COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1961-106

YABBA CREEK 19.3M and AMAMOOR CREEK 17.7M DAM SITES

SEISMIC REFRACTION SURVEY, QUEENSLAND 1959

by

P.E. Mann

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ABSTRACT

This report gives the results of seismic refraction surveys undertaken in response to an application from the Irrigation and Water Supply Commission of Queensland; the areas surveyed are the sites of two dams which are proposed for development of the Mary Valley.

At the Yabba Creek 19.3M site the depth to bedrock ranges from 10 to 80 ft. A comparison with diamond drilling information shows that the seismic depth determinations are accurate to within 10 ft.

The value of Poisson's ratio calculated from longitudinal and transverse wave velocities is 0.39. Assuming a bedrock density 2.7 g/cm^3 the value of Young's modulus is 10^7 lb/in^2.

At the Amamoor Creek 14.7M site the depth to bedrock ranges from 19 to 108 ft. On the right bank (looking down stream) the calculated depths to bedrock are different when shot parallel and perpendicular to the strike of the strata; the discrepancy is explained by the phenomenon of hillside creep. On the left bank a shear zone is indicated.

For the bedrock the value of Young's modulus estimated from an empirical relation ranges from 1.6 to 5.3×10^6 lb/in^2.

Two positions for test drilling to check and control the seismic interpretation are indicated.

1. INTRODUCTION

The Mary Valley, a rich agricultural area of Queensland, uses water from the Mary River and its tributaries. To increase the water resources available for irrigation in the valley, the Irrigation and Water Supply Commission (I.W.S.C.) of Queensland is investigating a number of dam sites on the Mary River system. The Commission had investigated several sites on Amamoor Creek and Yabba Creek, tributaries of the Mary River; it requested that the Bureau of Mineral Resources, Geology and Geophysics carry out a geophysical survey to determine the type of bedrock and depth to bedrock at one site on each creek. The sites selected were the Yabba Creek 19.3M and Amamoor Creek 14.7M sites; their approximate coordinates are 572707 and 569726 on the "Gympie" sheet of the Australian 4-mile military map series.

Geological investigation of the dam sites has been carried out by the I.W.S.C. (Dunlop, 1959).

The Bureau geophysical party consisted of P. E. Mann, geophysicist and party leader, B. J. Bamber, geophysicist, J. P. Pigott, geophysical assistant; in addition four field assistants were supplied by the Commission. Field work at Yabba Creek site lasted from the 28th August to 1st September 1959, and at Amamoor Creek from 2nd September to 14th September 1959.

The Commission carried out the topographical surveying of the site and provided additional transport and some supplies for the party.

2. YABBA CREEK 19.3M SITE

2.1 Geology

The site is situated in a narrow valley on a creek whose banks rise steeply to over 150 ft above the creek bed.

The geology of the area is described by Dunlop (1959). Test drilling has been carried out in the area. The term "overburden" will refer to soil, sand, gravel, and weathered or decomposed rock, with seismic velocities of 7000 ft/sec or less.

At the dam site there are metamorphic rocks of Lower Palaeozoic age and alluvium of Quaternary age.

The metamorphic rocks consist predominantly of cherty shale and lesser amounts of greenstone jasper, quartzite, and shale. The bands vary in thickness from $\frac{1}{2}$ in. to 100 ft, dip at 80° to the east, and strike 170° to 175°. Cleavage of the metamorphic rocks is parallel to the bedding. Rock contacts are tightly banded and generally sharp, although some transitional rock types exist. Close jointing and irregular fracturing are characteristic of all the rock types. Outcrops are rare although some individual beds are hard or very hard and are resistant to weathering. In slightly weathered outcrops joints are stained with iron and manganese oxides.

The greenstones in the vicinity of the dam site result from the regional metamorphism of basic igneous rocks. The greenish grey colour is due to actinolite, chlorite, or epidote, the principal mineral constituents. The rock is a hard, fine-grained, unbanded rock highly resistant to weathering and erosion. In the left bank exposure, the greenstone is closely jointed; the major jointing strikes 135° to 140° and dips 55° to the east.

The interbedded red jasper in the metamorphic rocks is hard and brittle. Numerous irregular tightly banded white quartz veinlets occur throughout the jasper, which is very closely jointed and fractured.

The flood terrace deposits, irregular slopes at the edge of the alluvium, consist of fine sand, silt, and clay with organic material. The stream bed is gravel and sand. Soil on the right bank abutment consists of brown gravel-sand and clay. The gravel and sand consist chiefly of angular jasper. Fine alluvium is found up to 50 ft above the water's edge on the steep left bank. Surface material on the steep left abutment consists of fine sand and silt with occasional floaters of quartzite, cherty shale, and greenstone.

2.2 Methods and equipment

A general description of the seismic refraction method and the technique of the "method of differences" used on this survey is outlined in a report on the Moogerah dam site, Queensland (Polak and Mann, 1959).

The equipment used on the survey was a twelve-channel portable seismograph designed for shallow reflection and refraction seismic methods, manufactured by the Midwestern Geophysical Laboratory of Tulsa, Oklahoma. Midwestern geophones with a natural frequency of about 8 c/s were used to record the vertical motion of the ground.

The following types of geophone spread, based on the "method of differences", were used :

(i) Normal spreads - the geophones were spaced 50 ft apart in a straight line and shots were fired 50 ft and 200 ft beyond each end, in line with the spread.

(ii) Weathering spreads - these spreads were used to obtain the seismic velocity and thickness of the soil and near-surface layers. The geophone interval was 10 ft and shots were fired at distances of 10, 25, and 50 ft beyond each end, in line with the spread.

On several occasions a shot was placed in the centre of a normal spread to provide additional information on the seismic velocity and thickness of the near-surface layers.

Southwestern Industrial Electronics horizontal geophones having a natural frequency of 6 c/s were used to measure the transverse wave velocity of the bedrock on Traverse X between X3 and X14.

2.3 Results

Plate 1 shows the locality plan. The layout of the seismic traverses at the Yabba Creek 19.3M site is shown on Plate 2. The seismic refraction work has been interpreted to give the depths to bedrock, shown on the seismic cross-sections (Plate 3).

2.3.1 Right bank*, Traverses A and X

On Traverse A the seismic velocity of the top formation of soil, eluvium, and jasperoid fragments ranges from 1450 to 3300 ft/sec, the maximum thickness being 34 ft near A21. The seismic velocity recorded for the weathered bedrock of cherty shale, jasper, and fractured quartzite is 6000-7000 ft/sec. The unweathered bedrock with a seismic velocity between 18,000 and 23,000 ft/sec ranges in depth from 35 ft at A6 to 106 ft at A21. The average depth to bedrock is smaller between A2 and X10 than between X10 and A21.

On Traverse X the seismic velocity of the top formation consisting of soil, gravel-sand, clay, and eluvium is between 1000 and 2500 ft/sec. A seismic velocity greater than 1500 ft/sec was generally recorded between X2 and X14. The thickness of the top formation ranges from 9 ft at X6/X7 to about 20 ft at X13. On the flood terrace between X14 and X17 the top formation is a mixture of gravel, sand, and silt, with seismic velocity of 1000 ft/sec. A layer with a velocity of 10,000 ft/sec was struck at 19 ft in diamond-drill hole DD1 between X15 and X16.

The seismic velocity of the weathered bedrock on the hill slope between X2 and X12 is about 6000 ft/sec; between X12 and X17 in the creek bed the velocity is much greater, ranging from 10,000 to 13,000 ft/sec. In the creek bed the erosion is presumably too rapid for weathering to continue until the seismic velocity is as low as 6000 ft/sec. The seismic velocity of the unweathered bedrock on the right bank ranges from 19,000 to 21,500 ft/sec.

2.3.2 Left bank, Traverses B and X

On Traverse B the seismic velocity of the top formation, consisting of fine sand, silt, and floaters of weathered bedrock, ranges from 1450 to 3000 ft/sec and is thickest near B2 (about 20 ft). At stations where velocities of 3000 ft/sec were recorded the soil is thin, and very weathered bedrock crops out. The seismic velocities for weathered bedrock range from 6000 ft/sec for very weathered bedrock to 10,000 ft/sec for slightly weathered bedrock. The depth to the unweathered bedrock with a seismic velocity of 19,000 to 21,000 ft/sec ranges from 10 ft at B21, the up-stream end, to 65 ft at B3, the down-stream end.

* Looking down stream

On Traverse X the seismic velocity of the top formation ranges from 1000 to 2500 ft/sec. Higher up the slope near X22 the seismic velocity is 2500 ft/sec and is interpreted as soil and very weathered bedrock. The weathered to slightly-weathered bedrock has a seismic velocity of 5500 to 10,000 ft/sec. The depth to unweathered bedrock with seismic velocity 19,500 to 23,000 ft/sec ranges from 10 ft near X19 to 44 ft near X26. A shear or fracture zone is indicated uphill from X26, where the bedrock velocity is only 9000 ft/sec.

2.3.3 Seismic velocities

Although the principal objective of the seismic method is the determination of the depth to elastic discontinuities, the seismic velocity is an indication of weathering, jointing, and fracturing of the rock. In general terms it may be said that the higher the seismic velocity the more consolidated the sediments are or the less fractured, jointed, and weathered the bedrock is.

Table 1 lists the interpretation, in geological terms, of the seismic velocities marked on the cross-sections.

TABLE 1

Seismic Velocity ft/sec	Rock type
1000 - 1500	Unconsolidated rock - sand, silt, gravel, with angular, metamorphic fragments.
1500 - 3300	Unconsolidated to semiconsolidated rocks - soil, eluvium, very weathered slate, quartzite and cherty shale.
5000 - 13,000	Consolidated rock, weathered to slightly weathered slate, quartzite, cherty shale, and greenstone.
9000	Sheared and fractured unweathered bedrock, slate, quartzite, cherty shale, and greenstone.
19,000 - 23,000	Unweathered bedrock of slate, quartzite, cherty shale, and greenstone.

2.3.4 Comparison of seismic depth determination and diamond-drill hole data

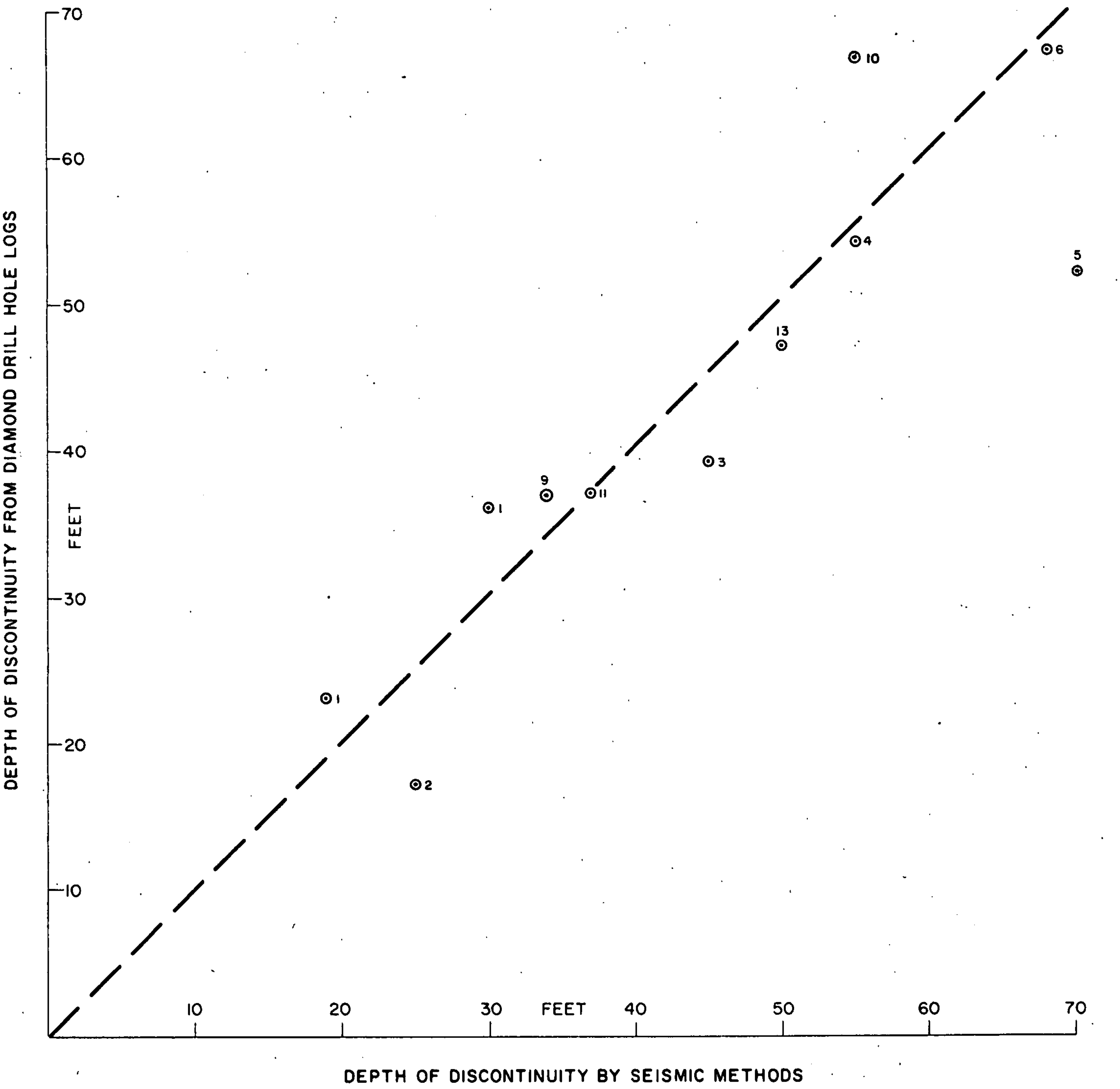
In Table 2 a comparison is made between the depth to bedrock determined by seismic methods, and the interpretation (Dunlop, 1959) of diamond-drill cores from holes located on or near the seismic traverses.

TABLE 2

Drill Hole number, Dip/Bearing, Locality	Depth to discontinuity by seismic methods, ft	Depth to discontinuity from drill hole logs ft	Geological interpretation of drill core
DD1. 90° Right Bank X15 - X16	19 (10,000)	23	Blue and grey quartzite with iron staining
		26	Greenish grey very weathered and weathered greenstone
	30 (19,000)	36	Bluish grey quartzite and purplish brown jasper
DD2. 50°/128° Left Bank X19	25 (23,000)	17	Greenish grey fresh greenstone
DD3. 50°/128° Left Bank X22 - X23	45 (23,000)	39	Greenish grey fresh greenstone
DD4. 45°/308° Right Bank X12		16	Greyish white to light brown very weathered to weathered slate
	55 (19,000)	54	Greenish grey to purple quartzite with iron staining
DD5. 45°/308° Right Bank X10		15	Greyish white to light purple very weathered and unweathered slate
		52	Grey purple to red jasperoid slate
	70 (19,000)		Jasper with iron staining
		88	Grey quartzite, jasperoid slate, and jasper

DD6.			
90° Right Bank X3		7	Greyish white, light brown and khaki very weathered slate, weathered slate, and grey quartzite. Faulted with clay seams
	68 (19,000)	67	Khaki slightly weathered slate and grey quartzite with fault zones and clay seams
		76	Grey quartzite with iron staining
DD9.			
45°/82° Right Bank X12		6	Greyish brown to orange very weathered and weathered slate. Between 6' and 23' three fault breccia zones
		23	Dark grey to purple decomposed to weathered jasperoid slate
	34	37	Reddish brown to grey jasperoid slate and quartzite
DD10.			
60°/128° Left Bank X25 - X26		6	Brown very weathered and weathered slate
		27	Greyish brown weathered slate with some quartzite faulted with clay seams
	55 (23,000)	67	Brown to greyish brown slate, quartzite, breccia, and clay
DD11.			
45°/308° Left Bank X25 - X26		10	Brownish grey weathered and slightly weathered slate with some quartzite
	37 (20,000)	37	Grey fresh slate and quartzite with iron staining

FIGURE 1



LEGEND

⊙ 2 DIAMOND DRILL HOLE NUMBER

SEISMIC REFRACTION SURVEY AT THE 19·3 M. YABBA

CREEK DAMSITE, NEAR IMBIL, QUEENSLAND, 1959

GRAPH TO COMPARE DEPTHS TO DISCONTINUITIES DISCLOSED BY DRILLING AND SEISMIC REFRACTION METHOD

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DD13. 90° Left Bank X27 - X28		5	Brownish grey to grey very weathered and fresh slate with some quartzite
		23	Grey fresh slate and quartzite with iron staining
		37	Brown grey weathered slate to very weathered slate
	50 (9000)	47	Brown to grey decomposed to fresh porphyry
		62	Grey fresh slate and quartzite
DD16. Left Bank X20	10 (23,000)	-	No data available

In Fig. 1 the depth to a discontinuity from diamond-drill hole logs is plotted against the depth to a discontinuity determined by the seismic refraction method. The figure shows that in 8 of the 10 cases the depth determined by the seismic method is accurate to within 8 ft of the depth proved by drilling.

2.3.5 Elastic properties

A value of Poisson's ratio (σ) can be calculated from the compressional and transverse wave velocities. To obtain these figures, a spread with horizontal geophones instead of vertical geophones was laid out between X3 and X14, and shots were fired 150 ft beyond the end of the spread. The transverse wave velocity V_S of the bedrock deduced from this spread was 8000 ft/sec, and from the normal spread at these stations the compressional wave velocity (V_P) of the bedrock was 19,000 ft/sec.

$$\text{Now} \quad (V_P/V_S)^2 = (\sigma - 1)/(\sigma - \tfrac{1}{2})$$

(see Polak and Mann, 1959)

$$\therefore \quad \sigma = 0.39$$

The dynamic values of the elastic constants of the rock with longitudinal velocity of 19,000 ft/sec and density taken as 2.7 g/cm^3 (0.098 lb/in^3) are :

Youngs modulus E	=	9.9×10^6	lb/sq.in.
Bulk modulus B	=	1.5×10^6	" "
Modulus of rigidity G	=	3.6×10^6	" "

The values of the elastic constants of the rock determined as in this case by a dynamic method (seismic wave propagation) are generally larger than those determined by static methods, which are based on dimensional changes under stress (U.S. Dept. of Interior, 1953).

The compressional wave velocity can be used to estimate Young's modulus. The value of Young's modulus (E) is obtained from an empirical formula :

$$E = V^{2.34} \times 10^{-3} \text{ lb/sq.in.}$$

where V is the velocity of the compressional wave in ft/sec. This formula has been established from a compilation of values published by Birch, Schairer, and Spicer (1950), and by Heiland (1946), and of values established during field work by the Bureau. The value of E estimated from the formula is considered to have a probable error of 30 per cent.

For bedrock with a compressional wave velocity 19,000 to 23,000 ft/sec, Young's modulus is 10.8×10^6 to 15.0×10^6 lb/sq.in.

2.3.6 Conclusions

The seismic refraction survey provided information on the depth to unweathered bedrock at the Yabba Creek 19.3M dam site. The depth ranges from 10 ft near X19 to 80 ft near X4. On the cross-section of Traverse X (Plate 3) the depth to slightly weathered bedrock, which may serve as good foundation rock, is about 20 ft. The rock with a measured seismic velocity greater than 19,000 ft/sec should be very good foundation rock.

A comparison between the seismic depth determinations and drilling information suggests that the depths indicated on the seismic cross-sections are accurate to within 10 ft.

The value of Poisson's ratio calculated from longitudinal and transverse seismic wave velocities is 0.39. Assuming a bedrock density of 2.7 g/cm^3, the value of Young's modulus for bedrock with a velocity of 19,000 ft/sec is 10^7 lb/sq.in.

3. AMAMOOR CREEK 14.7M SITE

3.1 Geology

The bedrock consists of siliceous metamorphic rocks (thinly banded jasper) of Lower Palaeozoic age. Outcrops are formed of tightly bonded bands, $\frac{1}{4}$ in. to 3 in. wide, with many irregular quartz veinlets. The jasper is irregularly fractured, and the fracture surfaces are coated with iron or manganese oxide.

The beds in outcrops on the right bank strike N 5°E and dip 50° to 55° to the west. Subsequent to Dunlop's geological investigation of the site a "platform" for a diamond drill had been cut into the hillside of the right bank near station X7. The jasper bands exposed dip steeply into the hillside and strike approximately parallel to Traverse B. No accurate measurements were made of the dip and strike of the beds exposed at the platform. On the upper part of the right bank the soil contains many floaters of angular jasper.

The bed of the creek is about 50 ft wide and consists of gravel and sand.

The surface material on the steep left bank consists of a scree deposit with red clay soil.

The right bank saddle consists of sand, clay, and decomposed phyllite.

3.2 Methods and equipment

The seismic equipment and field technique of the "method of differences" used on this survey have already been treated in part 2.2 of this report.

A geophone spread to determine the depth of alluvium was laid out in the creek bed. The geophone spacing was 10 ft and shots were fired at distances of 10, 50, and 150 ft beyond each end, in line with the spread.

3.3 Results

Plate 1 is a locality plan. Plate 4 shows the traverse plan, and Plate 5 shows cross-sections giving the depths to bedrock on each traverse. In addition to the tests at the dam site, Traverse E was surveyed to test the depth of weathering in a possible spillway site.

3.3.1 Right bank, Traverses A, B, and X

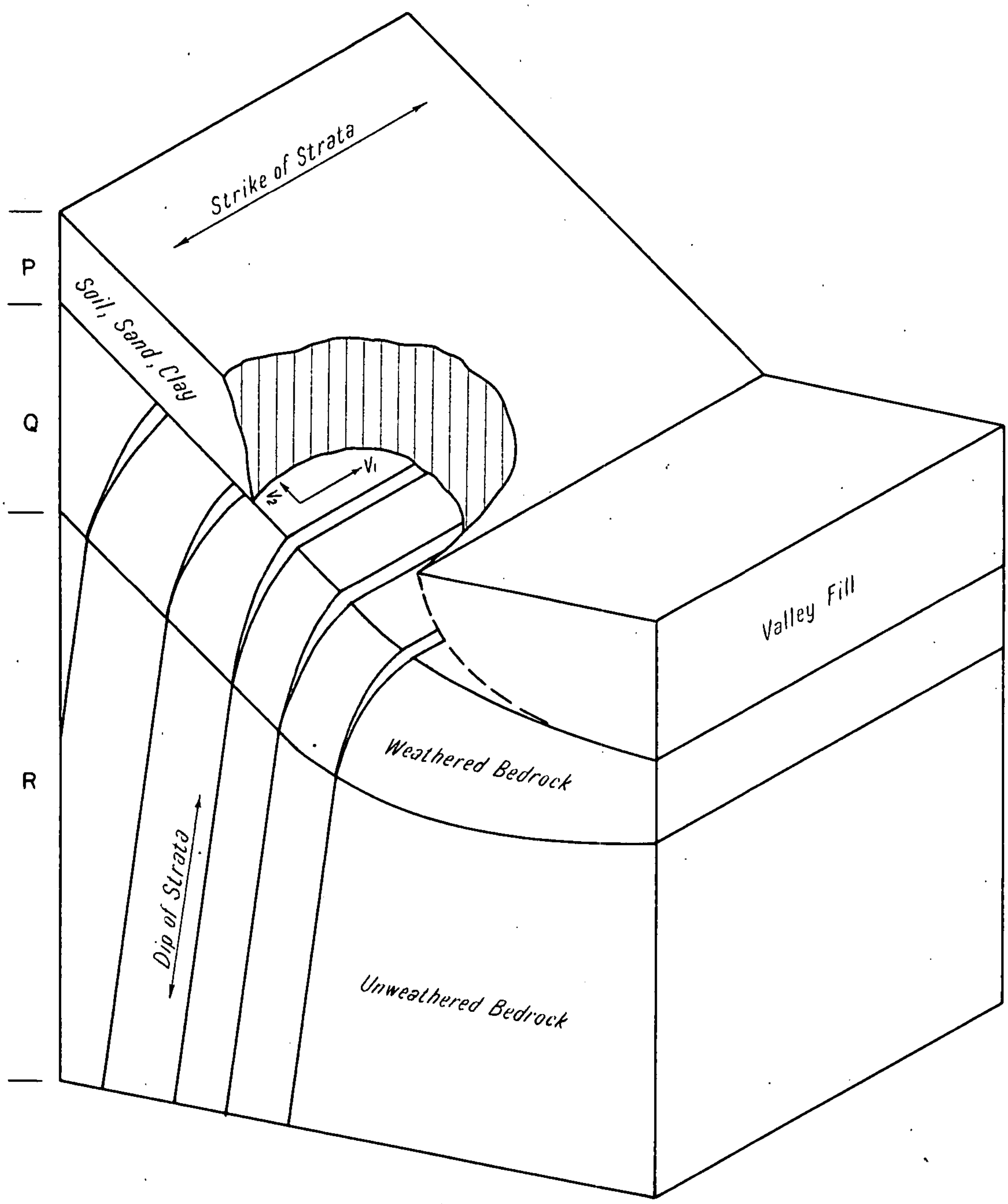
On Traverses A and B the seismic velocity of the top formation of soil and angular jasper floaters ranges from 1100 to 2800 ft/sec. A seismic velocity greater than 2000 ft/sec is recorded on or near the ridge, where the soil cover is very thin (generally less than 5 ft). A velocity of 2500 to 4000 ft/sec was recorded for the upper formations on Traverse X. The seismic velocity of the weathered bedrock on Traverses A and B ranges from 3500 to 9000 ft/sec and generally the larger value is recorded on the right bank ridge.

The unweathered bedrock with a seismic velocity of 12,000 to 15,500 ft/sec ranges in depth between 34 ft and 78 ft on Traverse A, and 17 and 55 ft on Traverse B. The average depth to bedrock on Traverse B is less than that on Traverse A. On Traverse X the depth to bedrock (seismic velocity greater than 12,000 ft/sec) ranges from 9 ft at X9 to 117 ft at X3. The depth to unweathered bedrock at the intersection points of Traverses A, B, and X is different when computed for each traverse. The discrepancy of about 40 ft is due to velocity anisotropy (Section 3.3.5).

3.3.2 Creek bed

In the creek bed, water-saturated gravel and gravel-sand mixture of seismic velocity 5500 ft/sec overlie unweathered bedrock of seismic velocity 14,000 ft/sec. The depth to the unweathered bedrock is 27 ft near X10.

FIGURE 2



SEISMIC REFRACTION SURVEY AT THE 14·7M AMAMOOR CK.

DAMSITE, NEAR IMBIL, QUEENSLAND

SEISMIC ANISOTROPY

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3.3.3 Left bank, Traverses C, D, and X

The top formation consisting of scree deposit and red clay soil has a seismic velocity of 2000 to 3000 ft/sec.

A seismic velocity of 8000 ft/sec recorded on Traverse C probably represents weathered bedrock.

On Traverse C, unweathered bedrock of seismic velocity 17,000 to 18,000 ft/sec ranges in depth from 19 ft at C2 to 52 ft at C7.

On Traverse X the depth to unweathered bedrock ranges from 20 ft at X11 to 68 ft near X17; the seismic velocity decreases from 14,000 ft/sec between X9 and X15 to 8500 ft/sec between X15 and X19.

On Traverse D the depth to a refractor with a velocity of 8000 ft/sec ranges from 22 to 108 ft. Only a limited part of Traverse D was surveyed because of instrumental trouble. It was not considered worth-while to persist further with this traverse, as its surface elevation was higher than that of the right bank.

3.3.4 Right bank saddle area, Traverse E

The top formation, consisting of a sand-soil mixture and clay, has a seismic velocity of 1600 to 2600 ft/sec and an average thickness of about 20 ft. The weathered bedrock has seismic velocities of 8000 to 9000 ft/sec and the unweathered bedrock from 15,500 to 18,500 ft/sec. The depth to unweathered bedrock ranges from 54 to 105 ft.

3.3.5 Velocity anisotropy

The depth to unweathered bedrock computed for Traverse X at X4 and X6 is larger than that calculated from Traverses A and B. The discrepancy, due to the phenomenon of velocity anisotropy, is probably caused by hillside creep. Visual observation of the dip and strike of the banded jasper at the drill platform shows that Traverse X would be approximately perpendicular to the strike and Traverses A and B approximately parallel to the strike. The block diagram (Fig. 2) illustrates the three layers present on the right bank. If hillside creep were acting in layer Q, joints parallel to the strike would be more open, and weathering more advanced in the open joints than in the individual bands of jasper. In layer Q the seismic velocity V_1 measured parallel to the strike would be much larger than the velocity V_2 measured perpendicular to the strike, because the seismic waves parallel to the strike are propagated in the less-weathered material. Thus the "time depth" to a higher-velocity refractor is less when shooting parallel to the strike than when shooting perpendicular to the strike.

In layer R the difference between weathering of joints in the two directions is not so marked, and the seismic velocities V_1 and V_2 are approximately equal. The "time depth" to the refractor is approximately equal for both directions of shooting.

On Traverse X, an unweathered bedrock velocity of 14,000 ft/sec was recorded between X9 and X15, but on Traverse C the bedrock velocity is 17,500 to 18,000 ft/sec. Velocity anisotropy is present in the upper layers, but the depths to unweathered bedrock calculated from Traverses X and C agree.

The bedrock seismic velocities recorded on Traverse X between X15 and X19 and on Traverse D are 8500 and 8000 ft/sec respectively. It may be that these velocities represent weathered bedrock, and that a higher velocity for unweathered bedrock has not been recorded because the 200-ft shots of the normal spreads were too close to give refractions from a higher-velocity layer. Alternatively, the seismic velocity of about 8000 ft/sec may indicate a shear zone or a jointed and fractured bedrock.

3.3.6 Seismic velocities

Table 3 lists the tentative interpretation of rock type in terms of the seismic velocities marked on the cross-sections of Plate 5.

TABLE 3

Seismic Velocity ft/sec	Rock type
1100 - 3000	Unconsolidated rocks - soil with jasper floaters; scree material with red clay soil; alluvial material.
5500	Water-saturated gravel or gravel-sand mixture.
4000 - 8000	Very weathered and weathered jasper; weathered phyllite.
8000 - 8500	Intensely fractured and jointed jasper.
14,000 - 23,000	Unjointed jasper; weathered phyllite.

3.3.7 Elastic properties

The value of Young's modulus for the bedrock with a compressional velocity of 14,000 to 23,000 ft/sec, calculated from the formula quoted in Section 2.3.5, is 5.3×10^6 to 15.0×10^6 lb/sq.in. and for bedrock with a velocity of 8500 ft/sec is 1.6×10^6 lb/sq.in.

3.3.8 Accuracy of seismic depth determinations

In computations by the "method of differences", the depth (Z) is determined from the following equation :

$$Z = Vt$$

where V is the seismic velocity and t is the "time depth". Differentiating,

$$\frac{dZ}{Z} = \frac{dV}{V} + \frac{dt}{t}$$

The time depths, which are about 10 milliseconds, are probably reliable to within 1 millisecond, i.e. 10 per cent. A comparison of the apparent velocities found at adjacent stations on the seismic traverses indicates that the error in the determination of apparent velocity will be within approximately 10 to 20 per cent. The total error in a determination of the depth to bedrock will therefore be about 20 per cent. Although the errors in absolute depth may be large, the relative errors in depth from station to station along a traverse are likely to be much smaller, and the profile shown for the surface of the fresh rock is expected to be qualitatively accurate.

3.3.9 Conclusions

The seismic refraction survey provided information on the depth to unweathered bedrock at the Amamoor Creek 14.7M dam site.

On the right bank the depths to bedrock determined at stations common to intersecting traverses are not in agreement. On Traverse X the calculated depths at two places are 112 and 61 ft. Depths calculated from adjacent points on Traverses A and B are 37, and 24 ft, respectively. The discrepancy may be explained by the phenomenon of hillside creep.

On the left bank the depth to bedrock ranges from 19 to 108 ft. There is probably a shear zone between X15 and X19.

The depth to bedrock in the right-bank saddle area ranges from 54 to 105 ft.

The value of Young's modulus for bedrock, derived from an empirical relation, is 1.6×10^6 to 5.3×10^6 lb/sq.in.

It is recommended that some test drilling be done to act as a control on the seismic interpretation. The positions suggested for test drilling are :

(1) Near X7, vertical and horizontal holes to test the soundness of the rock and detect any significant difference in jointing due to hillside creep, and

(2) Near X12, vertical and angle holes to test the soundness of the rock on the left bank.

4. ACKNOWLEDGEMENTS

The assistance given to the party by Mr. G. B. Symmonds, Senior Planning Engineer, and other officers of the I.W.S.C. is gratefully acknowledged.

5. REFERENCES

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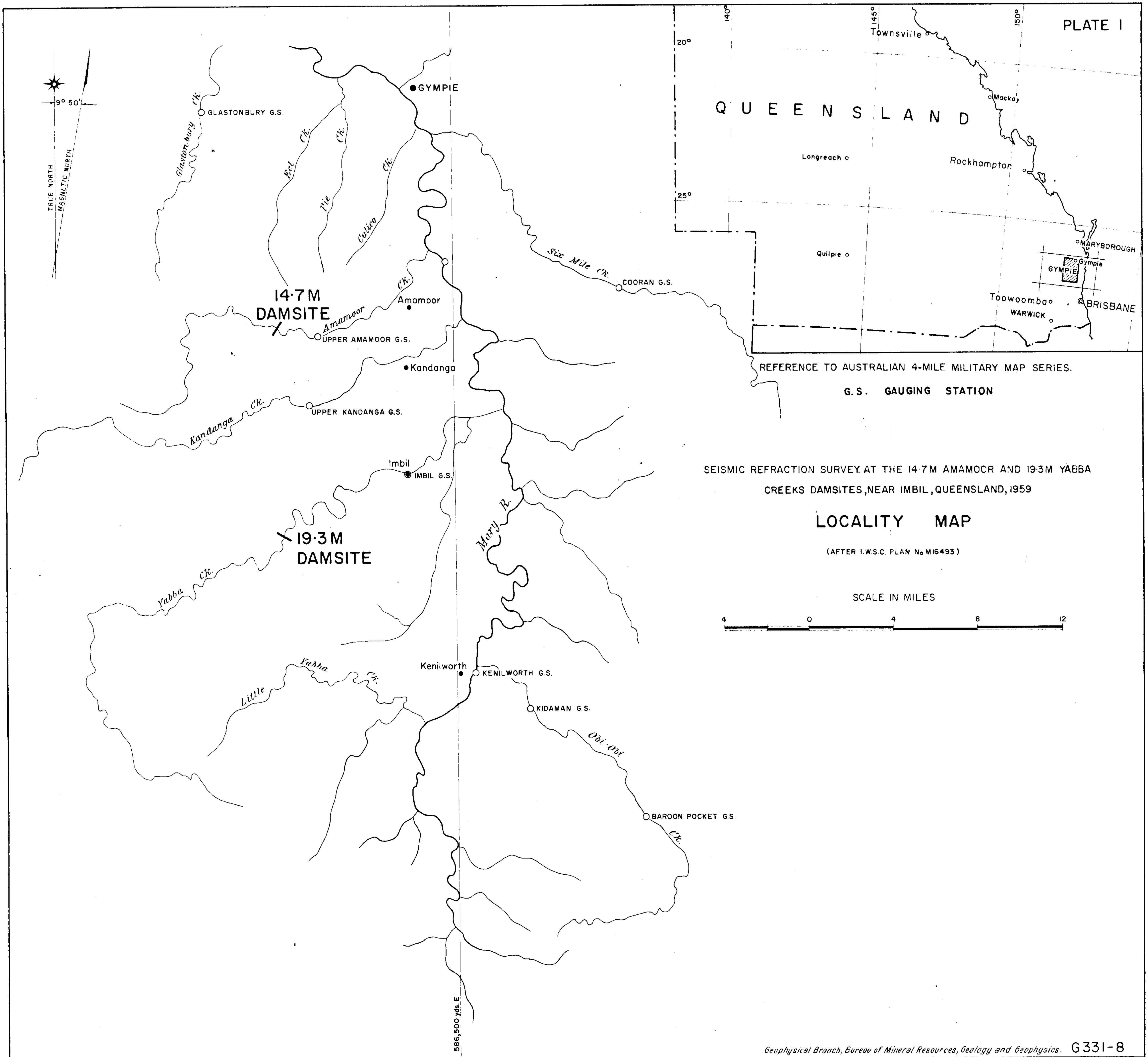

SEISMIC REFRACTION SURVEY AT THE 14·7M AMAMOOR AND 19·3M YABBA CREEKS DAMSITES, NEAR IMBIL, QUEENSLAND, 1959

LOCALITY MAP

(AFTER I.W.S.C. PLAN No M16493)

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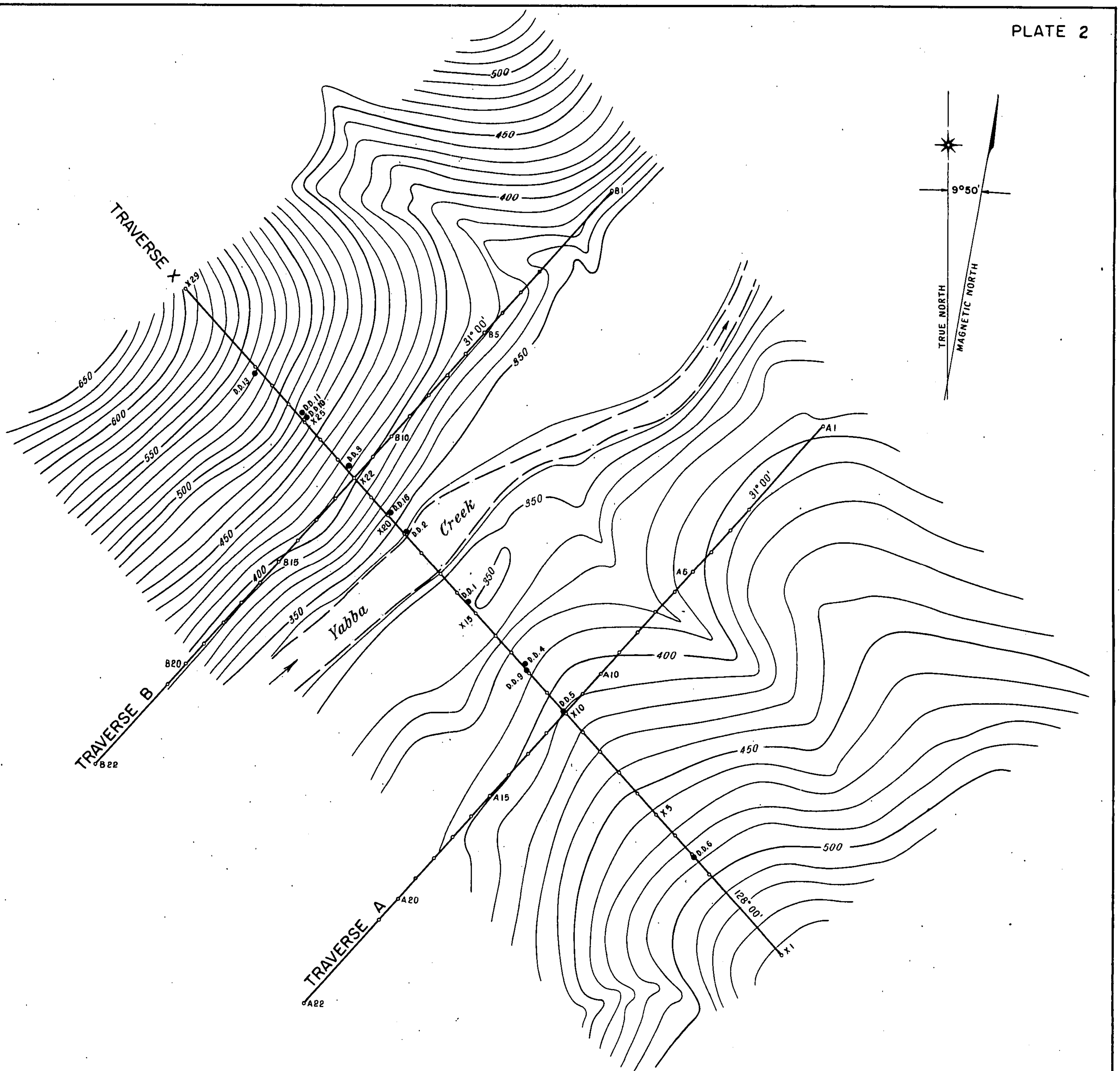
TO ACCOMPANY RECORD No 1961-106



LEGEND

A5	Seismic Traverse with Station
31°00'	Magnetic Bearing of Seismic Traverse
450	Topographical Contour (feet)
● D.D. 4	Drill Hole

SEISMIC REFRACTION SURVEY FOR THE 19·3M YABBA CREEK DAMSITE, NEAR IMBIL, QUEENSLAND, 1959

TOPOGRAPHICAL CONTOURS AND SEISMIC TRAVERSES

AZIMUTH DATUM: MAGNETIC

SCALE IN FEET

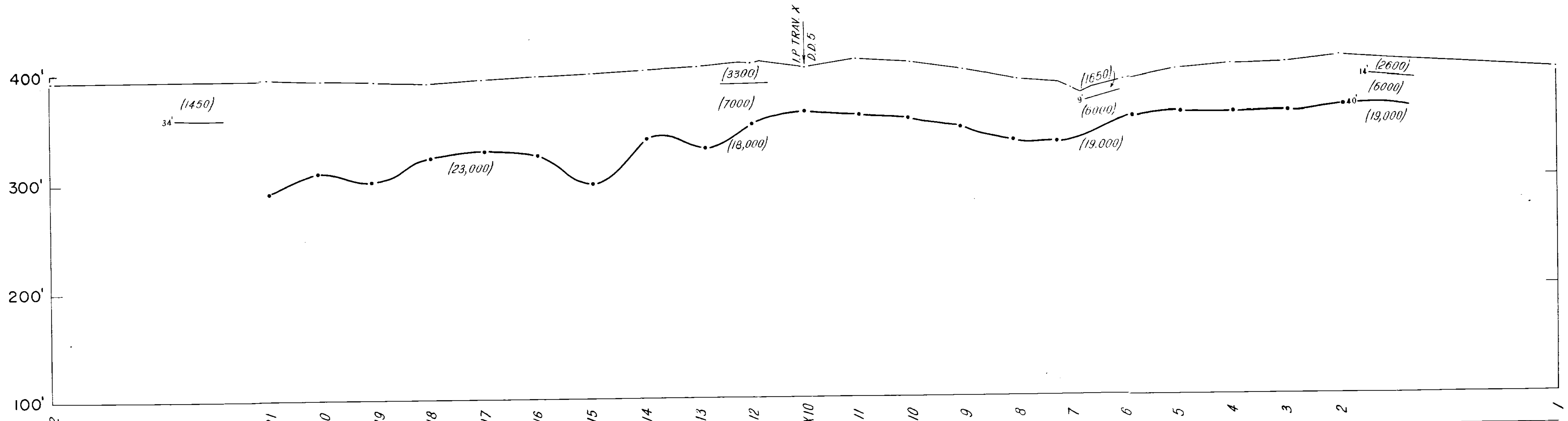
200 100 0 200 400 600

AFTER I.W.S.C. PLAN No L 17040

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G331-7

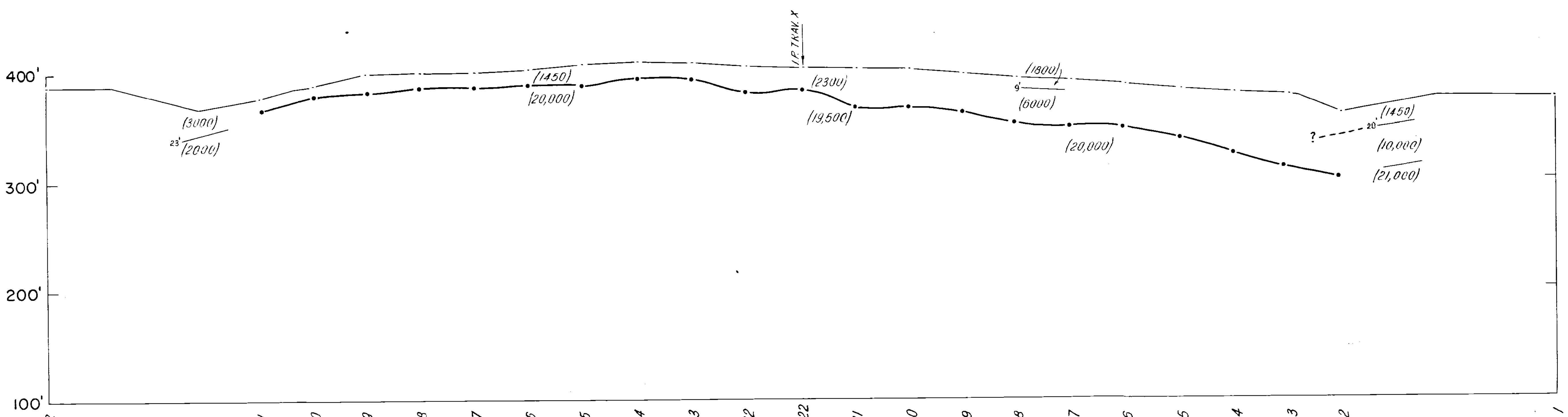
TO ACCOMPANY RECORD: No. 1961 - 106

TRAVERSE A



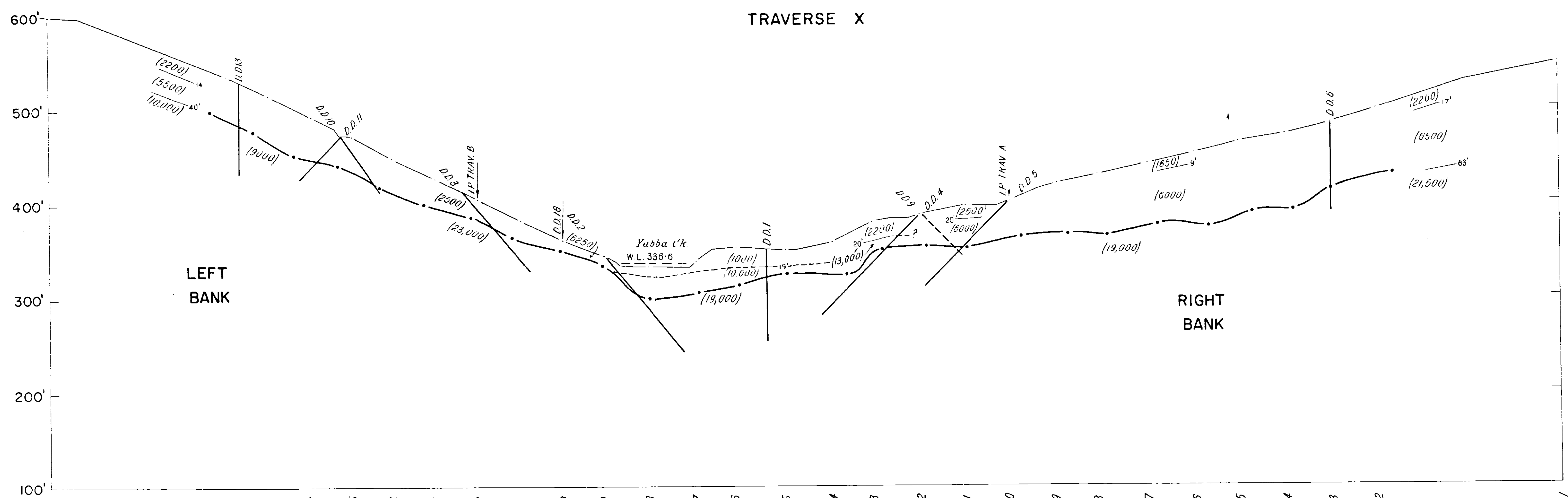
STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
22	394.9	
21	396.0	106
20	393.3	85
19	392.3	92
18	389.8	68
17	392.6	66
16	396.2	73
15	398.4	101
14	399.5	63
13	403.0	75
12	406.7	58
X10	402.2	40
11	409.3	52
10	405.7	52
9	397.6	52
8	388.9	54
7	381.4	52
6	388.6	35
5	396.8	40
4	401.9	45
3	404.3	45
2	407.5	45
1	394.7	

TRAVERSE B



STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
22	389.9	
21	377.9	10
20	389.8	10
19	399.7	17
18	401.3	14
17	401.5	15
16	403.1	15
15	408.0	20
14	410.4	15
13	409.2	15
12	405.7	24
X22	404.2	20
11	403.3	34
10	401.8	34
9	396.8	34
8	394.2	42
7	390.8	42
6	386.9	41
5	383.4	46
4	379.9	56
3	377.4	65
2	360.4	58
1	372.9	

TRAVERSE X



STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
29	599.6	
28	573.3	42
27	515.4	42
26	492.9	44
25	471.6	34
24	448.1	33
23	426.1	30
22	404.2	20
21	382.1	20
20	360.0	10
19	343.9	10
18	333.1	33
17	337.8	33
16	353.6	41
15	350.2	31
14	358.0	38
13	379.5	31
12	387.2	34
11	397.7	44
10	402.2	40
9	419.7	58
8	429.7	64
7	440.3	64
6	450.9	78
5	463.7	75
4	471.3	80
3	482.6	68
2	497.7	70
1	544.9	

LEGEND

(5000) FORMATION WITH SEISMIC VELOCITY IN FT./SEC.

19' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY.

D.D.5 DRILL HOLE

UNWEATHERED BEDROCK BOUNDARY

SLIGHTLY WEATHERED BEDROCK BOUNDARY

SEISMIC REFRACTION SURVEY FOR THE 19·3 M YABBA CREEK DAMSITE, NEAR IMBIL, QUEENSLAND, 1959

TRAVERSES A, B AND X

SECTIONS

HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300 400

ELEVATION IN FEET ABOVE STATE DATUM

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G331-9

TO ACCOMPANY RECORD No. 1961-106

SEISMIC REFRACTION SURVEY AT THE 14·7 M AMAMOOR CREEK DAMSITE, NEAR IMBIL, QUEENSLAND, 1959

TOPOGRAPHICAL CONTOURS AND SEISMIC TRAVERSES

AZIMUTH DATUM: MAGNETIC
ELEVATION ABOVE STATE DATUM

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G331-6

TO ACCOMPANY RECORD No. 1961-106

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G331-5

TO ACCOMPANY RECORD No. 1961-106