Copy 3

COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS.

RECORDS.

1957/21

REPORT ON LARRAKEYAH QUARRY, DARWIN, N.T.

by

W.F. McQueen

REPORT ON LARRAKEYAH QUARRY, DARWIN, N.T.

by

W. F. McQueen

RECORDS 1957/21

CONTENTS

PLATES

INTRODUCTION:

This quarry lies within the Darwin municipality and is near the Larrakeyah Military area. The site is very close to bitumen roads and has water and electricity supplied. It was selected for a supply of facing stone for a Cathedral to be built by the Catholic Church in Darwin. The location of the quarry is shown on Plate 1.

A plane table survey of the quarry was carried out in April, 1957 (see Plate 2).

GEOLOGY:

The stratigraphic sequence at Larrakeyah Quarry is shown in the cross section of the quarry (plate 3) and consists, from the top downwards of:-

AGE	THICKNESS	LITHOLOGY
Recent	1 foot	Soil and lateritic gravel.
Lower Cretaceous	9 feet	Silicified shale ("porcellanite").
	5 feet	Partially silicified shale.
	35 feet	Leached shale.
	4 feet	Ferruginous sandstone.
	2 feet	Quartz-pebble conglomerate.
---------- Unconformity ----------		
Precambrian	-	Siltstone with quartz veinlets.

Lower Cretaceous

The rocks of Lower Cretaceous age are members of the Darwin Formation which is part of the Mullaman Group (Noakes 1949). The total thickness of Darwin Formation at Larrakeyah Quarry is 55 feet.

The greater part of the quarry area is covered by silicified shale ("porcellanite") which crops out through a very thin soil cover. Some small areas are covered by a foot or so of lateritic gravel and brown soil. The thickness of hard silicified shale ranges from 9 feet to 7 ft. 6 in. Below this "porcellanite" the first 4 or 5 feet of the leached shale is also silicified but not to the extent of the "porcellanite". Below this layer the shale is relatively soft and shows only faint traces of iron. Traces of laminated bedding can be seen in some sections and this indicates that the strata is flat-lying with dips of no more than 2 or 3 degrees. These beds are 30 to 40 feet thick. The surface soil and massive ferruginous zone of the laterite have been removed by erosion and the silicified shale and leached shale represent the silicified and pallid zones of the lateritic profile.

Below the leached shale 3 to 4 feet of ferruginous, micaceous sandstone overlies a basal bed of quartz-pebble conglomerate. The sandstone contains small water-worn pebbles of quartz. The basal conglomerate is up to 2 feet thick and contains a mixture of water-worn and angular pebbles which vary in size from 5 or 6 inches in length to very small fragments.

Examination of the shale where the rubble has been removed shows a series of joint planes striking about 205 degrees. Another series strikes approximately at right angles to these (100 degrees to 108 degrees). A third (minor) series of joints strikes about 250 degrees.

Precambrian

Rocks of Precambrian age, which are members of the Noltenius Formation, underlie the Darwin Formation. An angular unconformity exists between the two formations. The Noltenius Formation is part of the Finniss River Group.

The Noltenius Formation occurs at the base of the cliffs in the quarry area and consists of finely-bedded siltstone, striking 343 degrees with dips ranging from 70 degrees to 50 degrees to the east. The siltstone is intruded by quartz veinlets.

TESTING OF SHALE:

To determine the suitability of the leached shale as a building and facing stone, tests have been carried out by the Commonwealth Experimental Building Station and the Geological Survey of Queensland on samples of the shale submitted by the architect designing the Cathedral. Extracts from their reports are given below:-

(a) A.K. Denmead, Chief Government Geologist Geological Survey of Queensland, Letter to Messrs. J.P. Donohue, Cusick and Edwards, Architects, 6/2/56 ---

"SAMPLE STONE, DARWIN, N.T.

"The specimens of stone submitted by you on the 25th ultimo as from the Darwin area were examined in the Laboratory and found to consist of -

1. One large specimen of a slightly clayey sandstone indurated by secondary silica.

2. Two sawn specimens of off-white fine sandy claystone, strongly compacted and wellbedded.

"A small amount of staining by iron oxides occurs along bedding and joint planes in both types of material. The joint planes are not particularly noticeable or persistent in either type, while the bedding planes are not very pronounced in Specimen No. 1, the material showing little or no tendency to split along the bedding planes in preference to any other direction, the rock having a typical conchoidal fracture. Specimen No. 2 shows a greater tendency to split along the bedding planes, this tendency, however, being hardly noticeable for stresses applied normal to the bedding planes when the material fractures with an uneven fracture surface at right angles to the bedding planes.

"The hardness of No. 1 is greater than that of No. 2 being about 4 on the Moh's scale of hardness.

"Neither type appears to be affected by solution using dilute acid while alternate wetting and drying appears likewise to have little effect. The average ratio of absorption of Specimen No. 1 is 7.46 per cent. that of Specimen No. 2 9.73 per cent. The clay mineral in Specimen No. 2 is a non-swelling type.

"From these observations it is considered that material similar to Specimen No. 1 would prove satisfactory for foundation purposes or as infilling. The high clay percentage in Specimen No. 2 may be a drawback which may be counteracted by its compact and non-swelling and non-plastic properties. The structural qualities of a material such as this would also depend on the disposition of the strata and the type and thickness of underlying rocks."

(b) Commonwealth Experimental Building Station, letter to Messrs. Woolacott, Hale & Bond. Consulting Structural Engineers, 3/10/1956 --

"The University of Technology have analysed the three samples of stone typical of that proposed for use in the new Darwin Cathedral, and have found them to consist of 75% quartz and 25% kaolin. The quartz is very fine and there may be some colloidal silica present. This colloidal silica and the kaolin are the cementing materials in this rock and they would account for the original comparatively soft condition and the phenomenon of hardening on drying. The rock is probably decomposed rhyolite.

"The following tests have been carried out on samples of the rock submitted and, for comparison, on typical samples of sandstone:-

1. Absorption-and-saturation-coefficient tests in accordance with British Standard 1257-1945.

2. Moisture-movement and drying-shrinkage tests in accordance with British Standard 1881-1952.

3. Compressive-strength tests in both wet and dry conditions in accordance with Standard C170-50 of the American Society for Testing Materials.

"The following is a summary of test results:-

	Specimen	Sandstone	Stone from Darwin.
Absorption after 24 hours' immersion, per cent by weight	1	3.97	16.10
	2	3.87	16.30
	mean	3.92	16.20
Absorption after 5 hours' boiling, per cent by weight	1	7.13	16.70
	2	6.88	16.85
	mean	7.00	16.78
Saturation coefficient	1	0.552	0.965
	2	0.562	0.967
	mean	0.557	0.966
Moisture Movement	1	0.042	0.014
	2	0.050	0.012
per cent	mean	0.046	0.013
Drying, Shrinkage,	1	0.058	0.014
	2	0.068	0.004
per cent	mean	0.063	0.009
Compressive Strength	1	7,800	3,450
Dry	2	9,370	4,330
lb per sq. in.	mean	8,585	3,890
Compressive Strength	1	3,210	2,850
Wet	2	2,800	2,310
lb. per sq. in.	mean	3,800	2,580.

"From the mineralogical analysis of the stone it would appear that expansions due to temperature would be of the same order as that of sandstone. It may be seen from the results that since the moisture movement and drying shrinkage are less than those of sandstone, expansion and contraction joints such as are used in good practice for sandstone should be adequate. The absorption after 24 hours' immersion, the absorption after 5 hours' boiling, and the saturation co-efficient are higher than for sandstone, so that it would be desirable to use a cavity wall as a means of weatherproofing the construction, since the thickness of a suitable solid wall would probably be excessive.

"The compressive strength of the stone is much less than that of sandstone, but is of the order of that of high quality concrete blocks. The stone may therefore be used for such structural purposes as would be usual for this type of concrete block."

MINING:

The quarry was opened initially by drilling and blasting the silicified shale which was then bulldozed over the edge of the cliff. Two benches were formed (see Plate 2). The lower bench is the working level and is 7 feet below the former natural surface.

From this working level a series of step benches were cut with the edges of the benches as closely parallel to the major joint direction as possible. Blocks of stone were removed by drilling at regular intervals and then using plugs and feathers. Uneven stresses set up by this method caused large pieces to break off conchoidally.

The present method being used is more successful. The block is now drilled so that it is channelled on three sides and then holes are drilled horizontally and the block is broken free by the use of plugs and feathers.

The shale is broken occasionally by joint planes. This is more evident close to the cliff face where weathering and the roots of trees and shrubs have opened up these fractures.

The initial blasting caused fracturing of the layer just below the "porcellanite" with the resultant loss of stone.

CONCLUSIONS AND RECOMMENDATIONS:

The area selected as the quarry is suitable for the type of stone required. Stone cut some twenty years ago from the western end of the site was used successfully in some Darwin buildings. Test drillings and a test pit show that the extent of the kaolinised shale is sufficient for present requirements and with reasonable care most of the rock available can be usefully employed.

It is important to note that the crushed rock must not be used in cement aggregate. Crypto-crystalline silica is present and this will cause adverse reactions during the setting of the concrete.

From the results of the tests shown above and observations made on the use of this stone in local buildings, the most suitable stone is that cut from fine grained rock showing no traces of bedding.

If the proportion of kaolin becomes much higher than in the samples tested the stone might be too soft for normal uses, hence a check should be made regularly on the stone being cut as the quarry faces move into less-weathered rock.

The upper layers in the quarry are strongly silicified and show limonitic staining. The blocks show weathering and fractures; are too hard to cut with a saw but can be trimmed with hand tools. Such blocks would be suitable for lower courses and fences.

The lower kaolinised layers are easily cut with tungsten-carbide tipped saws and these blocks gradually harden on exposure. The stone is almost pure white with occasional purplish stains. Most of this layer would be a suitable building and facing stone but any section showing bedding or cleavage planes should be rejected.

The present methods of cutting out blocks of stone seems the most effective to date, although the use of a drag or chain saw might save drilling in the softer material. The saw could be used to cut channels normal to the face while the drill could cut channels parallel to the face and drill the horizontal holes for the plugs and feathers.

It is recommended that blasting be kept to a minimum or eliminated entirely and some other method be used to strip the silicified shale.

================

REFERENCES:

Hossfeld, P.S. (1953) -

Stratigraphy and Structure of the Northern Territory of Australia. School of Geology, University of Adelaide.

Noakes, L.C. (1949) -

A geological reconnaissance of the Katherine-Darwin region, Northern Territory. Bureau Min. Resour. Aust. Bull. No. 16.

Woods, Rev. J.E. Tenison (1886) -

Report on the Geology and Mineralogy of the Northern Territory. Government, South Aust.

=================

29th April, 1957.

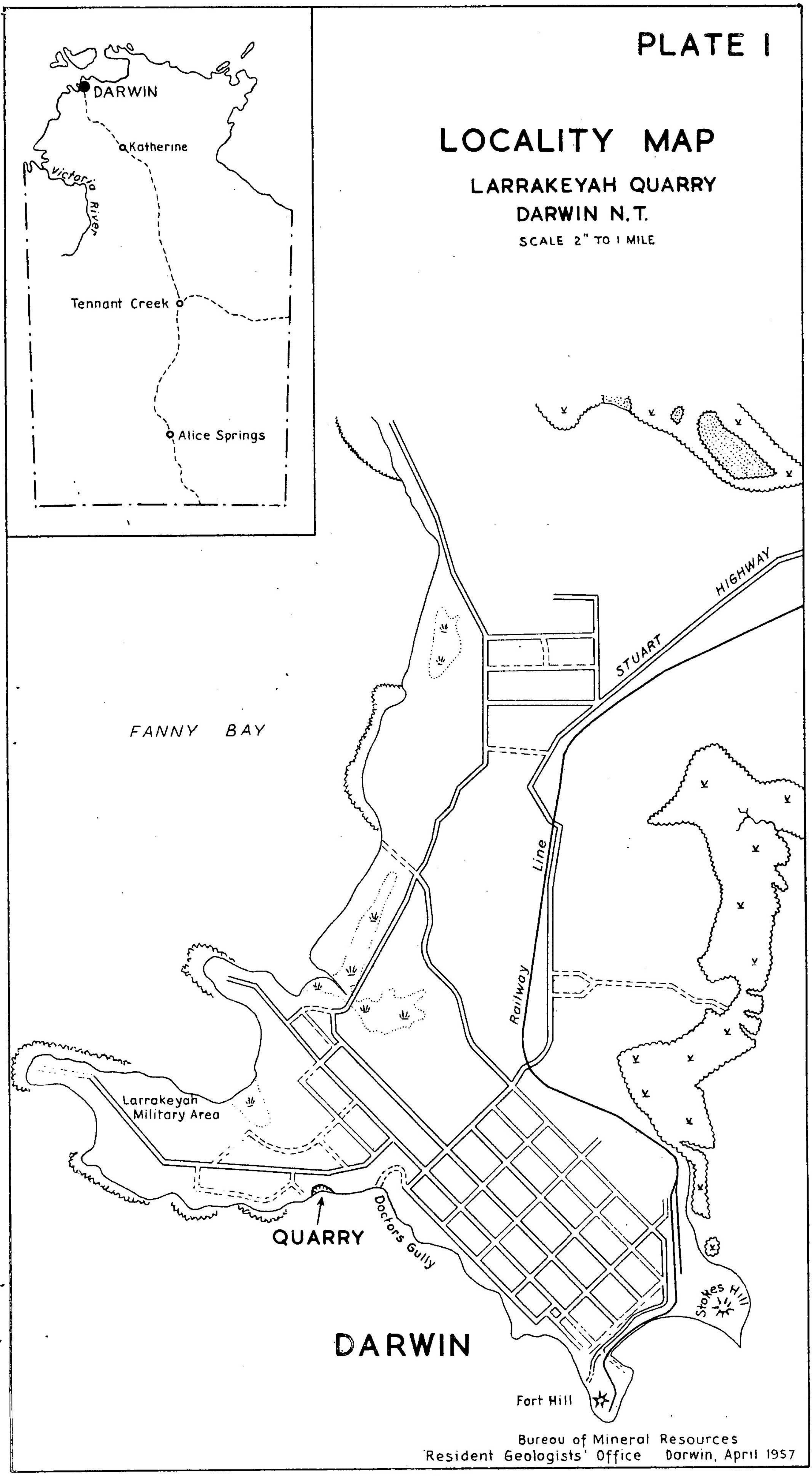


PLATE I
LOCALITY MAP
LARRAKEYAH QUARRY
DARWIN N.T.
SCALE 2" TO 1 MILE
DARWIN
Katherine
Victoria River
Tennant Creek
Alice Springs
STUART HIGHWAY
FANNY BAY
Railway Line
Larrakeyah Military Area
QUARRY
Doctors Gully
Stokes Hill
DARWIN
Fort Hill
Bureou of Mineral Resources
Resident Geologists' Office Darwin, April 1957

PLATE 2

SURFACE PLAN

FACING & BUILDING STONE QUARRY

LARRAKEYAH, DARWIN, N.T.

PLANE TABLE AND ALIDADE SURVEY BY W.F.M^c QUEEN

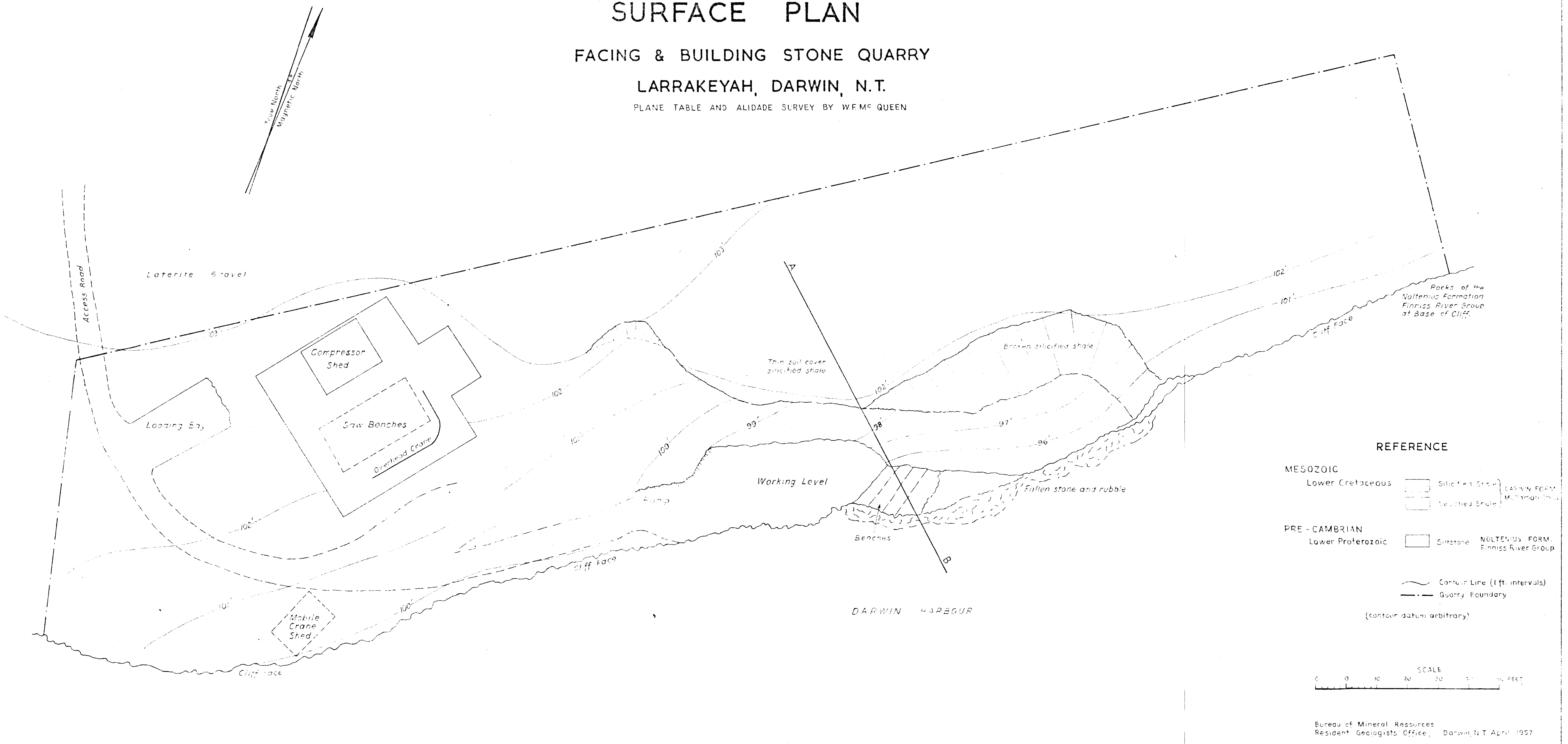
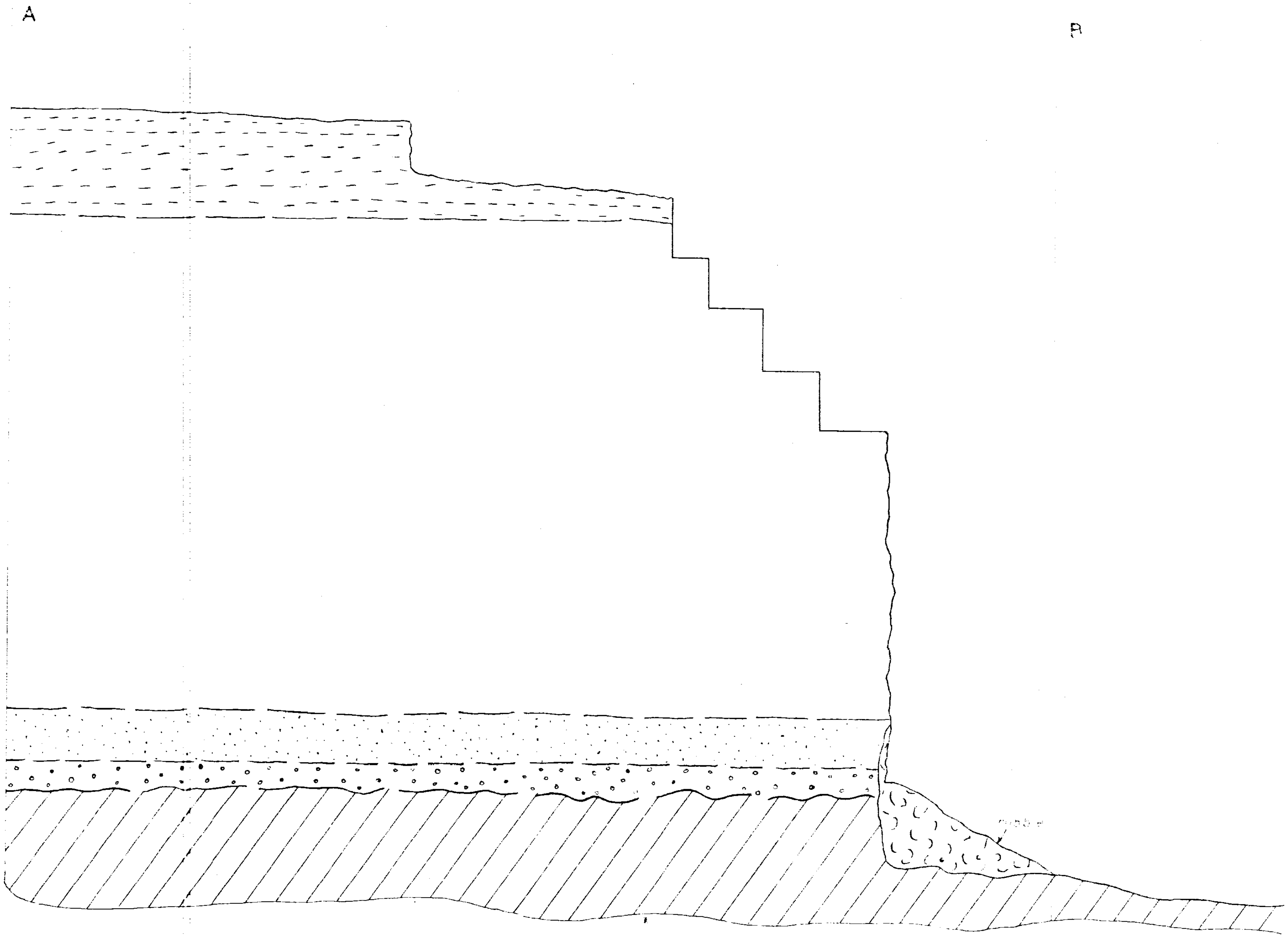


PLATE 3

CROSS SECTION A – B

BUILDING & FACING STONE QUARRY
LARRAKEYAH DARWIN N.T.



MESOZOIC

LOWER CRETACEOUS
- Silicified Shale
- Leached Shale
- Ferruginous Sandstone
- Quartz Pebble Conglomerate

} DARWIN FORMATION
Mullaman Group

PRE - CAMBRIAN

LOWER PROTEROZOIC
- Siltstone with Quartz Veinlets – NOLTENIUS FORMATION
Finniss River Group

—— Geological Boundary

~~ ~ Unconformity

HORIZ & VERT SCALE

FEET 10 5 0 10 20 FEET

BUREAU OF MINERAL RESOURCES
Resident Geologists' Office Darwin N T April 1957