 *Titanium oxide*	0.84	0.83	1.06	1.26	0.89	0.82	0.98
Al_2O_3 *Aluminium oxide*	16.8	15.2	18.4	17.6	22.5	19.0	23.1
Total Iron as Fe_2O_3	7.85	6.71	8.95	9.15	3.78	6.20	3.26
MnO Manganese oxide	0.03	0.05	0.08	0.10	0.01	0.01	0.02
MgO Magnesium oxide	3.89	3.41	3.08	3.16	0.33	0.29	0.27
CaO Calcium oxide	0.24	0.34	0.39	0.87	0.12	0.32	0.06
Na_2O *Sodium oxide*	0.74	1.01	0.97	1.40	0.37	0.15	0.16
K_2O *Potassium oxide*	5.33	4.98	3.46	3.16	1.78	1.57	1.49
P_2O_5 *Phosphorus pentoxide*	0.06	0.12	0.16	0.23	<0.01	0.03	0.02
L.O.I.	4.54	3.70	4.78	4.02	8.25	6.10	8.65
Totals	100.8	100.6	100.4	99.9	99.8	99.4	99.5

ANALYSIS
%

SAMPLE MARK	*A24/83* RBS8	*A25/83* RBS9	*A26/83* RBS10	*A27/83* RBS11	*A28/83* RBS12	*A29/83* RBS13
SiO_2 *Silica*	*67.5*	*69.0*	*61.7*	*55.7*	*66.6*	*62.1*
TiO_2 *Titanium oxide*	*1.06*	*0.97*	*0.87*	*0.88*	*1.09*	*1.17*
Al_2O_3 *Aluminium oxide*	*18.6*	*19.5*	*20.3*	*18.9*	*20.5*	*23.1*
Total Iron as Fe_2O_3	*2.10*	*2.36*	*7.25*	*13.6*	*1.03*	*2.98*
MnO Manganese oxide	*0.01*	*<0.01*	*0.04*	*0.02*	*<0.01*	*<0.01*
MgO Magnesium oxide	*0.34*	*0.21*	*0.23*	*0.30*	*0.77*	*0.27*
CaO Calcium oxide	*0.05*	*0.04*	*0.03*	*0.13*	*0.33*	*0.04*
Na_2O *Sodium oxide*	*0.09*	*0.07*	*0.23*	*0.31*	*0.16*	*0.10*
K_2O *Potassium oxide*	*1.84*	*0.98*	*2.02*	*1.83*	*2.92*	*1.36*
P_2O_5 *Phosphorus pentoxide*	*0.05*	*0.03*	*0.04*	*0.03*	*0.03*	*0.02*
L.O.I.	*6.80*	*7.40*	*7.00*	*7.75*	*6.35*	*8.60*
Totals	*98.4*	*100.6*	*99.7*	*99.5*	*99.8*	*99.7*

ANALYSIS %

HOLE	RBA1		RBA2		RBA3		RBA4		RBA5		RBA6		RBA7		RBA8		RBA9	
Depth (m)	2-6	6-9	2-6	6-13	0-5	5-10	3-7	7-12	2-6	6-13	3-7	7-13.5	2-5	5-13.5	3-7	7-12	2-3	3-13.5
SiO_2	66.0	61.8	60.5	62.1	55.3	63.8	65.3	61.3	69.3	64.5	66.4	65.1	61.7	64.8	63.9	64.0	58.3	62.7
Al_2O_3	11.3	17.1	19.1	17.2	21.2	20.2	19.0	18.2	16.2	14.3	18.3	15.9	17.4	14.9	18.0	16.6	17.1	22.8
Fe_2O_3	5.4	4.9	4.7	7.0	9.4	3.1	2.7	7.0	3.1	4.2	2.1	7.7	11.2	6.0	4.1	5.7	8.1	1.3
CaO	0.3	0.1	0.2	0.1	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.3	0.5	0.3	0.2	0.8	0.1
MgO	0.4	0.4	0.3	0.2	0.2	0.3	0.2	0.4	0.3	1.0	0.3	0.8	0.5	1.9	0.3	0.9	0.3	0.2
TiO_2	0.9	0.8	1.1	0.9	1.2	1.0	1.0	0.9	0.8	0.8	0.9	0.9	0.9	0.8	1.0	0.9	1.8	0.9
Na_2O	0.09	0.15	0.07	0.06	0.07	0.12	0.07	0.13	0.06	0.12	0.09	0.06	0.05	0.69	0.14	0.09	0.08	0.12
K_2O	1.47	1.82	1.19	1.22	0.42	1.60	0.95	1.99	0.78	1.97	1.11	1.65	1.24	2.93	0.81	1.84	0.48	1.31
Eq.Na_2O	1.06	1.35	0.85	0.86	0.35	1.17	0.70	1.44	0.57	1.42	0.82	1.15	0.87	2.62	0.67	1.30	0.40	0.98
Loss	6.4	6.4	7.1	6.8	11.3	7.3	7.5	6.6	6.9	5.4	7.4	6.2	7.0	5.2	9.2	7.6	8.5	8.1

HOLE	RBA10		RBA11		RBA12		RBA13			RBA14		RBA15		RBA16		RBA17	
Depth (m)	2-8	8-12.5	2-6	6-13.5	0-5	5-10	2-4	4-9	9-13.5	2-7	7-13.5	2-6	6-13.5	2-9	9-13.5	2-7	7-13.5
SiO_2	54.1	54.5	59.6	62.8	59.3	64.4	67.4	62.9	60.8	56.2	60.1	62.2	62.0	65.3	67.6	54.7	64.2
Al_2O_3	19.9	23.0	18.1	17.3	17.4	16.1	16.1	22.4	20.9	20.8	19.3	17.5	16.3	17.1	16.7	19.3	17.5
Fe_2O_3	8.7	4.7	4.7	5.8	6.5	5.4	5.4	1.5	3.3	9.1	9.7	6.0	5.8	5.0	5.1	11.6	7.0
CaO	0.2	0.1	0.2	0.2	0.7	0.8	0.3	0.2	0.1	0.1	0.2	0.3	0.4	0.2	0.1	0.1	0.1
MgO	0.3	0.3	0.3	0.3	2.4	2.0	0.3	0.2	0.5	0.2	0.2	1.6	2.0	0.3	0.2	0.2	0.2
TiO_2	0.8	0.9	0.9	0.9	0.9	0.8	1.1	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.9
Na_2O	0.25	0.27	0.12	0.15	1.24	1.33	0.11	0.19	0.23	0.18	0.04	0.40	0.46	0.07	0.02	0.08	0.12
K_2O	1.94	1.76	1.31	1.31	3.65	2.99	0.27	1.40	1.84	0.56	0.96	2.40	2.79	1.35	1.08	0.88	1.11
Eq.Na_2O	1.53	1.45	0.98	1.01	3.64	3.30	0.29	1.11	1.44	0.55	0.67	1.98	2.30	0.96	0.73	0.66	0.85
Loss	7.4	9.0	3.9	3.0	4.4	4.0	7.6	5.8	7.0	7.0	7.0	6.7	5.3	6.4	6.8	9.0	6.8

ANALYSIS %

HOLE	RBA18		RBA19			RBA20			RBA21		RBA22		RBA23		RBA24	
Depth (m)	2-5	5-8.5	2-5	5-9	9-13.5	2-4	4-7	7-12	2-6	6-13.5	2-4	4-13.5	0-6	6-13.5	2-6	6-13.5
SiO_2	59.0	57.0	61.9	60.7	57.6	86.5	62.2	57.2	60.8	65.9	57.6	54.2	55.7	60.4	68.0	59.6
Al_2O_3	23.8	22.9	20.5	22.3	19.2	4.8	18.1	16.0	19.3	17.7	17.9	18.0	17.1	15.9	17.7	20.6
Fe_2O_3	3.2	4.7	3.2	1.7	7.0	2.4	2.2	5.7	4.4	2.6	7.9	7.6	6.5	6.0	2.6	4.7
CaO	0.2	0.4	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.3	0.2	0.3	0.2	0.1	0.1
MgO	0.2	0.3	0.3	0.2	0.4	0.1	0.2	1.0	0.2	0.2	0.4	1.1	1.0	1.7	0.2	0.2
TiO_2	1.1	1.0	1.6	1.0	1.0	0.5	1.0	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.7	0.9
Na_2O	0.28	0.26	0.09	0.30	0.29	0.00	0.18	0.12	0.06	0.05	0.17	0.23	0.19	0.14	0.03	0.04
K_2O	1.84	1.58	0.29	1.98	1.89	0.09	1.15	1.58	0.76	1.15	0.88	2.09	2.03	2.46	0.87	0.99
Eq.Na_2O	1.49	1.30	0.28	1.60	1.53	0.06	0.94	1.16	0.56	0.81	0.75	1.61	1.53	1.76	0.60	0.69
Loss	7.7	8.1	9.2	6.7	6.8	2.4	6.8	6.4	6.6	7.8	6.4	7.2	6.6	5.2	7.9	6.4

HOLE	RBA25			RBA26		RBA27		RBA28		RBA29		RBA30	
Depth (m)	0-3	3-7	7 13.5	2-6	6-13.5	2-6	6-10	4-7	7-12	2-7	7-13.5	2-7	7-13.5
SiO_2	69.9	69.1	67.5	60.9	68.8	58.2	65.5	56.6	69.3	58.8	62.0	54.1	61.2
Al_2O_3	13.9	19.5	15.9	19.7	16.3	20.8	16.4	16.5	15.2	16.2	17.5	17.3	17.5
Fe_2O_3	4.8	2.0	5.9	5.4	5.5	2.9	5.3	4.5	4.0	10.3	8.2	7.6	6.8
CaO	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.8	0.1	0.3	0.2	0.1
MgO	0.2	0.1	0.3	0.3	0.3	0.4	0.9	0.2	0.2	0.3	0.2	0.5	1.8
TiO_2	1.3	1.1	0.9	1.0	0.9	1.0	0.9	1.0	1.0	0.0	0.9	0.8	0.9
Na_2O	0.02	0.07	0.05	0.06	0.07	0.15	0.05	0.00	0.05	0.09	0.06	0.18	0.14
K_2O	0.24	0.42	0.79	1.30	1.34	1.87	1.75	0.69	0.80	1.34	1.26	1.76	2.66
Eq.Na_2O	0.18	0.35	0.57	0.92	0.95	1.38	1.20	0.45	0.58	0.97	0.89	1.34	1.89
Loss	7.1	7.1	6.4	8.4	6.0	8.3	6.3	9.8	6.6	6.0	7.0	7.6	12.7

ANALYSIS %

SAMPLE No.	A1875/83	A1876/83	A1877/83	A1878/83	A1879/83
DRILLHOLE	RBA2	RBA2	RBA5	RBA8	RBA8
DEPTH (m)	2-6	6-13	6-13	3-7	7-12
SiO_2	61.0	63.6	68.9	65.8	67.6
TiO_2	1.00	0.77	0.78	0.91	0.79
Al_2O_3	20.9	18.4	16.0	18.6	17.2
Fe_2O_3	6.40	8.00	4.52	5.15	5.60
MnO	<0.010	0.01	0.03	<0.010	0.03
MgO	0.28	0.23	1.07	0.23	0.87
CaO	0.03	<0.010	<0.010	0.03	0.01
Na_2O	0.06	0.07	0.09	0.08	0.08
K_2O	1.40	1.40	2.36	0.74	2.04
P_2O_5	0.05	0.08	0.10	0.22	0.12
LOI	7.90	6.80	5.35	7.35	6.60
Totals	99.0	99.4	99.2	99.1	100.9

Total Fe as Fe_2O_3

ANALYSIS %

SAMPLE No.	A1880/83	A1881/83	A1882/83	A1883/83	A1884/83
DRILLHOLE	RBA11	RBA11	RBA14	RBA14	RBA24
DEPTH (m)	2-6	6-13.5	2-7	7-13.5	2-6
SiO_2	62.4	62.4	56.5	59.7	61.6
TiO_2	0.81	0.79	0.92	0.81	0.88
Al_2O_3	20.9	19.0	22.2	20.5	22.5
Fe_2O_3	6.00	6.55	9.50	9.50	4.64
MnO	0.01	0.01	0.02	0.03	<0.010
MgO	0.27	0.26	0.22	0.15	0.21
CaO	0.08	0.02	0.17	<0.010	<0.010
Na_2O	0.13	0.16	0.13	0.10	0.04
K_2O	1.53	1.54	1.62	1.18	1.13
P_2O_5	0.04	0.03	0.06	0.04	0.04
LOI	7.50	6.90	8.15	7.65	8.15
Totals	99.7	97.7	99.4	99.7	99.2

Total Fe as Fe_2O_3

ANALYSIS %

SAMPLE No. DRILLHOLE DEPTH (m)	A1885/83 RBA24 6-13.5	A1886/83 RBA28 4-7	A1887/83 RBA28 7-12
SiO_2 Silica	67.5	60.8	69.0
TiO_2 Titanium oxide	0.67	0.89	0.89
Al_2O_3 Aluminium oxide	19.6	18.3	16.8
Fe_2O_3 Ferric oxide	2.84	9.40	5.05
MnO Manganese oxide	0.010	0.010	0.010
MgO Magnesium oxide	0.18	0.22	0.18
CaO Calcium oxide	0.010	0.12	0.02
Na_2O Sodium oxide	0.05	0.04	0.02
K_2O Potassium oxide	1.24	0.51	0.85
P_2O_5 Phosphorus pentoxide	0.03	0.06	0.14
Loss on Ignition	6.85	8.40	6.25
Totals	98.9	98.7	99.2

ANALYSIS

SAMPLE No.	DRILLHOLE	DEPTH (m)	TOTAL SULPHUR AS SO_3 %	CHLORINE Cl ppm
A1878/83	RBA8	3-7	0.05	460
A1879/83	RBA8	7-12	0.02	500
A1882/83	RBA14	2-7	0.03	190
A1883/83	RBA14	7-13.5	0.02	230

Selected drillholes - detailed analyses (R. Bourman)

	Analyses %											
RBA2	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	Fe_2O_3	Total
0-0.5	0.141	0.308	32.278	43.392	0.029	0.020	0.440	0.088	1.098	0.011	21.650	99.45
0.5-1	0.071	0.364	31.834	54.737	0.031	0.008	0.915	0.061	1.191	0.006	9.790	99.01
1-2	0.064	0.283	25.733	57.601	0.039	0.017	1.256	0.029	1.073	0.006	13.644	99.75
2-3	0.563	0.333	23.170	66.329	0.062	0.017	1.848	0.228	1.316	0.010	4.626	98.50
3-4	0.056	0.341	21.270	71.164	0.033	0.005	2.042	0.009	1.244	0.002	2.769	98.94
4-5	0.049	0.263	19.355	74.429	0.049	0.007	1.638	0.011	1.000	0.005	3.046	99.85
5-6	0.126	0.190	19.751	72.419	0.068	0.016	1.024	0.017	0.995	0.003	5.587	100.20
6-7	0.020	0.174	19.261	71.211	0.060	0.016	1.040	0.032	0.906	0.006	6.799	99.52
7-8	0.025	0.168	17.224	70.579	0.047	0.018	0.964	0.015	0.809	0.006	9.873	99.73
8-9	0.042	0.219	18.825	71.867	0.039	0.010	1.305	0.014	0.859	0.007	6.514	99.70
9-10	0.078	0.297	20.631	69.295	0.034	0.002	1.627	0.024	0.850	0.009	6.636	99.48
10-11	0.128	0.294	20.077	66.245	0.047	0.013	1.722	0.019	0.844	0.012	10.207	99.61
11-12	0.102	0.287	20.154	65.337	0.054	0.017	1.824	0.019	0.860	0.009	10.910	99.57
12-13	0.112	0.280	20.553	65.734	0.058	0.010	1.929	0.017	0.890	0.010	9.976	99.57
RBA9												
0-1	0.063	0.357	26.640	53.305	0.028	0.152	0.303	1.029	0.937	0.008	15.822	98.64
1-2	0.039	0.224	24.095	56.461	0.023	0.048	0.213	0.154	0.884	0.005	17.113	99.26
2-3	0.076	0.117	10.325	83.096	0.012	0.026	0.365	0.090	1.663	0.000	3.990	99.76
3-4	0.071	0.226	32.870	62.786	0.018	0.005	1.340	0.004	0.772	0.005	1.448	99.54
4-5	0.114	0.292	27.986	66.811	0.018	0.012	1.976	0.028	1.031	0.004	1.725	100.00
5-6	0.067	0.220	26.539	68.945	0.023	0.005	1.587	0.008	0.929	0.005	1.089	99.42
6-7	0.061	0.254	25.072	70.613	0.019	-0.003	1.730	0.027	0.880	0.003	0.746	99.38
7-8	0.798	0.237	23.157	74.623	0.029	0.010	1.610	0.255	0.849	0.005	0.856	102.43
8-9	0.047	0.131	21.862	75.470	0.038	0.002	0.890	0.018	0.876	0.001	0.444	99.78
9-10	0.048	0.228	21.343	74.778	0.020	0.003	1.888	0.008	0.903	0.004	0.672	99.69
10-11	0.066	0.267	22.974	73.122	0.029	0.004	1.722	0.021	0.879	0.003	0.599	99.73
11-12	0.060	0.247	21.531	74.701	0.027	0.009	1.631	0.020	0.968	0.003	0.780	99.98
12-13.5	0.055	0.209	19.833	73.660	0.034	-0.004	1.392	0.020	0.927	0.006	3.532	99.66

Analyses %

RBA11	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	Fe_2O_3	Total
0-1	0.133	0.372	28.224	61.217	0.026	0.006	0.940	0.214	0.989	0.007	6.950	99.08
1-2	0.374	0.289	25.022	67.055	0.019	0.020	1.274	0.093	0.972	0.005	4.591	99.72
2-3	0.153	0.283	22.425	68.877	0.030	0.050	1.519	0.048	0.899	0.010	5.693	99.94
3-4	0.159	0.244	21.145	68.602	0.038	0.015	1.532	0.036	0.900	0.011	7.064	99.74
4-5	0.202	0.300	22.836	68.333	0.051	0.014	1.763	0.069	0.903	0.009	5.314	99.79
5-6	0.180	0.701	22.183	66.827	0.047	0.044	1.985	0.624	0.861	0.010	6.314	99.77
6-7	0.219	0.301	22.223	67.334	0.036	0.006	1.852	0.045	0.908	0.009	7.104	100.04
7-8	0.201	0.295	21.499	68.511	0.038	0.008	1.749	0.060	0.882	0.011	6.496	99.75
8-9	0.137	0.243	20.231	69.911	0.026	0.005	1.293	0.074	0.909	0.012	7.528	100.37
9-10	0.141	0.251	20.254	69.484	0.026	0.017	1.180	0.093	0.910	0.008	7.411	99.78
10-11	0.177	0.261	20.402	69.679	0.030	0.011	1.466	0.063	0.900	0.011	6.829	99.83
11-12	0.176	0.257	20.694	68.475	0.028	0.010	1.567	0.092	0.915	0.011	7.297	99.52
12-13.5	0.174	0.287	20.153	69.114	0.033	0.003	1.883	0.055	0.922	0.014	6.844	99.58
RBA14												
0-1	0.103	0.221	18.499	51.616	0.035	0.015	0.552	0.171	0.940	0.014	27.363	99.53
1-2	0.032	0.209	24.068	50.931	0.056	0.025	0.427	0.097	0.996	0.010	22.941	99.79
2-3	0.303	0.236	21.277	61.915	0.054	0.137	1.079	0.099	1.016	0.008	12.849	98.97
3-4	0.174	0.227	24.631	63.952	0.027	0.009	1.734	0.024	1.111	0.015	7.380	99.28
4-5	0.291	0.226	23.588	63.672	0.014	0.011	2.235	0.013	1.030	0.019	7.877	98.98
5-6	0.189	0.223	23.672	64.590	0.025	0.013	2.083	0.026	1.015	0.019	7.751	99.61
6-7	0.256	0.235	22.552	62.254	0.022	-0.015	2.384	0.028	0.932	0.022	10.962	99.63
7-8	0.218	0.222	24.536	66.462	0.014	-0.035	1.948	0.043	1.020	0.025	4.832	99.29
8-9	0.138	0.189	23.347	65.400	0.017	0.014	1.720	0.012	0.965	0.023	7.354	99.18
9-10	0.080	0.123	21.745	64.977	0.033	0.019	0.911	0.019	0.903	0.021	10.845	99.68
10-11	0.085	0.132	20.497	63.872	0.069	0.022	0.857	0.024	0.862	0.022	13.921	100.36
11-12	0.114	0.132	21.638	66.927	0.056	0.016	0.925	0.033	0.915	0.021	9.267	100.04
12-13.5	0.172	0.155	20.951	66.196	0.058	0.014	1.387	0.016	0.869	0.019	9.834	99.67

Analyses %

RBA20	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	Fe_2O_3	Total
0-1	0.078	0.216	18.860	65.151	0.021	0.062	0.223	1.392	0.931	0.007	11.976	98.92
1-2	0.020	0.116	10.645	83.489	0.013	0.000	0.131	0.030	0.731	0.003	4.213	99.39
2-3	-0.011	0.039	4.902	90.138	0.007	-0.032	0.055	0.013	0.371	0.001	3.881	99.16
3-3.7	-0.024	0.025	3.153	93.790	0.006	-0.005	0.038	0.007	0.247	-0.002	1.608	98.84
3.7-4	0.007	0.042	5.106	91.608	0.006	-0.032	0.141	0.005	1.365	0.002	0.952	99.20
4-5	0.110	0.207	22.504	72.048	0.026	-0.013	1.094	0.013	1.145	0.014	2.357	99.50
5-6	0.091	0.227	22.057	72.748	0.077	-0.015	1.247	0.015	1.040	0.014	2.145	99.65
6-7	0.170	0.253	22.110	71.402	0.061	0.003	1.702	0.011	1.010	0.015	3.123	99.86
7-8	0.172	0.400	21.598	67.839	0.097	-0.036	1.903	0.022	0.979	0.022	6.458	99.45
8-9	0.141	0.665	20.355	68.265	0.232	0.009	1.621	0.042	0.938	0.025	6.919	99.21
9-10	0.156	0.762	17.128	73.637	0.162	-0.033	1.373	0.070	0.948	0.028	4.275	98.51
10-11	0.123	1.085	18.962	68.758	0.190	-0.002	2.035	0.053	0.888	0.034	7.279	99.40
11-12	0.135	1.500	18.284	69.550	0.146	-0.017	2.148	0.059	0.859	0.047	6.654	99.36
RBA29												
0-1	0.141	0.148	17.149	44.927	0.034	0.049	0.498	0.212	0.829	0.015	36.216	100.22
1-2	0.070	0.177	20.253	46.337	0.027	0.042	0.925	0.041	0.994	0.016	30.385	99.27
2-3	0.081	0.221	18.396	66.677	0.024	0.002	1.380	0.026	1.144	0.011	11.863	99.83
3-4	0.071	0.254	17.255	68.631	0.019	-0.001	1.499	0.018	1.038	0.004	10.764	99.54
4-5	0.066	0.312	18.559	70.481	0.012	-0.015	1.910	0.015	1.016	0.006	7.593	99.96
5-6	0.075	0.287	19.893	70.163	0.018	-0.003	1.917	0.016	0.961	0.007	6.080	99.41
6-7	0.065	0.274	18.136	70.665	0.012	0.008	1.855	0.022	0.927	0.006	7.653	99.82
7-8	0.048	0.238	20.085	70.347	0.016	-0.013	1.681	0.015	0.924	0.005	6.012	99.36
8-9	0.077	0.197	19.501	68.592	0.019	0.000	1.313	0.018	0.919	0.008	8.616	99.26
9-10	0.055	0.192	19.131	67.334	0.033	0.032	1.249	0.069	0.918	0.008	10.871	99.89
10-11	0.043	0.252	19.565	68.483	0.039	-0.029	1.623	0.012	0.877	0.004	8.586	99.46
11-12	0.066	0.249	19.804	68.317	0.055	-0.030	1.824	0.019	0.902	0.006	8.155	99.37
12-13.5	0.051	0.233	19.079	68.524	0.059	0.030	1.700	0.051	0.902	0.003	8.593	99.23

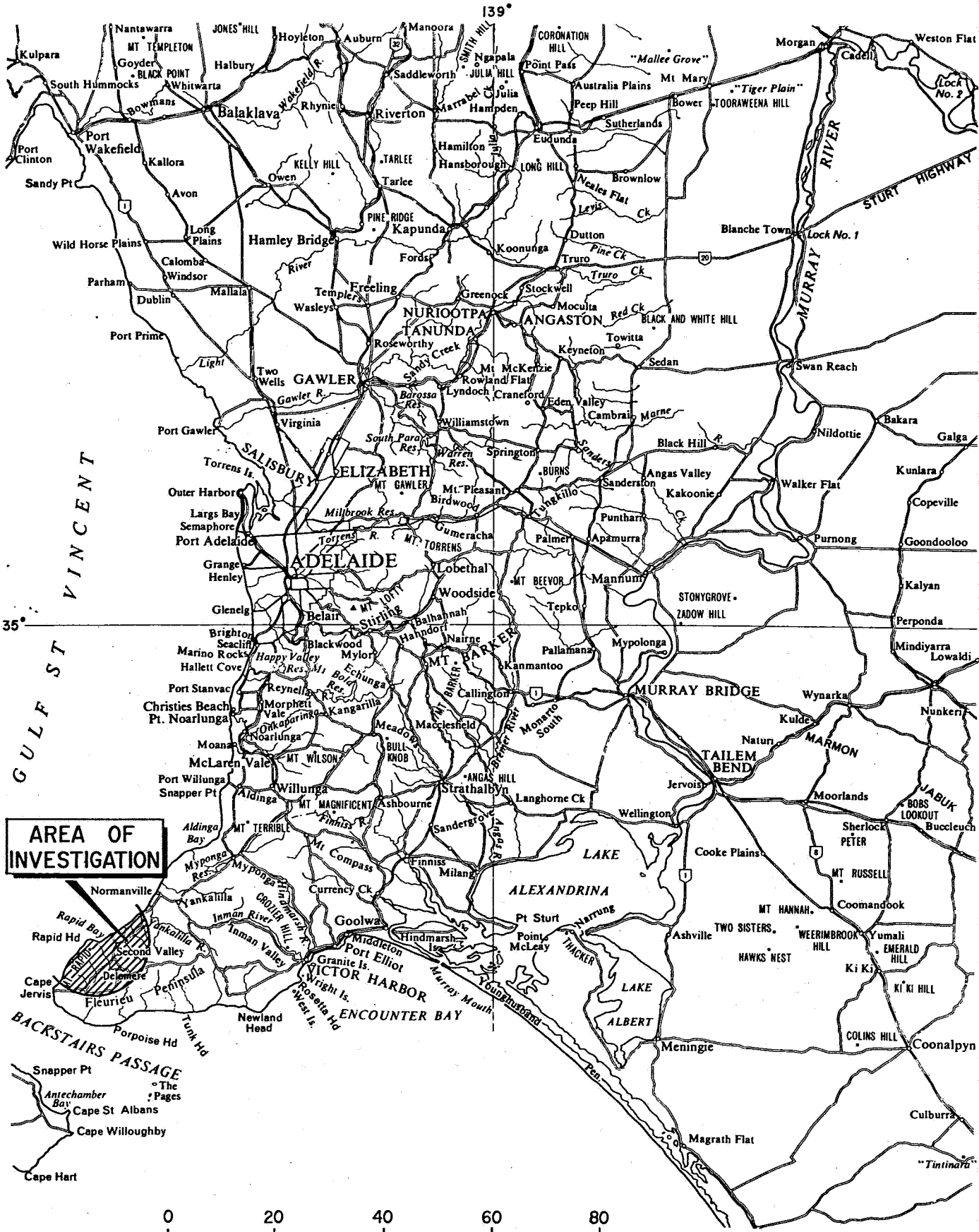


Fig. 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RAPID BAY – DELAMERE AREA
LOW ALKALI SHALE INVESTIGATION
LOCALITY MAP

COMPILED J.K.	C.D.O DATE
DRAWN A.F.	SCALE 1:1 000 000
DATE 5-9-83	PLAN NUMBER S16930
CHECKED	

3260

LEGEND

PERMIAN-QUATERNARY

Undifferentiated sediments – includes Permian fluvioglacial clay, silt and sand, Tertiary sand and ironstone gravel and Holocene outwash deposits and modern soils.

CAMBRIAN — KANMANTOO GROUP

TAPANAPPA FORMATION: Sandstone facies/ greywacke facies.

TALISKER FORMATION: Calcsilicate and siltstone.

BACKSTAIRS PASSAGE FORMATION: Laminated arkose with minor greywacke.

CARRICKALINGA HEAD FORMATION: Feldspathic greywacke with minor siltstone and limestone near top.

NORMANVILLE GROUP: Marble and calcareous shale, thin quartzite beds at base and dark phosphatic shale at top.

LATE PROTEROZOIC (ADELAIDEAN) — WILPENA GROUP

BRACHINA FORMATION: Aluminous siltstone and sandstone.

UPPER UMBERATANA GROUP: Calcareous shale, gritty siltstone and sandstone.

UMBERATANA GROUP

TAPLEY HILL FORMATION: Calcareous shale and siltstone, Brighton Limestone at top.

STURT TILLITE: Diamictite, gravelly quartzite and slate.

BURRA GROUP

Basal conglomerate and sandstone of Aldgate Sandstone showing heavy mineral layers, dolomitic siltstone overlain by siltstone and quartzite of Belair Subgroup.

ARCHAEAN TO E. PROTEROZOIC

BAROSSA COMPLEX: Mica schist and gneiss.

— — — .... Fault.

——— .... Geological boundary.

● RBS 12 ..... Surface sample point.

○ RBA 10 ..... Auger drillhole location

RAPID BAY LIMESTONE QUARRY

Gulf St Vincent

Backstairs Passage

YANKALILLA BAY

Normanville

Yankalilla

Lady Bay

Unalta

Wirrina

Anacoilla

Tonto

BOAT HARBOUR HILL

Rapid Head

RAPID BAY

Rapid Bay

Second Valley

MOUNT RAPID

Yo-Ho Stockyards

SECOND VALLEY FOREST

BULLAPARINGA HILL

Glen Eagles

Talamara

Bonnyview

Thylungra

Bedlam Flat

Honeysuckle Flat

Foggy Farm

Three Bridges

Allan Flat

Dog Trap Creek

Sunnybank

WATTLE HILL

STOCKYARD HILL

Delamere

STARFISH HILL

SALT CREEK HILL

SHEEP HILL

SOUTH FLEURIEU PENINSULA

MOUNT LOFTY RANGES

Woodleigh Park

Hillsdale

Cape Jervis

Lands End

Fishery Beach

Silverton

Silverton Park

Valwood

Callanda Brae

Glen Burri

Richmond Downs

Deep Creek

Seabrook

Yapanappa

TAPANAPPA HILL

Yapanappa Rocks

Southern Pastures

Tunkalilla Beach

TREE HILL

Xulti Wirra

STORMY POINT

Goondooloo

TENT HILL

Tent Rock

BOBBLER HILL

CAMPBELL HILL

Parkang

Porpoise Head

BLACK BULLOCK HILL

MOUNT HAYFIELD

Kentish Downs

Hay Flat

Montana Downs

PUTLAND HILL

SOUTH OF MOUNT HAYFIELD

ARTHUR HILL

GRASS TREE HILL

DEEP CREEK CONSERVATION PARK

WAITPINGA CONSERVATION PARK

ERIC BONYTHON CONSERVATION PARK

RBS 1 RBS 2 RBS 3 RBS 4 RBS 5 RBS 6 RBS 7 RBS 8 RBS 9 RBS 10 RBS 11 RBS 12 RBS 13

RBA 1 RBA 2 RBA 3 RBA 4 RBA 5 RBA 6 RBA 7 RBA 8 RBA 9 RBA 10 RBA 11 RBA 12 RBA 13 RBA 14 RBA 15 RBA 16 RBA 17 RBA 18 RBA 19 RBA 20 RBA 21 RBA 22 RBA 23 RBA 24 RBA 25 RBA 26 RBA 27 RBA 28 RBA 29 RBA 30

5 km

10 km

35° 30'

35° 35'

35° 40'

138° 05'

138° 10'

138° 15'

138° 20'

SCALE IN KILOMETRES

1 0 1 2 3 4 5

Geology adapted from Mancktelow (1979)

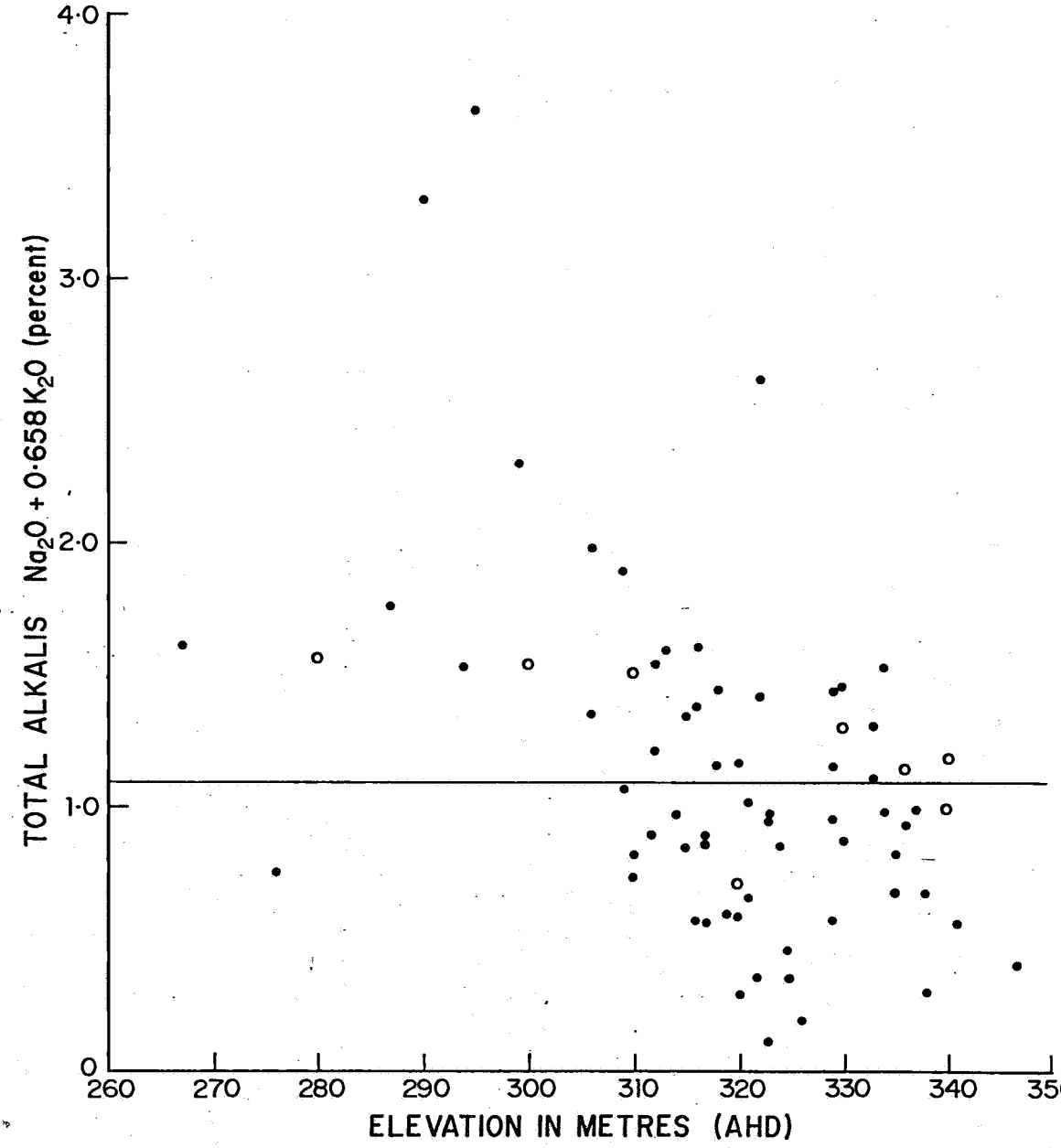
Fig. 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

RAPID BAY – DELAMERE AREA LOW ALKALI SHALE INVESTIGATION GEOLOGICAL PLAN SAMPLE and DRILLHOLE LOCATIONS

COMPILED	J. Keeling
DRAWN	A. F.
DATE	5-9-83
CHECKED	
C.D.O.	20·12·83 DATE
SCALE	1 : 50000
PLAN NUMBER	83-396

3260



●..... Drillhole sample (ABC Ltd results)

o..... Surface sample

Fig. 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED J.K.	C D O DATE
RAPID BAY – DELAMERE AREA LOW ALKALI SHALE INVESTIGATION PERCENTAGE OF TOTAL ALKALIS vs ELEVATION	DRAWN A.F.	SCALE
	DATE 5-9-83	PLAN NUMBER S16932
	CHECKED	

REFERENCE

Low alkali shale distribution

Weathering profile in excess of 10m thick – high potential for low alkali shale.

As above but untested.

Forest reserve.

Conservation or recreation park.

● RBS 12 .... Surface sample location.

O ..... Auger drillhole location (see plan 83-396 for number)

RAPID BAY LIMESTONE QUARRY

YANKALILLA BAY

Normanville

Yankalilla

Lady Bay

The Gorge

YANKALILLA HILL

Unaita

Gulf St Vincent

10 km

35° 30'

RIVER

Tonto

Wirrina

Anacoilla

BOAT HARBOUR HILL

Rapid Head

RAPID BAY

Rapid Bay

Second Valley

Hay Flat

Montana Downs

BAKER NOB

MOUNT HAYFIELD

Kenneh Downs

MOUNT RAPID

Yo Ho

RBS 1

RBS 2

SECOND VALLEY FOREST

PUTLAND HILL

SOUTH OF MOUNT HAYFIELD

Bonnynew

Thylungra

Glen Eagles

Talamara

Binnowee

STARFISH HILL

RBS 4

RBS 3

Delamere

BULLAPARINGA HILL

Bedlam Flat

SECOND VALLEY FOREST

RBS 13

SALT CREEK HILL

RBS 11

STOCKYARD HILL

RBS 12

Honeysuckle Flat

35° 35'

10 km

SOUTH MOUNT LOFTY RANGES

Sunnybank

WATTLE HILL

Allan Flat

Foggy Farm

Three Bridges

RBS 9

RBS 5

RBS 10

WAITPINGA CONSERVATION PARK

SHEEP HILL

FLEURIEU PENINSULA

Cape Jervis

Woodleigh Park

RBS 6

Yalwood

RBS 7

RBS 8

BLACK BULLOCK HILL

Glen Burn

Deep Creek

Callanda Brae

Richmond Downe

ERIC BONYTHON CONSERVATION PARK

Seabrook

Lands End

Silverton

Silverton Park

TREE HILL

Xulti Wirra

The Wither Swamp

Tapanappa

TAPANAPPA HILL

Tapanappa Rocks

ARTHUR HILL

GRASS TREE HILL

Fishery Beach

STORMY POINT

Goondooloo

TENT HILL

Tent Rock

Southern Pastures

Tunkalilla Beach

CAMPBELL HILL

Rarkang

GOBBLER HILL

DEEP CREEK CONSERVATION PARK

Porpoise Head

Backstairs Passage

35° 40'

138° 05'

138° 10'

138° 15'

138° 20'

SCALE IN KILOMETRES

1 0 1 2 3 4 5

Fig. 4

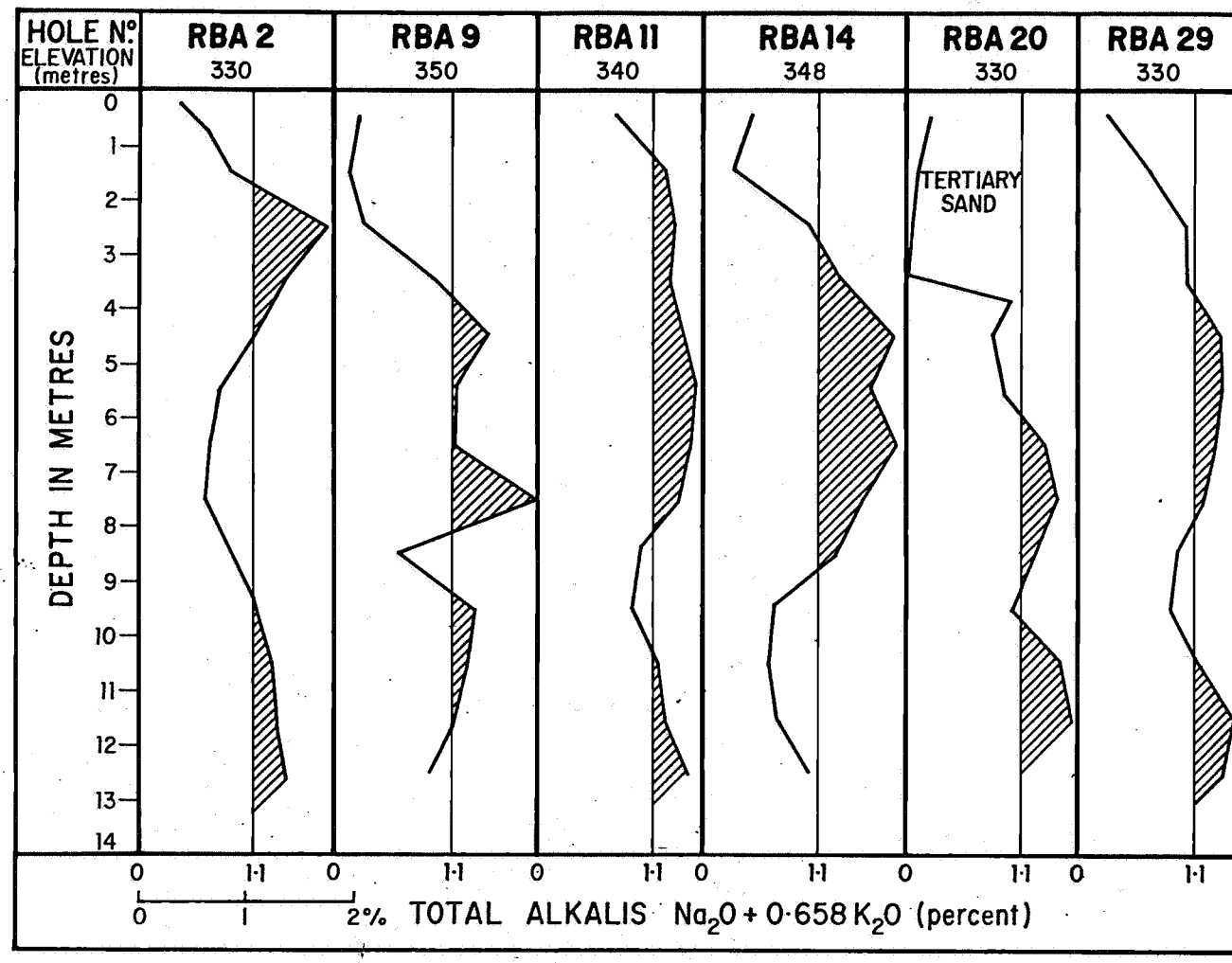
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

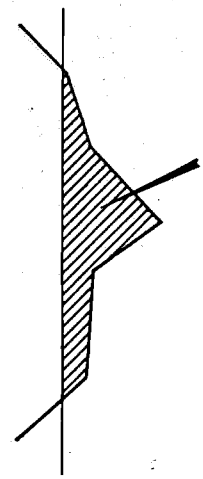
RAPID BAY – DELAMERE AREA LOW ALKALI SHALE INVESTIGATION

LOW ALKALI SHALE DISTRIBUTION

COMPILED	J. Keeling
DRAWN	A. F.
DATE	5-9-83
CHECKED	
CDO	UR 20-12-83 DATE
SCALE	1:50000
PLAN NUMBER	83-397

3260





Total alkalis exceed ideal specifications
ie $Na_2O + 0{\cdot}658K_2O > 1{\cdot}1\%$

Fig. 5

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RAPID BAY – DELAMERE AREA
LOW ALKALI SHALE INVESTIGATION
VARIATION IN TOTAL ALKALI CONTENT WITH DEPTH

COMPILED J.K.	C D O DATE
DRAWN A.F.	SCALE
DATE 5-9-83	PLAN NUMBER S 16933
CHECKED	

3260