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RECORDS 1969/45

GEOLOGICAL INVESTIGATION OF PROPOSED C.S.I.R.O. SITE, CAMPBELL, A.C.T., 1968

by

G.A.M. Henderson

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SUMMARY

A geological and geophysical investigation of a proposed new building site for the C.S.I.R.O. head office, in Limestone Avenue, was carried out during May and June, 1968. Bedrock at the site is dacite crystal tuff of the Lower Devonian Ainslie Volcanics. Good foundation conditions are expected at moderate depth, and excavation without blasting should generally be possible to a depth of 15 feet, except at major outcrops. Surface drainage is good but heavy-textured clay of low permeability occurs below the surface. Augering, standard penetration and bearing tests, and possibly drilling, are recommended to test the site of any proposed major structure.

INTRODUCTION

In response to a request by the National Capital Development Commission in April, 1968, a geological and geophysical investigation was carried out at a proposed new building site for the C.S.I.R.O., (Block 1, Section 38, Campbell). Rock outcrops were mapped by plane table tacheometry and several seismic refraction traverses were done to determine sub-surface conditions. The work was carried out during May and June 1968.

GEOLOGY

All outcrops in the area are of massive dacite crystal tuff of the Ainslie Volcanics, which are thought to be of Lower Devonian age (Opik, 1958). The tuff crops out as tors and boulders; it is generally fresh and extremely hard and strong. No bedding can be seen in the rock but many of the constituent crystals are aligned approximately north-south; in places this imparts a distinct lineation to the tuff. Many of the outcrops are also elongated in the direction of the lineation. Joints in the rock are generally widely spaced; most of them strike about 015° magnetic and dip roughly either 55°E or 80°W. No faults are known in the area; however, substantial rock outcrop covers only about one percent of the site, and areas of scattered outcrop cover a further five percent.

The unconsolidated cover on the site consists of thin, discontinuous soil (in the pedological sense) and clay. Much of the soil is residual, having developed in place by weathering and other soil-forming processes from the parent bedrock, but some low parts, particularly along Limestone Avenue, are covered by transported clay and soil. Clay is the main product of decomposition of the bedrock. It is moderately plastic and is believed to be only slightly expansive.

Weathering

The dacite crystal tuff exposed at the site, although a volcanic rock, appears to display the mode of weathering that is typical of granitic rocks. Tors and boulders of fresh rock at the surface are surrounded by weathered material which may extend to considerable depth. Boulders of fresh rock may also occur below the surface in the weathered material such as in the quarry adjacent to the

end of Ainslie Avenue, west of the site. The rock, even where fresh, may have weathered material along joints. In short, the depth of weathering is extremely erratic and unpredictable.

Experience in excavations elsewhere suggests that in areas lacking outcrops the weathering may be more uniform owing to a more general alteration of the rock mass. Testing will be necessary to ascertain whether these conditions apply at the site.

Even if, in the areas free of outcrops, rock conditions are more uniform than for exposed rock, local weak clay seams may be encountered.

ENGINEERING GEOLOGY

Seismic Investigations

Several seismic refraction traverses were conducted during the course of the investigation to gain some information on foundation and excavating conditions. Three traverses were carried out by the Engineering Geology Group using a portable 6-channel seismic timer, and another four traverses by the Geophysical Branch, (Hart, 1968) using 24-channel equipment.

The seismic work indicates the depths to various refracting layers, which mark contacts between zones having different elastic properties. The speed of travel of the seismic wave is related to the modulus of elasticity of the rock mass; it therefore serves as an indication of rock quality. As the rock on the site is a fairly uniform crystal tuff, seismic wave velocity indirectly indicates the degree of weathering or other alteration of the rock mass as a whole within that velocity zone. The seismic velocity is reduced by discontinuities in the rock mass, such as joints, faults and shears and by weathering along these discontinuities.

The results of the seismic work are presented on Plates 2 and 3. The depths to each refracting surface and the mean seismic velocity of each layer have been calculated and plotted; correlations of layers of similar velocities and depth ranges are shown by dashed lines. At the intersection points of traverses there are differences in estimated velocities and depth ranges from one traverse to the other. The larger variations are probably due to the irregular weathering, and lack of sharp boundaries between velocity layers, and to the effect of discontinuities on the traverses at right angles to the discontinuities. Some of the small variations between intersecting traverses could be due partly to inherent error in the method of recording and calculating results.

Foundation Conditions

The top layer of soil and clay extends to a depth of about 5 feet. Below the soil and clay is a layer of highly weathered dacite. As a foundation material, this has the properties of a

clayey, silty sand, and can probably support a low to moderate unit loading. Beneath this weathered rock, at around 15 feet, is a harder layer - probably moderately weathered dacite which would provide suitable foundations for moderate to heavy loadings. Fresh rock is indicated at depths ranging from about 30 to 60 feet. However, as pointed out under "weathering", uniform conditions at any particular depth should not be assumed; foundation testing is necessary for the site of any structure planned.

The general depth ranges of the different layers are shown on Plate 2. The traverses shown on Plate 3 distinguish only three layers, generally of soil and weathered bedrock; only on Traverse 2 is the depth to fresh bedrock shown.

No fresh rock is indicated near the surface in any of the seismic traverses, although some of the traverses cross small outcrops of fresh rock. Apparently blocks of fresh rock are set in generally weathered rock and are too small to have an appreciable effect on the seismic velocities. Similar blocks of fresh rock surrounded by completely weathered material may also occur below the surface, and should not be mistaken for continuous fresh bedrock. The large outcrops near plane table stations 2 and 3 are probably firmly based on fresh bedrock, but there is no indication from the seismic traverses of a decrease in the depth to fresh bedrock in the vicinity of the outcrops. On the contrary, some traverses suggest particularly deep weathering near the outcrops; the outcrops may therefore be bounded by deeply weathered joints.

Excavating Conditions

Except where outcrops occur, easy excavating conditions are indicated to about 5 feet, in soil and clay. The highly weathered rock below the soil and clay could probably be excavated by bulldozers and other earth-moving equipment in most places. In traverse D, however, the seismic velocities in one part of the highly weathered layer indicate the presence of material that is too hard to be excavated without explosives*. Possibly the higher velocities are due to patches of slightly weathered or fresh rock within the highly weathered layer. Explosives would probably be required for any excavation below about 15 or 20 feet over most of the area and possibly at shallower depths in a few places. The large outcrops near plane table stations 2 and 3 would require explosives for their removal.

*Weathered bedrock in which the seismic velocity is 5,500 feet per second is generally too hard for economic excavating by earth moving equipment without some preliminary drilling and blasting.

Stability of Cuts

In walls of excavations, the surface layer of soil and clay will be unstable when moist; trenches will need support to guard against failure in wet weather. The weathered bedrock will be stable when moist, except where cut by clay seams and joints in such a way that a block is without adequate support. For example, an excavation wall that is nearly parallel to the set of joints that dip about 55 degrees east is likely to need local support.

Groundwater and Drainage

Surface drainage in the area is good owing to the sloping ground. Groundwater movement is believed to be slight because of the heavy clay subsoil and virtually impermeable bedrock. Some seepage may occur along joints; rate and volume of water movement is likely to be greatest in the zone of slight weathering where joints tend to be open.

Under these conditions subsurface inflow of water into excavations is expected to be small, but because of poor drainage any accumulation of water in excavations would have to be pumped out.

The depth to the water table is not known, but it is unlikely that foundations and excavations would reach the zone of permanent saturation.

CONCLUSIONS AND RECOMMENDATIONS

1. Bedrock at the site is dacite crystal tuff of the Ainslie Volcanics.

2. To verify the interpreted depths and properties of layers indicated by the seismic results, and to aid site planning, a programme of augering involving thirteen holes, of total length about 300 feet (but not exceeding 350 feet) is suggested. Laboratory testing of undisturbed samples obtained while augering would provide data for preliminary planning of structures.

3. Good foundation conditions are expected at moderate depth. However, augering, load-bearing tests and possibly drilling, would be desirable at the proposed location of any major structure. Alternatively, as foundation conditions may vary considerably over short horizontal distances, one or more continuous trenches may be desirable at design stage to check proposed building sites in detail.

4. Excavation without blasting should generally be possible to a depth of 15 feet, except at a few large outcrops.

5. In any deep excavations clay seams or joints may provide planes along which failure of cuts could occur.

6. Surface drainage is good but heavy clay of low permeability occurs below the surface.

REFERENCES

HART, G.F., 1968 - C.S.I.R.O. Headquarters site, seismic refraction survey, Canberra, 1968.
Bur. Miner. Resour. Aust. Rec. 1968/129

" OPIK, A.A. - The Geology of the Canberra City District.
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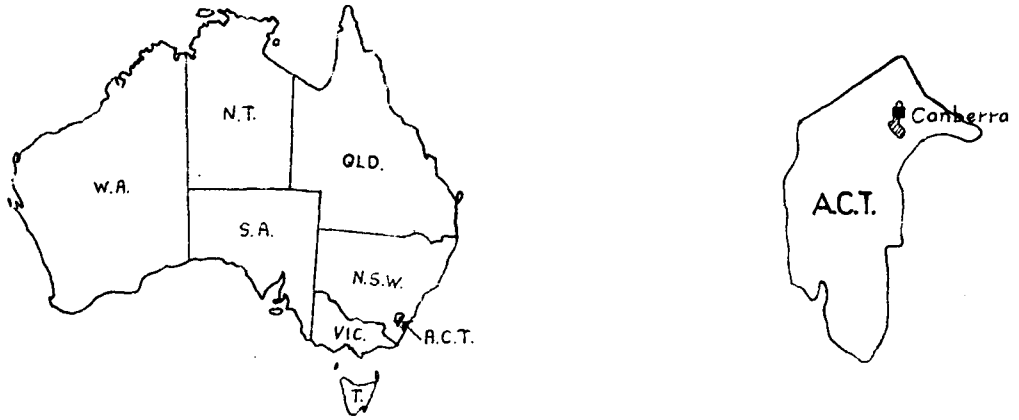
Fig.1

C.S.I.R.O. SITE, CAMPBELL
LOCALITY MAP



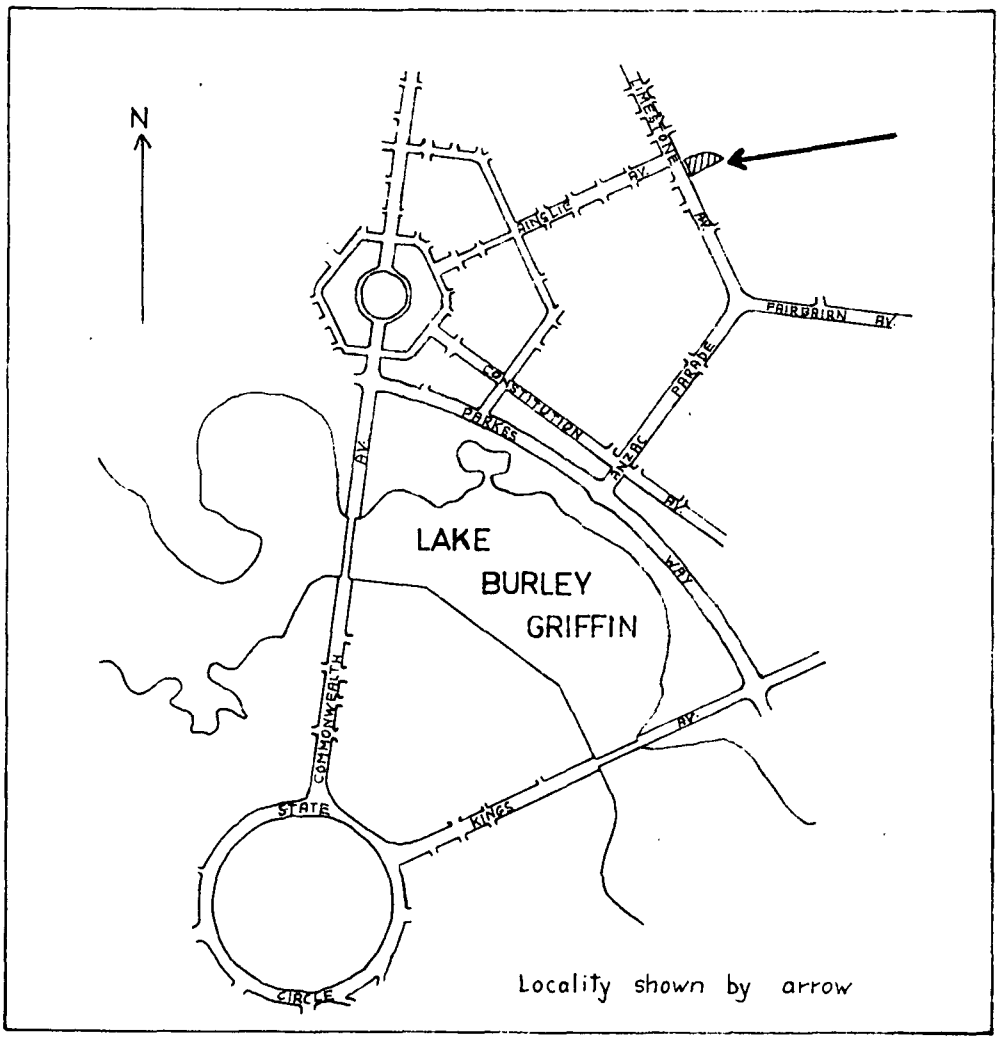


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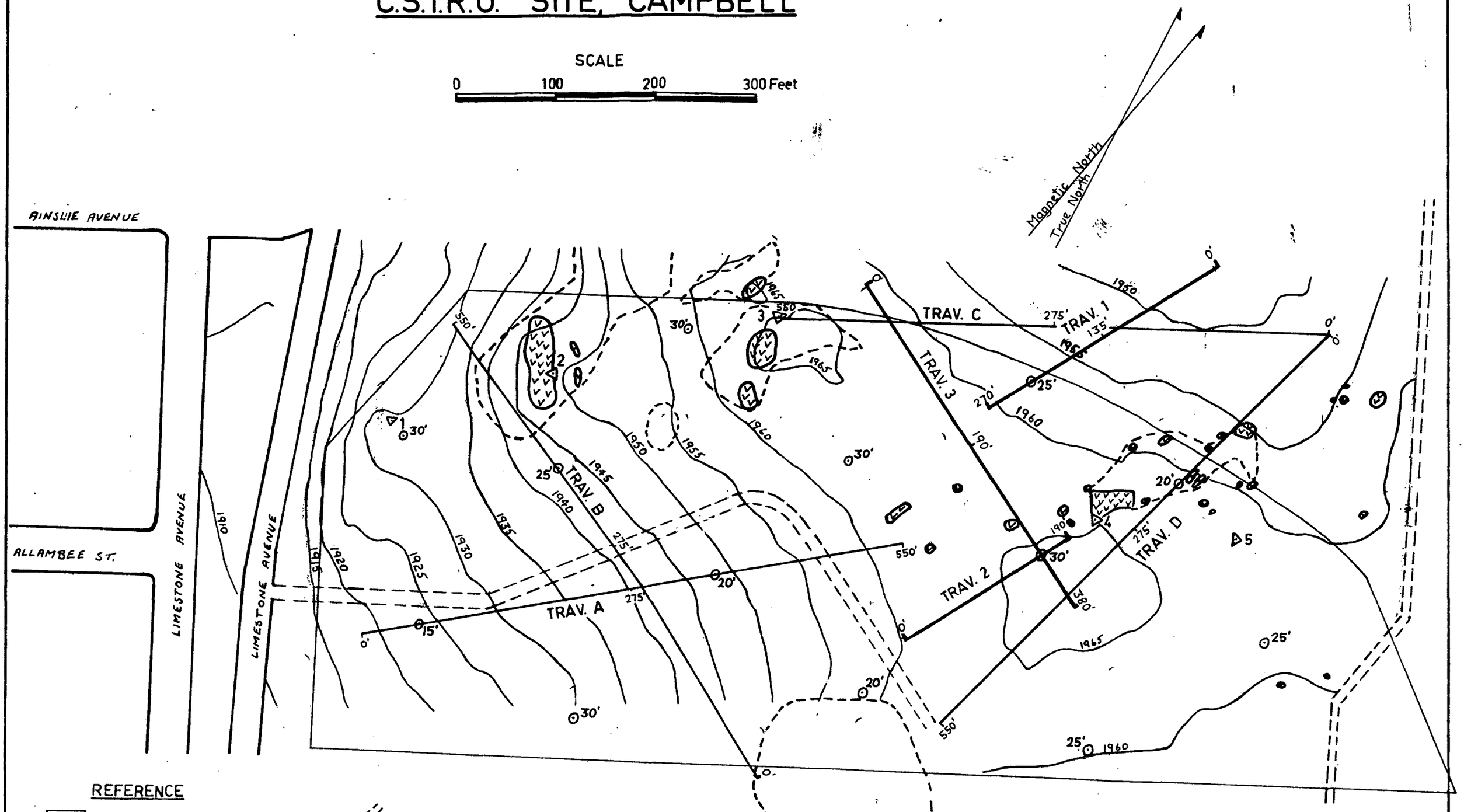
PLATE 1

GEOLOGICAL MAP OF C.S.I.R.O. SITE, CAMPBELL

SCALE

0 100 200 300 Feet



REFERENCE

- Dacite tuff
- Outcrop of dacite tuff
- Scattered boulders of dacite tuff
- 1960 Contour, based on A.C.T. Detail series sheet J6D
- Plane table station
- Vehicle track
- ⊙20' Recommended auger hole showing estimated depth of penetration
- TRAV. B — Seismic traverse by Geophysical Branch
- TRAV. 1 — Seismic traverse by Engineering Geology Group

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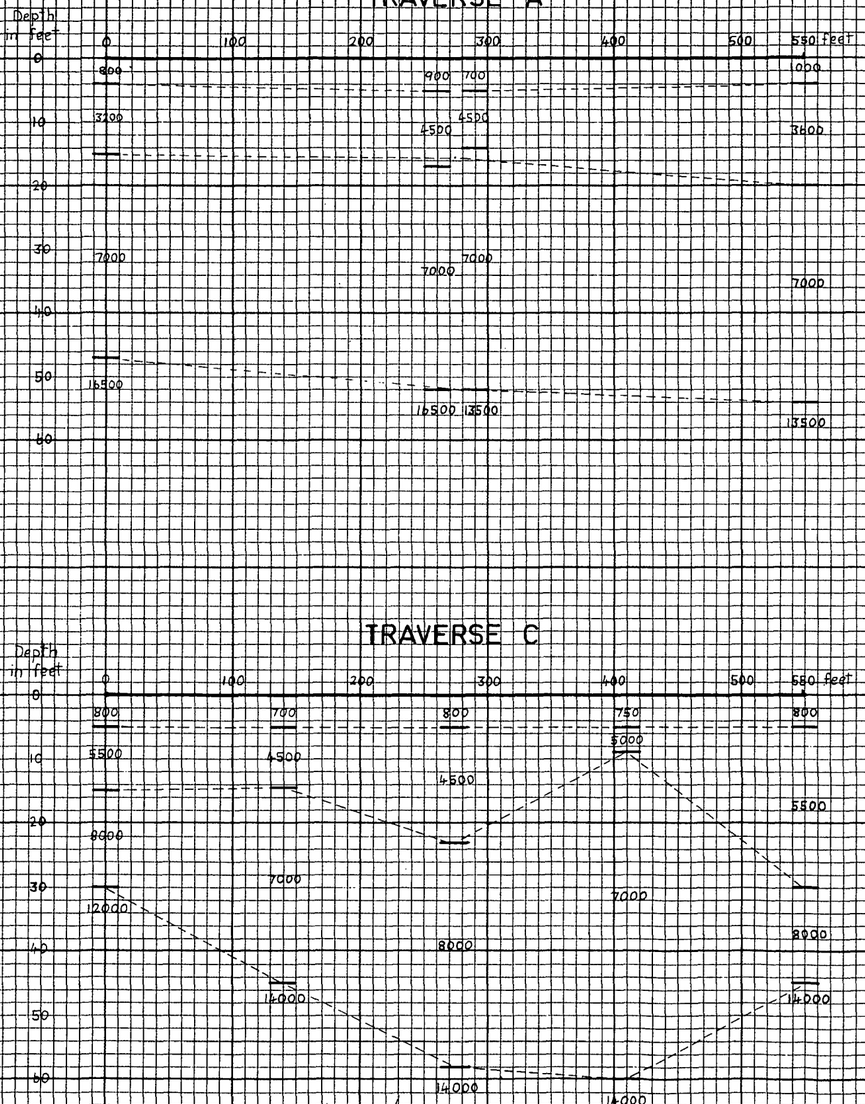
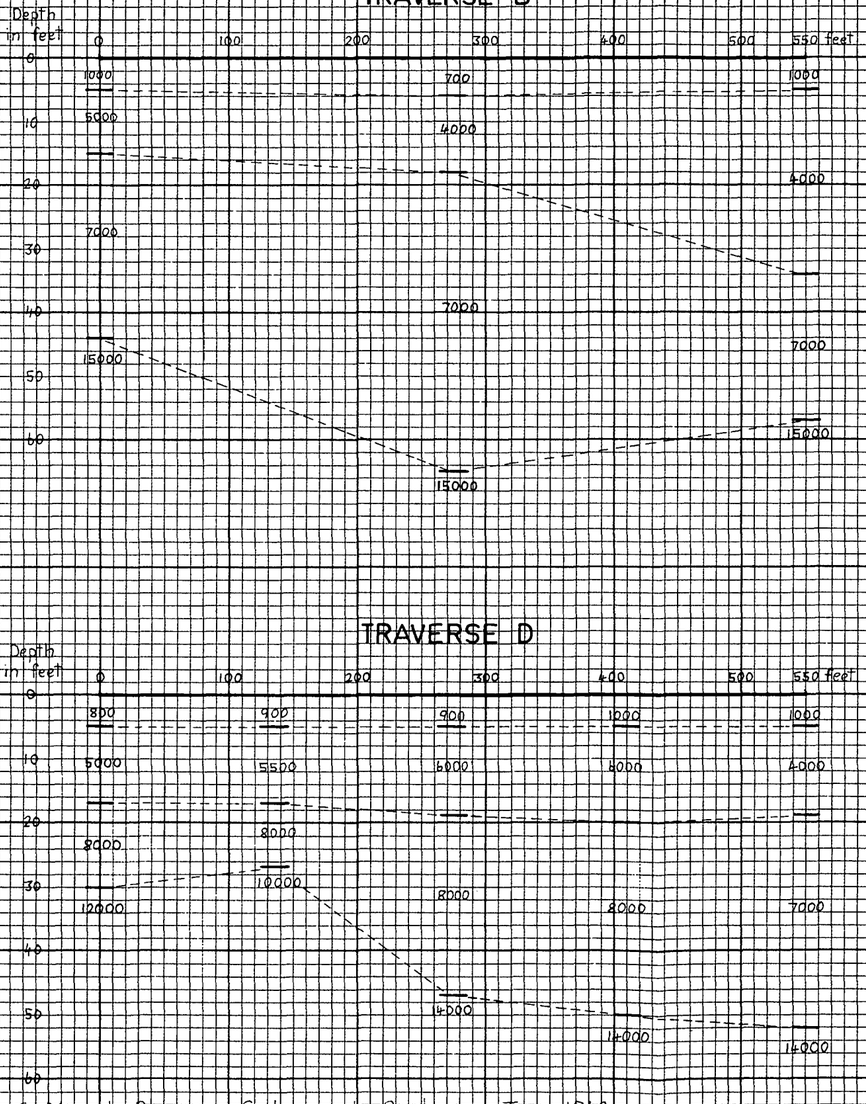
PLATE 2

CROSS SECTIONS OF SEISMIC TRAVERSES AT PROPOSED C.S.I.R.O. SITE, CAMPBELL





REFERENCE

SURFACE

Soil & clay — 900 SEISMIC VELOCITY OF LAYER (IN FEET PER SECOND)

Highly weathered dacite tuff — 4500

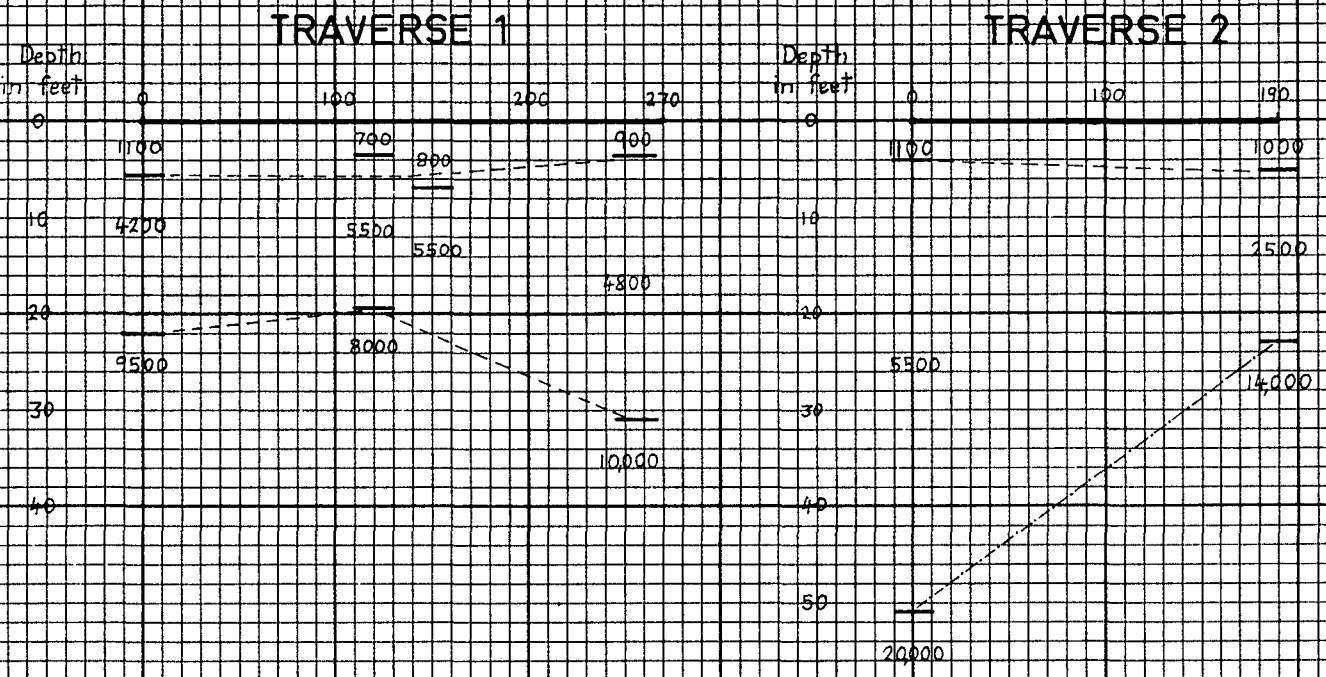
Moderately weathered dacite tuff — 7000

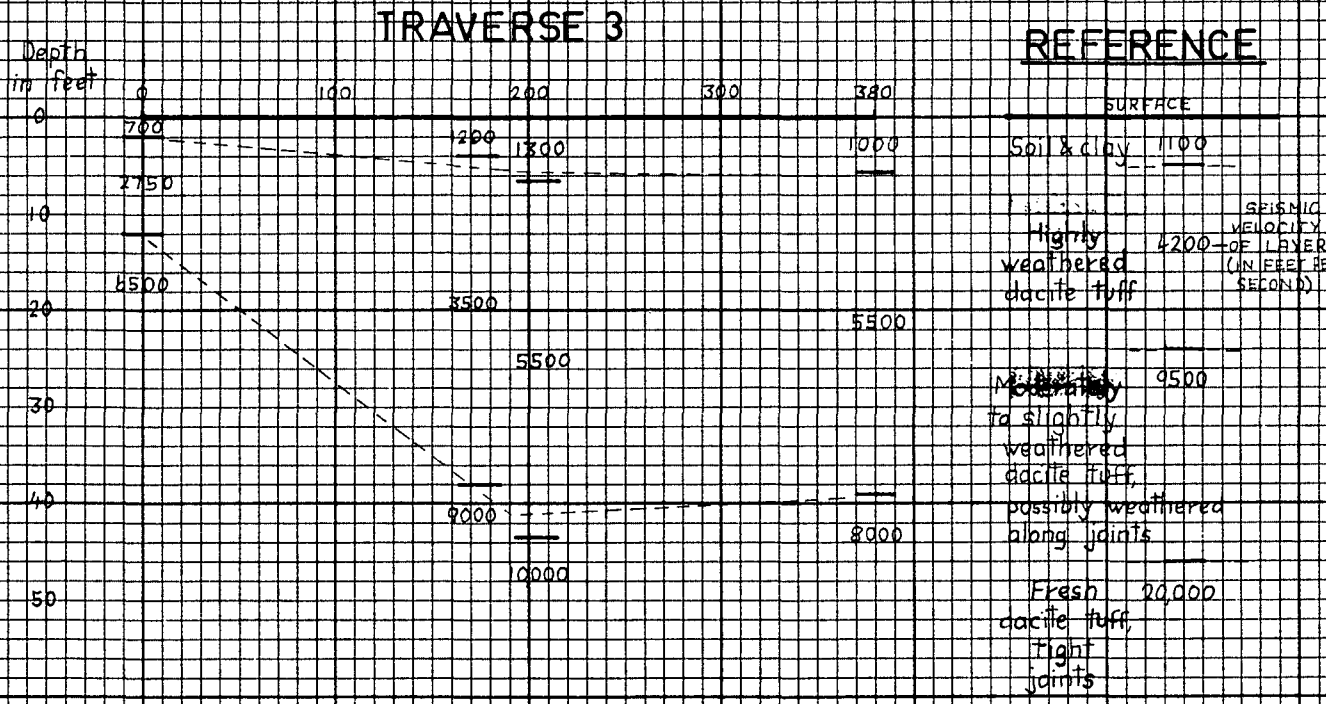
Fresh dacite tuff Tight joints — 16500

Sections based on seismic refraction survey by Geophysical Branch, June 1968.

PLATE 3

CROSS SECTIONS OF SEISMIC TRAVERSES AT PROPOSED C.S.I.R.O. SITE, CAMPBELL





REFERENCE

SURFACE

Soil & clay 1100

Highly weathered dacite tuff 4200 — SEISMIC VELOCITY OF LAYER (IN FEET PER SECOND)

9500

Moderately to slightly weathered dacite tuff, possibly weathered along joints

Fresh dacite tuff, tight joints 20,000

Sections based on seismic refraction survey by Engineering Geology Group, May 1968

Bureau of Mineral Resources, Geology and Geophysics, June 1968 155/A16/575

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