COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

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SEISMIC SURVEY OF THE ROYAL MINT SITE, CANBERRA, A.C.T.

by

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ABSTRACT

A seismic refraction survey of the proposed site of the Canberra Royal Mint was carried out to determine foundation conditions.

The geophysical results show a surface layer of weathered or unconsolidated rock between 26 and 38 feet in thickness, an intermediate layer of weathered bedrock, part of which may be suitable foundation rock, and a lower layer of unweathered bedrock at depths exceeding 69 feet. The seismic results also indicate the presence of a shear zone. The Young's Modulus of the intermediate layer is estimated at between 0.7×10^6 lbs/sq. inch in the shear zone and 1.4×10^6 lbs/sq.inch outside the shear zone.

1. INTRODUCTION

The Department of Works, Canberra, proposes to construct a Royal Mint on the north-eastern corner of Commonwealth Avenue and King Edward Terrace. A seismic refraction survey was conducted during July, 1956, by the Geophysical Section of the Bureau of Mineral Resources, to investigate the foundations conditions at the proposed site. A detailed survey was not requested, and it was originally intended to survey only two intersecting traverses. However, as the survey along these traverses revealed some bedrock of low elastic wave velocity, a third traverse was surveyed (see Plate 1).

A topographic survey of the site was carried out by the Department of the Interior, Canberra, and plans were made available to the geophysical party. Four field hands and explosives were supplied by the Department of Works, Canberra.

The geophysical party consisted of L.V. Hawkins (party leader) and A. Stocklin, geophysicists, and J.P.Pigott, field assistant.

2. GEOLOGY

The geology of the Canberra city district has been described by Öpik (1955) and is shown on the geological map of Canberra (Öpik, 1953).

The proposed site is located on the Riverside Formation, which consists of calcareous shales and mudstone, current-bedded, fine-grained sandstones, prominent limestone lenses, tuffaceous sediments, tuffs and rhyolites. The Riverside Formation is part of the Canberra Group and is of Lower Silurian age.

In this report the term "overburden" is used to refer to rock with a velocity of 8,000 ft/sec. or less and the term bedrock to rock with a velocity of 8,000 to 11,500 ft/sec., or greater.

3. METHOD AND EQUIPMENT.

The seismic refraction "Method of Differences", which was used on this survey, is fully described by Hawkins (1957).

An explosive charge is used as a source of elastic waves. The waves are refracted at elastic discontinuities, such as between overburden and bedrock, and the travel times of the first arrival of the elastic waves from the shot point to a series of detectors (geophones) are recorded.

From the observed travel times, the depth to discontinuities, e.g. bedrock, can be computed. Also, by removing the effect of the overburden on the travel times (Hawkins, 1957) the horizontal variations in the bedrock velocity can be reliably estimated.

The geophones were spaced at intervals of 50 feet and 10 feet.

A "Century Geophysical Corporation" 12-channel,portable refraction seismograph was used, with "T.I.C." geophones of natural frequency about 20 cycles per second.

4. RESULTS.

Plate 1 shows the traverse and locality plans, and Plate 2 the profiles of the upper surfaces of the weathered and unweathered rock as indicated by the seismic results.

The results show the presence of a surface layer with seismic velocities ranging from 2,400 to 2,800 feet per second and a thickness of 26 to 38 feet. The low velocities in this layer indicate a completely weathered or an unconsolidated rock. The thickness of the surface layer was not determined at all stations because no great detail was requested.

The results indicate that below the surface layer is an "intermediate" layer with seismic velocities of 6,000 and 8,000 feet per second and extending to depths between 69 and 118 feet. This intermediate layer is interpreted as weathered bedrock (see Plate 2).

The rock below the intermediate layer shows two velocity ranges, namely 8,000 to 11,500 ft/sec, which is interpreted as slightly weathered and sheared bedrock, and 16,000 to 17,000 ft/sec, which is interpreted as unweathered bedrock outside any shear zone.

Experience has shown that in many places seismic velocities within a bedrock that are lower than normal indicate the presence of shear or fracture zones. Also, the layer of weathered bedrock within shear zones is usually thicker than outside the shear zones. Hence, the "low-velocity bedrock" zone with seismic velocities of 8,000 to 11,500 ft/sec, indicated on Plate 1 between stations B500, C00, B300, A500 and A650, is interpreted as a shear zone. Plate 2 shows that within this shear zone the depth to unweathered bedrock is greater than outside the shear zone. Also, the velocity of 6,000 ft/sec in the intermediate layer occurs only within the shear zone and the intermediate layer of 8,000 ft/sec velocity follows the areal distribution of the high-velocity bedrock.

The quality of a rock for engineering purposes can often be judged from the recorded seismic velocities within the rock. The more compact and rigid the rock the higher the seismic velocities.

An alternative way of expressing rock quality is in terms of the Young's Modulus of the rock. The approximate values of the Young's Modulus can be derived from the seismic velocities and the estimated values of the density and Poisson's ratio of the rocks. Also, the Young's Modulus appears to have an empirical relation to the seismic velocity (Hawkins, 1957). The following table summarises the rock characteristics as estimated from the seismic data and geology.

"Rock type"	Seismic velocity (ft/sec)	Young's Modulus (lbs/sq.inch) (approximately)
Surface layer, completely weathered or unconsolidated rock	2,600	0.1×10^6
Intermediate layer, weathered bedrock outside shear zone	8,000	1.4×10^6
Intermediate layer, weathered bedrock inside shear zone	6,000	0.7×10^6
Unweathered bedrock outside shear zone	16,000 - 17,000	7.1×10^6 - 8.1×10^6
Slightly weathered bedrock, fractured inside shear zone.	8,000 - 11,500	1.4×10^6 - 3.4×10^6

To convert Young's Modulus values from lbs/sq. in to dynes/sq.cm, multiply by 6.89×10^4.

The maximum error in the depth estimates of the seismic results is considered to be ± 15 percent.

5. CONCLUSIONS

The investigation disclosed three main rock layers, namely a surface layer of weathered or unconsolidated rock, an intermediate layer of weathered bedrock, and a lower layer of unweathered bedrock. The distribution of seismic velocities within the intermediate and lower layers (see Plate 1) suggests the presence of a shear zone. Although the unweathered bedrock would be the most suitable for foundation purposes, its great depth (more than 69 feet) rules it out at this site. The only alternative for a foundation rock is the top of the weathered bedrock, which is between 26 and 38 feet deep and has a seismic velocity of 6,000 ft/sec in the shear zone and 8,000 ft/sec outside the shear zone, with estimated Young's Moduli of 0.7×10^6 and 1.4×10^6 lbs/sq. inch respectively.

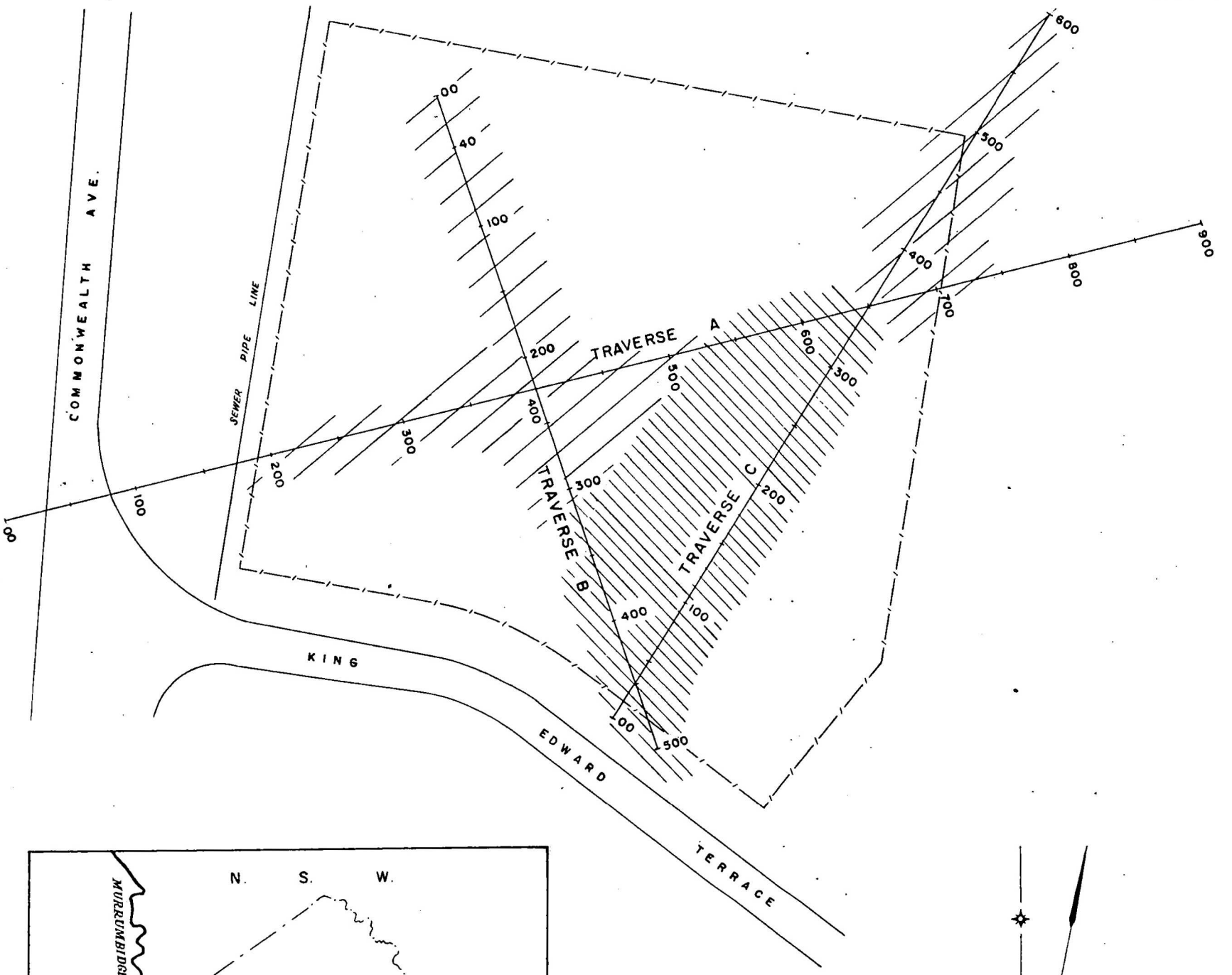
6. REFERENCES

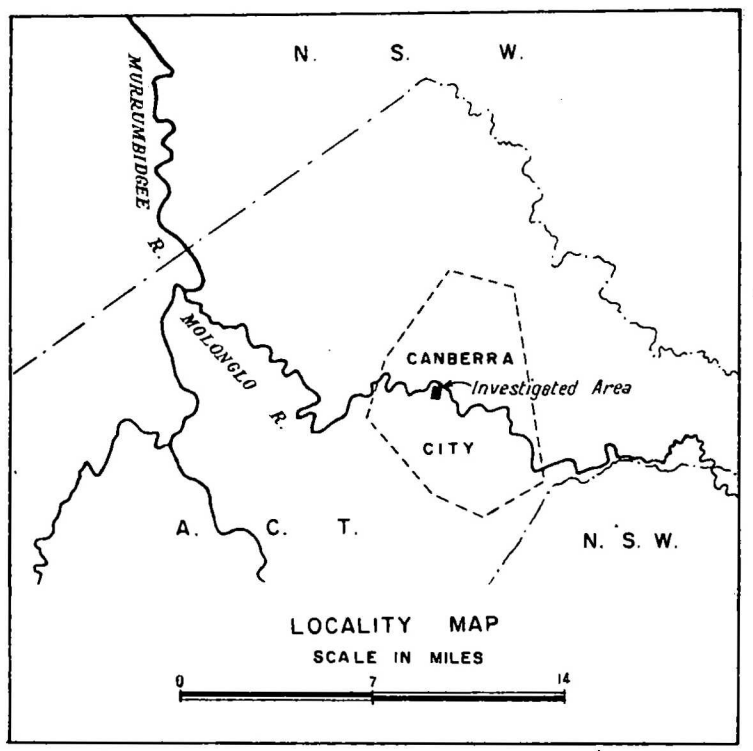
Hawkins, L.V., 1957 - Geophysical survey of the Acton Weir site, Canberra, A.C.T. Bur. Min. Resour. Aust., Rec. 1957 No. 31.

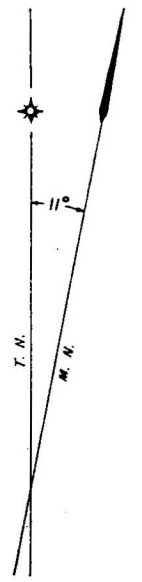
" Opik, A.A., 1955 - The Geology of the Canberra City district. The Aust. Cap. Territory as a Region.

" Opik, A.A., 1953 Geological Map of Canberra. Bur. Min Resour. Aust., A.C.T. G2-12.

PLATE 1







LEGEND

- GEOPHYSICAL TRAVERSE AND STATIONS
- FENCE
- LOW VELOCITY SUBSURFACE BEDROCK 8000–11,500 ft/sec.
- HIGH VELOCITY SUBSURFACE BEDROCK 16,000 – 17,000 ft/sec.

SEISMIC SURVEY OF THE ROYAL MINT SITE,
CANBERRA, A.C.T.

LOCALITY MAP AND SEISMIC TRAVERSES

SCALE IN FEET
100 0 100 200

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I55/B5-16

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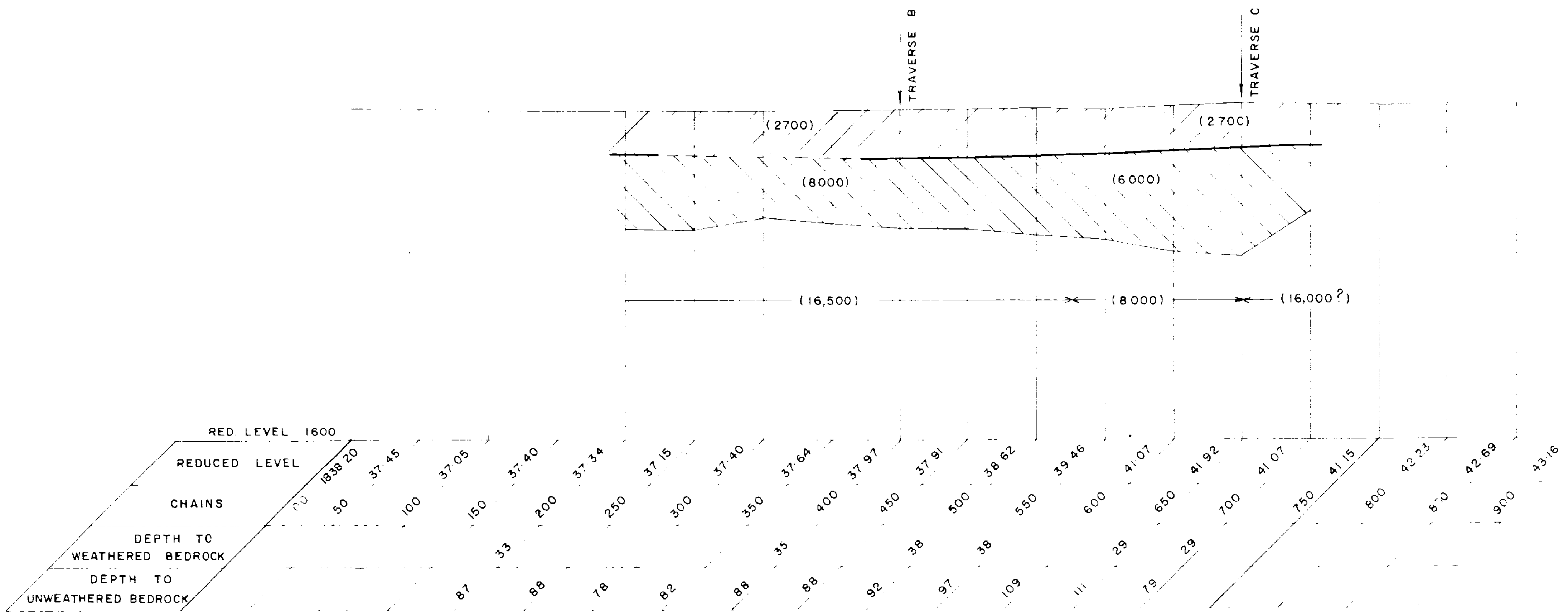
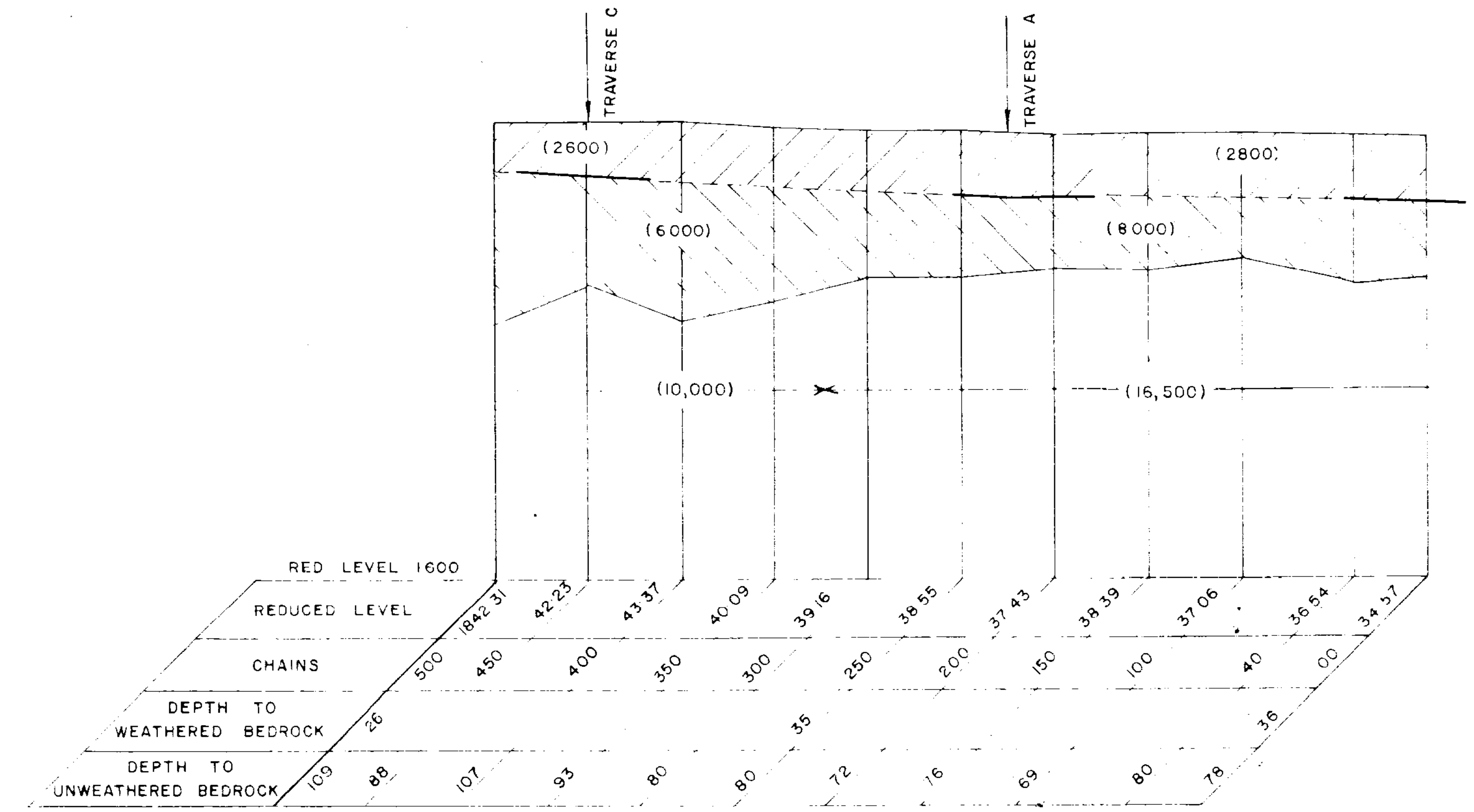
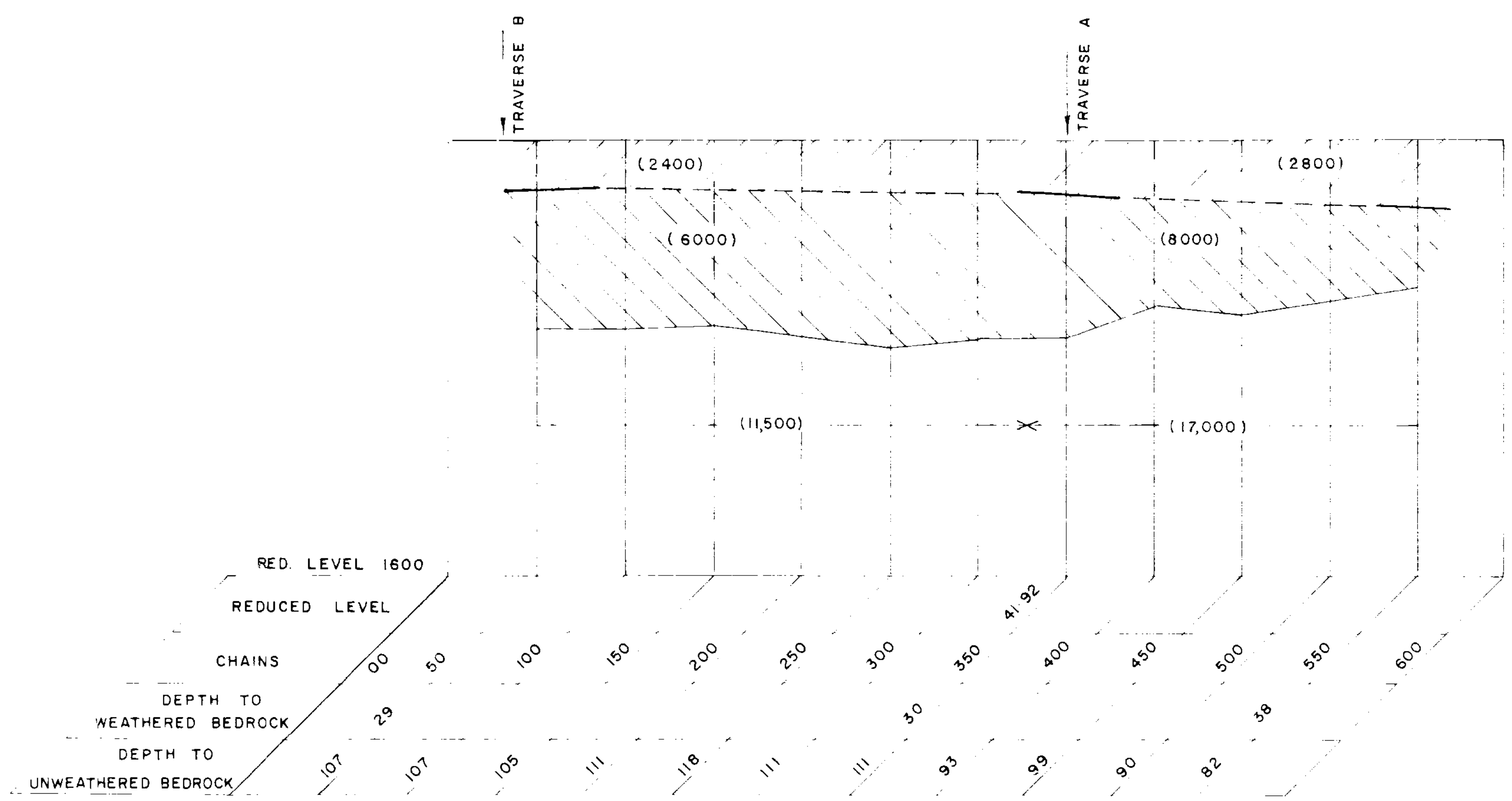


TRAVERSE A



TRAVERSE B



TRAVERSE C

LEGEND

Surface layer (Completely weathered or unconsolidated rock).

Weathered bedrock.

Unweathered or slightly weathered and sheared bedrock

(6000) Seismic velocity (ft./sec.)

SEISMIC SURVEY OF THE ROYAL MINT SITE,
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VERTICAL SECTIONS, WEATHERED AND UNWEATHERED ROCK PROFILES

SCALE IN FEET

100 0 100 200 300

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