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DEPARTMENT OF MINES
SOUTH AUSTRALIA

Report on

MARBLE DEPOSIT

SECS. 113, 341, 343, HD. MOOROOROO, CO. LIGHT

(Hydrated Lime Limited)

by

L. G. Nixon
Geologist

MINERAL RESOURCES SECTION

GEOLOGICAL SURVEY

CONTENTS

Map No.	Title	Scale
L60-137	Geological Plan, Marble Deposit Secs. 113, 341, 343, Hd. Moorooroo, Co. Light. (Hydrated Lime Limited)	1" = 100 feet

Rept. Bk. No. 51/94
G.S. No. 1844
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25th October, 1960.

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(Hydrated Lime Limited)

1. ABSTRACT

Marbles in the area mapped are equated with the Lower Cambrian Archaeocyatha limestones found elsewhere in the State. The Cambrian sediments which include arkoses, greywackes, and amphibolites are folded into a broad syncline in Sec. 113, with drag fold structures developed on the limbs. North of the main syncline numerous fold structures are developed on the eastern limb of the main fold, all these structures are interpreted as drag folds. In Sec. 341 the beds swing westerly and dip steeply to the south. Total reserves of marble in the areas outlined are estimated at 88,600 tons per vertical foot. It is possible that the marbles may be slightly more extensive than outlined on the accompanying map. Drilling is desirable to test the marble in depth and a tentative programme is laid out totalling 910 feet of drilling. Trenching to test the quality of marble outcrop is outlined on map No. L 60-137 accompanying this report.

2. INTRODUCTION

On 21st December 1959 a report by R. K. Johns (Senior Geologist, Mineral Resources Section) was forwarded to Hydrated Lime Limited, outlining areas of marble in the Angaston district which were considered the most promising source of raw material for lime burning. Detailed mapping of Secs. 341 and 343, Hd. Moorooroo was recommended.

Hydrated Lime Ltd. obtained options over Pt. Secs. 556, 343, 341, and 113 and on May 24th requested a Geological and Contour Survey of the area. This survey was completed in approximately 12 field days between June 28 - July 28.

The company anticipate a production of 1,500 tons per day and require reserves of at least five million tons.

3. REFERENCES

CAMPBELL, J.D. "The Geology of the Angaston Marble Beds" I.C.I. Alkali (Aust.) Pty. Ltd. (unpublished)

JOHNS, R.K. "Limestone for Production of High Grade Lime" Rept. Bk. No. 49/188 (unpublished).

COATS, R.P. Truro Sheet, Geological Atlas 1 mile series

4. LOCATION AND TOPOGRAPHY

The area investigated lies about 2 miles north east of Angaston which is approximately 50 miles north east of Adelaide, in the Mt. Lofty Ranges to the east of the Barossa Valley. Access is good, a bitumen road passes the south western corner of Sec. 343 and a gravel road gives all weather access to the southern portion of Sec. 113. Within the sections there are few access tracks.

Topography within the area mapped is fairly mature with wide valleys and low rounded hills, almost completely cleared of native trees and shrubs. In parts of the valleys and on some of the hill slopes grape vines and apricot orchards may be seen.

All the gullies drain eastwards to the Gawler River which runs northerly past the sections; no permanent surface water occurs on the sections mapped; one well located near the south eastern corner of Sec. 343 taps a sub-surface water supply.

5. GEOLOGY

(a) General Geology

The regional geology of the area is outlined on map No. L56-49 "Geological Map of Angaston District" which accompanies Campbell's report op. cit., and on the Truro Sheet of the Geological Atlas 1 mile series. Campbell's map is a good factual map outlining areas of outcrop with a general differentiation of the rock types. The Truro sheet covers about 6½ times the area

covered by Campbell's map and shows the main stratigraphic units and structures. Sediments include slates and quartzites of the Marinoan Series unconformably overlain by calcareous sediments of Lower Cambrian Age. The main structures include northerly trending anticlines and synclines with faults parallel to and across the bedding. Features of the Lower Cambrian sediments here are rapid facies changes along the bedding planes and relatively large and rapid thickening and thinning of beds.

(b) Detailed Geology

Outcrops within the area mapped are generally good where marbles occur, but poor elsewhere. Rock types recognised include marbles, calc-silicates, arkoses, greywackes, amphibolites, quartzite, quartz-mica schists, talcose rock and quartz veins.

A general sequence of the various types of sediments within the mapped area from top to bottom is

(i) Interbedded calc-silicates laminated siltstone greywackes and quartz mica schists. Rapid facies changes.

(ii) Transition zone of calc-silicates and grey, white, actinolitic marbles.

(iii) Pink marbles.

(iv) Grey and white marbles.

(v) Actinolite marbles with lenses of white or pink marble.

(vi) Impure marbles, intercalated greywackes, arkoses, quartzites showing rapid facies changes.

Leached calc-silicate rocks with interbedded siltstones greywackes and quartz mica schists outcrop poorly and sporadically in the keel of a large synclinal structure in Sec. 113. The calc-silicates (which outcrop better than any of the other varieties) outcrop as a porous light weight rock with skeletal quartz structures. It is possible that the original rock was a quartz tremolite marble (see appended petrological report P.459/60 L.G.N. 22/60. T.S. 6828). The other rock types outcrop in the creek bed in Sec. 343 or occur as occasional floaters in

Sec. 113.

A narrow transition zone of poor outcrop in which there is intercalation of calc-silicates and marble beds occurs above the marble horizon.

The marbles which include pink, white, grey brown and dark-grey actinolite rich varieties outcrop well and is a feature of these rocks in the area generally. The first named of these varieties are frequently coarse grained, massive and structureless. Although they grade from one variety to another, along and across the strike of the beds, the contact of two varieties may be sharp and well defined both along and across the strike of the bedding planes. On the limbs of the main synclinal structure in Sec. 113 the rock types tend to follow the bedding planes (See Map No. L60-137 appended) which are well defined.

The main impurities in the marbles include actinolite, tremolite, pyrite, tourmaline, opaque iron oxides, quartz, varieties of mica, small amounts of manganese and probably phosphate in certain beds. Numerous pits scattered throughout the sections inspected are believed to be on phosphate rich rock. In the marbles these pits were found to be on the brown coloured variety of marble which frequently occurs with pink and white varieties. At the surface the brown marble was often rotted and crumbly, and in places was weathered to a deep red brown colour. At the time of the survey pink marble was being quarried from the south eastern corner of Sec. 113 for monumental stone.

Field evidence suggests that the purer marbles are formed by the replacement of deleterious materials by calcite during recrystallisation. This view is supported by petrological work on the marbles which indicates replacement of actinolite, quartz and micas, (See petrological report appended) in these rocks.

Actinolite marbles may occur as irregular bodies in the purer marbles but usually they underlie them. The rock is dark grey to almost black in colour and outcrops well. Bedding planes which vary in thickness between ½ inch and 2 inches stand out clearly because of differential weathering. Actinolite rich layers (which are characterised by long acicular crystals dark green to nearly black in colour) alternate with finer grained lighter coloured beds. Usually these beds are crenulated by drag folding to such a degree that from some angles the arrangement of small drags one behind the other give the appearance of bedding or lineation.

Intercalated with the basal beds of the actinolite marbles and underlying are amphibolites, arkoses, calc-silicates, thin white marble beds and talc rock. This appears to be a zone of rapid facies variation.

The amphibolite outcrops poorly in the east bank of the creek in Sec. 341 just below and north of the marble outcrop. The rock is medium to fine grained, dense and fairly heavy, dark green to almost black in colour with some conspicuous bronze coloured flaky micaceous mineral.

Talc underlies the amphibolite, intercalated with calc silicates and arkoses. It outcrops poorly in the same creek as the amphibolite in the east bank as a light off white granular rock.

Calc-silicates and arkosic rocks are interbedded with narrow beds of white marble outcropping poorly in the east bank of the creek and the northern portions of Secs. 341, 343.

(c) Structural Geology

Interpretation of the structure in this area is complicated by lack of outcrop in some places, lack of marker horizons, recrystallisation of sediments and the transgression of beds by rock types, rock flowage and crenulation by drag folding of beds so that dips and strikes cannot be projected with certainty for any great distance.

Folding as shown on the Truro sheet indicates a series of elongated northerly trending folds with some flowage. In Sec. 113 a well developed syncline with large drag folds developed on both limbs has been mapped (see accompanying map). Minor folds are developed on these drags and drags on these till the individual beds in places show intense crenulation and flow folding. The direction and pitch on all the drags measured on the east limb of the syncline is 15°-20° towards 185°-190°(m). This pitch direction is maintained on a fairly large synclinal structure mapped immediately to the north of the synclinal nose which may also be a drag on the main fold structure. To the north of this synclinal fold other less well developed folds with similar pitch attitudes were mapped. Two small tight overturned folds have been observed in the actinolite marbles and outlined on the accompanying map. The pitch on the northern fold is similar to the pitch on the drag folds on the east limb of the syncline. The pitch on the southern overturned fold is 12° towards 112°.

In about the centre of Sec. 341 all the beds swing to the west and strike just south of westerly, dips vary from vertical to 40°S, forming the southern limb of an anticlinal cross fold which may also cause a change in strike of the synclinal axis. Local overturning of the beds may be seen in the north-eastern portion of the outcropping sediments in Sec. 343 where some beds dip to the north; the remainder of the beds are right way up. The marbles here are overlain by greywackes, quartz mica schists which outcrop in the creek and arkoses.

Flow structures causing attenuation on the limbs and thickening on the nose of fold structures occur in many parts of the area as outlined on the map. In the vicinity of the marble quarry the beds have flowed from a large bulge to the east. This large flow structure does not reflect the true structure or attitude of the beds and does not reflect the stresses which have produced the folding.

Faulting has been inferred from the displacement of some beds and the abrupt termination of others. The attitudes and directions of the fault planes are not known but the approximate strike directions are indicated on the accompanying plan. Relative movement on the easterly trending fault is north block west and on the northerly trending fault (on the west limb of the main syncline) east block north.

Lineation is well developed in some areas, in the actinolite marbles, in which the preferred orientation of the actinolite crystals is constant and pitches 15°-20° towards 180°-190°, this is parallel to the pitch on the drag folds on the eastern limb of the fold.

Joints are best developed in the massive marbles, their attitudes vary throughout the area.

6. RESERVES

Because of the rapid change of one variety of marble to another, reserves have been calculated per vertical foot on outcrop only. Total reserves for areas A to E (as outlined on plan No. 60-578 appended to this report) are estimated at 88,600 tons per vertical foot based on a tonnage factor of 13.22 cubic feet per ton, comprising area A 31,680 tons per vertical foot (area 418800 sq. feet); area B, 14,570 tons per vertical foot (area 192,700 sq. feet); area C, 15,730 tons per vertical foot (area 208,000 sq. feet); area D, 16,970 tons per vertical foot (area 224,500 sq. feet); area E, 9,700 tons per vertical foot (area 128,400 sq. feet).

7. TESTING

Drilling is desirable to test the nature of the marble at depth and the following preliminary test drilling programme is suggested.

		Direction	Depression	Depth
D.D. Hole No. 1	Sec. 113, pt. Sec. b	328°	72°	220'
D.D. Hole No. 2	Sec. 113, pt. Sec. m	268½°	45°	250'
D.D. Hole No. 3	Sec. 113, pt. Sec. m	053°	55°	120'

		Direction	Depression	Depth (feet)
		-	Vertical	100
D.D. Hole No. 4	Sec. 113, pt. Sec m			
D.D. Hole No. 5	Sec. 343	323½°	43½°	220
	Total footage to be drilled =			910

All the holes, except No. 4, are designed to test the entire width of outcropping areas of marble at depth, at approximately right angles to the dip of the bedding planes.

Trenching is necessary to test the quality of the outcropping marble and trenches at approximately 100 yard intervals (as outlined on the accompanying map) is suggested, to indicate the grade. It is expected that the grade of marble is reflected by its colour, the purest marble being white, followed by the pink then the grey. At the present time Hydrated Lime Ltd. are test firing a specimen of actinolite marble but results are not to hand. Because of the iron content in the brown marbles it is possible that this rock will be unsuitable for use in the manufacture of lime.

8. CONCLUSIONS

Sediments including varieties of marble (equated with the Archaeocyatha Limestones of Lower Cambrian age) greywackes, amphibolites and arkoses occur in the area mapped.

Varieties of marble pass rapidly from one type to another, along and across the strike of bedding planes. Because of this feature no rock type can be projected for any distance, for this reason outcrop only of rock types, is shown on the accompanying map. Marbles outcrop well in the sections examined in contrast to other rock types. Macro and micro folding is well developed; in Sec. 113 a broad southerly pitching syncline has been mapped showing drag folding and flow folding. To the north of this major syncline other fold structures have been mapped having similar attitudes to the drag folds and are inferred as being large drags. An anticlinal cross fold north of the area mapped causes the beds to change strike to a westerly direction in the centre of Sec. 341.

Faulting is indicated by displacement of beds or their abrupt termination. Three faults have been inferred, two striking east of northerly. One of these (on the west limb of the syncline) shows east block north. An east west fault shows north block west movement.

The grade of marble is expected to follow colour, the best quality being white followed by pink, then grey brown and lastly black actinolite marble.

Total reserves in the area outlined are estimated at 88,600 tons per vertical foot.

Drilling the various areas is desirable to test the marble at depth and five holes totalling 910 feet are located on the accompanying map.

Trenching is suggested to test outcropping marbles and trenches at about 300 ft. intervals are shown on map No. L60-137 accompanying this report.

L.G. Nixon
Geologist
MINERAL RESOURCES SECTION

LGN:AGK
25/10/60

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

MINERALOGY & PETROLOGY SECTION

REPORT NO: 1.2.0/1009.

MATERIAL:	Rock samples.
SUBMITTED BY:	L. G. Nixon, Mineral Resources Section Department of Mines.
DATE RECEIVED:	15.8.60
MARKS OR NO'S:	P450-460/60
SOURCE OR LOCALITY:	Hd. Moorooroo, sections 113, 341, 343.
INFORMATION REQUIRED:	Petrological description.
METHODS OF EXAMINATION:	Thin section.

RESULTS OF EXAMINATION:

P450/60 (L.G.N. 13/60, T.S. 6819)

A fine-grained sub-greywacke consisting essentially of quartz (of fine-sand and silt grades) with abundant fine biotite and a little highly altered felspar (probably albite). A small amount of muscovite has been introduced into the rock and occurs as ragged flakes which either occupy interstitial areas or form larger poikiloblastic flakes enclosing grains of other minerals.

Occasional grains of detrital tourmaline and zircon are present and a little limonite occurs as interstitial material.

P451/60. (L.G.N. 14/60, T.S. 6820)

A very fine-grained quartz-mica schist. The main constituents are fine quartz, biotite and muscovite with subordinate felspar (albite). The mica flakes have a sub-parallel arrangement which imparts a rather weak schistosity to the rock. Occasional grains of tourmaline and zircon were also observed.

P452/60 (L.G.N. 15/60, T.S. 6821)

A fine-grained amphibolite consisting almost entirely of hornblende. Fine grains of opaque iron oxides are disseminated throughout the rock. Minor amounts of quartz and muscovite have been introduced into the rock. Both of these minerals occur as poikiloblastic material with highly irregular outlines and enclose crystals of hornblende.

P453/60 (L.G.N. 16/60, T.S. 6822)

A moderately to poorly sorted arkose. The main constituents are quartz and felspar (oligoclase), with smaller amounts of muscovite and biotite. The quartz and felspar grains are generally of fine or medium sand grades while the mica flakes are usually fine and rather ragged. The biotite is also rather decomposed. The quartz grains are often cemented by secondary silica in optical continuity with the original grains. Accessory heavy minerals present are zircon, tourmaline, opaque iron oxides

P453/60 (Contd.)

and rutile. Limonite occurs as very fine interstitial material in some parts of the rock and also occupies cavities which may have resulted from the alteration of pyrite.

P454/60. (L.G.N. 17/60, T.S. 6823)

This rock is essentially similar to P453/60. The main differences are that this rock exhibits slightly better sorting, most of the grains being of fine-sand grade, and that the mica content is slightly higher. However, this rock is still classified as an arkose. A small amount of limonite is again found occupying occasional small cavities, but since these cavities are of rather irregular shape it does not appear that the limonite forms pseudomorphs after another mineral.

P455/60. (L.G.N. 18/60, T.S. 6824)

A fine to medium-grained impure marble consisting essentially of interlocking anhedral crystals of calcite. The main impurity is an amphibole in the tremolite-actinolite series. This occurs as highly corroded remnants undergoing replacement by calcite. Other impurities are grains of tourmaline, flakes of muscovite and biotite and a trace of limonite which occurs as fine interstitial material.

P456/60 (L.G.N. 19/60, T.S. 6825)

A medium to coarse grained white marble which consists almost entirely of interlocking anhedral crystals of calcite. Impurities present are small amounts of quartz, opaques and muscovite. Quartz occurs as occasional corroded remnants within the calcite crystals and also as fine interstitial material which has been introduced. Opaque minerals present include pyrite and opaque iron oxides. These form the dark specks which can be seen in handspecimen. Muscovite occurs as rare interstitial flakes. The impurities would not amount to more than 2% of the rock.

P457/60 (L.G.N. 20/60, T.S. 6826)

A medium-grained impure grey marble. The main constituent is calcite which occurs as interlocking anhedral crystals. The main impurities are biotite, which is present as corroded remnants, and quartz, which also occurs as remnants surrounded by calcite. Pleochroic haloes can be observed in the biotite flakes.

P458/60 (L.G.N. 21/60, T.S. 6827)

A coarse-grained pink marble consisting essentially of calcite. The impurities are present in dark coloured streaks and patches of irregular shape. The main impurities are corroded remnants of biotite and quartz with smaller amounts of pyrite and chlorite.

P459/60 (L.G.N. 22/60, T.S. 6828)

This is a very porous rock which appears to be a leached calc-silicate rock. The main constituent is now quartz with small amounts of tremolite and muscovite. Fine earthy limonite occurs as a lining in most of the cavities. The original rock was probably a tremolite-marble which suffered severe crushing followed by the introduction of quartz. As a result of leaching the carbonate mineral has been removed leaving the skeletal quartz structures.

P460/60 (L.G.N. 23/60, T.S. 6829)

A laminated siltstone consisting of quartz, biotite and muscovite. The mica flakes have a sub-parallel to parallel arrangement. Occasional grains of tourmaline and zircon are present, and limonite has been introduced along narrow veinlets cutting across the laminations of the rock.

The calcite in the samples of marble has been found to contain small amounts of manganese. The relative proportions of manganese is these samples were measured on the X-ray spectrograph. P456/60 has the highest manganese content. P455/60 and P457/60 both contain approximately 25% of the manganese in P456/60. P458/60 contains approximately 20% of the manganese content of P456/60. The calcite in these samples is therefore manganocalcite.

R. A. Both

MINERALOGIST

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

AN 1.2.0/1005

Samples marked as under, yielded on analysis:-

Mark	13/60 A1421/60	14/60 A1422/60	15/60 (A1423/60 Section 341)
Calcium Oxide (CaO)	3.55 %	0.52 %	11.35%
Iron (Fe)	3.45	2.65	11.0
Magnesium Oxide (MgO)	3.45	2.95	11.4
Silica (SiO_2)	58.7	58.1	43.1

Locality: - Hd. Moorooroo, section 343

L. G. Nixon, Department of Mines

Thomas R. Frost

CHIEF ANALYST

GEOLOGICAL PLAN

OF

MARBLE DEPOSIT

HD. MOOROOROO

SECTIONS 113, 341 & 343

113

3
Bearing 53° Mag.
Depression 55°
Depth 120'

2
Bearing 268° Mag.
Depression 45°
Depth 250'

1
Bearing 328° Mag.
Depression 72°
Depth 220'

6
Bearing 270° Mag.
Depression 75°

A

B

C

FAULT

e rocks

SCALE

FEET 100 0 100 200 300 400 500 600 700 800 FEET

SCALE IN FEET 100 0 100 200 300 400 500

SCALE IN METRES 50 0 50 100 150

8

S.A. Department of Mines

L60-137/4
Gk 9 B.A.T.

F 2

340

341

556

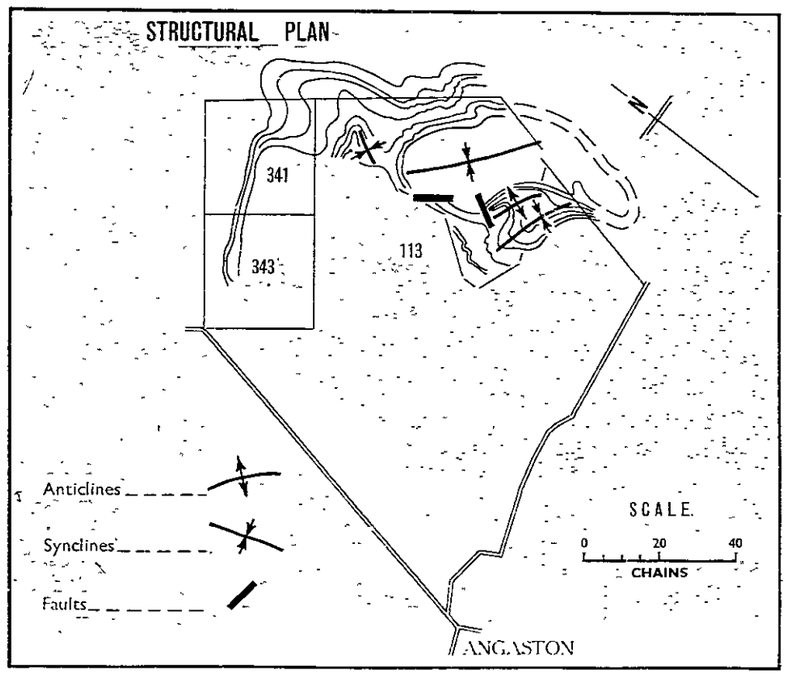
343

Vertical Depth 100'

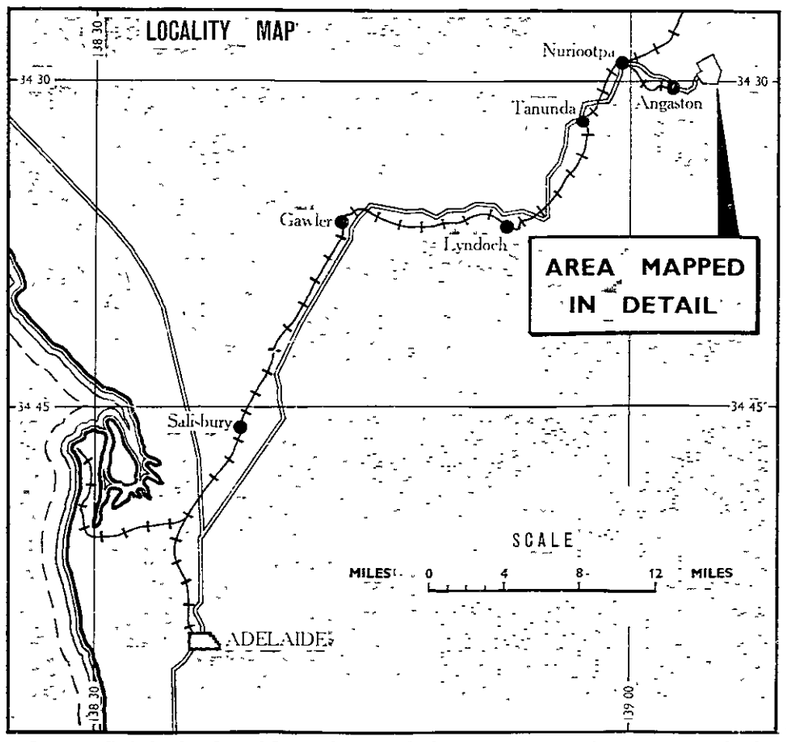
Bearing 323½° Mag.
Depression 43½°
Depth 220'

L60–137

STRUCTURAL PLAN



LOCALITY MAP



Pink marble

Brown marble

Actinolite marbie

Soil cover and alluvium

Strike and dip of bedding

Strike and dip overturned

Synclines

Borehole

Areas outlined for reserve estimates

L. G. Nixon