COPY 3

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1970 / 45

015437

Stratigraphic Bores BMR Ulladulla 1 and 2, and Implications for Engineering Geology, Jervis Bay, A.C.T.

BUREAU OF MINERAL RESOURCES LIBRARY CANBERRA, A.C.T.

by

M.J. Jackson

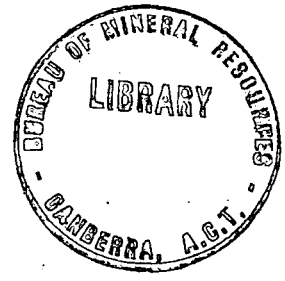
The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology & Geophysics.

BMR Record 1970/45 c.3

STRATIGRAPHIC BORES BMR ULLADULLA 1 AND 2, AND IMPLICATIONS FOR ENGINEERING GEOLOGY JERVIS BAY, A.C.T.

by

M.J. Jackson



RECORDS 1970/45

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospect or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

STRATIGRAPHIC BORES BMR ULLADULLA 1 AND 2, AND IMPLICATIONS FOR ENGINEERING GEOLOGY

JERVIS BAY, A.C.T.

Contents

SUMMARY

Two stratigraphic bores, Ulladulla 1 and 2, were drilled by the Bureau of Mineral Resources at Jervis Bay, A.C.T., in March 1969 to supplement the Bureau's 1968/9 engineering geology survey of this Commonwealth territory.

The stratigraphy, lithology, palaeontology and hydrogeology are described in detail. Additional comments on the engineering geology, including water resources, are made in the light of observations from the two bores.

INTRODUCTION

Two stratigraphic bores were drilled in the Commonwealth Territory of Jervis Bay, in March 1969, by the Petroleum Technology Section of the Bureau of Mineral Resources. The bores were drilled to provide geological information to supplement that contained in BMR Record 1969/88 (Jackson, 1969): BMR Ulladulla 1 mainly for additional information on the Permian succession, BMR Ulladulla 2 mainly for information on the Quaternary succession. A secondary purpose of both holes was to provide continuing groundwater observation points at Jervis Bay.

BMR Ulladulla 1 is about two miles south-east of the Royal Australian Naval College (RANC) at Jervis Bay; BMR Ulladulla 2 is about four miles south-west of the RANC (Plate 1). Technical details of the bore-holes are included in Appendix 2.

The core recovered from both bore-holes is stored at the Bureau's Core and Cuttings Laboratories, Fyshwick, A.C.T., where it is available for examination under the usual conditions.

GEOLOGICAL INFORMATION

BMR ULLADULLA 1

General

BMR Ulladulla 1 was drilled in the southern part of the Sydney Basin through part of an arenite sequence* that crops out extensively in the Jervis Bay area. The top of the sequence, part of the Conjola Formation (Rose, 1966), is not exposed in the Jervis Bay area; time permitted only 280 feet of coring, and the bottom was not reached. Consequently, the exact stratigraphic position of the bore-hole in the Conjola Formation is not known. Dickins, Gostin and Runnegar (see Appendix 4) consider this arenite sequence corresponds to the upper sandy part of the Conjola Formation of Artinskian (Lower Permian) age.

Sixty-seven feet of Quaternary sand and 6 feet of sandstone were drilled on 6th March, and a 6 inch casing was cemented in place. The bore was then continuously cored from 76 to 356 feet. Between 76 feet and 115 feet core recovery was poor (only 16 feet of core retrieved); from 115 to 356 feet 95% to 100% recovery was obtained.

Quaternary sand

The Quaternary sand in the area surrounding the bore is a fine-grained, grey, feldspathic, quartz sand. The Quaternary succession exposed during drilling included grey, yellow, orange and brown sands. Therefore, it would appear that sand at depth is not necessarily the same colour as that exposed at ground level. The grey feldspathic sand on the surface in this area may have had its colouring material (? iron oxide) removed by downward percolation of groundwater.

---

* Formerly referred to as the 'Jervis Bay Sandstone' by Perry and Dickins (1952) and Jackson (1969). The rock name is formal (having been used, once only in passing, in a printed work) but invalid; it should not be used unless validated with an adequate published definition.

Conjola Formation

Examination of the core from Ulladulla 1 has revealed several features that were not observed during the field survey in November/December 1968 (Jackson, 1969).

1. The presence of small scale variations in the composition and texture of the arenite. Two major arenite types (A and B) and one minor type (C) were logged at the drill site (Plate 2).

Type A - a massively bedded, medium to coarse-grained, dark grey, feldspathic greywacke.

Type B - a very thinly bedded, generally medium-grained, light grey feldspathic sandstone.

Type C - a medium-grained arenite containing many black clay stringers and with much argillaceous material in the matrix (greywacke).

These units range in thickness from a few inches to a few feet; they are repeated many times through the succession (Appendix 2). Petrographic studies (Appendix 3) show that the variations are due largely to the type and quantity of cementing material or matrix that is present. Clean sandstones and greywackes appear to be the end members, but gradations between these two types do occur. Conglomerates, thin bands of orthoquartzite, and sandy shales are also present.

2. Many sedimentary structures are present. Scour and fill channels (with slump structures) are common. Marked breaks in sedimentation usually separate the different arenite types. The scours and breaks in sedimentation probably indicate periods of wave activity at the depositional interface. Pyritised remains (probably leaf remains), wood fragments, and organic burrows (Plate 2) were found at several horizons. These features may indicate deposition in shallow water or proximity to the strand line. In the thin sections examined most of the constituent grains are sub-angular to angular, reflecting a lack of prolonged erosion and transportation. Most of the feldspar grains were fresh or little altered.

The small scale alternation of the different arenite units, as described above, probably indicates a delicate balance between sediment supply and deposition - a characteristic of present day deltas.

3. Fossiliferous horizons were logged (Appendix 2) at about 185, 230, 260, and 300 to 350 feet below ground level. They may, or may not, represent distinct fossil bands. The lowest horizon (300-350 feet) was by far the most fossiliferous and may be of use as a marker horizon. Determinations (by J.M. Dickins) of the shelly fossils from Ulladulla 1 are included in Appendix 4.

4. Many of the recorded fractures were caused by rotation of the core along bedding plane weaknesses. A few, narrow, high-angled joints were present.

Gamma-ray logs were run using a Widco Porta Logger and the records have been incorporated on the geological log sheets (Appendix 2). Run 1 (80 to 356 feet) recorded many small variations in the radioactivity of the arenite; they probably correspond to differences in clay content. Relatively high recordings of radioactivity were observed between 90 and 110 feet, so a second log at a higher scale was run. This area of the bore was one where core recovery was very low, and drilling speeds were high. This may possibly represent a clay sill similar to that seen south-west of R.A.N. airfield (Jackson, 1969). A third log, at a lower scale, was run in the Quaternary sand. The position of the water table, and the upper surface of the sandstone bedrock were well defined.

To summarise, the arenite intersected in BMR Ulladulla 1 is predominantly an interbedded sequence of sandstones, greywackes, and conglomerates, probably of shallow water origin and of Lower Permian age. No stratigraphic subdivisions were made. If, as suggested, the arenite at Jervis Bay was deposited in a region of shallow water deltaic sedimentation, lateral facies changes should be expected; stratigraphic sub-division would probably require extensive further studies.

Three samples of core of the arenite from BMR Ulladulla 1 were tested for permeability and porosity (Appendix 5). The samples were selected so that the most permeable looking, least permeable looking and an intermediate type were tested. The average effective porosity was 7.2 (% bulk volume); the absolute permeability was nil (less than 0.01 millidarcy). The lack of open joints in the core recovered and the low porosity of the three samples indicates that the arenite at Jervis Bay will probably not be a good aquifer in the unweathered zone. This was confirmed, at BMR Ulladulla 1, by using the drilling rig for a pump-out test after the completion of the hole. An air pressure of 150 lbs/sq. in. was applied, 70 feet from the bottom of the hole, and a flow of only 40 gallons/hour was obtained.

BMR ULLADULLA 2

BMR Ulladulla 2 was drilled in the south-west of the Territory where a thick sequence of Quaternary sand was thought to occur. Unfortunately, core recovery was nil below the water table (10 feet below ground-level) despite careful use of a 4 foot percussion barrel; logging was based on continuous mud sampling, until sandstone bedrock was reached. After completion of drilling, a Hydroflow plastic bore screen (type A, aperture size 0.41 mm) was set between 90 feet and 97 feet.

The three most important features observered were:-

1. The Quaternary succession in this area consists of 30 feet of fine-grained yellow sand overlying approximately 100 feet of fine-grained grey sand. Three black, peaty, clay layers are present at approximately 95, 118, and 130 feet (below ground-level). The clay layers contain fragments of wood* and were formed probably under lagoonal, marshy conditions. The upper two bands contain small white lamellibranch and gastropod shells.

---

* The exact stratigraphic positions of the plant fragments, brought to the surface in the drilling mud, are unknown. Under these conditions radiocarbon dating was considered to be not warranted.

2. The upper surface of the underlying bedrock of sandstone (Conjola Formation) was reached at a depth of 130 feet. The 30 feet of sandstone that was cored was soft and highly weathered. The weathering should be noted carefully (see Engineering Geology Section).

3. The water table at the time of drilling was 10 feet below the ground surface; hence a section of water-saturated sand, 120 feet thick, is present in the area. A $1\frac{3}{4}$ hour pump-out test using the drilling rig was carried out on 10th April: a return of 2,000 gallons/hour with undetermined drawdown was obtained. An analysis of a water sample from Ulladulla 2, taken in the last stage of the test, is included in Appendix 6. The chemical quality of the water is good; it is well within the limits of salinity considered suitable for human consumption.

WATER ANALYSES

To provide some information on the likely range in chemical qualities to be expected, six water samples were collected from different environments and chemically analysed. The sample localities, shown on Plate 1, were:

1. Ulladulla 1
2. Ulladulla 2
3. Lake Windermere - the sample was taken close to the pumping station.
4. Green Patch Weir - a small weir at the foot of the perennial Telegraph Creek. The weir is on sandstone, a few hundred yards south of Green Patch Beach.
5. Piezometer 3 - in the Quaternary sands south-west of Lake Windermere.
6. Piezometer 8 - in the Quaternary sands about $\frac{1}{2}$ mile north of Bherwherre Beach; sea spray probably falls on surrounding sand during high winds.

The partial analyses show that the salinity of water in Lake Windermere, Green Patch Weir and Ulladulla 2* is good; the elements tested are well within the chemical limits specified for human consumption. The waters in Ulladulla 1 and Piezometer 8 have less desirable qualities and higher contents of dissolved salts. The analysis of water from Piezometer 3 showed abnormally high concentrations of boron and flouride; it would not be suitable for domestic use (in view, however, of the abnormal conductivity of this water sample, this piezometer should be resampled and the new sample analysed).

The Sodium Adsorption Ratio (S.A.R.) and the hardness of the samples were calculated; these are included in Appendix 6. The S.A.R. is related to the possible adsorption of sodium by soil to which the water is added. The S.A.R. is useful in considering base-exchange reactions in soils and in evaluation of irrigation water.

It should be noted that the analyses are chemical only and are based on single samples; additional assessments of quality are essential if groundwater development is to be considered.

* Jackson (1969, p 18) suggested that the three black clay bands encountered in the bore-hole could cause the water to be too acidic for domestic use: the analysis suggests that this is not the case.

ENGINEERING GEOLOGY

WEATHERING

Ulladulla 1 and 2 have provided evidence of thick weathered sections in the arenites at Jervis Bay which are not obvious in surface mapping and inspections.

Construction workers from the Sydney area may be misled into believing that the sharp headlands and cliffs, similar in appearance to those around Sydney, indicate the same conditions of stability and shallow hard bedrock commonly found in the quartz sandstones around Sydney.

Micropetrological inspection of core from Ulladulla 1 revealed considerable proportions of feldspar and clay (Appendix 3); organic material, including fragments of decomposed wood, was also present. The feldspar and organic material render the arenites susceptible to deep weathering in favourable topographic situations. In exposed cliff sections the weathered profile is, or has been, removed by waves, wind or running water as rapidly as it is formed: in more protected areas, where wind and water have been less active (such as the areas where thick sand deposits have accumulated), considerable quantities of groundwater have moved through the surface section of open jointed arenite and caused chemical weathering in it to considerable depth. During periods of inundation by the sea when at higher levels base exchange between the sodium of the sea water and the calcium of more basic feldspars may also have occurred and hence complicated the weathering pattern.

The susceptibility of the feldspathic and clayey arenites to deep weathering in certain areas must be born in mind in the investigation of works connected with tunnelling, excavations, foundations, and winning of sound rock materials.

SAND

The Quaternary sand exposed in Ulladulla 1 indicates variations in colour and nature between the surface and sub-surface.

Evaluation of sand deposits should, therefore, include sufficient sub-surface exploration to enable the character of the sand to be evaluated adequately.

WATER RESOURCES

Future development at Jervis Bay may require larger quantities of water than Lake Windermere and McKenzie can supply. An alternative source of surface water is lengthy reticulation from the Shoalhaven River or the more important of the major small rivers in the Sussex Inlet - Nowra area.

Groundwater within the Territory offers several additional alternatives:-

a. for short term emmergencies, for local use outside the area of town reticulation
b. to supplement surface supplies
c. for agricultural and forestry use where quality tolerances may not be so strict
d. for long term major use

For short term or minor use the groundwater can be developed with only minor additional investigation and at a low capital cost. Investigation of the quality of the water is, however, important.

Major use of groundwater would require the normal carefully planned and well balanced investigation with particular emphasis being placed on the assessment of total storage, recharge, quality of water and design of extraction points.

The determination of permeability of the core samples from Ulladulla 1 (Appendix 5), the nature of the sediments (Appendix 3), and their depositional environment suggest that the location of important permeable zones in the arenites (other than the zone of shallow surface jointing or zones of fracturing) will be difficult, if not impractical. The Permian, therefore, is not regarded as a likely major source of groundwater. Groundwater observations, nevertheless, should be made in any government exploratory drilling programme, so that useful groundwater resources, or hazards caused by excavating through isolated aquifers, will not be missed.

The principal groundwater resources lie in the extensive thick deposits of Quaternary sand. The 120 feet of sand containing apparently good quality water located in Ulladulla 2 and the initial yield of 2000 gallons per hour further confirms this.

Jackson (1969, pp 14-19) discusses some of the factors that will probably affect the quantity of groundwater present in the Quaternary sands south-west of Lake Windermere; an initial piezometer network has been installed in this area to provide information on recharge in the sands.

The water analyses in Appendix 6 give an indication of the chemical quality to be expected in the groundwater at Jervis Bay. Some of the analyses are less acid than would have been expected in proximity to peaty layers: this may be due to changes in the pH between the field and laboratory (or in the case of Ulladulla 2 due to aeration during the air-lift pump test, or to lime that was added to condition the drilling mud). The possibility of local neutralisation of acid groundwater by shell beds or strong flushing by localised leaks from Lake Windermere should not be overlooked. These points emphasize the need for planned careful sampling of the groundwater with both pH and the presence of H_2S being assessed at the point of sampling as well as in the laboratory. Sampling should also be planned to assess the contamination of the groundwater by sea spray or by the salt water wedge in the areas adjacent to the beaches.

The failure to recover suitable samples of the sands for mechanical analyses from Ulladulla 2 using the special sampling barrel was unfortunate. The recovery of essentially undisturbed sand samples, to determine the grading of the sand and the proportions of clay and weathered feldspar, is vital to the successful design of wells, and assessment of the total water reserves of the sand. In view of this, further examination of core barrel designs has been undertaken and should, if possible, be completed before further major drilling.

It is recommended that the possible need for developing the groundwater at Jervis Bay be determined as soon as possible. If major use of groundwater is foreseen a suitable programme for further investigation should then be designed. Such an investigation would probably include drilling, pump tests (to determine aquifer constants and designs for wells), chemical and bacteriological sampling, resistivity and seismic surveys, and the construction of one or two permanent observation bores with continuous recorders. In the meantime pump tests, water level measuring and water sampling should be continued on the existing bores and piezometers to provide preliminary data. Particular care should be taken to preserve the sands from pollution (see comments on the Jervis Bay area by Burton (1969) to the Senate Select Committee on Water Pollution).

GENERAL

The presence of peaty layers and shelly beds in the sands in Ulladulla 2 may be further reminders of the fact that sea level fluctuated considerably in the Quaternary (Fig. 2). Drowned estuaries containing several hundred feet of sediment, erosion valleys filled with water-bearing sands, and deep open-jointing in the arenites (formed by expansion of joints when sea levels were lower) may occur in the Jervis Bay area. The difficulties and hazards associated with these features should be considered in major engineering works.

REFERENCES

BURTON, G.M., 1969 - Pollution of groundwater. Bur. Min. Resour. Aust. Rec., 1969/74 (unpubl.).

GUPPY, D.J., 1964 - Classification of the Sedimentary Rocks. Bur. Min. Resour. Aust. Rec., 1964/112 (unpubl.).

HEM, J.D., 1959 - Study and interpretation of the chemical characteristics of natural water. Water Sup. Pap. U.S. geol. Surv., No. 1473.

INGRAM, R.L., 1954 - Terminology for the thickness of stratifaction and parting units in sedimentary rocks. Geol. Soc. Amer. Bull., 65, 937-938.

JACKSON, M.J., 1969 - Engineering geology and economic resources of Commonwealth Territory, Jervis Bay. Bur. Min. Resour. Aust. Rec., 1969/88 (unpubl.).

PERRY, W.J., & DICKINS, J.M., 1952 - Report on a geological survey of Commonwealth Territory, Jervis Bay. Bur. Min. Resour. Aust. Rec., 1952/88 (unpubl.).

PETTIJOHN, F.J., 1964 - SEDIMENTARY ROCKS. Harper & Bros., New York.

ROSE, G., 1966 - Ulladulla 1:250,000 Geological Sheet N.S.W. geol. Surv. 1:250,000 Geol. Sheet.

VAN STRAATEN, L.M.J.U., 1964 - DELTAIC AND SHALLOW MARINE DEPOSITS. (Proceedings of the sixth International Sedimentological Congress - 1963) Elsevier Publ. Company.

WILLIAMS, H., TURNER, F.J., and GILBERT, C.M., 1958 - PETROGRAPHY W.H. Freeman & Company, San Francisco.

APPENDIX 1

DEFINITIONS OF DESCRIPTIVE TERMS

Particle Size

Pebble	4 to 64 mm
Very-coarse-grained sand	2 to 4 mm
Coarse-grained sand	1 to 2 mm
Medium-grained sand	$\frac{1}{4}$ to 1 mm
Fine-grained sand	1/16 to $\frac{1}{4}$ mm

Degrees of Weathering

Fresh	Rock shows no discolouration, loss of strength, or any other effect of weathering.
Slightly weathered	Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock.
Moderately weathered	Rock is discoloured and noticeably weakened, but a 2 inch diameter drill core cannot usually be broken up by hand across the rock fabric.
Highly weathered	Rock is usually discoloured and weakened to such an extent that 2-inch diameter cores can be broken up readily by hand, across the rock fabric.
Completely weathered	Rock is discoloured and entirely changed to a soil, but original fabric of rock is preserved.

Hardness

Hard to very hard	Rock impossible to scratch with knife blade.
Moderately hard	Shallow scratches with knife blade.
Soft	Deep scratches with knife blade.

Percussive Strength of Rock

Strong to very strong	Not broken by repeated blows with a 2 lb. geological hammer.
Moderately strong	Rock broken by 3 or 4 heavy blows with a 2 lb. geological hammer.
Weak	Rock broken by one blow or with hand pressure.

Bedding Thickness (After Ingram 1954)

Very thick-bedded	100 - 1000 cm
Thick-bedded	30 - 100 cm
Medium-bedded	10 - 30 cm
Thin-bedded	3 - 10 cm
Very thin-bedded	1 - 3 cm
Thickly laminated	0.3 - 1.0 cm
Thinly laminated	0.1 - 0.3 cm

BORE DATA

BMR Ulladulla 1

Location:	Latitude	35°09' 12"S
	Longitude	150°43' 35"E
	1:250,000 sheet	Ulladulla SI 56-13
	General Location	2 miles south-east of the Royal Australian Naval College (R.A.N.C.) at Jervis Bay (Plate 1).
Elevation:	Ground level	Approx. 285 feet above sea level (A.S.L.) (Estimated from 1:50,000 Military Sheet).
Date Commenced:	5-3-1969	
Date Completed:	26-3-1969	
Total Depth (G.L.):	356 feet (ft)	
Casing:	6 inch (in) casing to 71 ft. 6 in.	
Logs:	Gamma Ray Log 1 - 80 ft. to 356 ft. 2 - 90 ft. to 115 ft. 3 - 0 to 80 ft.	
Status:	Capped; used for observations of groundwater level.	
Personnel:	Driller, K. Reine Drilling Assistants, K. Huth, T. Shanahan Well-site Geologist, M. Jackson (Geologist) A.W. Schuett, (Technical Assistant)	

BMR Ulladulla 2

Location:	Latitude	35°09' 18"S
	Longitude	150°39' 21"E
	1:250,000 sheet	Ulladulla SI 56-13
	General Location	4 miles south-west of the Royal Australian Naval College at Jervis Bay (Plate 1).
Elevation:	Ground level	Approx. 25 ft. A.S.L. (Estimated from 1:50,000 Military Sheet).

Date commenced:	28-3-1969
Date completed:	2-4-1969
Total Depth (G.L.):	169 ft. 9 in.
Casing:	6 in. casing to 90 ft.
Screen: (90-97ft.)	Hydroflow plastic bore screen (type A, aperture size 0.41 mm).
Logs:	Gamma-Ray Log.
Status:	Capped: used for observations of groundwater levels.
Personnel:	(as Ulladulla 1).

APPENDIX 2

BORE-LOGS

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY. A.C.T.

LOCATION 3,800FT. NORTH FROM BHERWERRE TRIG STATION, JERVIS BAY. A.C.T.

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 111925FT. E 198020FT. N. R.L. 285FT. A.S.L.

HOLE NO. ULLADULLA 1

SHEET 1 OF 5

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	γ-RAY LOGS
T LEACHED SOIL	Unconsolidated, fine-grained sandy soil. Leached, but containing much vegetable matter.								
LOAM	Fine-grained, brown iron stained quartz sand. Vegetable matter common.								
QUATERNARY SAND	Unconsolidated, fine-grained quartz sand. Yellow coloured.						Sand sequence established from continuous mud sampling.		
	Unconsolidated, fine grained, orange, quartz sand. Occassional fine-grained fragments of shells present.								
	Predominantly fine-grained orange quartz sand. Proportion of coarse quartz grains, & pebbles and cobbles, of highly weathered sandstone increases gradually downwards.						Resistance to drilling increases progressively from approx. 50FT to the top of the Sandstone		
HIGHLY WEATHERED ARENITE	Coarse grained, grey, friable sandstone. Weak strength Soft.						Occassional grey shale fragments present.		

10 20 30 40 50 60 70 80

0–76FT. DRILLED NO CORES TAKEN

RUN 3

DRILL TYPE HAYHEW 1000
FEED MECHANICAL
CORE BARREL TYPE TRIEFUS
ISFT. 2½" DIA.
DRILLER K. REINE
COMMENCED 5.3.1969
COMPLETED 26.3.1969
LOGGED BY M. J. JACKSON
VERTICAL SCALE 1" = 10FT.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blacked in.
BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

WATER PRESSURE TESTS

PACKER TYPE
SUPPLY LINE
VERTICAL SCALE
Figures given are gauge pressures
Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE
COLOUR

156/A13/21 (1-5)

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY, A.C.T.

LOCATION 3,800FT. NORTH FROM BHERWERRE TRIG STATION JERVIS BAY. A.C.T.

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 111925FT. E. 198020 FT. N R.L. 285FT. A.S.L.

HOLE NO ULLADULLA 1

SHEET 2 OF 5

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	γ - RAY LOGS	PHOTO REF NO CORE BOX	PHOTO REF NO CORE SHARED

HIGHLY TO MODERATLY WEATHERED ARENITE

Qzt.

MODERATLY WEATHERED ARENITE

MODERATLY TO SLIGHTLY WEATHERED ARENITE

A coarse to medium grained, light grey sandstone.

Weak to moderate strength.

Moderately Hard.

Occassional breaks in sedimentation are present.

Highly weathered porous horizon. coarse-grained

Planes of bedding are seldom visible

C A C

s.b.

90 100 110 120 130 140 150 160

60% 20% 100% 10% 100% 100% 100% 100% 100%

82 to 86': - thin vertical joint with black clay staining.

98': friable micaceous/clayey sandstone

100': Grey soft clay band 6" thick.

MOST FRACTURES ARE APPROX. HORIZONTAL AND DOE TO DRILLING.

117': Joint dip 30°

122': Cut and fill structure

123': Bedding approx 30°

124': low angled fractures with clay

132': 4 annelid burrows? size-4" × 1/4"

138': cut and fill structure

147': Joint dipping 70°, clay filled.

149': cut and fill structure

150': Raft of grey, plastic clay.

154': cut and fill structure.

RUN 2

RUN 1

DRILL TYPE HAYHEW 1000
FEED MECHANICAL
CORE BARREL TYPE TRIEFUS'
15FT. 2 1/2" DIA.
DRILLER K. REINE
COMMENCED 5.3.1969
COMPLETED 26.3.1969
LOGGED BY M. J. JACKSON
VERTICAL SCALE 1" = 10FT.

NOTES

FRACTURE LOG.- Number of fractures per foot of core. Zones of core loss are blocked in.
BEDDING AND JOINT PLANES:- Angles are measured relative to a plane normal to the core axis

- Conglomeratic horizons (generally less than 2foot thick)
- @ Fossil cast
- cut and fill structure, former erosion and deposition channels?
- s.b. marked break in sedimentation
- thin clay seam

WATER PRESSURE TESTS

PACKER TYPE
SUPPLY LINE
VERTICAL SCALE
Figures given are gauge pressures
Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE
COLOUR

156/A13/21(2-5)

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY, A.C.T.

LOCATION 3800 FT NORTH FROM BHERWERRE TRIG STATION, JERVIS BAY, A.C.T.

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 1119250 FT. E 198020 FT. N. R.L 285FT. A.S.L.

HOLE NO ULLADULLA 1

SHEET 3 OF 5

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION (LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC)	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES (JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES)	WATER LEVEL	γ RAY LOGS	CORE BOX	CORE NO / BARREL

MODERATLY TO SLIGHTLY WEATHERED ARENITE

Type A and type B interbedded

A 55%

B 30%

C 15%

moderately to highly weathered sandstone

FRESH ARENITE (moderatly weathered along joints, faults and porous shell horizons)

Type A dominant

A 85 %

B 10 %

C 5 %

Highly weathered, permeable, shelly horizon.

Qzt

s.b.

164' to 166' – Several marked breaks in sedimentation present. Cut and fill structures present.

170' – one thin joint dipping at 45°

185' to 187' – Core heavily fract major joint or fault plane?

188' – one joint with black clay dipping at 60°

197' – one joint, dip 60°

197' to 202' Several high-angled joints visible (dipping 60°–90°). Core heavily fracture and stain in presence of soft black clay.

211' one joint dip 60°

216' 3" Dia., sub-rounded quartz pebble

215' to 220 – small patches of pyrite staining present

220' marked break in sedimentation with worm burrows? 4" long.

223' black clay/sandstone band 2" thick.

231 to 233 – 3 marked breaks in sedimentation

233 – large angular slab of grey/green siltstone with original quartz veining.

DRILL TYPE MAYHEW 1000

FEED MECHANICAL

CORE BARREL TYPE TRIEFUS

15FT. 2½" DIA

DRILLER K. REINE.

COMMENCED 5. 3. 1969

COMPLETED 26. 3. 1969

LOGGED BY M. J. JACKSON

VERTICAL SCALE 1" = 10FT

NOTES

FRACTURE LOG – Number of fractures per foot of core. Zones of core loss are blacked in.

BEDDING AND JOINT PLANES – Angles are measured relative to a plane normal to the core axis

TYPE A – Massively bedded, medium to coarse grained, dark grey feldspathic greywacke

TYPE B – Very thinly bedded, medium grained, light grey feldspathic sandstone

TYPE C – Medium grained arenite containing numerous black clay stringers, or with considerable black clay in matrix.

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically, by blacked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

156/A13/21(3-5)

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY, A.C.T.

LOCATION 3800FT NORTH FROM BHERWERRE TRIG. STATION, JERVIS BAY, A.C.T.

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 111925FT. E. 198020FT. N. R.L. 285FT. A.S.L.

HOLE NO. ULLADULLA 1

SHEET 4 OF 5

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	γ RAY LOGS	CORE BOX	CORE SAMPLES

FRESH ARENITE (moderately weathered along joints, faults and porous shell horizons)

Type A and type B interbedded

A 57%
B 38%
C 5%

Type B

s.b. = shell bed

242' – Pyritised fossil leaf impression.

244'6" – 3" band of hard black mudstone

246' – joint 3mm wide with black clay, dip 45°

247'–248' – pebble horizon containing highly weathered igneous pebbles.

250–252' – cut and fill structures common

257'–259' – 45° joints, fractured by drilling.

265'6" – pyritised fossil leaf impression

270'–280' numerous breaks in sedimentation with cut + fill structures (shallow water)

275 – pebble horizon with weathered igneous pebbles.

FRACTURES ARE APPOX. HORIZONTAL & DUE TO DRILLING EXCEPT WHERE STATED OTHERWISE

285, 288, 291 } annelid burrows?

296, 299 } band of hard black mudstone

307 – clay filled vertical joint

308 – leaf impression

311–312 80° fractures probably joints

313, 317 } thin bands of hard, black mudstone.

100%

2080

DRILL TYPE MAYHEW 1000
FEED MECHANICAL
CORE BARREL TYPE TRIEFUS
15FT. 2½" DIA.
DRILLER K. REINE.
COMMENCED 5.3.1969
COMPLETED 26.3.1969
LOGGED BY M.J. JACKSON.
VERTICAL SCALE 1" = 10FT.

NOTES

FRACTURE LOG – Number of fractures per foot of core. Zones of core loss are blacked in.

BEDDING AND JOINT PLANES – Angles are measured relative to a plane normal to the core axis.

Cross stratified, Unit B.

Qzt. Quartzitic sandstone

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures
Test sections are indicated graphically, by blacked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE GA/2080 – see PLATE 2 of this report

COLOUR

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY, A.C.T.

LOCATION 3,800FT. NORTH FROM BHERWERRE TRIG STATION, JERVIS BAY. A.C.T.

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 111925FT. E 198020FT. N. R.L. 285FT. A.S.L.

HOLE NO. ULLADULLA 1

SHEET 5 OF 5

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	γ-RAY LOGS	CORE PHOTO REF	CONE PHOTO NO

FRESH ARENITE

dominant

A 15%
B 80%
C 5%

B
C
A
B

Qzt.
A
Qzt.
A

Type A dominant

A 70%
C 7%
Qzt. 23%

A
Qzt.
C
A

330
340
350
360

100%
95%
60%

324' - pyritised fossil leaf.

328' - 329 - joints with clay, dipping at 80°

FRACTURES ARE APPROX. HORIZONTAL & DUE TO DRILLING EXCEPT WHERE STATED OTHERWISE

Fractures horizontal due to rotation along clay seams

END OF HOLE

356 Feet

DRILL TYPE MAYHEW 1000
FEED MECHANICAL
CORE BARREL TYPE TRIEFUS
15FT. 2½" DIA.
DRILLER K. REINE
COMMENCED 5.3.1969
COMPLETED 26.3.1969
LOGGED BY M.J. JACKSON
VERTICAL SCALE 1" = 10FT.

NOTES

FRACTURE LOG – Number of fractures per foot of core. Zones of core loss are blacked in.
BEDDING AND JOINT PLANES – Angles are measured relative to a plane normal to the core axis

WATER PRESSURE TESTS

PACKER TYPE
SUPPLY LINE
VERTICAL SCALE
Figures given are gauge pressures
Test sections are indicated graphically by blocked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE
COLOUR

156/A13/21(5-5)

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY, A.C.T.

LOCATION 1 MILE South-west of LAKE McKENZIE, JERVIS BAY.

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 1096880 FT. E. 1979380 FT. N. R.L. app. 25' A.S.L.

HOLE NO. ULLADULLA 2

SHEET 1 OF 3

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	γ-RAY LOG	CORE BOX	SHOT FIRE PT.	CORE BARREL
SOIL	Brown Sandy soil						yellow, fine grained quartz sand					
	Fine-grained quartz feldspathic sand. Yellow.		10					W.T.				
							6" yellow sand					
			20				3' pale yellow/grey quartz sand					
							yellow sand					
			30				grey sand					
UNCONSOLIDATED QUATERNARY SAND												
	Fine-grained quartz feldspathic sand. Grey. Sparse wood fragments		40				CORING CEASED AT 44FT BINC.					
							DRILLING WITH MUD SAMPLING					
			50				55' sand pellets; semi consolidated pebble-sized pellets of sand.					
			60									
							NO CORES TAKEN					
			70									
			80									

DRILL TYPE MAYHEW 1000
FEED MECHANICAL
CORE BARREL TYPE
DRILLER K. REINE
COMMENCED 28-3-1969
COMPLETED 2-4-1969
LOGGED BY M.J. JACKSON
VERTICAL SCALE 1" = 10'

NOTES

FRACTURE LOG.- Number of fractures per foot of core. Zones of core loss are blacked in.
BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis.

WATER PRESSURE TESTS

PACKER TYPE
SUPPLY LINE
VERTICAL SCALE
Figures given are gauge pressures
Test sections are indicated graphically by blacked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE
COLOUR

156/A13/22 (1-3)

J 56/4 3 2

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY A.C.T.

LOCATION 1MILE south-west of LAKE McKENZIE, JERVIS BAY

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 1096880FT. E. 1979380FT. N R.L. app. 25' ASL.

HOLE NO. ULLADULLA 2

SHEET 2 OF 3

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	γ-LOG RAY	CORE BOX	PHOTO REF. CORE BOX NO.
Sand	Fine-grained quartz feldspathic sand GREY		90								
clay	Black fossiliferous clay						94'-96': tenaceous black clay containing numerous white lamellibranch shells				
Sand	GREY sand		100								
clay	Black fossiliferous earthy clay		110				115-120 black clay with white lamellibranch shells				
Sand	GREY sand		120								
clay	Black clay		130				130-135 black clay, no fossils				
Brown sandy clay with highly weathered sandstone fragments	highly weathered Jarvis Bay Sandstone Soft, friable and weak. Probably reworked upper surface of sandstone		140				135' CORING RECOMMENCED; soft friable dark brown sandy clay. Quartz grains ½mm, slightly micaceous				
highly weathered SANDSTONE	Soft, weak, conglomeratic sandstone. greyish-brown.		150				med/crs grained sandstone massively bedded, porous; as above, white clay in pores.				
			160								

NO CORES TAKEN

DRILL TYPE MAYHEW 1000
FEED MECHANICAL
CORE BARREL TYPE
DRILLER K. RIENE
COMMENCED 28.3.69
COMPLETED 2.4.69
LOGGED BY M.J. JACKSON
VERTICAL SCALE 1" = 10'

NOTES

FRACTURE LOG:- Number of fractures per foot of core. Zones of core loss are blacked in.
BEDDING AND JOINT PLANES:- Angles are measured relative to a plane normal to the core axis

WATER PRESSURE TESTS

PACKER TYPE
SUPPLY LINE
VERTICAL SCALE
Figures given are gauge pressures
Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE
COLOUR

156/A13/22(2-3)

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ENGINEERING GEOLOGY, JERVIS BAY A.C.T.

LOCATION 1 MILE south-west of LAKE MCKENZIE, JERVIS BAY

ANGLE FROM HORIZONTAL 90° DIRECTION VERTICAL

COORDINATES 109680FT. E : 197980FT. N. R.L. 25' A.S.L

HOLE NO. ULLADULLA 2

SHEET 3 OF 3

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	γ-RAY LOG	CORE BOX NO.	CORE BARREL NO.
Moderately weathered Sandstone	soft, weak, conglomeratic grey sandstone annelid burrows?		160				med/fine grained sst. med/crs pebbly sst light grey grey/brn congl. sst				
	END OF HOLE		170				169FT 9"				
			180								

DRILL TYPE MAYHEW 1000

FEED MECHANICAL

CORE BARREL TYPE

DRILLER K. REINE

COMMENCED 28.3.1969

COMPLETED 2.4.1969

LOGGED BY M. J. JACKSON

VERTICAL SCALE 1inch = 10feet

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures
Test sections are indicated graphically by blocked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

156/A13/22(3-3)

APPENDIX 3

PETROGRAPHY

Specimen 587 Core Depth 234 ft 7 inch (Fig 1)

The core is a light-grey, very thinly bedded, medium-grained sandstone (Unit B). The following minerals were identified under the petrographic microscope.

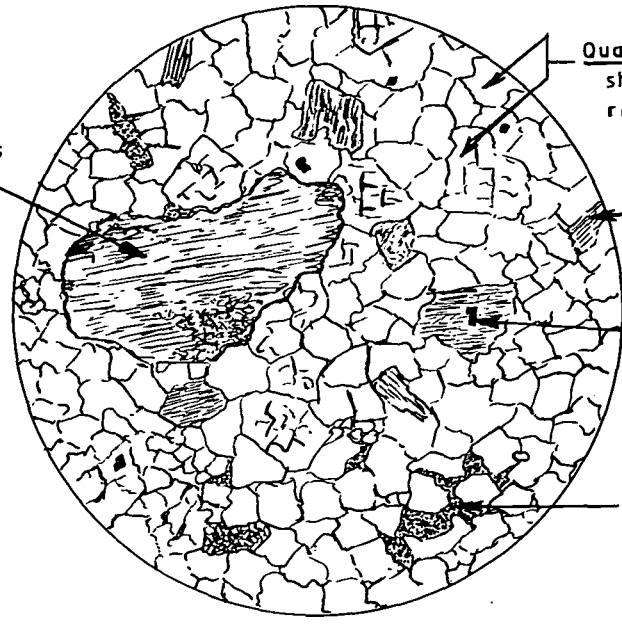
	Approximate percentage
quartz	70-75
feldspar	15-20
mica (muscovite)	less than 5
argillaceous matrix	" " 5
opaques (pyrite)	" " 2

The quartz and feldspar form the bulk of the rock. They occur as an interlocking mosaic of sub-angular to angular grains, generally of fairly uniform grain size. The individual grains have an average diameter of about $\frac{1}{4}$ millimetre (mm), but sparse grains of 1 mm dia. occur. The quartz commonly exhibits strain extinction and an imperfect rectangular cleavage. Most of the feldspar is fresh; it is untwinned but can be distinguished from the quartz by its slight cloudiness and a poorly developed cleavage. A few small grains of twinned microcline are present and graphic intergrowth of the quartz and feldspar is seen in a few grains.

Several, small elongated laths of a transparent mica (muscovite) are present; scaly aggregates of the same mineral (sericite variety) occur in the matrix. A light brown argillaceous matrix, made up of fine grains of quartz, feldspar and mica in clay, occurs between some of the larger grains. It does not constitute an important part of the rock.

A number of small euhedral crystals of pyrite are scattered throughout the slide.

Thin Section 587



Quartz, angular grains showing an imperfect rectangular cleavage

Feldspar, irregular grains slightly cloudy

Muscovite, well-developed cleavage

Pyrite, small euhedral crystals (opaque)

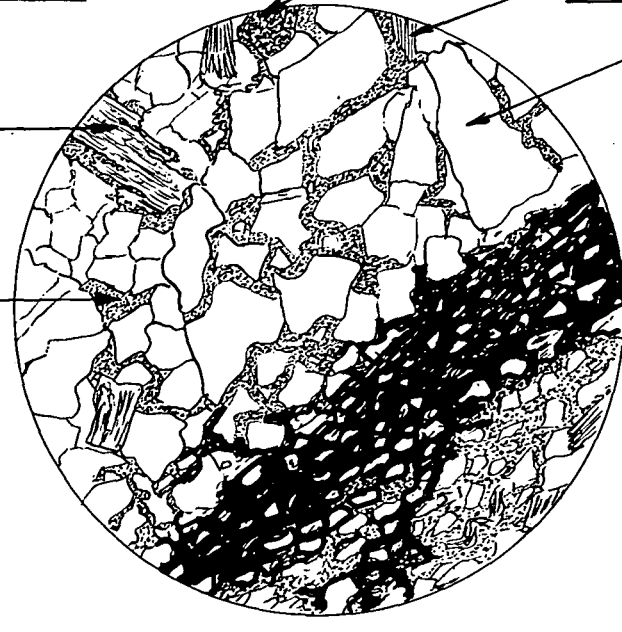
Intergranular matrix

FELDSPATHIC SANDSTONE

×28

0 ½ 1 mm

Thin Section 582



Lithic fragment

Muscovite

Quartz, angular grains showing strain extinction.

Feldspar

Intergranular matrix

black clay band small grains of quartz, feldspar and mica in an argillaceous matrix.

FELDSPATHIC GREYWACKE

Microdrawings of two specimens of arenite from Ulladulla 1

MJ

FIGURE 1

The angularity of most of the grains and the freshness of the feldspar would suggest little erosion during transport. The moderate sorting and lack of a clay matrix suggest washing and winnowing in the depositional environment. The grains are cemented by a thin veneer of quartz. This quartz cement is dominantly primary; evidence of secondary enlargment and recrystallisation is lacking. This specimen is classified as a feldspathic arenite.*

Specimen 582 Core Depth 264 ft 9 inch (Fig 1)

The core is a greyish-brown, medium to coarse-grained sandstone containing thin veins of black micaceous clay. Under the petrographic microscope the general appearance of thic rock is similar to Specimen 587 except that there is a much higher proportion of matrix. The specimen has the following composition.

	Approximate percentage
quartz	60
feldspar	10
argillaceous matrix	15-20
lithic fragments	less than 10
mica and opaques	less than 5

The sorting and angularity are similar to that seen in Specimen 587. The grainsize is slightly coarser (average diameter about $\frac{1}{2}$ mm). Some of the constituent grains are cemented together by quartz, but a large number of them are separated from each other by a light-brown argillaceous matrix. This matrix is concentrated to form a band of clay, 5 mm wide, in part of the thin section. This band contains minute irregular grains of quartz, feldspar and mica which are oriented to form irregular bedding planes. This rock is classified as a feldspathic greywacke and is indicative of a lack of winnowing and sorting at the time of deposition. The clay stringers probably indicate periods of increased turbidity.

(* Classification after Guppy 1964).

Specimen 584 Core Depth 282 ft 9 inch

The core is almost identical in appearance to Specimen 582. The composition of the rock is very similar to Specimen 582 except that it contains a noticeable amount of lithic fragments. Under the petrographic microscope the following minerals were identified.

	Approximate Percentage
quartz	65
feldspar	15
lithic fragments	15
matrix	less than 2
mica	" " 2

This rock is classified as a sub-labile, feldspathic sandstone. It is similar to Specimen 582 in the angularity of fragments, but the sorting is poor; grains up to 3 mm in diameter are present. The lithic fragments are dominantly very-fine-grained arenites.

Several other thin sections were examined. As they are all similar in composition and texture to those described above, further descriptions are not warranted.

Quartz is the dominant mineral in all the thin sections examined (generally in excess of 60%). Lithic fragments, feldspar and argillaceous matrix are the main variables. The small differences in composition between the specimens examined were probably caused by small changes in the depositional environment.

APPENDIX 4

PERMIAN MARINE INVERTEBRATE FOSSILS FROM B.M.R. ULLADULLA NO. 1.

by

J.M. Dickins

Although in some of the pieces of core examined, shelly fossils are relatively abundant, only a few species are represented. In many of the shells the calcium carbonate has been leached away leaving only the internal and external impressions of the shell.

Identifications:

Brachiopods

Neospirifer sp.

Ingelarella cf. *plana* Campbell, 1960.

Notospirifer? sp. ind.

Other organisms: In some pieces of core much burrowing is evident.

Plants: Coalified wood.

Conclusions

Neospirifer sp. and *Ingelarella* cf. *plana* are known to occur in the Conjola Formation or its equivalents in the Sydney Basin. Their occurrence here is therefore in accord with the conclusion made by Dickins, Gostin, and Runnegar (in press) that sandstone at Jervis Bay corresponds to the upper sandy part of the Conjola Formation. The middle and upper units of the Conjola Formation are regarded as equivalent in age to the Farley Formation, the Greta Coal Measures and the lower part of the Branxton Formation of the Hunter Valley. This part of the sequence is apparently of Artinskian (Lower Permian) age (Dickins et al., in press).

References

DICKINS, J.M., GOSTIN, J.A., and RUNNEGAR, B., in press - Correlation and age of the Permian sequence in the southern part of the Sydney Basin, New South Wales. DOROTHY HILL COMMERATIVE VOLUME, A.N.U. PRESS, Canberra.

Petroleum Technology Laboratory, Bureau of Mineral Resources, Geology and Geophysics, Canberra

APPENDIX 5. CORE ANALYSIS RESULTS

NOTE: (i) Unless otherwise stated, porosities and permeabilities were determined on two plugs (V&H) cut vertically and horizontally to the axis of the core. Ruska porosimeter and permeameter were used with air and dry nitrogen as the saturating and flowing media respectively. (ii) Oil and water saturations were determined using Soxhlet type apparatus. (iii) Acetone test precipitates are recorded as Neg., Trace, Fair, Strong or Very Strong.

SAMPLES FOR ENGINEERING GEOLOGY GROUP

WELL NAME AND NO. ULLADULLA No.1. (BMR). DATE ANALYSIS COMPLETED 10th June, 1969.

Core No.	Sample Depth		Lithology	Average Effective Porosity two plugs (% Bulk Vol.	Absolute Permeability (Millidarcy)		Average Density (gm/cc.)		Fluid Saturation (% pore space)		Core Water Salinity (p.p.m. NaCl)	Acetone Test	Fluorescence of freshly broken core	
	From	To			V	H	Dry Bulk	Apparent Grain	Water	Oil				
14	193'4"	193'11	sst: m.gr.	6.7	Nil	Nil	2.49	2.67	N.D.	N.D.	N.D.	N.D.	N.D.	
19	227'4"	227'6½	sst;v.c.gr. sl.carb.	7.8	Nil	Nil	2.48	2.69	N.D.	N.D.	N.D.	N.D.	N.D.	
20	238'11½	239'5½	sst;m.gr. to l.gr.	7.3	Nil	Nil	2.46	2.65	N.D.	N.D.	N.D.	N.D.	N.D.	

Remarks: - Absolute permeability probably less than 0.01 millidarcy.

General File No. 62/399
Well File No. _____

APPENDIX 6

WATER ANALYSES, JERVIS BAY A.C.T.

(Analyses by Australian Mineral Development Laboratories)

Record 1970/45.

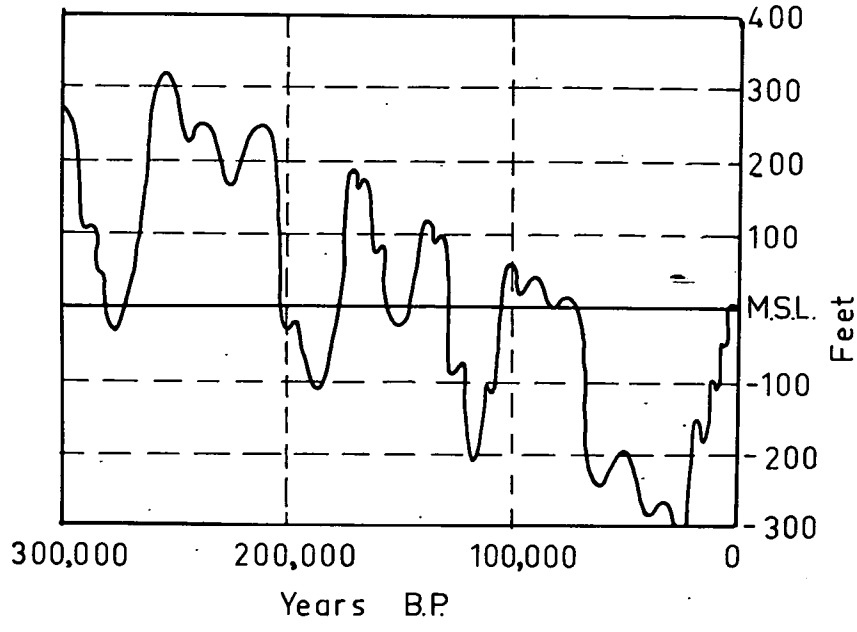
		Lake Windermere		Ulladulla 1		Ulladulla 2		Green Patch Weir		Piezometer 3		Piezometer 8	
		ppm	me/L	ppm	me/L	ppm	me/L	ppm	me/L	ppm	me/L	ppm	me/L
Calcium	Ca	1	0.05	35	1.7	21	1.0	3	0.15	62	3.1	5	0.25
Magnesium	Mg	4	0.32	4	0.32	5	0.41	6	0.49	8	0.7	2	0.16
Sodium	Na	27	1.2	1131	5.7	41	1.8	58	3.5	34	1.5	224	9.7
Potassium	K	1	0.02	8	0.2	3	0.1	2	0.05	93	2.4	3	0.08
Iron	Fe total	-	-	-	-	0.08	0.003	0.03	0.001	0.02	0.001	-	-
Manganese	Mn	0.02	0.001	-	-	0.02	0.001	0.02	0.001	0.02	0.001	-	-
Boron	B	-	-	-	-	0.002	<0.001	0.002	<0.001	31	8.6	-	-
Fluoride	F	<0.01	<0.001	-	-	0.11	0.006	0.77	0.041	15.6	0.82	-	-
Chloride	Cl	45	1.3	180	5.1	50	1.4	65	1.8	95	2.7	50	1.4
Sulphate	SO_4	7	0.15	40	0.8	15	0.3	<5	<0.1	10	0.2	130	2.7
Bicarbonate	HCO_3	6	0.1	125	2.0	100	1.6	85	1.4	245	4.0	325	5.3
Carbonate	CO_3	Nil		Nil		Nil	-	Nil	-	Nil	-	18	0.6
Phosphate	PO_4	<0.01	-	-	-	-	-	-	-	-	-	-	-
Silica	SiO_2	0.31	0.01	-	-	10.8	0.36	2.04	0.07	14.6	0.49	-	-
Nitrate	NO_3	Nil	-	-	-	0.05	<0.001	0.02	<0.001	0.36	0.006	-	-
Bromine	Br	<2.0	<0.02	-	-	-	-	-	-	-	-	-	-
Nitrite	NO_2	<0.05 (ND)		-	-	-	-	<0.05 (ND)		<0.05 (ND)		-	-
Aluminium	Al_2O_3	-	-	-	-	0.01	0.001	0.55	0.032	0.34	0.02	-	-
Copper	Cu	0.02	-	-	-	-	-	-	-	-	-	-	-
Zinc	Zn	0.03	-	-	-	-	-	-	-	-	-	-	-
Strontium	Sr	0.11	0.003	-	-	-	-	-	-	-	-	-	-
T.D.S. (at 180°C)		96		536		246		186		583		722	
pH		7.4		8.3		7.8		7.6		7.8		8.9	
Conductivity (at 25°C)		230		910**		275		300		8850		993**	
Sodium Adsorption Ratio *		2.7		5.6		2.1		4.4		1.1		21.4	
Hardness *		19 (soft)		104 (mod hard)		73 (mod hard)		32 (soft)		188 (very hard)		21 (soft)	

< less than.

(ND) not detected.

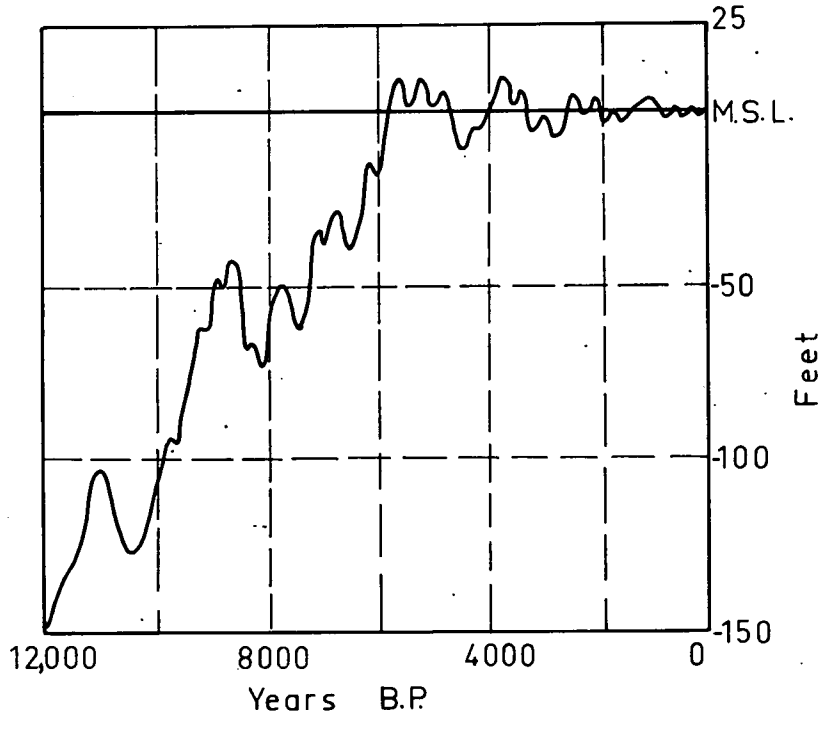
* calculated at B.M.R.

** B.M.R. figures used.



Sea level oscillations during Quaternary times (The peaks mark interglacial high sea levels, the troughs mark glacial low sea levels)

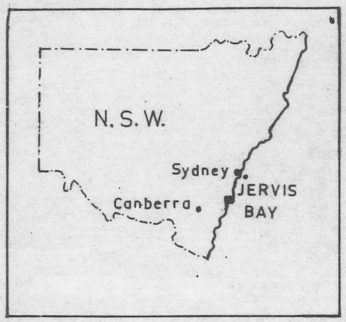
(both graphs after Bird & Fairbridge)

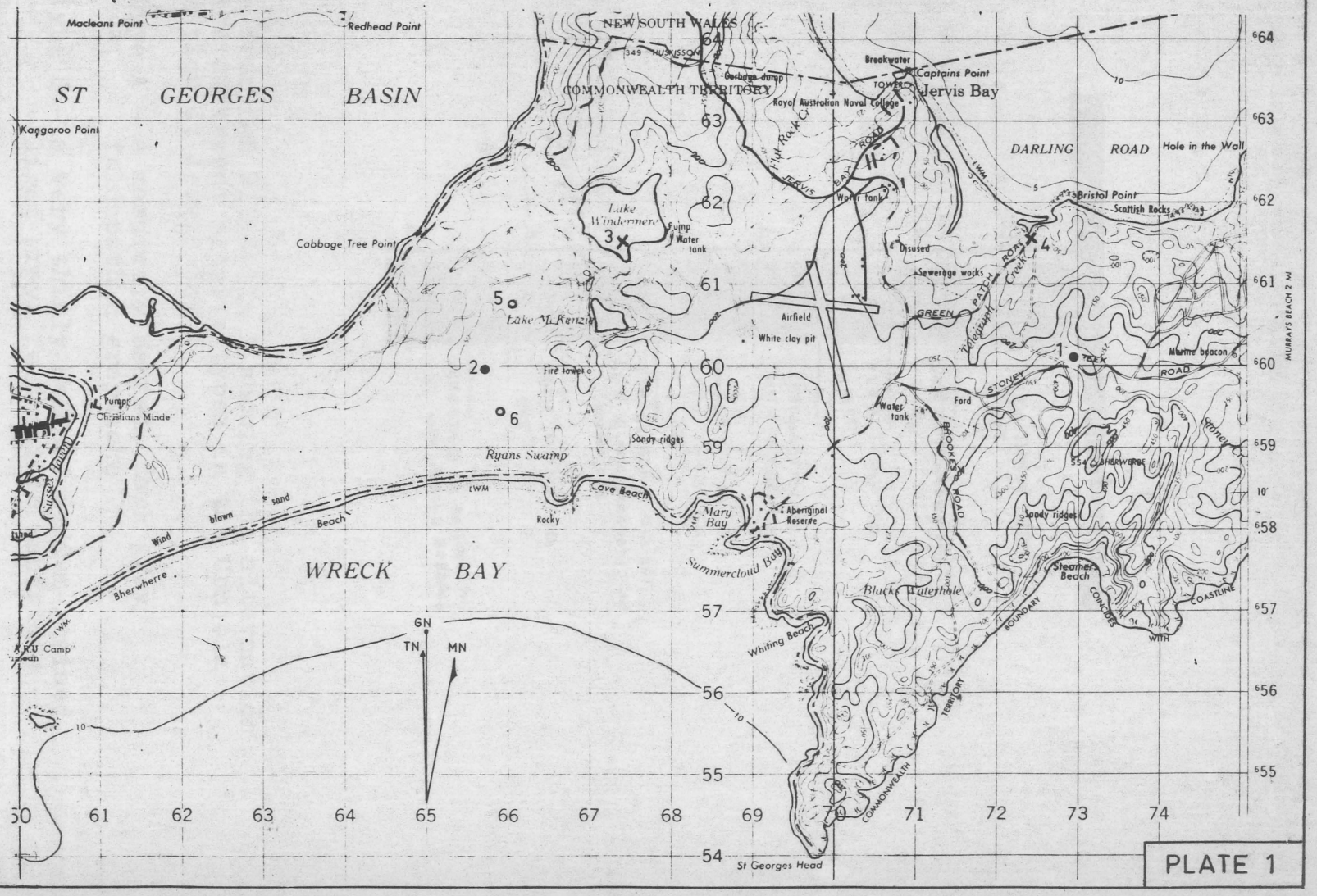


Sea level oscillations during the past 12,000 years

FIGURE 2 *Oscillations of sea level during Quaternary and Recent times*

LOCALITY MAP, JERVIS BAY, A.C.T.





SCALE

0 ½ 1 miles

(Contour Interval 50feet)

TRANSVERSE MERCATOR PROJECTION

REFERENCE

Water sample localities

- ●1— Ulladulla 1
- ●2— Ulladulla 2
- ×3— Lake Windermere
- ×4— Green Patch wier
- o5— Piezometer Nº 3
- o6— Piezometer Nº 8

BASE MAP — 1: 50,000

Sheet 9027–IV

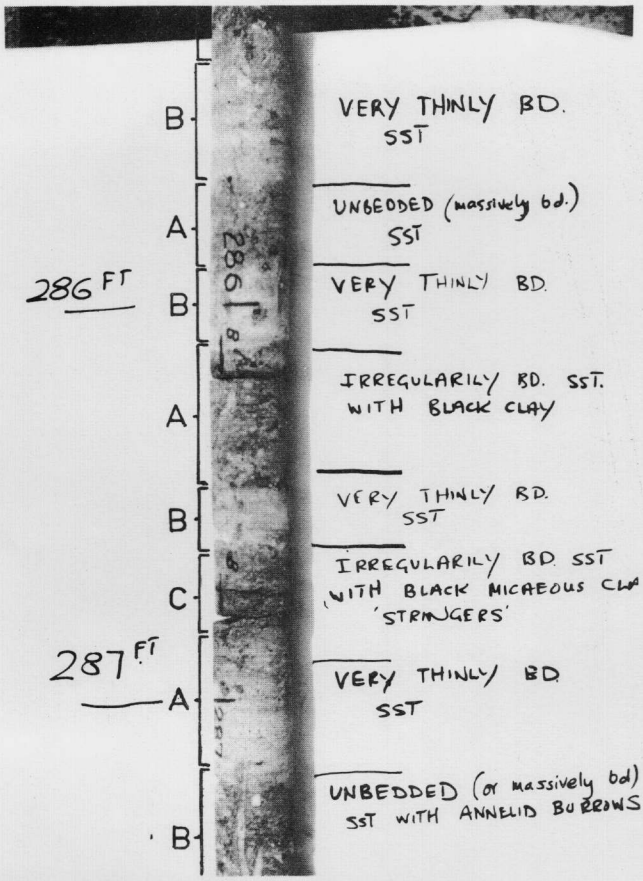
MJJ

PLATE 1

To accomany B.M.R. Record 1970/45.

156/A13/18.

PLATE 2



Core from BMR Ulladulla 1 showing the alternation of the different arenite types in the Conjola Formation at Jervis Bay

Type A - a massively bedded, dark grey feldspathic greywacke

Type B - a very thinly bedded, medium-grained, light grey, feldspathic sandstone

Type C - a medium-grained arenite containing dark brown clay stringers and with much argillaceous material in the matrix (greywacke)