DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1974/107

LUNAR LASER RANGER SITE, ORRORAL VALLEY A.C.T.

FOUNDATION INVESTIGATION - 1974

by

G.B. Simpson

Record 1974/107

LUNAR LASER RANGER SITE, ORRORAL VALLEY A.C.T.

FOUNDATION INVESTIGATION - 1974

by

G.B. Simpson

CONTENTS

SUMMARY

The Lunar Laser Ranger is to be sited on a ridge of granodiorite on the western slopes of the Orroral Valley.

Surface mapping and diamond drilling have confirmed that the Ranger will be founded on a boulder of granodiorite which is underlain by up to 2 m of weathered material. The boulder must therefore be considered capable of moving independently of the surrounding rocks.

The combined dead and live load on the boulder will be about 15 percent of the weight of the boulder, and it is considered by Engineers of the Department of Housing and Construction (DHC) that for stability within the operational limits, the load on the boulder should not exceed 1 to 2 percent.

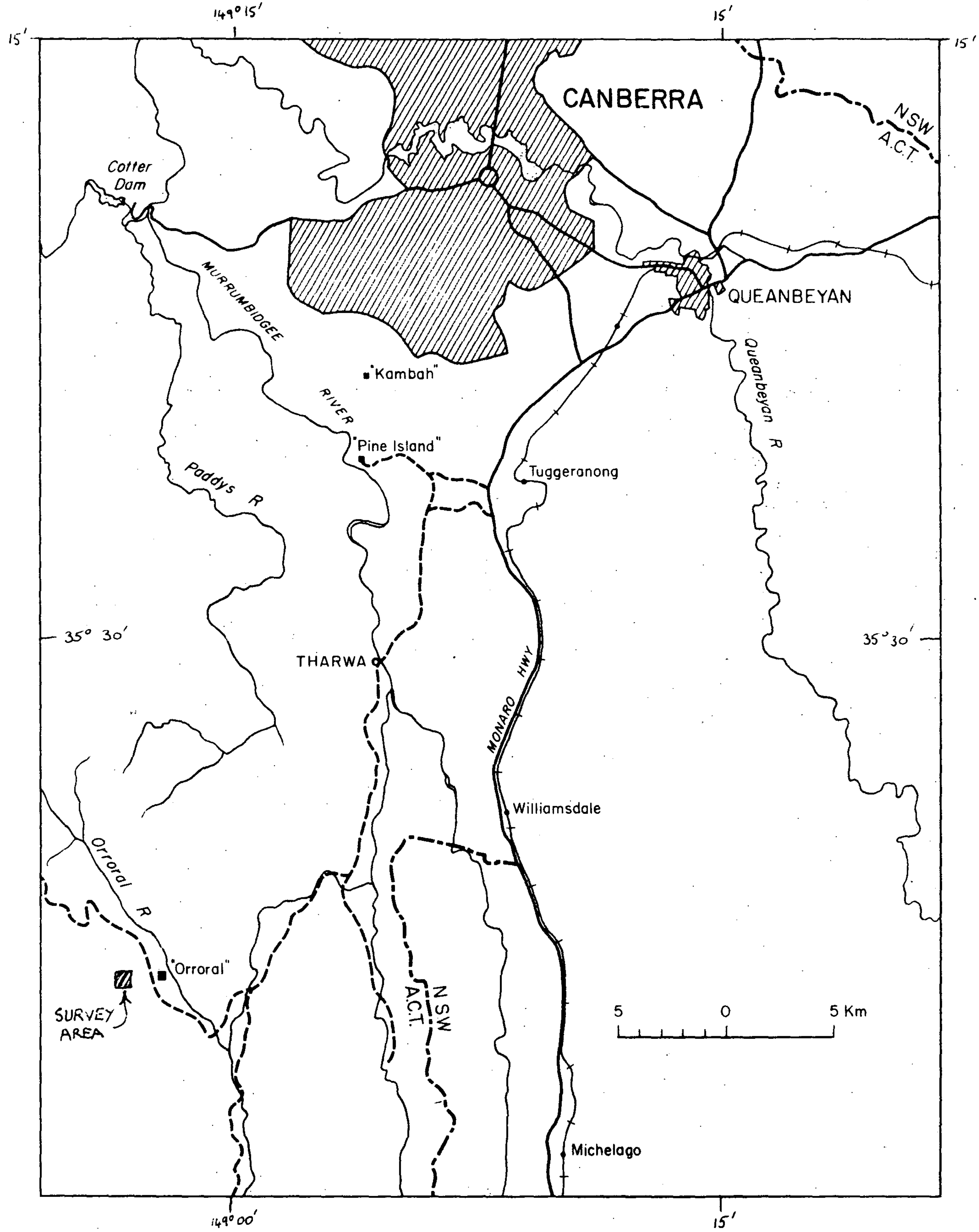
Consolidation of the weathered material underlying the boulder is not expected to be uniform across the foundations and the differential settlement may be in the order of 1 to 2 mm, with the maximum settlement on the north and west sides of the foundations.

In the event of excessive movements occurring during the operational life of the Ranger any attempts to stabilize the foundations will be difficult and expensive.

It is essential that tiltmeters be installed at the site to monitor any movements which might occur.

In the event of excessive movement occurring it is essential that a foundation engineer carry out a detailed analysis of foundation conditions and directly supervise any subsequent foundation treatment.

FIGURE 1



LOCALITY MAP

LUNAR LASER RANGER SITE

To Accompany Record 1974/107

I55/A16/1151

INTRODUCTION

The Lunar Laser Ranger Site is on a ridge of granodiorite to the west of the Space Tracking and Data Acquisition Network (STADAN) installation in the Orroral Valley (Fig. 1).

The ridge is part of the western slope of the Orroral Valley and trends parallel to the valley. To the west of the ridge is a saddle feature also parallel to the main valley which is probably fault defined; it is aligned with a prominent aerial photo lineation and is marked by low seismic velocities (seismic traverses D and C, Dolan 1974 & Simpson). The slopes from the ridge to the main valley floor are steep and of similar gradient to the natural slopes throughout most of the valley. The top of the ridge shows boulder development and it is on one of the larger boulders that the Ranger is to be sited.

Figure 2 shows the approximate position of boulders at the site. The Ranger is to be sited on Boulder A; Boulder C forms the foundation of the existing Collimation Tower.

Description of Ranger structure and settlement limits

The Ranger will be mounted on a pedestal structure, housed in a concrete-block building about 10m in diameter and 13m high with an aluminium dome forming the roof. The combined dead and live load on the foundations is estimated by Engineers of Department of Housing and Construction (DHC) at about 300 tonnes maximum.

Lateral displacements of the Ranger are not critical as these can be measured and allowed for. Tilting movements in the order of 1 minute of arc can be tolerated. In terms of settlement this represents a differential settlement of about 3 mm across the proposed foundations.

Previous Work

A seismic refraction survey was carried out at the site by the BMR Engineering Geophysics group in April and July 1973 (Dolan & Simpson, 1974). Dolan recommended a geological investigation of the site and the author visited the site in November 1973 and recommended further investigation, including diamond drilling, to be followed by consultations with a foundation engineer (Dolan & Simpson, 1974).

In November 1973 about 45 cm of rock was removed from the top of Boulder A by blasting to give a flat surface, and a triangular trench, about 45 cm deep, was excavated in the surface for the foundations of the ranger (Fig. 3).

Present investigation

The foundations were mapped in detail and four diamond-drill holes put down (Fig. 3). The drill core was oriented by painting a north mark on the rock at the point where drilling was to commence and projecting this orientation along the core. It was found that use of the Craelius rock core orienter was not necessary.

ENGINEERING GEOLOGY

Surface geology

The rock at the site is a coarse-grained granodiorite with plagioclase phenocrysts up to 6 cm in length. The rock shows a coarse foliation trending 90/360.

Three prominent joint sets were measured at the site; 80N/260, 90/360 and horizontal. These joint sets are continuous and to a large extent define the shape of the boulders.

The horizontal joints have a spacing of between 1 m and 6 m, and, where exposed, are weathered and open.

The joints at the base of Boulders B and C are well-exposed. About 35 cm of weathered material has been removed from these joints leaving the joints open. These open joints can be seen to extend about 5 m under the boulders.

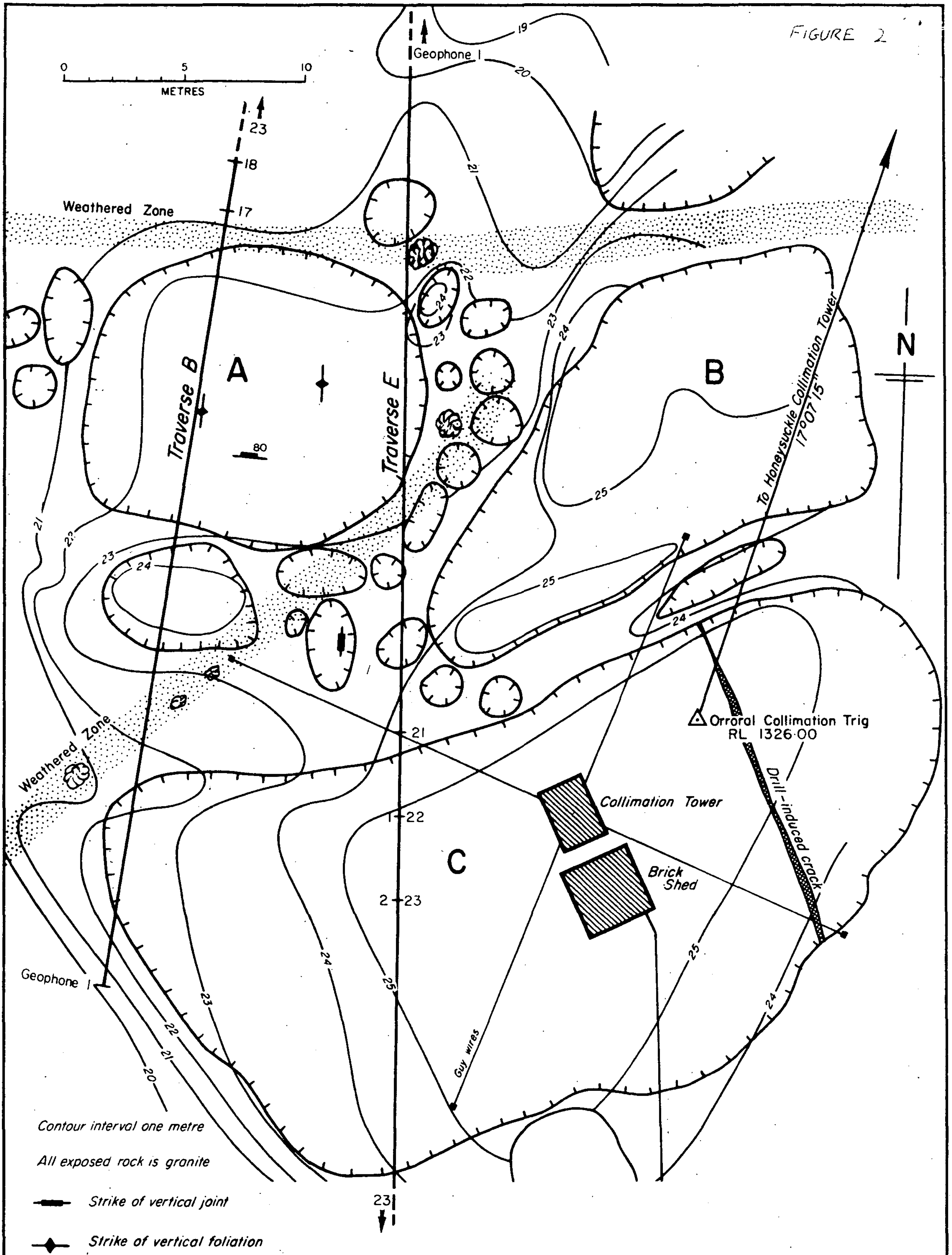
Two weathered zones were observed and these are shown on Figures 2 and 3. It should be noted that gum trees with trunks up to 0.5 m diameter are growing in the weathered zones.

The excavated surface of Boulder A shows no continuous joints but does show continuous incipient joints along narrow quartz-epidote veins trending 80N/260. The incipient joints are slightly weathered and the rock adjacent to them is limonite-stained for up to 15 cm either side.

Seismic results

The seismic traverses across the site gave an average longitudinal velocity of 3000 m/s, which is considerably lower than the velocity that would be expected in tightly jointed granite (Dolan & Simpson 1974).

FIGURE 2



Contour interval one metre

All exposed rock is granite

▬ *Strike of vertical joint*

◆ *Strike of vertical foliation*

▬ 80 *Dip and strike of joint*

⌒ *Outline of boulder*

✿ *Position of tree*

SURFACE GEOLOGY

To Accompany Record 1974/107

I55/A16/1152

Diamond drilling

Four diamond-drill holes were put down through the foundations (Fig. 3). Geological logs of the drill holes form Appendix 2.

The diamond drilling confirmed that Boulder A is a boulder of fresh granodiorite underlain by horizontal joints which have weathered to give between 60 cm and 2 m of highly and completely weathered granodiorite, at a depth of between 8 m and 10 m below the surface.

Drill hole 1 also penetrated a 60 cm wide zone of completely and highly weathered horizontal joints at a depth of 14 m.

The thickest part of Boulder A penetrated by a drill hole was in hole 1. The base of the boulder dips from holes 2, 3 and 4 towards hole 1 at angles between 4 and 11 . The configuration of the base of the boulder is therefore convex.

Water losses from the drill holes occurred in holes 1 and 2 via open weathered joints. Water losses were not high in zones of completely weathered rock where the presence of clay resulted in reduced permeability.

All holes indicated the rock of Boulder A to be homogeneous and without major defects. Incipient joints along quartz-epidote veins intersected at a depth of 3.6 m in hole 1, are continuous from the surface and are expected to be continuous through to the base of Boulder A.

Drill core from holes 1 to 4 will be stored in the BMR stores at Fyshwick for future reference.

Stability of foundations

Results from surface mapping and diamond-drilling show that Boulder A is capable of moving independently of the surrounding rocks.

The maximum combined dead and live loading on the boulder after construction is estimated to be approximately 300 tonnes. This is about 15 percent of the estimated weight of Boulder A. In discussions with engineers of DHC it was generally considered that this percentage is high. DHC Engineers considered that for stability within the operational limits of the Ranger the load of the structure should be in the order of 1 to 2 percent of the weight of the boulder.

Compaction and Settlement. The configuration of the base of Boulder A is convex and fairly uniform; however, the thickness of the weathered seam below the boulder is variable between 60 cm and 2 m. Within the weathered seam the thickness of completely weathered material varies from 30 to 60 cm. Compaction after construction is not expected to be uniform throughout the weathered zone, and the differential settlement may be in the order of 1 to 2 mm with the maximum settlement occurring on the north and west sides of the foundation.

Groundwater. Groundwater was not intersected in the diamond-drill holes. Run-off at the site will be channelled between the boulders and will enter the weathered material and percolate down to the water table. This will cause wetting and drying of the weathered zone, and the removal of material in solution and in suspension, which will weaken the weathered zone and in the long term facilitate settlement.

Removal of trees. The trees at the site probably have extensive root systems in the weathered joints. These trees have recently been cut down and voids may be left when the roots die back.

Some channelling of the groundwater into the old root system within the weathered rock is to be expected, and could accelerate weathering and indirectly induce settlement of the foundations.

Movement of the surrounding boulders. Boulders B and C may be considered to be in a critical position. They are situated at the top of the steep valley slopes and are underlain by open joints. The critical state of these boulders is indicated by the drill-induced crack which formed across Boulder C when the anchorage for the collimation-tower guy wires were being installed. The crack is up to 4 cm wide and 15 m long. Movement of Boulders B and C may cause movement of Boulder A, either directly or indirectly by loosening the weathered material.

Stabilization of foundations

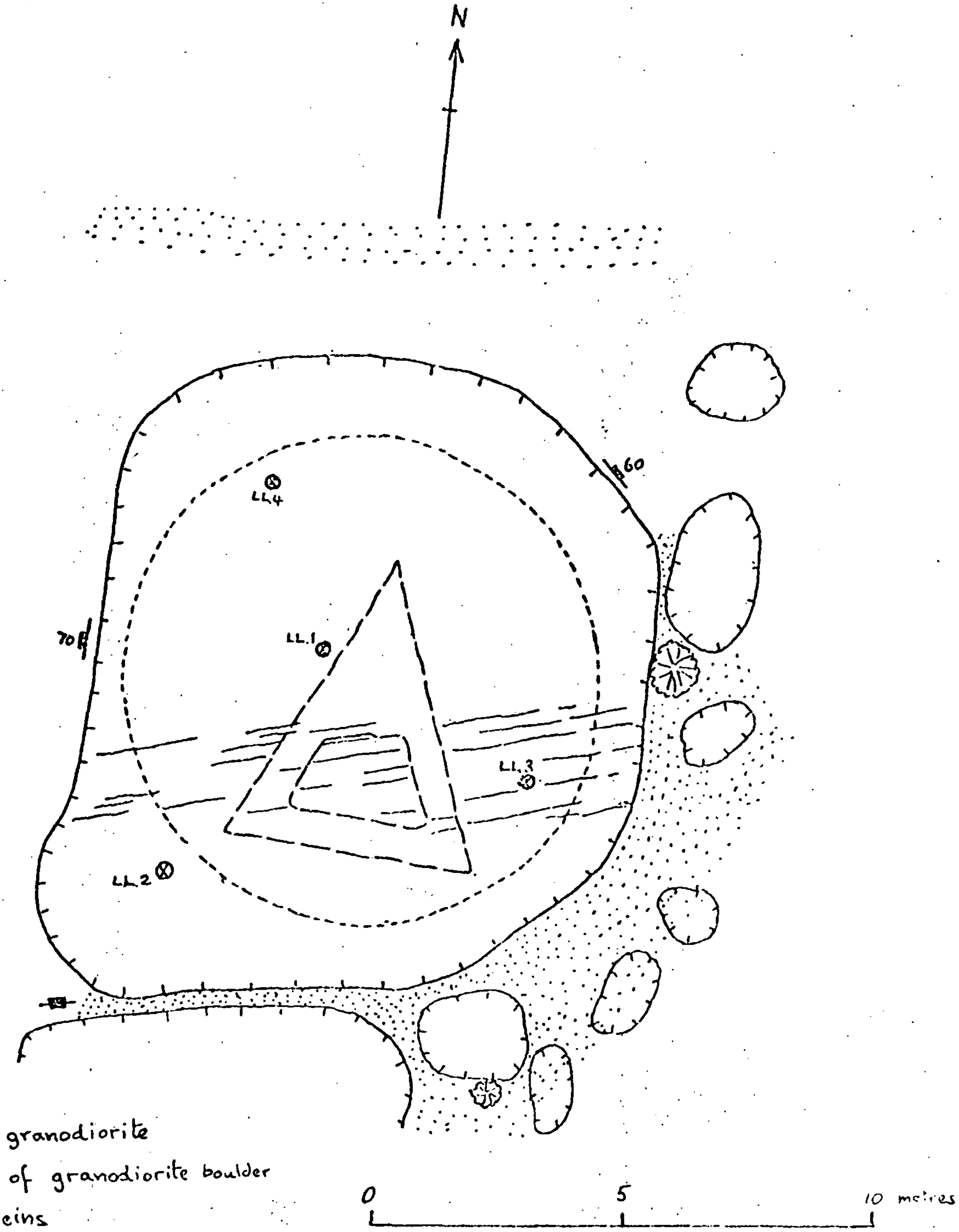
The contract for construction was let before the diamond drilling commenced, and construction started immediately after the drilling was completed. It was therefore not possible to carry out or assess any foundation treatment prior to construction.

In the event of excessive movements occurring during the operational life of the Ranger any attempts to stabilize the foundations will be difficult and expensive. The following suggestions were made during brief discussions

FIGURE 3

LUNAR LASER RANGER SITE – ORRORAL VALLEY, ACT

GEOLOGY OF FOUNDATIONS
(BOULDER A of Figure 2)



▨ Area of weathered granodiorite
Limit of outcrop of granodiorite boulder
Quartz-epidote veins
Tree stump
70 Dip and strike of joint
Strike of vertical joint
Limit of excavated foundation trench
Position of proposed building foundation
LL2 ⊗ Position of vertical diamond drill hole, number indicated

To accompany Record 1974/107

Base map/survey TAPE & COMPASS
Geology by G.B. SIMPSON
Compiled and checked GBS Project geologist
Checked and approved Senior geologist
Supervising geologist

COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.
TITLE GEOLOGY OF FOUNDATIONS
PROJECT LUNAR LASER RANGER SITE, ACT
Drawn by GBS
Drawing No I55/A16/1153

with foundation engineers of DHC. It should be noted that before any treatment is carried out a foundation engineer must carry out a detailed analysis of the foundation conditions, and the subsequent treatment should be under the direct supervision of an engineer.

(a) Grouting. Grouting will reduce permeabilities in the weathered zone by sealing up open joints. However grouting will not be effective in reducing permeability of completely weathered rock in the weathered zone. Restriction of groundwater movement will reduce the removal of material from the weathered zone, and therefore long-term settlement. Grouting will not act to directly strengthen the foundations.

(b) Anchoring Boulder A. Installing tension cables at the site would be both difficult and expensive with the risk that they would not achieve the desired result. Weathered seams are present to a depth of at least 15 m, and satisfactory anchorage of the cable may be difficult. The stressing of Boulder A by the cables might result in the boulder cracking along the incipient quartz-epidote vein fractures or parallel to the foliation as has occurred across Boulder C.

CONCLUSIONS

1. Results of surface mapping and diamond-drilling show that Boulder A is capable of moving independently of the surrounding rocks.

2. The combined live and dead load of the Ranger and building will be about 15 percent of the weight of Boulder A; for stability within the operational limits of the Ranger the load should not exceed 1 to 2 percent of the weight of Boulder A.

3. The configuration of the base of Boulder A is convex, however the thickness of weathered material below the boulder is variable between 60 cm and 2 m.

4. Compaction of the weathered material is not expected to be uniform throughout the weathered seam; differential displacement may be in the order of 1 to 2 mm with the maximum settlement on the north and west sides of the foundation.

5. Long-term settlement may be induced by the removal of weathered material underlying the boulder by groundwater and facilitated by groundwater movement along the rotted roots of felled trees.

6. Movements of surrounding boulders may cause movements of Boulder A either directly, or indirectly by the loosening of weathered material.

7. In the event of excessive movement occurring during the operational life of the Ranger any attempt to stabilize the foundations will be difficult and expensive.

RECOMMENDATIONS

1. As it is most important that the extent and return of any movement of Boulder A be currently known, it is recommended that tiltmeters be installed at the site to monitor any movements of the boulder.

2. In the event of excessive movements occurring during the operational life of the Ranger, it is essential that a foundation engineer carry out a detailed analysis of foundation conditions and directly supervise any subsequent foundation treatment.

REFERENCES

DOLAN, B.H. & SIMPSON, G.B., 1974 - Lunar Laser Ranger Site, Foundation Investigation, Orroral Valley, A.C.T., 1973. Bur. Miner. Resour. Aust. Rec. 1974/23 (unpubl.).

APPENDIX 1 - DEFINITIONS OF TERMS

WEATHERING OF ROCK

FRESH	: No discolouration or loss in strength
FRESH-STAINED	: Limonitic staining along fractures, rock otherwise fresh and shows no loss of strength.
SLIGHTLY WEATHERED	: Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock.
MODERATELY WEATHERED	: Rock is discoloured and noticeably weakened; N - size drill core generally cannot be broken by hand across the rock fabric.
HIGHLY WEATHERED	: Rock is discoloured and weakened; N - size drill core can generally be broken by hand across the rock fabric.
COMPLETELY WEATHERED	: Rock is decomposed to a soil, but the original rock fabric is mostly preserved.

PERCUSSIVE STRENGTH OF ROCK

STRONG TO VERY STRONG	: Cannot be broken by repeated blows with a hammer.
MODERATELY STRONG	: Rock broken by 3 or 4 blows.
WEAK	: Rock broken by one blow.

HARDNESS OF ROCK

HARD TO VERY HARD	: Impossible to scratch with knife blade.
MODERATELY HARD	: Shallow scratches with knife blade.
SOFT	: Deep scratches with knife blade.

ROCK QUALITY DESIGNATION (RQD) : Sum of the total length of core recovered, counting only those pieces of core which are 10 cm in length or longer, and which are hard and sound.

GRANODIORITE : A plutonic rock consisting of quartz, calcic oligoclase or andesine, and othoclase, with biotite, hornblende, or pyroxene as mafic constituents. Granodiorite is intermediate between quartz-monzonite and quartz-diorite and contains at least twice as much plagioclase as orthoclase.

APPENDIX 2

GEOLOGICAL LOGS OF DIAMOND-DRILL HOLES

BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE
LOCATION ORRORAL VALLEY, ACT
ELEVATION OF COLLAR 00+00
ANGLE FROM HORIZONTAL (θ) -90° DIRECTION Vertical
COORDINATES [redacted]

HOLE NO. LL1
SHEET 1 OF 3

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core (FEET)	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
GRANODIORITE FRESH	Coarse-grained, foliated granodiorite. White felspar phenocrysts up to 2" in length, quartz and biotite up to ½". Sedimentary xenoliths up to 6" long are seen aligned parallel to the foliation. Where fresh the rock is moderately hard and moderately strong tending to be brittle owing to presence of micro-fractures.	NO CASING	+	100 100 100	NMLC 1 2 3 1m 4 5 6 2m 7 8 9 3m 10 11		100 100 100	1 1 1	Drill-induced fractures		NOT WATER PRESSURE TESTED
GRANODIORITE SLIGHTLY WEATHERED AND FRESH STAINED.	Rock limonite stained in 2'6" wide zone trending 240/70N		+ EP		12 13 4m			1	12'6" Joint 240/70N. Epidote on surface 13' Incipient fracture along epidote vein 1mm wide.		
GRANODIORITE FRESH	Coarse-grained, foliated granodiorite		+	100	14 15 16 5m 17 18 19 6m		100				

R.Q.D. = Rock Quality Designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple tube
Stationary split inner tube
Driller ARDEC
Commenced 13. 3. 74
Completed 15. 3. 74
Logged by G.B. SIMPSON
Vertical scale 1cm = 1ft
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in.
Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis
Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range
Water Level Measurements — ∇ Level when hole in progress at specified depth
∇ Level in completed hole on specified date

[+] Granodiorite
EP Quartz-epidote vein

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips

Core Photograph Negative No

Depth (m)	Black & White	Colour

To accompany Record 1974/107

I55/A16/1155 (1 of 3)

BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE
LOCATION ORRORAL VALLEY, ACT.
ELEVATION OF COLLAR 00+00
ANGLE FROM HORIZONTAL (θ) -90°
DIRECTION Vertical
COORDINATES [redacted]

HOLE NO LL1
SHEET 2 OF 3

Rock Type and Degree of Weathering	Description. Lithology, colour, strength, etc	Casing	Lift and % core recovery	Depth and size of Core	RQD	Defect Frequency – Intercept Angle 0–30	30–60	60–80	80–90	Structures. Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
FRESH GRANODIORITE	Coarse-grained foliated granodiorite	NO CASING	100 100 100	NMLC 21 22 7m 23 24 25 26 8m 27	100 100 100					Drill induced break at 20' 8"		
COMPLETELY WEATHERED	In completely weathered zone rock is reduced to a gravelly-clay material			28	60					Gravelly-clay	Water, loss at 27' 10"	NOT WATER PRESSURE TESTED
HIGHLY WEATHERED GRANODIORITE				29						No prominent joints		
COMPLETELY WEATHERED				9m								
HIGHLY WEATHERED GRANODIORITE				30 31 32		1	1 1 1 1	1 2 2 1		29'10" Open weathered horizontal joint. 29'10" to 33', joints oriented 270/45 to 80s 30'6" incipient joints 240/70s, 060/40N, limonite stained. 31'6" Incipient limonite stained joint 270/80s		
SLIGHTLY WEATHERED				10m 33								
FRESH-STAINED GRANODIORITE	Coarse-grained foliated granodiorite											
FRESH GRANODIORITE			100 100	34 35 36 11m 37 38 39 12m	100 100	1				33'10" Joint 225/30s limonite stained, open and irregular. 33'10" onwards, no joints, veins or defects		

R.Q.D. = Rock Quality Designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple tube Stationary split inner tube
Driller ARDEC
Commenced 13. 3. 74
Completed 15. 3. 74
Logged by G.B.SIMPSON
Vertical scale 1cm = 1ft.
Checked by

Notes

Fracture Log - Number of fractures per 25 cm of core. Zones of core loss blocked in

Bedding and Joint Planes - Angles are measured relative to a plane normal to the core axis

Defect Frequency - Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range

Water Level Measurements - ▽ Level when hole in progress at specified depth
▼ Level in completed hole on specified date

[+] Granodiorite
[⁘] Gravelly-clay
/ Joint

To accompany Record 1974/107

I55/A16/1155

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips

Core Photograph Negative No.

Depth (m) Black & White Colour

(2 of 3)

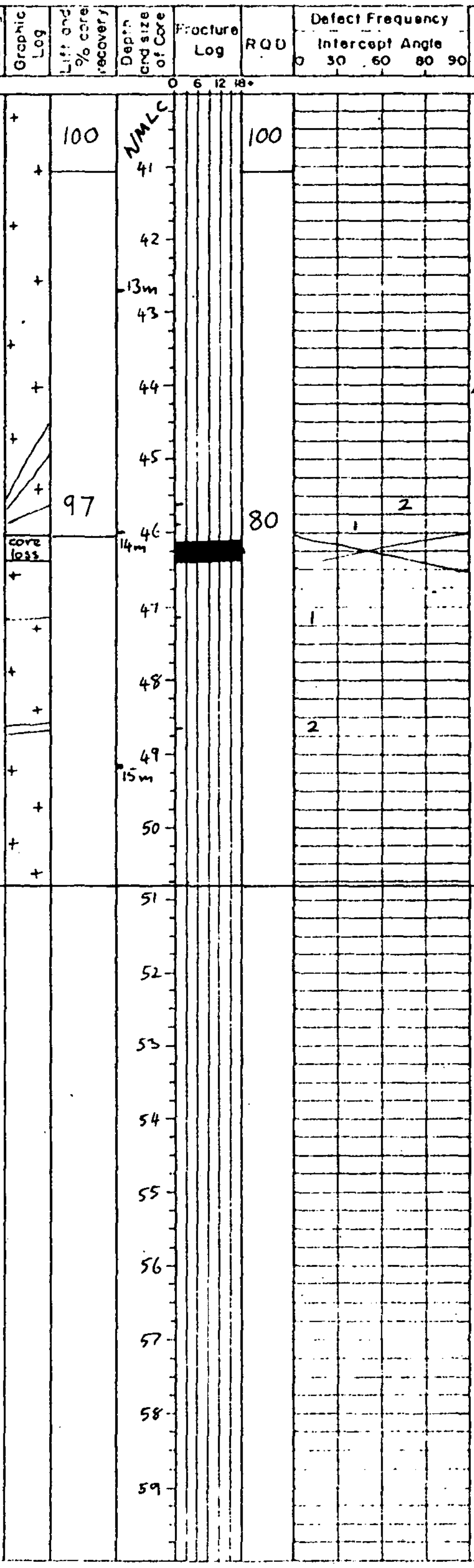
BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE
LOCATION ORRORAL VALLEY, ACT.
ELEVATION OF COLLAR 00+00
ANGLE FROM HORIZONTAL (θ) -90° DIRECTION Vertical
COORDINATES [redacted]

HOLE NO. LL1
SHEET 3 OF 3

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Lift and % core recovery	RQD	Structures Joints, veins, seams, faults, etc	Water Pressure Test Lugeons (Lugeons) *
GRANODIORITE Fresh	Coarse-grained foliated granodiorite. hard and strong.	100	100		NOT WATER PRESSURE TESTED
GRANODIORITE Slightly weathered and fresh stained		97	80	44'6" incipient vertical joint	
46'1½" to 46'4½"	No core recovered	core loss		46'1½" to 46'6½" completely weathered zone. 3 inches of core washed out by drill. Rock has weathered to a gravelly-clay with particles up to 1 cm across.	
GRANODIORITE mostly moderately weathered. Highly and completely weathered in joints	Rock limonite stained, pale yellow in colour. feldspars altered to clay and rock shows marked loss in percussive strength.				
GRANODIORITE slightly weathered	Coarse grained foliated granodiorite. hard and strong			48'7" 2 subhorizontal joints, limonite-stained	
GRANODIORITE Fresh	HOLE ENDS 51' 10".				



RQD = Rock Quality Designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple tube stationary split inner tube
Driller ARDEC
Commenced 13. 3. 74
Completed 15. 3. 74
Logged by G.B. Simpson
Vertical scale 1cm = 1ft
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range

Water Level Measurements ∇ — Level when hole in progress at specified depth
▼ — Level in completed hole on specified date

+ Granodiorite
/ Joint

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips

Core Photographs Negative No.
Depth (m) Black & White Colour

To accompany Record 1974/107 155/A16/1155 (3 of 3)

BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE
LOCATION ORRORAL VALLEY, ACT
ELEVATION OF COLLAR 00 + 4"
ANGLE FROM HORIZONTAL (θ) -90° DIRECTION vertical
COORDINATES [redacted]

HOLE NO. LL2
SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log 0 6 12 18+	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
GRANODIORITE Fresh	Coarse-grained, foliated granodiorite. White felspar phenocrysts up to 2" in length, quartz and biotite up to ½". Sedimentary xenoliths up to 6" long are seen aligned parallel to the foliation. Where fresh the rock is moderately hard and moderately strong tending to be brittle owing to the presence of micro-fractures.		+ +	100	NMLC 1		100	1 1	Incipient fractures broken by drill 25W/150		NOT WATER PRESSURE TESTED
			+ +	100	2 3		100				
			+ +	100	1m 4		100				
			+ + + + + + +	100	5 6 2m 7 8 9 3m 10		100		No joints or incipient fractures		
			+ + + + + +	100	11 12 13 4m 14 15		100				
			+ + + + + + +	100	16 5m 17 18 19 6m		100				

RQD = Rock Quality Designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple tube Split stationary inner tube
Driller ARDEC
Commenced 15. 3. 74
Completed 18. 3. 74
Logged by G.B Simpson
Vertical scale 1cm = 1ft
Checked by

Notes

Fracture Log — Number of fractures per 25cm of core. Zones of core loss blocked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range

Water Level Measurements — ▼ Level when hole in progress at specified depth
▽ Level in completed hole on specified date

[+] Granodiorite.

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

To accompany Record 1974/107

I55/A16/1156 (1 of 2)

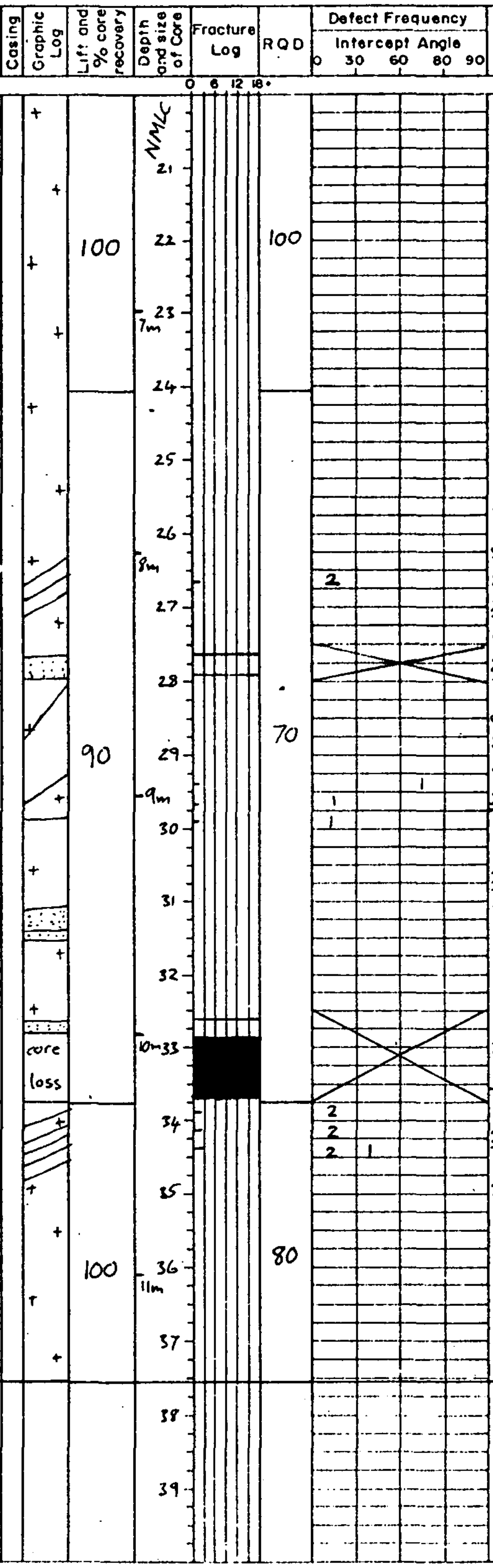
BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE
LOCATION ORRORAL VALLEY, ACT.
ELEVATION OF COLLAR 00 + 4"
ANGLE FROM HORIZONTAL (θ) - 90° DIRECTION vertical
COORDINATES [redacted]

HOLE NO LL2
SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc
GRANODIORITE Fresh	Coarse-grained foliated granodiorite. Moderately hard and moderately strong.
GRANODIORITE Slightly weathered	Rock slightly limonite-stained felspars partially altered.
completely weathered	Rock pale yellow to light brown in colour. Some grain-size diminution owing to weathering and microfractures. Gravelly-clay in CW seams. Rock mostly weak and moderately soft to soft.
GRANODIORITE moderately weathered and highly weathered	
GRANODIORITE moderately and slightly weathered	
HW to CW	
GRANODIORITE moderately weathered	
CW	
No core recovered	
HW and MW	
GRANODIORITE SW	Coarse-grained foliated granodiorite, Moderately hard and moderately strong
GRANODIORITE fresh	HOLE ENDS 37'7"



Structures Joints, veins, seams, faults, etc

26'8½" 20° joints dipping approx. north. limonite-stained and rough joint surfaces.
27'3" Incipient fracture dipping north at 85°
27'6" to 27'10½" 10°, 4", CW seam. AFS 2m gravelly-clay material.
29'5" Joint 65E/170, open smooth, limonite-stained.
29'6" Open joint, ½" wide filled with gravelly-clay 30°N/090
29'10" Horizontal joint ½" wide, open, rough limonite-stained.
31'1" to 31'6" weathered zone at 10° of gravelly-clay
31'9" Incipient 10° fracture
32' Incipient horizontal fracture
32'4" Incipient horizontal fracture.
32'6" to 33'9" CW zone of gravelly clay at 25°.
33'9" to 34'7" 5 x 25° joints spaced 1" to 2" open rough limonite stained

Water Level: water loss at 33'9"

Water Pressure Test Losses (Lugeons) *: NOT WATER PRESSURE TESTED

RQD = Rock Quality designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple tube Split stationary inner tube
Driller ARDEC
Commenced 15. 3. 74
Completed 18. 3. 74
Logged by G.B. Simpson
Vertical scale 1cm = 1ft
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth
▽ Level in completed hole on specified date.

CW = completely weathered
HW = highly weathered
MW = moderately weathered
SW = slightly weathered

/ joint

⁙ gravelly - clay
\+ granodiorite

To accompany Record 1974/107

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.*

Core Photograph Negative No

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

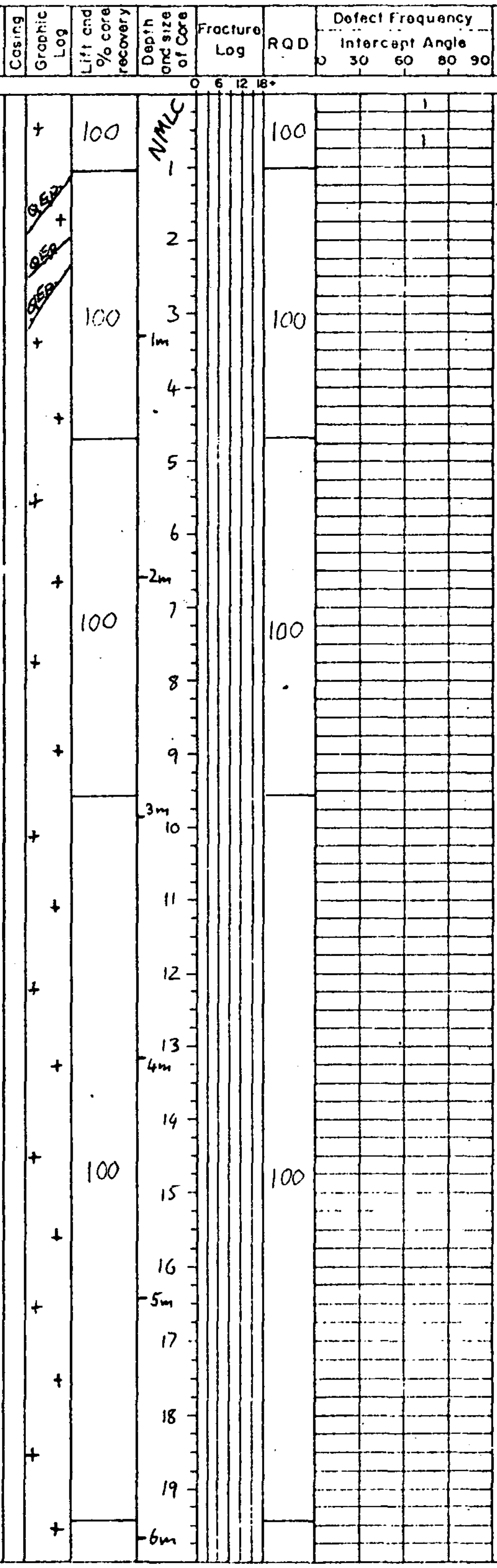
GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE
LOCATION ORRORAL VALLEY, ACT
ELEVATION OF COLLAR 00+00
ANGLE FROM HORIZONTAL (θ) 90° DIRECTION vertical
COORDINATES [redacted]

HOLE NO. LL3

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
GRANODIORITE Fresh	Coarse-grained, foliated granodiorite. White felspar phenocrysts up to 2" in length, quartz and biotite up to ½". Sedimentary xenoliths up to 6" long are seen aligned parallel to the foliation. Where fresh the rock is moderately hard and moderately strong tending to be brittle owing to presence of microfractures.	Drill induced fractures at 3" and 10". 1'3" QEp vein 2mm wide 270/70N. 2'1" Incipient fracture 2'5" QEp vein 270/70N		



RQD = Rock Quality Designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple tube Stationary split inner tube
Driller ARDEC
Commenced 15.3.74
Completed 18.3.74
Logged by G.B. Simpson
Vertical scale 1cm = 1ft.
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in
Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis
Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.
Water Level Measurements — ▼ Level when hole in progress at specified depth
▽ Level in completed hole on specified date

QEp = Quartz-epidote
+ = Granodiorite
QEp = Quartz-epidote vein

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative N°

Depth (m)	Black & White	Colour

To accompany Record 1974/107 I 55/A16/1157 (1 of 2)

BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE

LOCATION ORRORAL VALLEY, ACT

ELEVATION OF COLLAR 00+00

ANGLE FROM HORIZONTAL (θ) 90 DIRECTION vertical

COORDINATES [redacted]

HOLE NO LL3

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log 0 6 12 18+	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
GRANODIORITE Fresh	Coarse-grained granodiorite foliated. Moderately hard and moderately strong		+	100	NMLC 21 22 23 7m 24 25		95		25'8" Joint 30W/140 25'9" Joint 30W/140		NOT WATER PRESSURE TESTED
GRANODIORITE Moderately to completely weathered	Rock mostly weak and moderately soft to soft. limonite stained.				26 8m			2	26'3" Joint @50° 26'6" CW seam 45S/100, 1"w. 26'9" to 27' CW jointed zone 20N/100		
GRANODIORITE Fresh.	HOLE ENDS 27'6"		+		27						
					28 29 30						

R.QD.= Rock Quality Designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple Split Stationary inner tube
Driller ARDEC
Commenced 15.3.74
Completed 18.3.74
Logged by G.B. Simpson
Vertical scale 1cm = 1ft

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth.
▽ Level in completed hole on specified date.

⊞ Granodiorite
▨ clayey-gravel
CW = completely weathered

To accompany Record 1974/107 I 55/A16/1157

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

(2 of 2)

BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Lunar Laser Ranger site
LOCATION Orroral Valley, ACT.
Elevation of collar 00-12"
ANGLE FROM HORIZONTAL (θ) -90 DIRECTION vertical
COORDINATES [redacted]

HOLE NO LL4
SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log 0 6 12 18+	RQD	Defect Frequency Intercept Angle 0 30 60 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
GRANODIORITE slightly weathered	Coarse-grained, foliated granodiorite. White felspar phenocrysts up to 2" in length, quartz and biotite up to ½". Where fresh the rock is moderately strong and moderately hard, tending to be brittle owing to presence of microfractures.		+ +	100	NMLC 1		100		No fractures or incipient defects.		NOT WATER PRESSURE TESTED
GRANODIORITE Fresh.			+ +	100	2 3 1m		100				
			+ + + +	100	4 5 6 2m 7 8		100				
			+ + + + + + + + +	100	9 3m 10 11 12 13 4m 14 15 16 5m 17 18		100				
			+ +		19 6m						

RQD = Rock Quality Designation expresses the percentage of core longer than 10cm per run of core

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple split stationary inner tube
Driller ARDEC
Commenced 18.3.74
Completed 21.3.74
Logged by G.B. Simpson
Vertical scale 1cm = 1ft.

Checked by

Notes

Fracture Log — Number of fractures per 25cm of core. Zones of core loss blocked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth.
▽ Level in completed hole on specified date.

[+] Granodiorite

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

To accompany Record 1974/107 I55/A16/1158 (1 of 2)

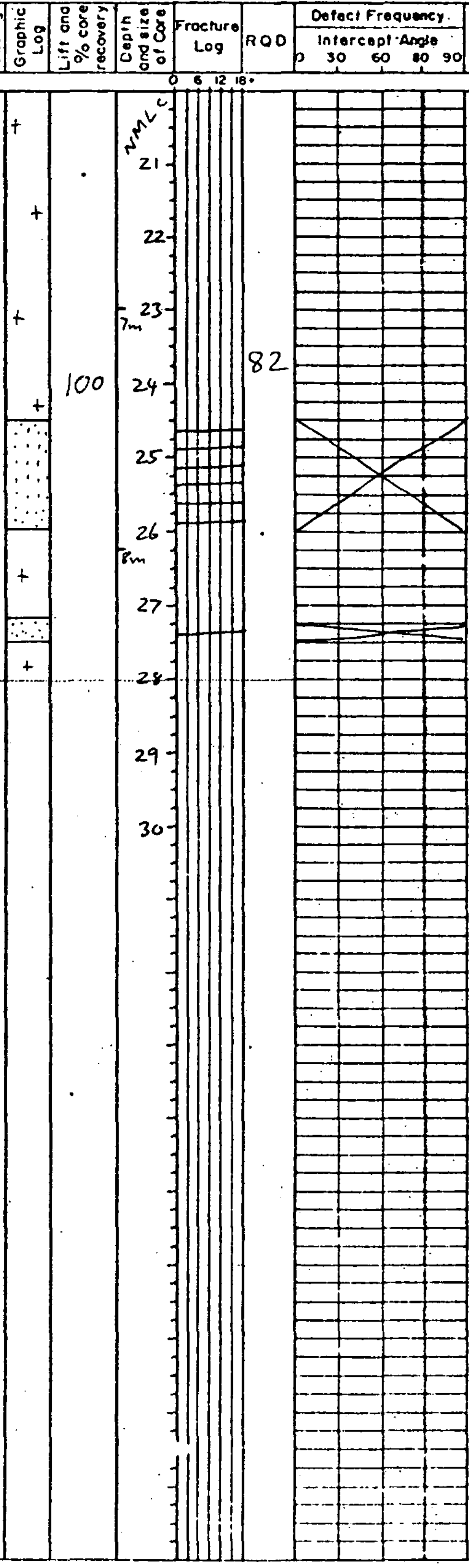
BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LUNAR LASER RANGER SITE.
LOCATION ORRORAL VALLEY, ACT.
ELEVATION OF COLLAR = 00 - 12"
ANGLE FROM HORIZONTAL (θ) -90 DIRECTION vertical
COORDINATES [redacted]

HOLE NO. LL
SHEET 2 OF

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Structures Joints, veins, seams, faults, etc
GRANODIORITE Fresh	Coarse-grained, foliated granodiorite.	
GRANODIORITE completely weathered	Pale yellow to light brown weathered granodiorite. Where completely weathered rock is reduced to a gravelly clay. Rock weak to moderately weak.	24'6" to 26' gravelly-clay seam.
GRANODIORITE moderately weathered		27'2" to 27'5½" gravelly clay seam.
CW		
Fresh	HOLE ENDS 28'	



Water Level

Water Pressure Test Losses (Lugeons) *

NOT WATER PRESSURE TESTED

RQD = Rock Quality Designation expresses the percentage of core longer than 10cm per run of core.

Drill type MINDRILL
Feed HYDRAULIC
Core barrel type Triple tube Stationary spit innertube
Driller ARDEC
Commenced 18.3.74
Completed 21.3.74
Logged by G.B. Simpson
Vertical scale 1cm = 1ft
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range

Water Level Measurements — ▼ Level when hole in progress at specified depth
▼ Level in completed hole on specified date

⁙ Gravelly clay
+ Granodiorite

To accompany Record 1974/107 155/A16/1158

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

(2 of 2)