COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1963/171

FLAGGY CREEK DAM SITE

GEOPHYSICAL SURVEY, KURANDA, NORTHERN QUEENSLAND 1962

by

E.J. POLAK

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CONTENTS

ILLUSTRATIONS

SUMMARY

Details and results are given of seismic refraction, resistivity, and magnetic surveys that were made in response to a request from the Co-ordinator General's Department, Queensland, to investigate a proposed site for a dam on Flaggy Creek, near Kuranda, North Queensland. The dam will be part of the Barron Falls Hydro-Electric Scheme.

The maximum depth to the bedrock was found to be 83 ft. Seismic velocities of 8000 to 21,000 ft/sec were recorded in the bedrock. Poisson's ratio of 0.33 to 0.35 and Young's modulus of 6.5×10^6 to 9.7×10^6 lb/sq.in. were determined using longitudinal and transverse wave velocities.

1. INTRODUCTION

The Co-ordinator General's Department for Public Works, Queensland (COG) proposes to construct a dam on the Flaggy Creek, five miles above its junction with the Barron River. The dam is a part of a scheme to provide additional water supply for the Barron Falls Hydro-Electric Station at Kuranda (Polak and Mann, 1959a).

In response to an application from the COG, the Bureau of Mineral Resources, Geology and Geophysics carried out a geophysical survey to determine the nature of the overburden and the bedrock and the depth to the bedrock at the dam site and on the ridge separating the proposed reservoir from the lower reaches of the Flaggy Creek valley.

As used in this Record, the term 'bedrock' refers to unweathered, jointed to solid rock in which the velocity of the seismic wave exceeds 10,000 ft/sec. The term 'overburden' refers to river sand and gravels, scree and talus material, and completely to partly weathered rock, in which the seismic velocities are less than 10,000 ft/sec.

The survey was made in August 1962 by a geophysical party consisting of E.J. Polak (party leader), J.E.F. Gardener (geophysicist), and J.P. Pigott (geophysical assistant). COG provided additional assistants and carried out a topographical survey along the traverse lines.

2. GEOLOGY

The general geological survey of the area was made by Brooks (1957). Twenty diamond-drill holes and two exploratory shafts were completed.

The detailed stratigraphy of the area was given by Polak and Mann (1959a); a short summary (after Brooks) will be given here.

The rocks of the dam site consist of meta-greywacke and slate. The meta-greywacke is coarser in grain size and more felspathic than the greywacke in the Kuranda area. The slates are better cleaved and the greywacke more noticeably foliated, indicating a higher grade of metamorphism than in the Kuranda area. The rocks are heavily jointed, the joints being filled with quartz.

The strike of the cleavage ranges from 315 degrees to 340 degrees, and the dips are usually vertical or 80 degrees to the south-west, or less commonly to the north-east.

The slate and greywacke are impermeable in the unweathered state and the main possible source of leakage would be the major joints and faults. Slightly weathered rock, included in bedrock, should provide sound rock for foundation.

The rock is covered with alluvium in the creek valley and with scree and talus material on the ridge.

3. METHODS AND EQUIPMENT

Seismic refraction, resistivity constant-spacing profiling, and magnetic methods were used. A detailed description of the methods has been given by Polak and Mann (1959a).

Seismic method

In the calculation of the depth to bedrock the 'method of differences' was used (Heiland, 1946). The dynamic properties of rocks were calculated from longitudinal and transverse velocities by a similar method to that used at the Moogerah dam site (Polak and Mann, 1959b).

The equipment used was a 24-channel TIC seismograph, with TIC geophones of natural frequency of 20 c/s to record longitudinal waves, and three-component Hall-Sears geophones to record longitudinal and transverse waves.

The total length of traverses surveyed was 15,000 ft.

Resistivity method

The spacing of 50 ft between electrodes in Wenner configuration was used. A Megger Earth Tester with scale values 0-3, 0-30, 0-300, and 0-3000 ohm was used.

Magnetic method

The differences in the magnetic intensities along Traverses A to H were too small for positive conclusions to be reached from them. The use of the method was therefore discontinued on the survey. An ABEM torsion magnetometer was used.

4. RESULTS

Seismic velocities

Plate 1 shows the arrangement of the geophysical traverses and the velocities found in the deepest refractor. Table 1 shows the seismic velocities recorded on the Flaggy Creek dam site area.

TABLE 1.

Seismic velocity (ft/sec)	Rock type
1000 - 1500	Soil
2300 - 2500	Alluvium
2000 - 3000	Scree and talus material
5000 - 10,000	Weathered rock
8000 - 21,000	Bedrock

The very wide range of velocities found in the bedrock may indicate that :

(a) the rocks at the lower limit of the range are jointed, possibly sheared, and weathered on joints. Between stations 23 and 27 on Traverse A, near DDH 7, the low velocity of 8000 ft/sec suggests the presence of sheared or fractured bedrock,

(b) the rocks with the higher range of velocities are probably solid; if these rocks are jointed, the high velocity would indicate that joints are closed, either by high lateral pressure or recementing,

(c) the seismic velocity in the meta-greywacke is higher than in slates; therefore cross-sections with low content of slate show higher velocities,

(d) Plate 1 indicates the velocity anisotropy, e.g. the velocity along Traverse A (western portion) is lower than that along Traverse J.

Depth determination

The depth to the highest-velocity refractor was calculated using apparent velocity values that were determined from normal spreads and weathering spreads (Polak and Mann, 1959a). The calculated depths are shown on Plates 2 to 6 with the seismic cross-sections.

Nine diamond-drill holes and two shafts were put down on the site close to the geophysical traverses. These can be used to compare the depth to bedrock obtained by drilling with the depth calculated from the seismic data. The comparison shown in Table 2, and plotted in a graph on Plate 6, indicates that the bedrock depths from seismic determinations average about 20 percent greater than those found by drilling.

TABLE 2

Drilling			Seismic survey		
Drill hole or shaft	Rock type	Bedrock depth(ft)	Stn	Depth to layer boundary (ft)	Seismic velocity (ft/sec)
DDH 19	weathered rock	2	A8	4	7000
	fresh rock	33		36	13,500
DDH 11	weathered rock	42	A13	42	6000
	fresh rock				20,000
DDH 10	weathered rock	29 (1)	A17	43	5500
	fresh rock				20,000
DDH 6	river sand	23	A21	20	2300
	weathered rock	29 (1)		57	6000
	fresh rock				20,000
S 1	weathered rock	30 (3)	A25	52	5500
	fresh rock				8000
S 2	alluvium	}			2500
	weathered rock	39 +(2)	A29		7000
				54	20,000
DDH 1	alluvium	}			2500
	weathered rock	45	A31	49	7000
	fresh rock				20,000
DDH 2	alluvium	}			2500
	weathered rock	42	A36	50	6000
	fresh rock				20,000
DDH 12	weathered rock	38 +	C252	53	6000
					20,000

Drilling			Seismic survey		
Drill hole or shaft	Rock type	Bedrock depth(ft)	Stn	Depth to layer boundary (ft)	Seismic velocity (ft/sec)
DDH 13	weathered rock	49	D268	41	6000
	fresh rock				17,000
DDH 15	weathered rock	63	E302	62	6000
	fresh rock				18,000

Note: Layer of soil (seismic velocity 1000 - 1500 ft/sec) has been omitted from the table.

Remarks on Table 2:

(a) Possibly a slightly weathered to moderately weathered rock was encountered at a depth of 29 ft in drilling. Such a thin layer could easily be missed in refraction seismic work.

(b) Shaft S2 went only 3 ft in unweathered slate. Weathering may still be present below 39 ft.

(c) No log was available for DDH 7; therefore, shaft S1 was compared with seismic results at A25, although DDH 7 is nearer than S1.

Dynamic properties of rocks

Table 3 gives the results of the tests made at the Flaggy Creek dam site to determine the dynamic properties of the rock present. The measurements were made using three-component geophones placed 200 ft apart. Specific gravity of 2.7 was assumed for the calculation.

TABLE 3

Traverse	Station	Seismic velocity (ft/sec)	Poisson's ratio	Modulus x 10^6 lb/sq. in.		
				Young's	Bulk	Rigidity
A	15 - 19	20,000	0.33	9.7	9.3	3.8
D	274 -278	17,000	0.35	6.5	7.3	2.5

Poisson's ratio calculated at Flaggy Creek is higher than that obtained at the Barron Falls survey (Polak and Mann, 1959a); it may be indicative of the jointed character of the rock.

Resistivity results.

The variations in apparent resistivity show no correlation with either depth of bedrock or quality of bedrock as indicated by seismic velocities. Hence, they probably reflect near-surface variations in porosity and moisture content and are not significant for the results of the survey. To complete the presentation of the data, they are plotted on Plates 2 to 4 above the seismic profiles.

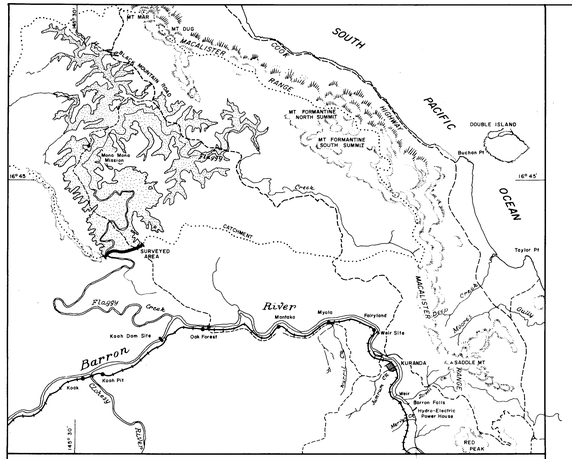
5. CONCLUSIONS

The overburden at the proposed dam site consists of a thin layer of scree material overlying about 50 ft of weathered rock near the creek and about 80 ft farther east. The seismic velocity in the bedrock ranges from 8000 to 21,000 ft/sec.

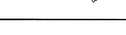
6. REFERENCES

BROOKS, J.K.	1957	Geological survey Lower Barron River and Flaggy Creek Areas. Geological Survey of Queensland (unpubl.)
HEILAND, C.A.	1946	GEOPHYSICAL EXPLORATION. New York, Prentice-Hall Inc.
POLAK, E.J. and MANN, P.E.	1959a	Geophysical survey at the Barron Falls Hydro-Electric Scheme, Kuranda Qld. Bur. Min. Resour. Aust. Rec. 1959/93 (unpubl.).
POLAK, E.J. and MANN, P.E.	1959b	A seismic refraction survey at the Moogerah Dam Site near Kalbar, Queensland. Bur. Min. Resour. Aust. Rec. 1959/62. (unpubl.)

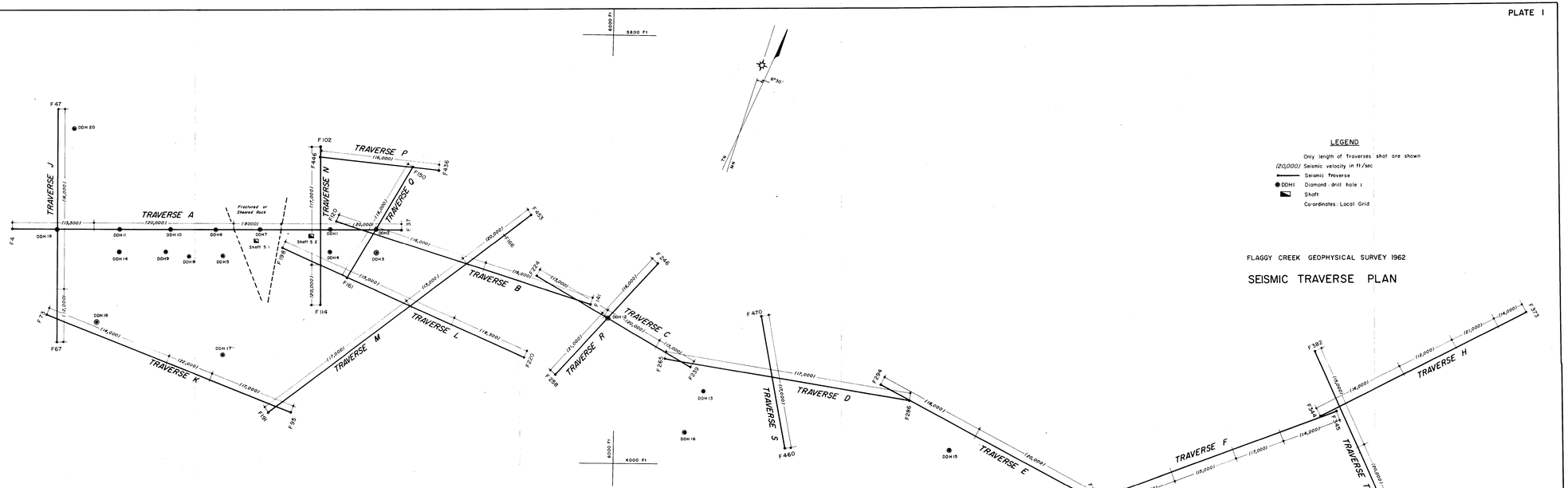
PLATE 1



REFERENCE TO AUSTRALIA STANDARD MAP SERIES



LOCALITY MAP



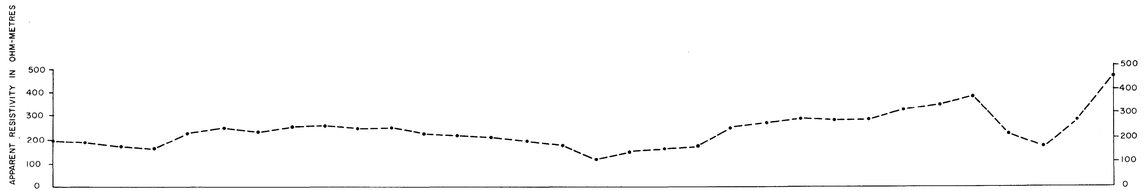
FLAGGY CREEK GEOPHYSICAL SURVEY 1962

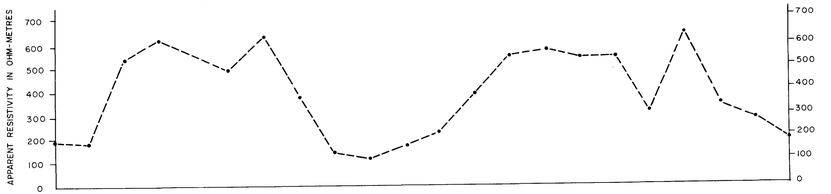
SEISMIC TRAVERSE PLAN

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. E55/B5-1

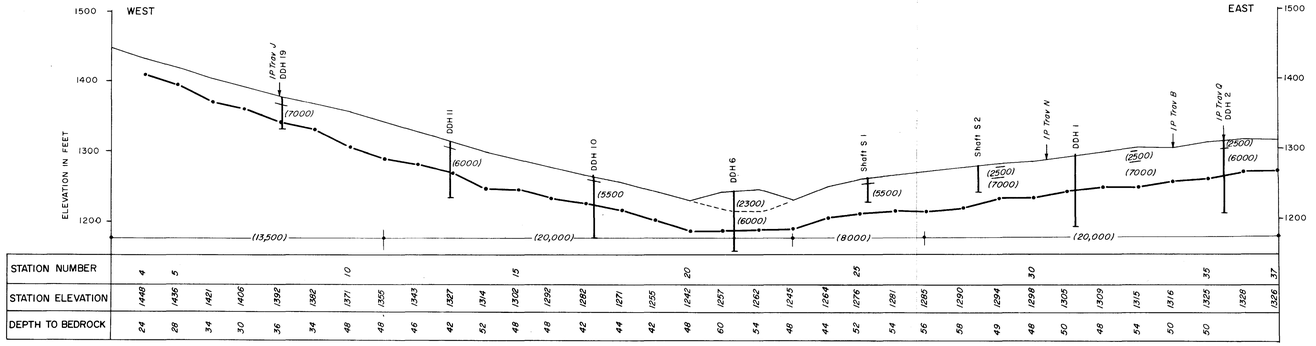
TO ACCOMPANY RECORD No. 1965/171

PLATE 2



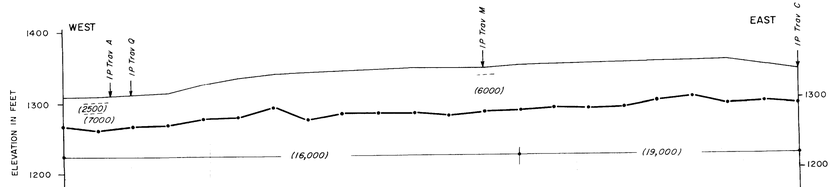


TRAVERSE A



STATION NUMBER	4	5					10						15						20						25						30						35						37
STATION ELEVATION	1448	1436	1421	1406	1392	1382	1371	1355	1343	1327	1314	1302	1292	1282	1271	1255	1242	1257	1262	1245	1264	1276	1281	1285	1290	1294	1298	1305	1309	1315	1316	1325	1328		1326						
DEPTH TO BEDROCK	24	28	34	30	36	34	48	48	46	42	52	48	48	42	44	42	48	60	54	48	44	52	54	56	58	49	48	50	48	54	50	50										

TRAVERSE B



STATION NUMBER	120					125					130					135					140	141
STATION ELEVATION	1310	1313	1315	1316	1326	1335	1340	1343	1345	1346	1344	1343	1345	1346	1347	1349	1350	1351	1352	1353	1347	(1340)
DEPTH TO BEDROCK	44	40	46	49	49	56	50	70	58	61	61	68	65	65	63	67	62	52	53	65	53	54

LEGEND

(7000) Formation with seismic velocity of 7000 ft/sec
DDH 19 Diamond-drill hole 19
I P Intersection point
Unweathered bedrock boundary

Based on C O G Maps 1002 and 1004
Elevation: State datum

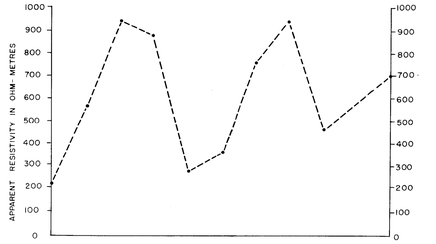
FEET
100 50 0 100 200 300
(Horizontal and Vertical)

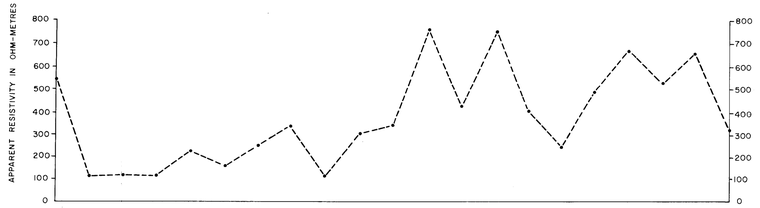
TO ACCOMPANY RECORD No. 1963/171

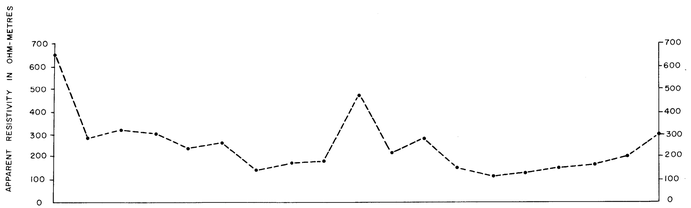
TRAVERSES A AND B

SEISMIC CROSS-SECTIONS AND RESISTIVITY PROFILES

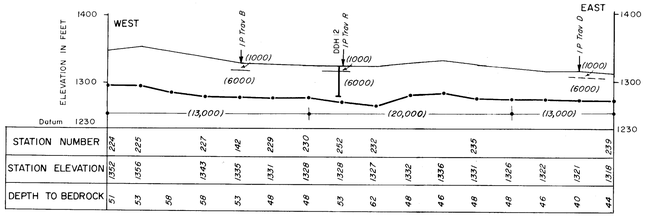
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E 55/B5-2





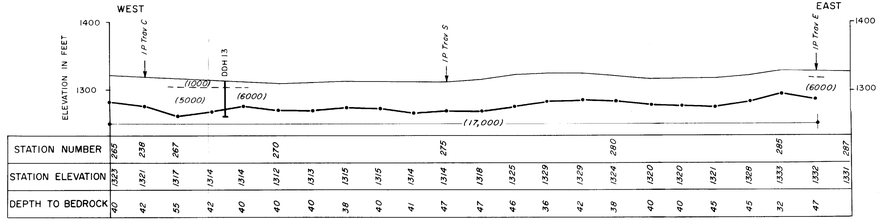


TRAVERSE C



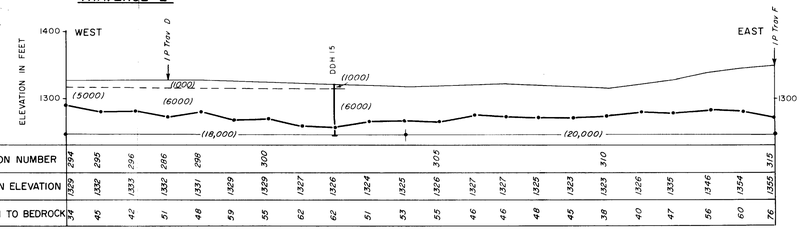
STATION NUMBER	224	225		227	142	229	230	252	232		235				239
STATION ELEVATION	1352	1356		1343	1335	1331	1328	1328	1327	1332	1336	1331	1326	1322	1321	1318
DEPTH TO BEDROCK	51	53	58	58	53	48	48	53	62	48	46	48	48	46	40	44

TRAVERSE D



STATION NUMBER	265	238	267			270				275				280				285		287
STATION ELEVATION	1323	1321	1317	1314	1314	1312	1313	1315	1315	1314	1314	1318	1325	1329	1329	1324	1320	1320	1321	1328	1333	1332	1331
DEPTH TO BEDROCK	40	42	55	42	40	40	40	38	40	41	47	47	46	36	42	38	40	40	45	45	32	47	

TRAVERSE E



STATION NUMBER	294	295	296	286	298	300			305											310						315
STATION ELEVATION	1329	1332	1333	1332	1331	1329	1329	1327	1326	1324	1325	1326	1327	1327	1325	1323	1323	1326	1335	1346	1354	1355				
DEPTH TO BEDROCK	34	45	42	51	48	59	55	62	62	51	53	55	46	46	48	45	38	40	47	56	60	76				

LEGEND

(20,000)	Formation with seismic velocity 20,000 ft/sec
DDH 12	Diamond-drill hole 12
I/P	Intersection point
●——●	Unweathered bedrock boundary

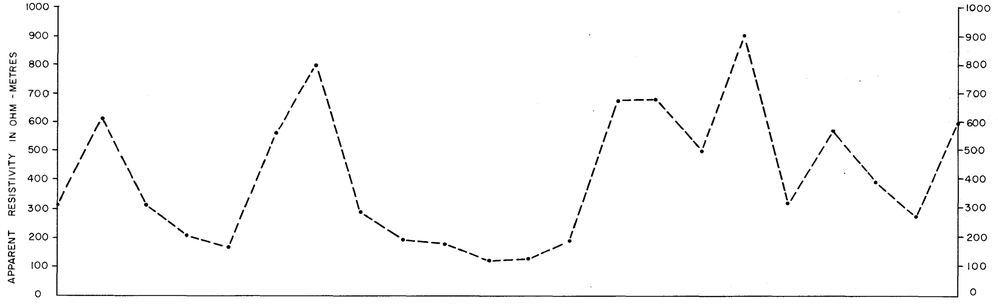
Based on C.O.G. Maps 1006 and 1007
Elevation: State datum

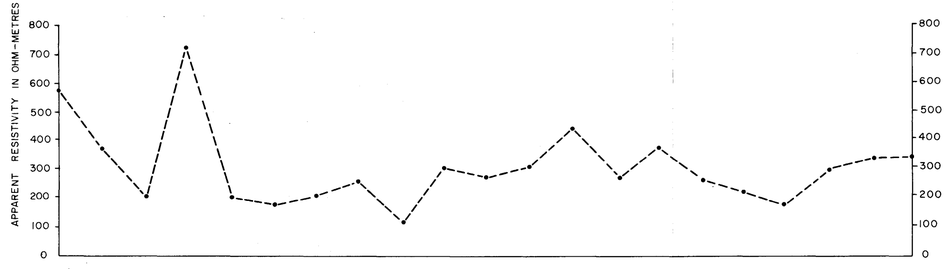
FEET
100 50 0 100 200 300
(Horizontal and Vertical)

TRAVERSES C, D, AND E

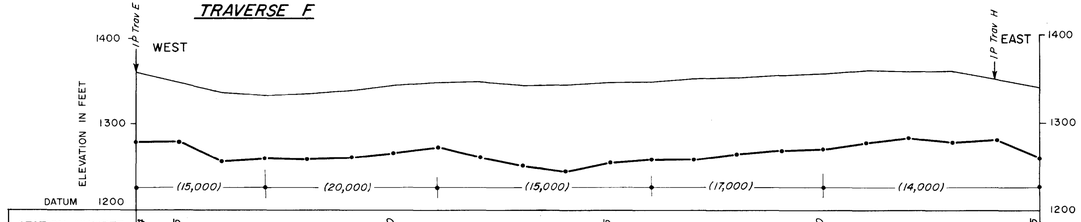
SEISMIC CROSS-SECTIONS AND RESISTIVITY PROFILES

TO ACCOMPANY RECORD No 1963/171





TRAVERSE F



STATION NUMBER	324	325					330					335					340					345
STATION ELEVATION	1355	1348	1337	1334	1336	1340	1346	1350	1352	1347	1348	1350	1352	1355	1354	1358	1362	1363	1363	1363	1354	1341
DEPTH TO BEDROCK	76	70	80	73	82	80	80	76	95	99	102	97	95	95	93	90	95	88	82	88	70	82

TRAVERSE H

STATION NUMBER	344	354	355					360					365					370				373
STATION ELEVATION	1354	1341	1337	1339	1342	1345	1348	1350	1353	1354	1355	1356	1358	1360	1363	1368	1379	1389	1396	1404	1413	
DEPTH TO BEDROCK	73	80	80	83	83	70	75	77	66	70	67	47	57	53	42	57	59	45	43	53	47	

LEGEND

(15,000) Formation with seismic velocity of 15,000 ft/sec

I/P Intersection point

Unweathered bedrock boundary

Based on COG Maps 1008 and 1009

Elevation State datum

FEET

100 50 0 100 200 300

(Horizontal and Vertical)

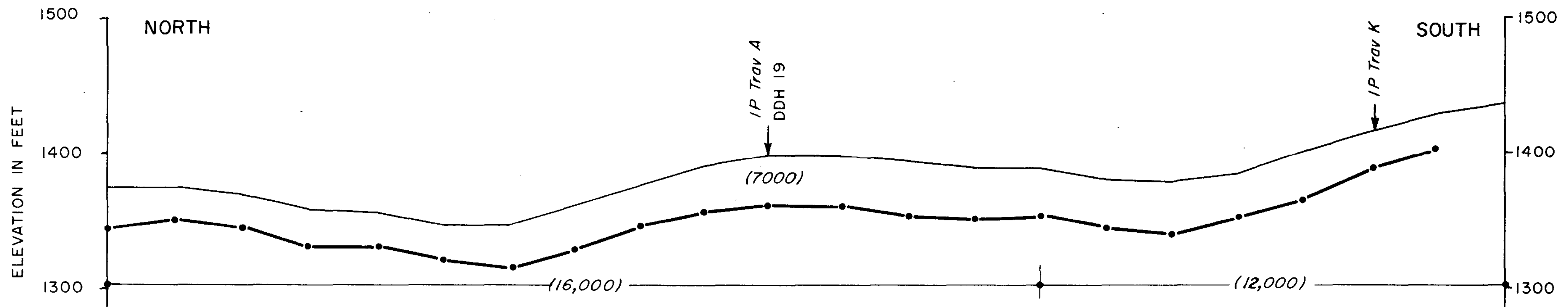
TRAVERSES F AND H

SEISMIC CROSS-SECTIONS AND RESISTIVITY PROFILES

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-4

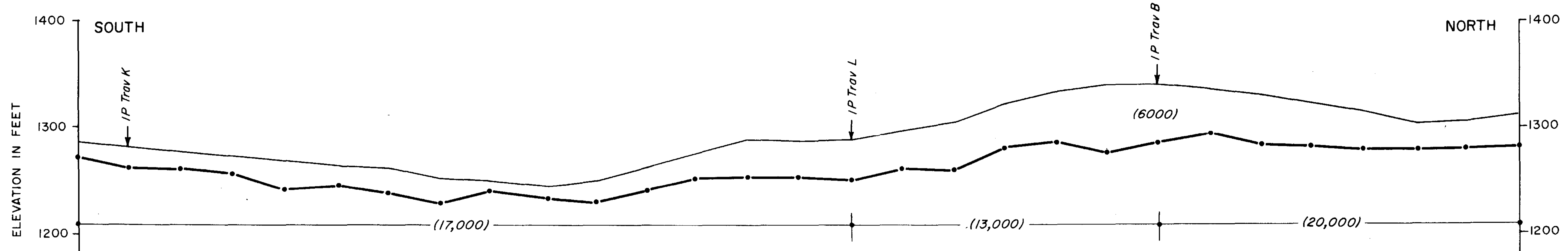
TO ACCOMPANY RECORD No. 1963/171

TRAVERSE J



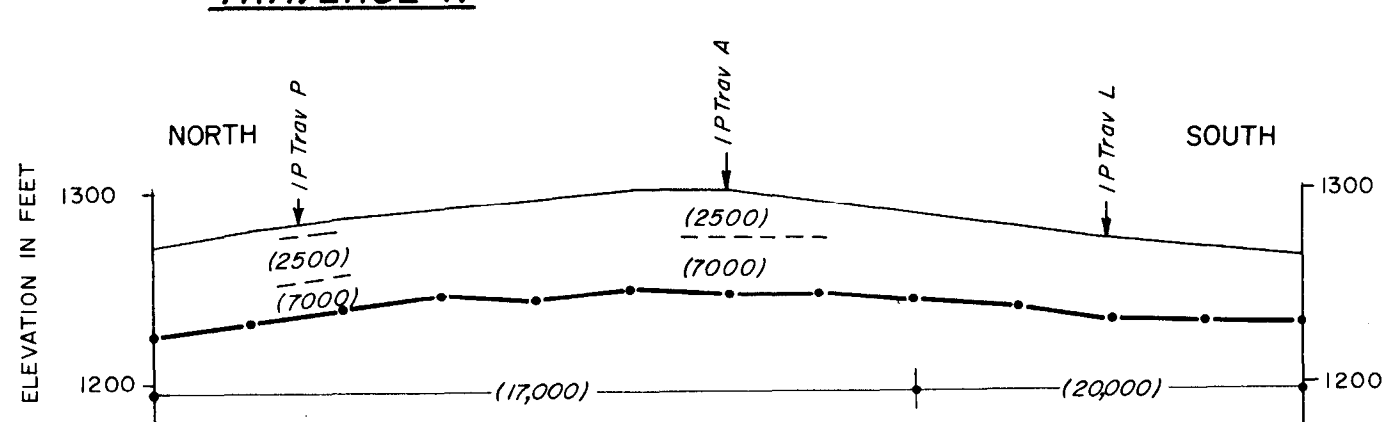
STATION NUMBER	47			50					55	56	8	58		60					65		67
STATION ELEVATION	1370	1368	1363	1351	1348	1340	1340	1354	1369	1383	1392	1393	1387	1385	1382	1375	1372	1379	1396	1409	1423
DEPTH TO BEDROCK	32	24	26	28	24	28	32	32	32	34	36	38	42	42	40	40	42	40	38	32	46

TRAVERSE M



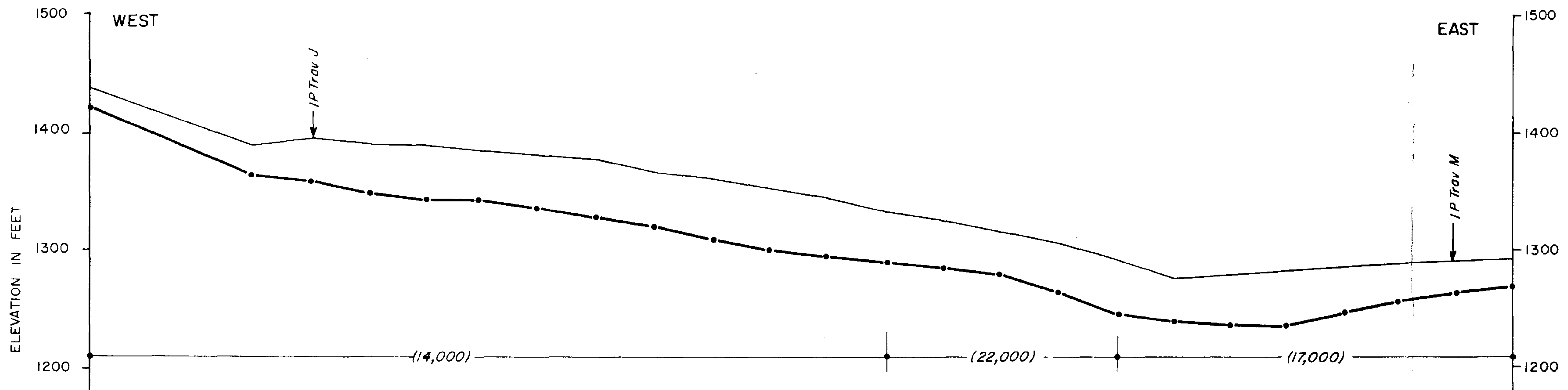
STATION NUMBER	191	190					185					180					175				171	132	169			166	451		453
STATION ELEVATION	1290	1286	1283	1279	1275	1270	1265	1257	1253	1248	1253	1266	1282	1292	1290	1293	1300	1309	1325	1336	1344	1345	1341	1335	1327	1317	1308	1309	1315
DEPTH TO BEDROCK	15	20	19	17	28	19	25	23	8	7	23	21	25	32	33	40	37	45	45	49	64	63	46	47	40	36	26	26	30

TRAVERSE N



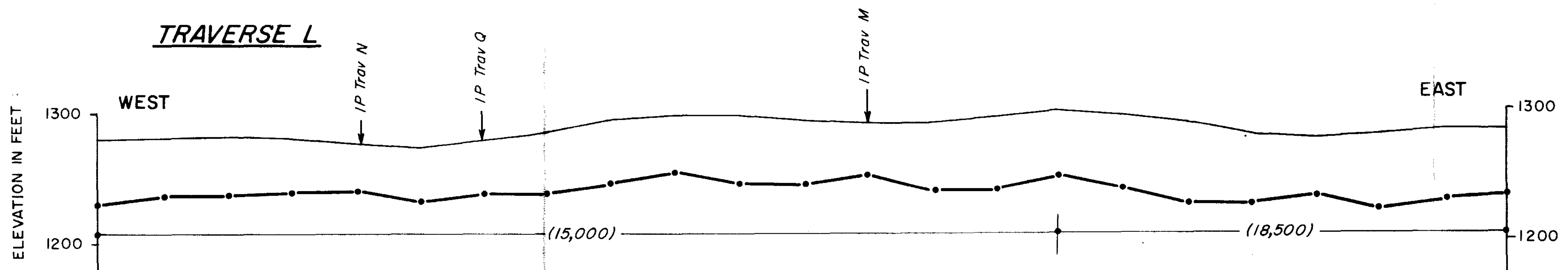
STATION NUMBER	102			105					110				114
STATION ELEVATION	1274	1282	1288	1294	1298	1303	1302	1295	1288	1282	1276	1273	1270
DEPTH TO BEDROCK	42	46	46	46	50	48	54	46	44	38	38	40	36

TRAVERSE K



STATION NUMBER	73	85	75					80					85					90					95
STATION ELEVATION	1390	1396	1389	1387	1385	1380	1374	1364	1360	1350	1341	1331	1323	1315	1303	1289	1274	1277	1280	1283	1285	1287	1289
DEPTH TO BEDROCK	30	38	38	46	46	48	48	48	50	52	48	42	42	42	46	48	44	46	50	40	32	26	22

TRAVERSE L



STATION NUMBER	198		200					205					210					215					220
STATION ELEVATION	1281	1282	1284	1282	1278	1275	1281	1289	1297	1300	1300	1296	1294	1294	1298	1305	1299	1293	1285	1286	1286	1288	1289
DEPTH TO BEDROCK	51	48	46	40	38	40	42	51	48	44	48	48	40	46	48	46	51	53	51	46	51	50	51

LEGEND

(15,000)	Formation with seismic velocity of 15,000 ft/sec
DDH 19	Diamond-drill hole 19
IP	Intersection point
•———•	Unweathered bedrock boundary

Based on COG Maps 1002, 1003, 1005, and 1006
Elevation: State datum

TRAVERSES J, K, L, M, AND N

SEISMIC CROSS-SECTIONS

FEET

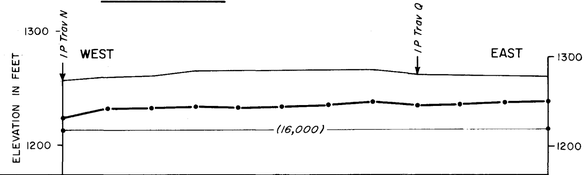
100 50 0 100 200 300

(Horizontal and Vertical)

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. E55/B5-5

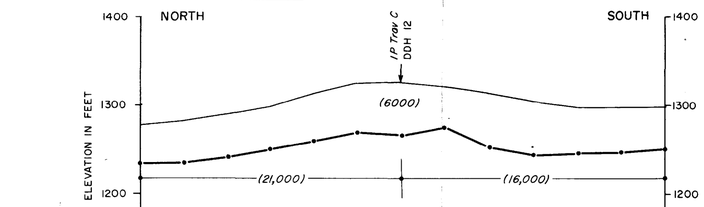
TO ACCOMPANY RECORD No. 1963/171

TRAVERSE P



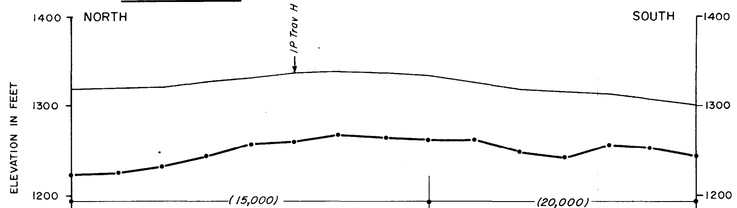
STATION NUMBER	446	445					440	439	150	438		436
STATION ELEVATION	1274	1279	1283	1286	1288	1289	1290	1288	1286	1283	1283	1282
DEPTH TO BEDROCK	40	39	40	38	44	42	40	34	40	34	32	30

TRAVERSE R



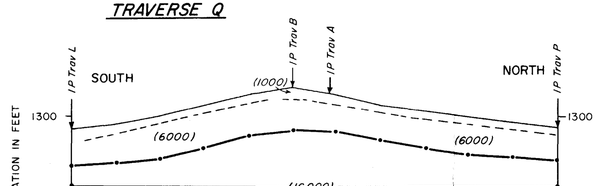
STATION NUMBER	258			255				250				246
STATION ELEVATION	1276	1282	1291	1300	1314	1325	1328	1322	1313	1306	1299	1298	1298
DEPTH TO BEDROCK	42	48	46	48	57	55	65	48	61	63	54	54	50

TRAVERSE T



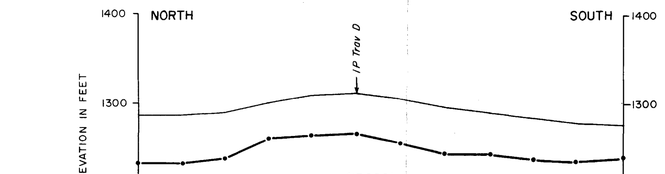
STATION NUMBER	382			385	386	355	368		390				395	396
STATION ELEVATION	1319	1320	1321	1327	1332	1336	1340	1337	1334	1327	1321	1317	1315	
DEPTH TO BEDROCK	96	92	90	81	78	78	73	73	71	65	72	75	98	56	55

TRAVERSE Q



STATION NUMBER	161	160					155					150
STATION ELEVATION	1280	1286	1296	1309	1320	1329	1320	1309	1301	1296	1291	1285
DEPTH TO BEDROCK	40	44	48	50	50	48	38	40	38	42	38	36

TRAVERSE S

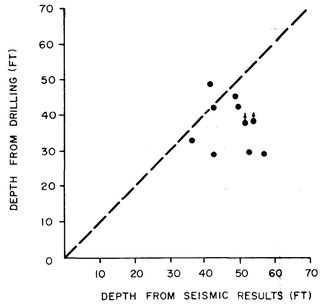


STATION NUMBER	470				446	474	465					460
STATION ELEVATION	1287	1287	1293	1303	1310	1313	1307	1298	1291	1285	1279	1276
DEPTH TO BEDROCK	56	56	50	40	46	49	52	56	56	48	48	39

LEGEND

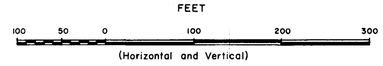
(6000)	Formation with seismic velocity of 6000 ft/sec
DDH 12	Diamond-drill hole 12
/P	Intersection point
●——●	Unweathered bedrock boundary
●	Unweathered bedrock not reached

Based on COG Maps 1004, 1007, 1009, and 1011
Elevation: State datum



TRAVERSES P, Q, R, S, AND T

SEISMIC CROSS-SECTIONS



Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. E55/B5-6
TO ACCOMPANY RECORD No. 1963/171