COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1961-163

KROOMBIT CREEK 34.0M DAM SITE SEISMIC REFRACTION SURVEY, QUEENSLAND 1959

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CONTENTS

ABSTRACT

This Record describes a seismic survey made by the Bureau of Mineral Resources on the Kroombit Creek 34.OM dam site in Central Queensland. This dam site is one of several under consideration by the Irrigation and Water Supply Commission of Queensland for the development of the Callide Valley.

The depth to bedrock is shown to have values between 11 and 117 ft. The overburden contains material which is probably of sufficient strength for use as dam foundations. This material lies at depths between 20 and 80 ft.

1. INTRODUCTION

Consideration is being given to constructing an electric power generating station to make use of coal from the Callide open cut mine near Biloela in Queensland. Such a power station would require an abundant water supply, and for this reason the Irrigation and Water Supply Commission of Queensland is examining sites suitable for construction of a dam in the Callide valley.

The Commission requested the Bureau of Mineral Resources to make geophysical surveys on these dam sites, to determine the depth to, and seismic velocities in, the rock formations. The objective of the survey was to locate formations strong enough to support a dam wall.

This Record describes a seismic refraction survey undertaken by the Geophysical Branch of the Bureau, on the Kroombit Creek 34.OM dam site, about ten miles east of Biloela (Plate 1), which has approximate co-ordinates 345800 yards east, 963250 yards north on the Monto 4-mile map.

The party consisted of W.A. Wiebenga (party leader and geophysicist), E.E. Jesson and B.J. Bamber (geophysicists), and J.P. Pigott (geophysical assistant). Field hands were supplied, and topographical surveying done, by the Irrigation and Water Supply Commission.

Field work on this site extended from the 7th to the 19th of October 1959.

2. GEOLOGY

The geology of the site is known from surface work and drill holes (Dunlop, 1959).

Kroombit Creek is situated near the centre of an alluvial flood channel approximately 350 ft wide. On the east of the flood channel a high-level alluvial terrace, 20 ft above the flood channel and 400 ft wide, is flanked by a 40-ft high bank followed by a long gentle slope consisting of sandstone and conglomerate partly covered by areas of sand and silt.

The west bank abutment is a 25-ft cliff comprising highly jointed sandstone overlain by conglomerate and pebbly sandstone. Beyond this cliff is a long gentle slope of soil with occasional bouldery outcrops of pebbly sandstone. The higher regions of this slope are capped by a quartzite boulder deposit. A minor gabbro intrusion is indicated on this west bank.

In this Record the term "bedrock" will refer to the deepest recorded seismic refractor. The term "overburden" will refer to soil, sand, gravel, scree material, weathered or decomposed bedrock, and unweathered sandstone where it overlies other rocks of higher seismic velocity.

3. METHODS AND EQUIPMENT

A discussion of the methods and techniques used in the seismic refraction survey was given by Polak and Mann (1959).

The seismic recording equipment used in the survey consisted of a Midwestern 12-channel portable, shallow reflection/refraction seismograph.

4. RESULTS

4.1 General discussion

The location of the seismic traverses is shown on Plate 2.

As a guide to the interpretation of the seismic refraction work, the following identification is made between the seismic longitudinal velocities and the rock types found in the dam site area. This is based on experience and on the comparison of drill-hole information with seismic recordings shown in Table 1.

Seismic velocity (ft/sec)	Rock type
1000 to 3000	Surface soil, sand, scree material, not water-saturated.
3000 to 6000	Sand or gravel, unconsolidated to slightly consolidated, well weathered sandstone or mudstone possibly with clay seams.
6000 to 12,000	Well weathered to slightly weathered sandstone, possibly with clay seams for the lower part of the range.
12,000 to 17,000	Slightly weathered and unweathered sandstone and mudstone.

The cross-sections (Plates 3, 4) show the depth to bedrock as derived from the seismic observations. A study of the bedrock velocities, which range from 12,000 to 19,000 ft/sec, shows that there is a considerable variation in bedrock characteristics over the survey area. This is probably explained by variations in age, compaction, and cementation of the unweathered sandstone bedrock.

Vertical variation in bedrock characteristics may occur, where one or more types of unweathered sandstone or mudstone overlie a higher-velocity material. An example of this is seen in the region of X55 where bedrock with a seismic velocity of 16,500 ft/sec is overlain by a material with a seismic velocity of 12,600 ft/sec. A test bore (DD4) shows that this upper material is an unweathered grey sandstone. Technically this sandstone is defined as overburden, but the high seismic velocity suggests that it may have sufficient strength for use as a foundation rock. The same may well be true of slightly weathered sandstone or mudstone.

It is considered that a material having a seismic velocity in excess of about 8000 ft/sec (corresponding to values of Young's modulus greater than about 1.4×10^6 lb/in.^{2}) would probably have sufficient strength for a dam foundation rock. This value may vary slightly depending on the type of dam structure in use.

The upper boundaries of the sandstone or mudstone, either unweathered or slightly weathered, with seismic velocities of 8000 ft/sec or greater, are shown on the cross-sections (Plates 3 and 4) as broken lines.

4.2 Detailed discussion of traverses

Traverse A (Plate 3) shows an average depth to bedrock of about 80 to 90 ft; the overburden is slightly thinner to the north-eastern end of the traverse owing to a lower surface elevation.

Three layers are indicated in the overburden; a surface layer of soil or scree material, a second layer of consolidated sand or gravel or a well weathered sandstone, and a third layer which is probably a slightly weathered sandstone. The third layer deepens from 17 ft at the south-western end of the traverse to about 40 ft in the middle. This layer is not detected on the north-east end of the traverse; it may be present but too thin to be recorded by the seismic methods. A theoretical consideration shows that at A20, as much as 30 ft of this third layer could be present without being detected by the seismic method.

Traverse B (Plate 3) shows an average depth to bedrock of about 45 to 55 ft, the overburden being much thinner to the south-east owing to lower topography. Two layers are indicated in the overburden; a thin layer of soil, and a second layer of well weathered sandstone, as is shown in a test bore (DD3) at the intersection of Traverses B and X.

Traverse C (Plate 3) shows an average depth to bedrock of about 90 or 100 ft, with a slight ridge at the intersection with Traverse X. The overburden is indicated as having three layers, as on Traverse A. The intermediate layer is shown by a test hole (DD5), to consist of well weathered or weathered mudstone. The third layer, with an average depth of about 40 ft, has a seismic velocity of 8800 to 10,600 ft/sec.

Traverse X (Plate 4) at its west end, from X_2 to X_{22}, is similar to Traverse A which intersects it at X_{10}. The depth to bedrock is generally between 50 and 70 ft. The overburden consists of three layers. The third layer is at a depth of about 25 ft and has a seismic velocity of 8000 ft/sec and higher.

The region from X_{22} to X_{49} has an average depth to bedrock of about 50 ft. The overburden is variable, consisting of two or three layers which generally have velocities below 8000 ft/sec. The exceptions to this are at X29, and X43 to X45, where layers with velocities of 7500 and 11,500 ft/sec occur at depths of about 13 and 45 ft respectively.

A test hole (DD1) near X46 shows a grey, probably fresh, pebbly sandstone at 18 ft, with a layer 14 ft thick of similar but slightly weathered sandstone overlying it. This sandstone shows a seismic velocity of 7500 ft/sec, which is slightly below the lower limit of 8000 ft/sec suggested as possibly suitable for a foundation rock. However, if this pebbly sandstone is considered suitable for a foundation rock, then the same formation may also be suitable in other parts of the region X22 to X49.

Between X49 and X59, the region containing the creek flood channel, the bedrock depth reaches a maximum of 117 ft. The lowest layer of the three-layer overburden is shown by DD4 to be brown weathered sandstone at a depth of 18 ft, and the high seismic velocity suggests that this should prove suitable for a foundation rock.

The region from X59 to X66, which is cut by Traverse B near X62, is a high-level river terrace; it is similar to Traverse B, having a two-layer overburden of soil and well weathered sandstone. The depth to bedrock ranges between 74 ft at X59 and 20 ft at X66.

The region X66 to X72 has a very thin (about 11 ft) overburden shown seismically as a single layer. However, test bore DD2 shows that this layer includes weathered sandstone with some clay seams which would be too thin to be recorded by the seismic method.

The region X72 to X77 has a two-layer overburden increasing in thickness from 12 ft at X72 to 48 ft at X77.

From X77 to X96, the depth to bedrock is between 45 and 90 ft. A layer with average velocity about 11,000 ft/sec ranges between 31 ft deep at X77 and 17 ft deep at X95. A test hole (DD6) at X77 shows a formation boundary at 38 ft with slightly weathered sandstone and mudstone below it, and a material similar but containing clay seams above it. This boundary at 38 ft probably corresponds with the seismic boundary with estimated depth of 31 ft.

From X96 to the eastern end of the Traverse at X112 the depth to bedrock ranges between 56 and 97 ft. At X104 where Traverse C cuts Traverse X, a layer with velocity 8100 ft/sec is indicated at a depth of 30 ft. This boundary does not appear to correlate with anything definite in test bore DD5, where a slightly weathered mudstone lies between 12 ft deep and the bottom of the hole at 50 ft, but there is a possible change in the degree of fragmentation at a depth of $27\frac{1}{2}$ ft.

Determination of the accuracy of observation is difficult but as a guide, a comparison of seismic and drill-hole information is given in Table 1.

TABLE 1

Correlation of cross-sections with drill logs

Location	Drill log boundary		Seismic boundary	
	Types of material across boundary	Depth (ft)	Depth (ft)	Seismic velocities across boundary (ft/sec).
DD 1 (X45)	Soil/weathered pebbly sandstone	4½	7	2000/7500
DD 2 (X72)	Soil/weathered pebbly sandstone with clay seams	4½	between 0 & 10; layer too thin to record	1300/7400
	Weathered pebbly sandstone with clay seams slightly weathered sandstone	11½	10	7400/17,000
DD 3 (X62)	? Poor core recovery	-	21	1100/7300
	Hole shallower than other seismic boundary			
DD 4 (X55)	Soil, scree/weathered sandstone and fresh sandstone	17	18	3100/12,600
DD 5 (X104)	Soil, scree/very weathered mudstone	9½	10	1600/3000
	? Slightly weathered mudstone, highly fragmented/ less fragmented	27½	30	3000/7000
	Hole shallower than other seismic boundary			
DD 6 (X77)	Soil, scree/very weathered sandstone and mudstone	5½	10	1600/3000
	Slightly weathered sandstone and mudstone with/ without clay seams	38	31	5000/10,000
	Hole shallower than other seismic boundary.			

At the shallow boundaries (0 to 12 ft) the drill logs generally show several thin layers between 1 and 5 ft thick. The corresponding seismic boundary would be the effect of a gradual transition across these layers.

4.3 Dynamic properties of rocks

For some of the dam sites of the group in the Biloela area, an analysis of the ground-roll waves has given useful data on the elastic constants of the rocks (Jesson, Wiebenga, and Dooley, 1961). A similar analysis was attempted for this Kroombit Creek 34.0M dam site but was unsuccessful. It is thought that this is due to the variations, both vertical and lateral, in the rock types (see Section 4.1).

Plate 5 shows an empirical relation between Young's modulus and the compressional wave velocity in rocks. This may be of value as a guide to the value of Young's modulus for the rocks characterised by their seismic velocity as shown on the cross-sections (Plates 3,4).

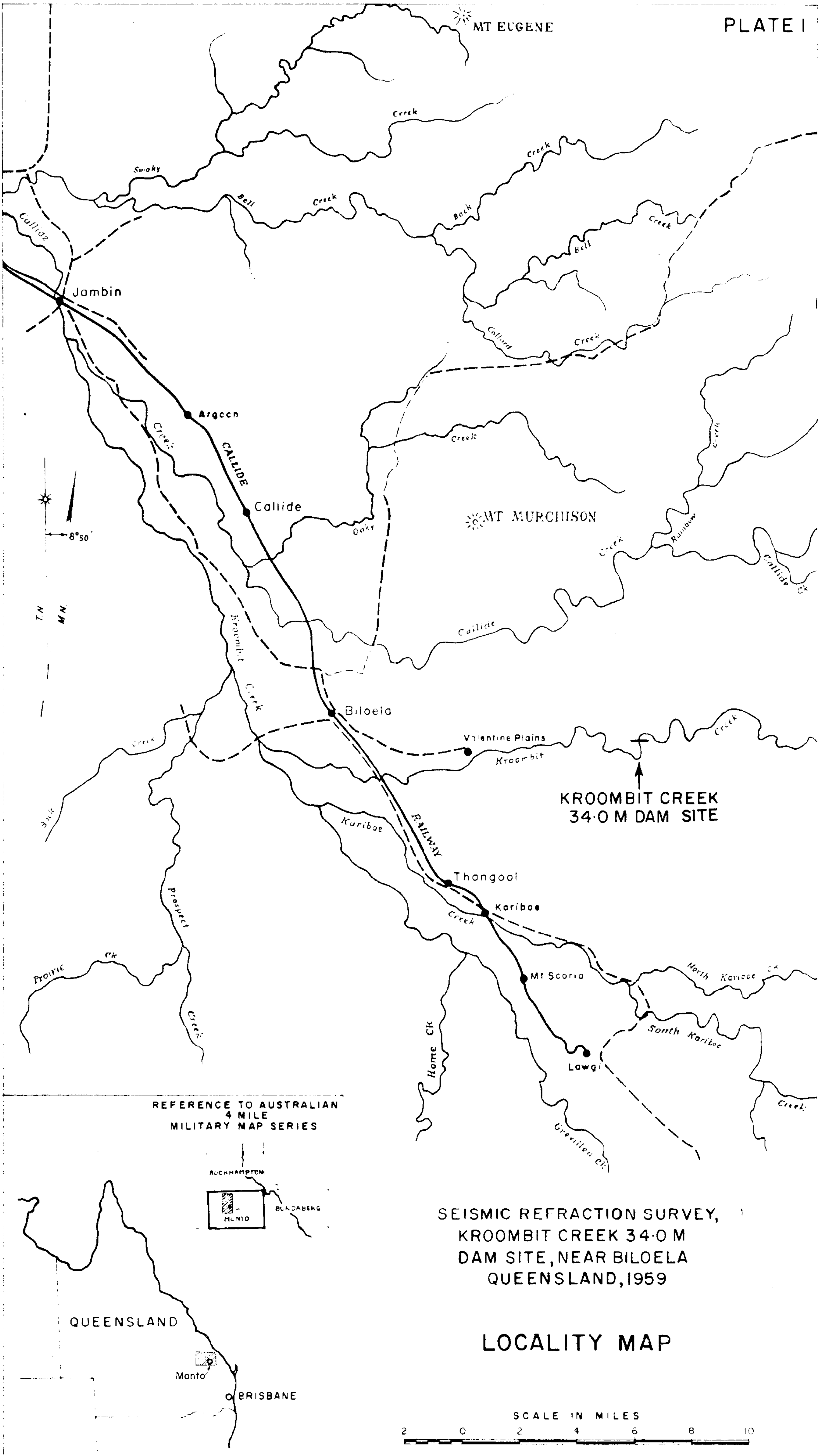
5. CONCLUSIONS

The seismic refraction survey showed that the overburden thickness ranges between 11 and 117 ft and consists of two or three layers. Over a large proportion of the area the deepest of the overburden layers has a seismic velocity of 8000 ft/sec or greater and is believed to have sufficient strength for use as a dam foundation rock. This material is shown to range in depth from about 20 to 80 ft.

6. REFERENCES

DUNLOP, R.A.,	1959	Kroombit Creek 34.0 A.M.T.M. Memorandum to Senior Planning Engineer, Irrigation and Water Supply Commission, Queensland.
JESSON, E.E., WIEBENGA, W.A., and DOOLEY, J.C.	1961	Bell Creek 17.3M dam site seismic refraction survey, Queensland 1959. Bur. Min. Resour. Aust. Rec. 1961-162.
POLAK, E.J. and MANN, P.E.	1959	A seismic refraction survey at the Moogerah dam site near Kalbar, Queensland. Bur. Min. Resour. Aust. Rec. 1959-62.

PLATE I



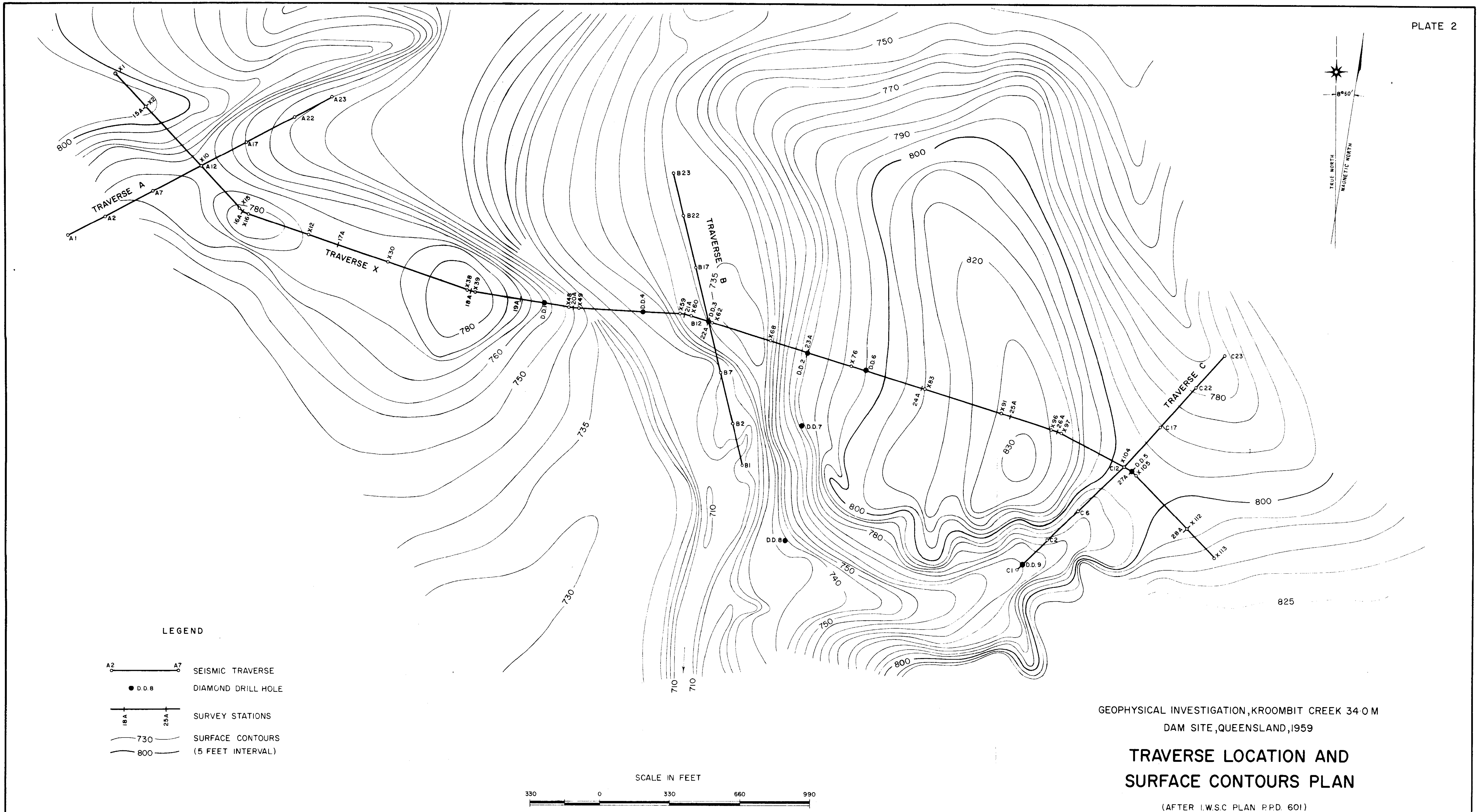
SEISMIC REFRACTION SURVEY,
KROOMBIT CREEK 34·0 M
DAM SITE, NEAR BILOELA
QUEENSLAND, 1959

LOCALITY MAP

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 59-1-1

To Accompany Record No. 1961-163

PLATE 2



GEOPHYSICAL INVESTIGATION, KROOMBIT CREEK 34·0 M DAM SITE, QUEENSLAND, 1959

TRAVERSE LOCATION AND SURFACE CONTOURS PLAN

(AFTER I.W.S.C PLAN P.P.D. 601)
LEVELS DATUM STATE

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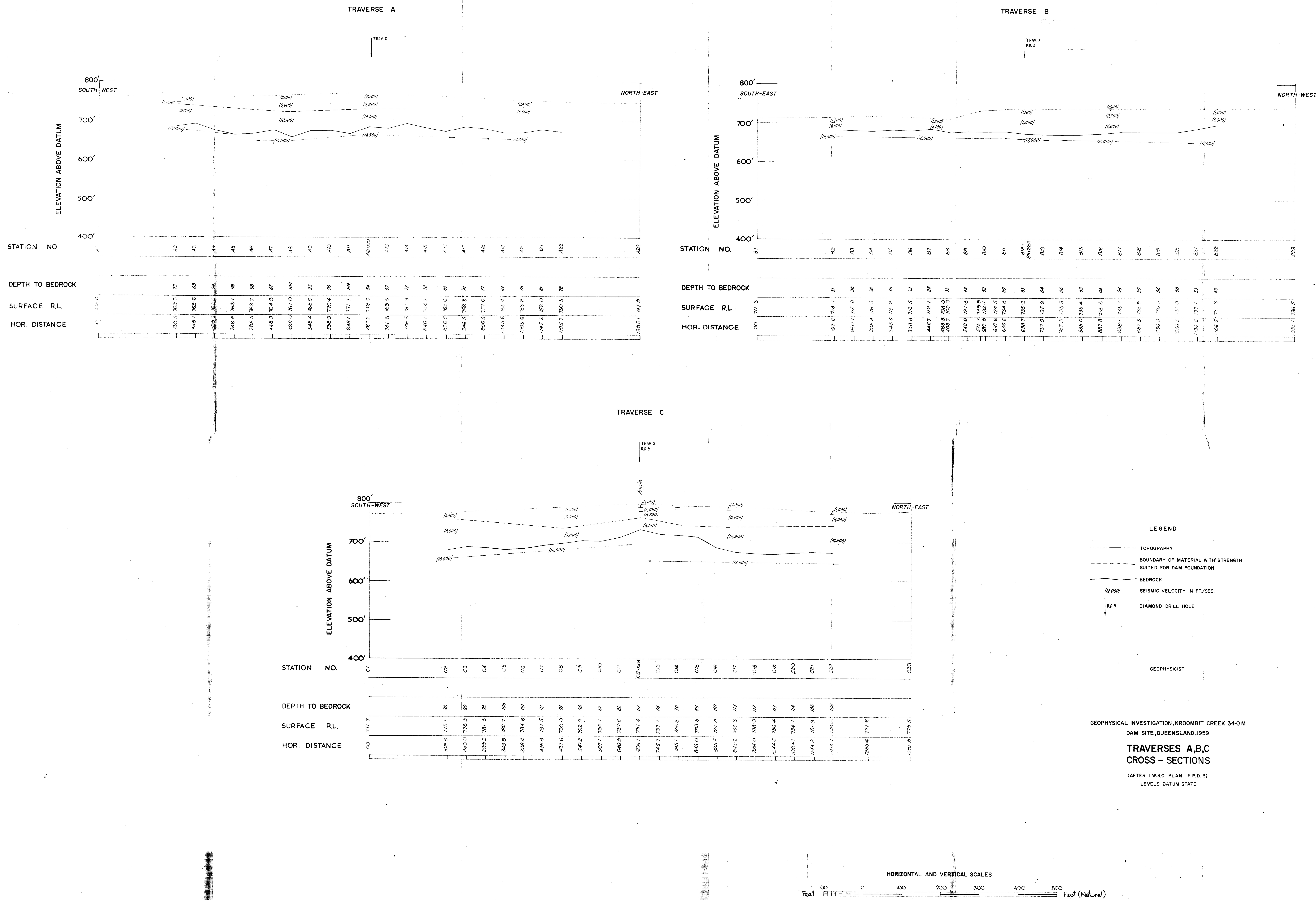
TO ACCOMPANY RECORD No. 1961-163

PLATE 3



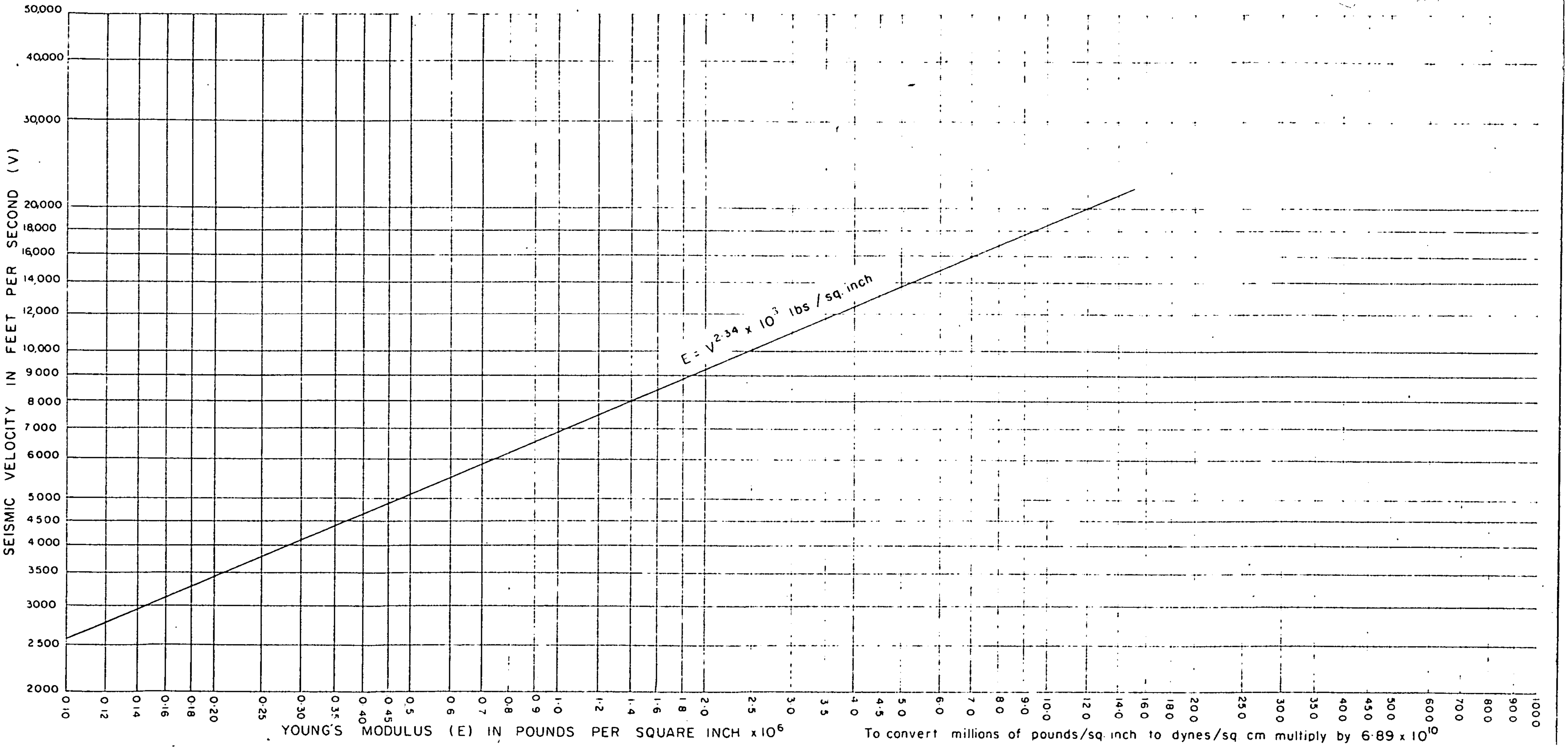
GEOPHYSICIST

GEOPHYSICAL INVESTIGATION, KROOMBIT CREEK 34·0 M DAM SITE, QUEENSLAND, 1959

TRAVERSES A,B,C CROSS – SECTIONS

(AFTER I.W.S.C. PLAN P.P.D. 3)
LEVELS DATUM STATE


PLATE 4
TRAVERSE X
TRAV. A
D.D. 1
D.D. 4
TRAV. B
D.D. 3
WEST
ELEVATION ABOVE DATUM
800′
700′
600′
500′
400′
RIGHT BANK
Water Level 708.3′
Angle
STATION NO.
DEPTH TO BEDROCK
SURFACE R.L.
HOR. DISTANCE
TRAVERSE X
D.D. 2
D.D. 6
TRAV. C
D.D. 5
900′
EAST
LEFT BANK
LEGEND
TOPOGRAPHY
BOUNDARY OF MATERIAL WITH STRENGTH SUITED FOR DAM FOUNDATION
BEDROCK
(12,000) SEISMIC VELOCITY IN FT/SEC.
D.D. 5 DIAMOND DRILL HOLE
GEOPHYSICIST
GEOPHYSICAL INVESTIGATION, KROOMBIT CREEK 34.0 M
DAM SITE, QUEENSLAND, 1959
TRAVERSE X
CROSS- SECTION
(AFTER I.W.S.C. PLAN P.P.D. 2)
LEVELS DATUM STATE
HORIZONTAL AND VERTICAL SCALES
Feet 100 0 100 200 300 400 500 Feet - Natural
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G59-1-3
TO ACCOMPANY RECORD No. 1961-158



The values of Young's Modulus may be considered to have a maximum error of ± 30 %
The above relationship is approximately correct for most rock types, other than salts

PLATE 5. EMPIRICAL RELATION BETWEEN YOUNG'S MODULUS AND THE COMPRESSIONAL WAVE VELOCITY IN ROCKS

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To accompany Record No. 1961-163

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