Rpt.Bk.No.68/18
G.S. No. 4169

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

ENGINEERING DIVISION

MURRAY BRIDGE ONKAPARINGA PIPELINE

OPEN CUTS FOR PIPELINE

GEOLOGICAL INVESTIGATIONS, PROGRESS REPORT NO. 1

DESIGN STAGE

Section 4262, 5214, Hd. Onkaparinga, Section 4412, 4423,

5219 Hd. Macclesfield

Client: Engineering and Water Supply Department

by

W.R.P. BOUCAUT
SENIOR GEOLOGIST
ENGINEERING GEOLOGY SECTION

14th February, 1969

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SOUTH AUSTRALIA

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Rpt.Bk.No.68/18
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D.M. No.350/69

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DEPARTMENT OF MINES
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DESIGN STAGE

Section 5214 Hd. Onkaparinga, Section 4412, 4423,
5219 Hd. Macclesfield

Client: Engineering and Water Supply Department

SUMMARY AND CONCLUSIONS

Three sections of the Murray Bridge Onkaparinga Pipeline, in the vicinity of the Summit Storage will involve excavations of up to 70 ft. depth. These have been explored by diamond drilling.

The drilling indicates that variably weathered claystones, siltstones, sandstones and schists of the Adelaidean System will occur in the excavations. Groundwater level measurements in the drill holes indicate that at the time of drilling the ground water table was below the invert level in the two shallower excavations and about 45 ft. below ground surface in the deeper (about 70ft. depth) excavation.

The rocks as recovered during drilling could be all excavated by ripping with heavy duty tractor. Some stronger beds, probably less than 20 ft. wide, requiring blasting could occur at depth.

Stable batters should be obtained, but minor local instability could occur, especially where associated with groundwater inflows.

Rock recovered during drilling indicates that material suitable for use as compacted rock fill in the Summit Storage dam embankment could only be recovered from one section below a depth of 35 ft.

It is recommended that further exploration by trenching, seismic refraction traverses and possibly diamond drilling should be carried out

INTRODUCTION

Three sections of the proposed Murray Bridge Onkaparinga Pipeline, in the vicinity of the Summit Storage, will involve excavations of up to 70 ft. depth. These are, in order upstream from the Summit Storage.

Section 1 An excavation up to about 70ft. deep for a distance of about 2000 ft. Water will flow in an open lined channel.

Section 2 An excavation up to about 50 ft. deep. A surge tank will be founded in the floor of the cut.

Section 3 An excavation up to about 30 ft. deep for a distance of about 500 ft. The pipeline will be founded in the floor of the cut, which will be backfilled.

Preliminary investigation of each section to determine possible foundation conditions and also possible suitability of excavated material for use in the embankment of the Summit Storage (Steel, 1963), was requested at a site inspection on 19th August 1968 by Mr. H.D. Fleming, Soils Section E.&W.S. Department, and confirmed in a letter from the Engineer-in-Chief dated 30th January 1969.

During investigation a diamond drill hole was put down in each of the sections - holes DH1 (80ft. deep), DH2 (35ft. deep) and DH3 (42ft. deep) respectively (Appendix A). Their location is shown on Figure 1.

GEOLOGY ALONG PIPELINE ROUTE

Topography

The pipeline sections are located in an area of gently undulating hills, with side slopes of less than 20°, rising usually less than 200 ft. above the valleys. Most of the

area is under cultivation.

Rock Types

The rocks exposed to the north and south of the pipeline are claystone, siltstone and sandstone grading to quartzites, phyllites, and schist of the Torrensian Series of the Adelaide System (Proterozoic in age).

It is difficult to determine actual rock types along the pipeline sections as outcrops are rare. Those which do occur are limited in extent and consist of the stronger rocks such as the quartzites and slates.

The drilling suggests that rock types are very variable along the pipeline, as the cores showed different types in each hole, with variations in strength from weak to strong rocks (Table 1). Details of the rock types recovered are shown in the drill logs (Appendix A). It is probable that rocks other than those recovered during drilling will also occur along the pipeline.

Geological Structures

The beds generally strike north-south to northeast-southwest and dip to the east although further to the south in the Littlehampton area the beds are broadly folded about north-south axes. If this general strike persists along the pipeline route, then the excavations will cut the beds almost at right angles.

Several indefinite crushed seams up to 0.5 ft. wide and sheared zones up to 4 ft. wide occur in the drill core. Most appear to be parallel to the bedding.

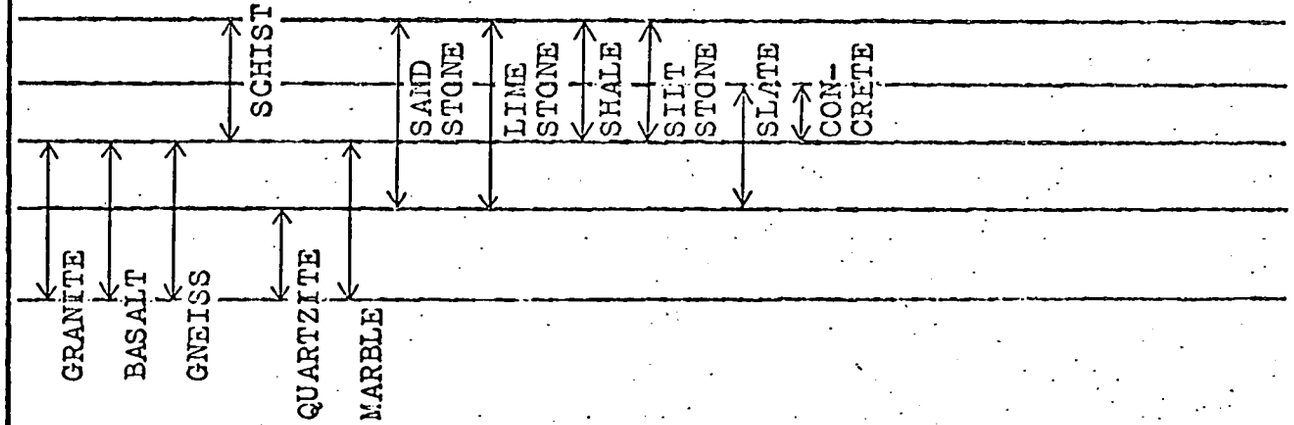
Prominent jointing in the rock is parallel to the schistosity or the bedding. Other joints occur with various orientations. The joints are spaced from 0.1 to 0.8 ft. apart and are either uncemented or weakly cemented by limonite.

TABLE I

CLASSIFICATION OF CLAY SOILS AND ROCK SUBSTANCES
BY UNCONFINED COMPRESSIVE STRENGTH

	TERM	ABBREVIATION	UNCONFINED COMPRESSIVE STRENGTH (Kg/sq.cm)
SOIL PROPERTIES — Disintergrates, or can be remolded in water	Very soft (clay)	VS	less than 0.25
	Soft "	S	0.25 - 0.5
	Medium "	M	0.5 - 1.0
	Stiff "	St	1.0 - 2.0
	Very Stiff "	V.St.	2.0 - 4.0
	Extremely stiff clay	E.St.	greater than 4.0
	Boundary Zone Substances		
ROCK PROPERTIES — Do not disintergrate cannot be remolded, in water	Very weak rock	VWR	less than 70
	Weak "	WR	70 - 200
	Medium Strong "	MSR	200 - 700
	Strong "	SR	700 - 1800
	Very Strong "	VSR	greater than 1800

Range of strengths of some Common Rock Substances, in the Fresh State



Water pressure tests carried out between 20 and 42 ft. depth in hole DH3 showed leakages of 5 to 7 Lugeons indicating that joints are probably slightly open at this depth.

Weathering

The drilling indicates that the degree of rock weatherin is variable along the pipeline sections, and ranges from slight to complete, but in general the weathering effects decrease with depth. Weathering appears to be deeper in the weaker rocks such as the schist and sandstone. Weathering effects are least in the slate intersected in Hole DH.1 where slightly weathered rock was recovered below 35 ft. depth.

Groundwater

No groundwater was present in Holes DH.2 and DH.3 after completion. A standing water level of 45 ft. was recorded in Hole DH.1 on 27th August, 1968, on completion of drilling and after standing overnight. Because the rock in this hole appears open jointed and hence permeable, it is considered that this represents the water table at the time of drilling. This suggests that the winter water table is about 25ft. above invert level.

METHODS OF EXCAVATION

The rocks as recovered during drilling could be all excavated by ripping with heavy duty tractor. It is likely that this would apply to most of the excavation in each section, but stronger beds, which occur at the ground surface as small outcrops (less than 20ft. wide) may require blasting at depth.

STABILITY OF CUTTINGS

If the bedding, and prominent joints are shown to be at about right angles to the excavations, then the following batter slopes should be generally stable for the rock types as intersected by the drill holes:

Section 1	-	1:1 in upper 35 ft.
		½:1 below
Section 2	-	1:1
Section 3	-	1.5:1 in upper 20ft.
		1:1 below.

These are maximum recommended slopes, and could be flattened if required to increase the volume of excavated material for use in other earthworks.

It is likely that minor instability of the batter slopes would occur during and after construction due to unfavourable orientations of crushed seams and joints, but these would not be likely to affect the overall stability of the excavation.

Groundwater inflows would be common if excavation passes below the groundwater table. Other local inflows may occur above the groundwater table associated with relatively impermeable zones such as clay seams.

The presence of groundwater would increase the chance of local instability of the batter slopes.

SUITABILITY OF MATERIAL FOR DAM EMBANKMENT

The suitability of the rock recovered in each drill hole for use in a compacted rock fill embankment is as follows:-

Table 2

Hole No.	Depth (feet)	Geological Description	Suitability for Embankment
DH.1	0 - 10	Topsoil and siltstone, moderately to completely weathered.	Not usable
	10 - 35	Siltstone with sandstone interbeds, moderately to highly weathered.	Borderline, but probably usable
	35 - 80	Siltstone with sandstone interbeds, slightly weathered.	Usable
DH.2	0 - 14	Topsoil and sandstone highly weathered.	Not usable
	14 - 23	Schist, moderately weathered.	Probably usable
	23 - 35	Schist, moderately to completely weathered.	Not usable
DH.3	0 - 10	Topsoil and mainly NO CORE (few completely weathered sandstone fragments)	Not usable
	10 - 25	Sandstone, moderately to highly weathered.	Probably usable
	30 - 42	Schist and sandstone, highly weathered.	Not usable

FURTHER EXPLORATION

It is recommended that each section of the pipeline be explored further by trenching to give a better indication of the orientation of the strata and distribution of rock types. This could be carried out by a bulldozer or heavy duty trench digger. Further diamond drilling may be necessary if other rock types are exposed in the trenches.

Seismic refraction traverses along each section would provide a good indication of ease of rippability and amount of blasting necessary, during excavation.

WRPB:JEM:JB
14.2.69

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REFERENCES

STEEL, R.D. 1963. Report on Site Investigation Proposed Pump Storage Dam, Balhannah. Dept. of Mines. Rept.Bk.No. 56/112.

APPENDIX A

LOGS OF DIAMOND DRILL HOLES

AND EXPLANATORY NOTES

APPENDIX A

LOGS OF DIAMOND DRILL HOLES

AND EXPLANATORY NOTES

NOTES ON DRILL PROCEDURES

Equipment

The core sizes are as follows:-

Symbol	Nominal Diameter of Cores (inches)
NXC (NX casing)	2.8
NMLC	2.0
BMLC	1.4

The NMLC and BMLC cores were obtained with "M" type stationery inner tube core barrels fitted with bottom discharge bits. The inner tubes were of the split type, ensuring minimum disturbance of the core during removal from the barrel.

Storing and Marking of Core

Cores are stored in wooden boxes, each compartment of which is designed to contain five feet of core. The internal length for each compartment is actually five feet one inch, to allow for 100 per cent core recovery. Roughness of the ends of the core, and small inaccuracies in measurement when breaking it to fit the box, make it difficult to fit five feet of core in a compartment of exactly that lenght. The boxes are marked with consecutive compartment numbers at one end, and the drilled depths from the surface in feet at the other.

The core was boxed in this manner at the drill site, the core being placed in its appropriate place in the box as soon as it was extracted from the core barrel. The bottom of each lift was marked with paint immediately it was placed in the box, and a corresponding paint mark was made on the side of the core box. The measured depth of the hole in feet from the surface was painted on the side of the core box and on the core. Timber blocks cut to the correct lenght indicate core not recovered (red blocks) and core removed for testing, (white blocks).

The core has been stored at the Department of Mines, Drilling and Mechanical Branch, Dalgleish Street, Thebarton, South Australia.

NOTES ON DIAMOND DRILL LOG SHEETS

The logs are plotted on a vertical scale of one inch = five feet (1:60) (Fig. 1) In the column headed "Log", places where core was obtained are shown by stippling. Places where core was lost are shown by blank spaces.

The descriptions given on the log sheet refer only to materials recovered as core. Core is lost by the material being ground or washed away during the drilling process; it may usually be inferred that such material is relatively weak. The weakness may arise from weathering or else from sheared, crushed, or jointed rock. It cannot always be assumed that the material not recovered is weak, since even solid rock core may be ground away and lost during drilling operations.

The drilling lifts and approximate percentage of core loss in each lift are shown graphically in the column "Core Loss, Lift %".

The degree of chemical decomposition or weathering of the rock material recovered is given in the "Rock Type and Degree of Weathering" column.

In the column marked "Structures" the angles shown on joints, bedding, or other geological structures are the angles which they make with the plane at 90° to the axis of the core, unless otherwise stated.

The "Fracture Log" to the right of the graphic log column shows the degree of fracturing of the core by means of a histogram-type plot. Degree of fracturing means the degree to which the rock has mechanically broken up along geological defects, such as joints, cleavage planes, foliation planes, bedding planes, or seams. Fresh fractures across the fabric of the rock, not along the existing planar geological defects, are not included. In sections in which no core was recovered the fracture log column is left blank.

Results of water pressure tests carried out on the drill holes, to obtain some measures of the permeability of the rock mass, are shown in the column headed "Water Pressure Test".

To the left of the graphic log is a geological description of the materials sampled. This includes:-

...Geological age
...Rock unit name
...Type of material
} Printed vertically

...Mineral composition

...Cementation

...Physical description of core

NOTES ON WATER PRESSURE TESTING

Water pressure testing was carried out during drilling by sealing the hole with an expandable packer and pumping in water at measured pressures.

The following procedure was used.

a. Immediately after drilling of the test section, the hole was cleaned out by flushing with water pumped down through the drill rods, until the returning water was clear.

b. A mechanically expandable rubber packer in series with NX drill rods, was placed down the hole at the top of the test section and expanded to form a seal against the walls of the hole.

c. Water was pumped into the test section between the packer and the bottom of the hole, and the pressure measured by a pressure gauge. The quantity of water pumped into the hole, for a given period, usually 5 minutes, was measured by a water meter.

The results have been used to calculate permeability figures for the rock mass, as described below.

Calculation of permeability figures

The results of the water pressure testing have been plotted as Lugeon units on the log.

One Lugeon unit is defined in Talobre (1957) as a water loss of 1 litre per minute per metre of drill hole of diameter 46 to 76 mm at a pressure of 10 bars (10.2 kg/cm^2) maintained for 10 minutes.

The testing procedure used has been described above. The conditions of test differed in some respects from those required by the above definition, but were sufficiently close to warrant the use of Lugeon units.

In some cases during testing water can be pumped into the test section at full pump capacity without registering any pressure in the gauge at the surface. The Lugeon value is then calculated assuming that the drill rods were filled with water, although it is most likely that the rods were only partly filled because no pressure was registered. In cases such as these the actual Lugeon value would be more than that calculated and is therefore shown on the detailed log as a "minimum value".

REFERENCE

TALOBRE, J. (1957) La Mechanique des Roches (Dunod : Paris), pp. 151-5.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

LOG OF DIAMOND DRILL HOLE

HOLE No. DH 1

SERIAL No.

PROJECT Murray Bridge — Onkaparinga Pipeline

FEATURE Pipeline open cut

LOCATION Balhannah

ADJACENT SECTION 1412 HUNDRED Macclesfield

CO-ORDINATES —

ANGLE FROM HORIZONTAL 90°

DIRECTION —

R.L. Surface 1505 (Approx) FT.

R.L. Collar FT.

Datum E & W.S.

DESCRIPTION OF CORE	SW WEATHERING MW HW CW	CORE SIZE. DEPTH R.L. FT.	LOG	FRACTURE LOG 1 4 16 64	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT. CORE LOSS % 5 50 10	WATER LEVEL DATE	CASING	DRILL WATER LOSS % 0-100	WATER PRESSURE TESTS LUGEONS 10 20 30 40 80 120
TOPSOIL, sand, excess fines organic, dark brown.	NLP	NX								
PROTEROZOIC - ADELAIDE SYSTEM		1500								
SILTSTONE with interbeds of SANDSTONE and few CLAYSTONE beds 0·1 to 0·5 ft. thick. Most beds micaceous, grey to blue in fresh state, yellow-brown when weathered.		NMLC 10			Contorted.					
Core mainly in smooth surfaced continuous sticks.		1490								
Some breakage to fragments in more weathered areas.		20			Sheared zone?					
		1480								
		30			Weathered zone crushed?					
Core broken to fragments at intersection of joints.		1470			Bedding 10° to 20°. Joints at 10° to 20° (parallel to bedding) few at 75° to 90° Spaced 0·1 to 0·8 ft, weakly cemented. Most joints limonite stained.		27 Aug 68	FULL RETURN		Not Tested
		40								
		1460								
		50			Weathered zone crushed?					
		1450								
		APPROX INVERT LEVEL 60								
		70								
		1430								
		80			END OF HOLE 80 Ft.					
		90								
		00								

WEATHERING

FR — Fresh
SW — Slightly weathered
MW — Moderately ''
HW — Highly ''
CW — Completely ''

FRACTURE LOG

1 4 16 64 — Natural fractures per foot of core;
12 3 ¼ 3/16 — Equivalent diameter in inches

ENGINEERING GEOLOGY SECTION

DRILL No. 16	LOGGED BY W.R.P. Boucaut
TYPE Diamond	DATE 2 Dec. 68
DRILLER Jensen	TRACED E.B.T.
START 23 Aug. 68	CHECKED
FINISH 27 Aug 68	

SHEET 1. OF 1. DRG. No. S7076 Hab.

P No S5027A MB

DEPARTMENT OF MINES — SOUTH AUSTRALIA

LOG OF DIAMOND DRILL HOLE

HOLE No. D.H 2

SERIAL No

PROJECT MURRAY BRIDGE

ONKAPARINGA PIPELINE

FEATURE PIPELINE OPEN CUT/~~SURGE~~ TANK

LOCATION BALHANNAH

SECTION 4423 HUNDRED Macclesfield

CO-ORDINATES —

ANGLE FROM HORIZONTAL 90°

DIRECTION —

R.L Surface 1445 (Approx) FT.

R.L Collar FT.

Datum E+WS.

DESCRIPTION OF CORE	SW WEATHERING MW HW CW	CORE SIZE. DEPTH R.L FT.	LOG	FRACTURE LOG 1 4 16 64	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT. CORE LOSS % 5 50 10	WATER LEVEL DATE	CASING	DRILL WATER LOSS % 0 100	WATER PRESSURE TESTS LUGEONS 10 20 30 40 80 120
TOPSOIL - SAND excess silt/ clay fines, organic, brown		NX 1440		N.A.	Joints at 45° to 55° Spaced 0.1 to 1.5 ft. ← Soil infill to 10 m.m. along joints.		Hole Dry	FULL RETURN		Not Tested
SANDSTONE - fine to medium grained, white to pale brown.		10 NM LC								
PROTEROZOIC ADELAIDE SYSTEM										
SPOTTED SCHIST - micaceous numerous cw mineral grains to 3mm dia. — in part grains are elongate, sheared? Pale to dark red brown.		1430			← weathered zone along joints. Schistosity at 55° - Joints at 25° 30° to 60° (parallel to and across schistosity)					
		20 TANK LW.L			partings along schistosity					
		1420			Indefinite sheared zone spaced 0.1 to 0.8 ft.					
		30								
SCHIST, micaceous, grey.		1410			partings along schistosity					
					END OF HOLE 35 FT					
		40								
		50								
		60								
		70								
		80								
		90								
		00								

WEATHERING

FR — Fresh
SW — Slightly weathered
MW — Moderately ″
HW — Highly ″
CW — Completely ″

FRACTURE LOG

1 4 16 64 — Natural fractures per foot of core
12 3 ¾ 5/16 — Equivalent diameter in inches

ENGINEERING GEOLOGY SECTION

DRILL No 16
TYPE Diamond
DRILLER Jensen
START 30 Aug '68
FINISH 30 Aug '68

LOGGED BY W.R.P. Boucaut
DATE 2 Dec '68
TRACED
CHECKED

SHEET 1 OF 1

DRG. No. S 7077 Ha6

DEPARTMENT OF MINES — SOUTH AUSTRALIA

LOG OF DIAMOND DRILL HOLE

HOLE No. DH 3

SERIAL No

PROJECT Murray Bridge – Onkaparinga Pipeline (surge tank)

FEATURE Pipeline open cut.

LOCATION Balhannah

SECTION 5299 HUNDRED Macclesfield.

CO-ORDINATES

ANGLE FROM HORIZONTAL 90° DIRECTION

R.L. Surface FT.

R.L. Collar FT.

Datum

DESCRIPTION OF CORE	SW WEATHERING MW HW CW	CORE SIZE. DEPTH R.L. FT.	LOG	FRACTURE LOG 1 4 16 64	STRUCTURES JOINTS, VEINS, SEAMS, SHEARED ZONES, CRUSHED ZONES	LIFT. CORE LOSS % 5 50 10	WATER LEVEL DATE	CASING	DRILL WATER LOSS % 0-100	WATER PRESSURE TESTS LUGEONS

PROTEROZOIC – ADELAIDE SYSTEM

TOPSOIL – sand poorly graded organic, less than 10% fines. 0.25 Ft sandstone fragment.

SANDSTONE, Medium to coarse grained, pale grey to red-brown

SCHIST micaceous grey to red brown

SAND STONE

Core in smooth to rough surfaced sticks, broken to soil and rock fragments in zones of increased weathering.

3 Inch — N.A.

No Core

No Core

Partly broken to sand

General: Joints at 15° to 25° 50° to 80°. Spaced mainly 0.1 to 0.4'

10

NM Ft

Weathered seam along joint at 50°

Weathered zone – sheared.

20

APPROX INVERT LEVEL

Sheared zone at 80°

0.2 Ft. weathered seam along joints at 50°

No Core

30

Weathered seam at 70°

Foliation and prominent joints at 75°

40

No Core

Hole Dry

FULL RETURN

END OF HOLE 42 FT.

50

60

70

80

90

00

WEATHERING

FR – Fresh

SW – Slightly weathered

MW – Moderately ''

HW – Highly ''

CW – Completely ''

FRACTURE LOG

1 4 16 64 — Natural fractures per foot of core

1/2 3/8 1/4 1/16 — Equivalent diameter in inches

ENGINEERING GEOLOGY SECTION

DRILL No 16

TYPE Diamond.

DRILLER Jensen

START 3. Sept '68

FINISH 4. Sept '68

LOGGED BY W.D.R. BOUCAUT.

DATE 2 Dec. '68

TRACED E.B.T.

CHECKED

SHEET 1 OF 1

DRG. No. S7078 Hab

TEXT FIGURE

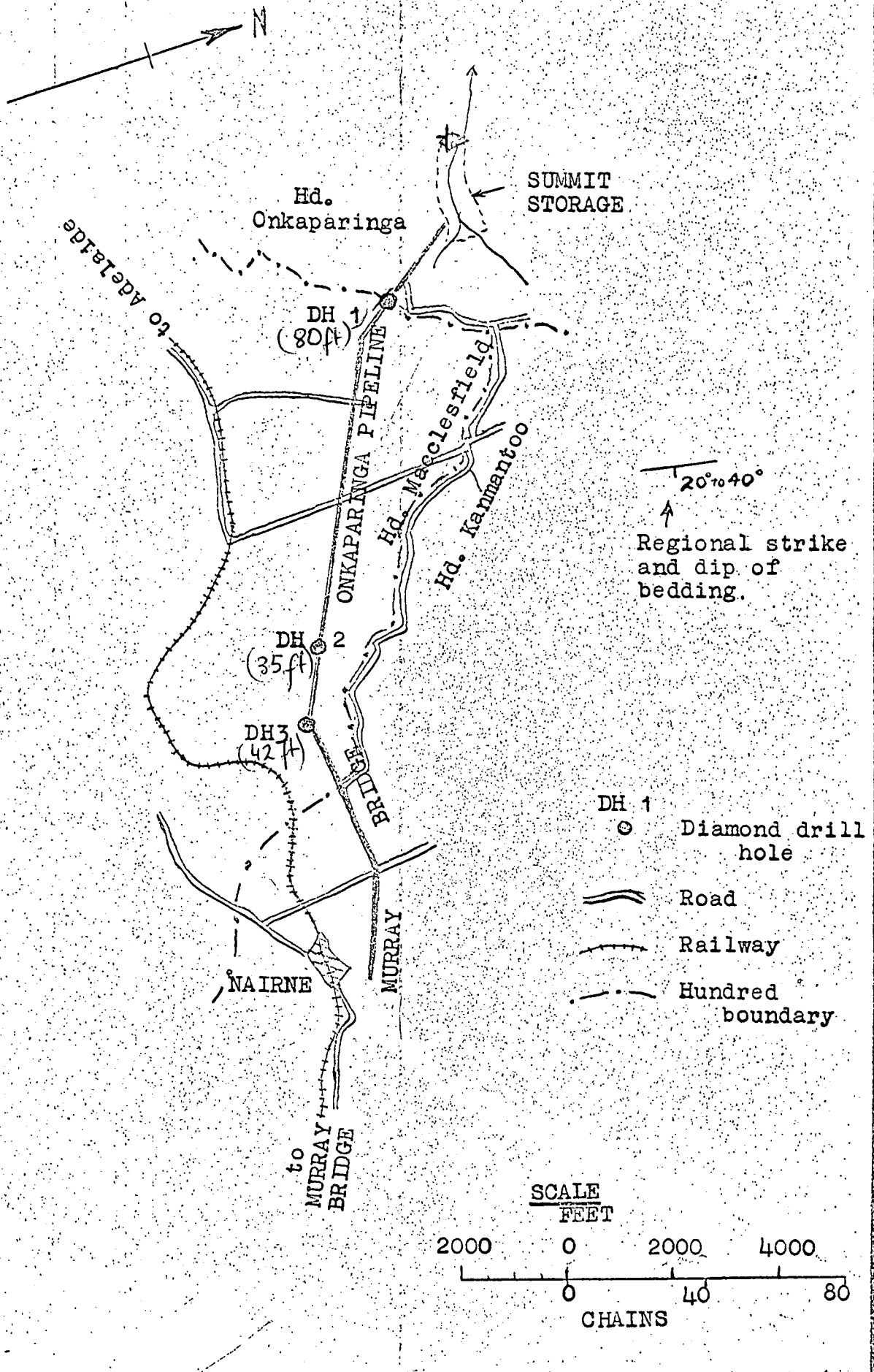

FIG. 1.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

ENGINEERING GEOLOGY SECTION	Drn. WRPB Tcd. Ckd. Exd.	MURRAY BRIDGE ONKAPARINGA PIPELINE PIPELINE OPEN CUTS LOCATION OF DIAMOND DRILL HOLES	SCALE: As shown S7149 H<1 DATE: 7 Feb. 69