COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1958, No. 29

GEOPHYSICAL INVESTIGATIONS AT THE HUON RIVER DAM SITE, TASMANIA

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W. A. WIEBENGA and E. J. POLAK

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ABSTRACT

The results are given of seismic refraction and magnetic surveys carried out in response to an application from the Hydro-Electric Commission of Tasmania for an investigation of proposed dam sites on the Huon River.

The purpose of the surveys was to determine the thickness and nature of the overburden and the nature of the bedrock. Seismic results indicate that the overburden is up to 94 ft. thick. It consists of scree, talus, river sands, gravel, clays and decomposed and weathered dolerite. The bedrock consists of jointed and unweathered dolerite.

It is estimated that the thickness of the overburden has been calculated with an error of no more than 20 per cent.

Geophysical Investigation of the Huon River Damsites, Tasmania.

1. INTRODUCTION.

The Hydro-Electric Commission of Tasmania proposes to construct a dam on the Huon River above its junction with Frying Pan Creek, approximately 12 miles upstream from Huonville (Plate 1). The dam is part of a hydro-electric scheme to provide additional power for Hobart and south-eastern Tasmania.

Five possible sites for the dam were chosen by the Commission for investigation. No. 2 site is the furthest upstream, and downstream from the No.2 site are Nos. 4, 1, 5 and 3 in that order. Some trial pits were sunk to determine the nature and thickness of the overburden.

In response to an application from the Commission, the Bureau of Mineral Resources, Geology and Geophysics, carried out a geophysical survey to determine the nature of the overburden and bedrock and the depth to bedrock at the four lower damsites.

As used in this report, the term "bedrock" refers to unweathered (but including jointed) dolerite in which the velocity of the seismic waves exceeds 8,000 ft/sec. The term "overburden" refers to river sands, gravels, clays, scree, talus and completely and partly weathered dolerite, all with seismic velocities less than 7,000 ft/sec.

Seismic refraction and magnetic methods were used. The survey was made between December, 1956 and February, 1957 by a geophysical party consisting of E.J. Polak, geophysicist, and J. Kronenburg, geophysical assistant. The Commission provided additional assistants and carried out a topographical survey along the traverse lines, the lay-out of which is shown on Plate 1.

2. GEOLOGY

The geology of the area has been described by Ford (1956), and a detailed geological examination of the damsites was made by McIntosh Reid, Carey (1950) and Hale (1957a). A map based on the results of the geological investigations is shown on Plate 2.

The main rock in the area is dolerite, probably of Jurassic age (Ford, 1956). The dolerite crops out in several places in the river bed. It also crops out on the slope above the right (south) bank of the river between traverses C-C' and B-B' and near traverse J-J' on the left bank of the river. The dolerite which crops out in the river bed is solid and relatively unweathered, but jointed. The direction of the jointing is shown on Plate 2. The dolerite which crops out higher up the slope is highly jointed and weathered. Elsewhere the dolerite is covered by one or more of the following materials,

(a) River terrace material. This material is found on the left bank of the river in, and down stream from, the mouth of Rocky Creek, and consists of sand, clay and boulders.

(b) River sands, gravels and clays. This material is found on the left bank of the river upstream from the junction with Rocky Creek. It is similar to the river terrace material but is more recent and does not include as many boulders.

(c) Scree. This material is found on the steep slopes of the right bank of the river and consists of boulders with a little clay.

(d) Talus. This material is found on both banks of the river on relatively steep slopes. It consists of soil and dolerite blocks of various sizes. It is believed that the weathering of the dolerite is more advanced under the talus than under the scree (Hale 1957b).

(e) Completely weathered dolerite. This material covers the top of the hill on the right bank of the river and the hill north of traverse M-M' on the left bank. It is in situ. Geological examination in the trial pits revealed that the sub-soil, under a layer of river sands, gravels and clay, consists of weathered dolerite. The weathering is complete at the top of this layer, and below the completely weathered dolerite are boulders of dolerite in a clay-like matrix (Carey, 1950).

3. METHODS AND EQUIPMENT

Seismic refraction and magnetic methods were used.

A. Seismic method.

The seismic method of exploration depends for its success on the contrast in the velocity of the seismic waves through different rock formations. Hard, unweathered rocks have higher velocities than their weathered counterparts, and these in turn have higher velocities than soil and unconsolidated deposits.

The method of differences was used (Heiland, 1946, p.548); 12 geophones were used per spread and the following types of spread were shot:-

(i) Weathering spreads. These were used to obtain seismic wave velocities in, and the thickness of, near-surface layers. Geophone interval was 10 feet and shot points were 5 and 50 feet from both ends of the spread.

(ii) Normal spreads. The geophone interval was 25 or 50 feet and shot points were 25 feet and 300 to 400 feet from both ends of the spread.

(iii) Broadside spreads. This type of spread was used on steep slopes. Geophones were spaced at 25-foot intervals and shot points were 200 feet from the spread along a line approximately perpendicular to the spread from its mid-point.

Velocity tests were carried out in three test pits. Shots were fired at the bottom of the pits and the resulting vibrations were recorded by geophones at the surface. From the recorded seismic travel times, velocities of propagation were calculated.

The equipment used in the survey was a Century 12-channel portable refraction seismograph (Model 506), with Technical Instruments Co. geophones of natural frequency about 20 cycles per second.

B. Magnetic Method.

The measured magnetic intensity at any point on the earth's surface is mainly the resultant of two vectors, namely an induced magnetic intensity vector in the approximate direction of the earth's magnetic field and a remanent magnetic intensity vector inherent in the rock, which may be in any direction. It is believed that, in Tasmania, this direction is nearly vertical. Magnetic measurements can, in some areas, indicate such features as faults and boundaries between near-surface formations and it is sometimes possible to obtain rough depth estimates from such measurements.

In the survey of the Huon river dam sites, a Watts vertical magnetic force variometer was used. Stations were spaced 50 feet apart along traverses and additional stations were occupied between traverses to assist in the plotting of magnetic contours. Five hundred and sixty-four magnetic stations were occupied.

4. RESULTS

A. Seismic

Compressional wave velocities for the various rock types at the Huon River dam sites are given in Table 1.

TABLE 1.

Rock Type	Seismic velocity (ft/sec.)	Estimated value for Young Modulus (c.g.s Units).
Soil	800 to 1,000	
River terrace material	1,000 to 2,000	
River sand, gravel and clay	1,400 to 2,200	
Scree	2,000 to 2,100	
Talus	2,200 to 3,500	
Completely weathered dolerite	2,500 to 3,500	
Partly weathered dolerite	3,500 to 7,000	- to 0.98×10^{11}
Jointed dolerite	8,000 to 13,000	1.34×10^{11} to 3.3×10^{11}
Unweathered and unjointed dolerite	15,000 to 19,000	4.7×10^{11} to 7.8×10^{11}

The seismic velocity in river sand, gravel and clay was determined on traverses E (stations 277 to 279), H (stations 218 to 220) and K(stations 335 to 337), and in the test pit on traverse E. The velocity in the test pit (including the soil layer) was 1,330 ft/sec.

The seismic velocity in the scree was determined on traverse C (stations 179 to 181) and O(stations 54 to 56).

The seismic velocity in the talus was determined on traverse G(stations 62 to 65), J(stations 258 to 260) and L(stations 296 to 298 and 286 to 288). The velocity survey in the test pit near station 105 on traverse R indicated an average velocity of 1,800 ft/sec. in talus overlain by soil; allowing for the velocity in, and the thickness of, the soil, this indicates a velocity of about 2,200 ft/sec. for the talus.

The velocity in completely weathered dolerite was determined on traverses A(stations 109 to 111), B(stations 29 to 31), C(stations 186 to 188), D(stations 157 to 159), E(stations 163 to 165) and R (stations 86 to 88).

The seismic velocity in partially weathered dolerite was determined on traverse O at stations 54 to 56 as 5,600 ft/sec., on traverse P at stations 126 to 128 as 6,800 ft/sec., on traverse S at stations 11 to 13 as 4,800 ft/sec., and on traverse R in the test pit near station 105 as 3,500 ft/sec.

The velocity recorded in the test pit was measured beneath the talus, and is lower than that usually found on outcrops. This finding agrees with Hale's statement (1957b) that dolerite underneath talus is more weathered than on dolerite outcrops.

Dolerite with compressional wave velocities of about 8,000 ft/sec. is interpreted as jointed dolerite. Jointed dolerite is anisotropic for seismic wave propagation. It has a higher velocity parallel to the jointing than at right angles to it. The rock may be slightly weathered along the joints but general opinion is that this rock is strong enough to be used as foundation rock.

The refractor showing the highest velocity was identified as unweathered dolerite.

Assuming a density of 2.8 and a Poisson's ratio of 0.28 (Birch, Schairer and Spicer, 1950), Young's Modulus values for the dolerite at the Huon river damsite were calculated from seismic velocities, and are included in Table 1.

Variations in Poisson's ratio of ±0.05 result in a variation of about 15 per cent in Young's Modulus, all other factors remaining constant. The values of Young's Modulus shown in Table 1 could be in error by ±30 per cent.

The depth to bedrock, as indicated by the seismic results, is shown on Plates 3 and 4 in the form of profiles, and on Plate 6 as a contour map. The following are the principal features to be noted :-

(i) Jointed dolerite crops out in and near the river bed. On the steep banks, the thickness of overburden is small (10 to 30 feet) and has little variation. In general, the thickness of overburden increases towards the top of the valley slopes and has a maximum value of 94 feet near station 159 on traverse D-D' (Plate 3).

(ii) On the left bank of the river, the thickness of overburden is less east of Rocky Creek (see profiles for traverses A, B and C on Plate 3) than it is immediately to the south-west of Rocky Creek. However, it is relatively small on the left bank along traverse G from station 202 to station 214.

(iii) Shear zones are characterised by a local thickening of the overburden and lower seismic velocities in the sheared unweathered rock below the overburden. Possible shear zones are indicated on Plate 6. However, because the geophone interval was 50 ft. and because many shear zones are relatively narrow, the widths of the shear zones could not be measured accurately and those which are less than 50 ft. in width may have been missed.

It is considered that errors in the determination of overburden thickness do not exceed 20 per cent.

B. Magnetic.

The results of the magnetic survey are shown on Plates 3 and 4 as profiles and on Plate 5 as a magnetic contour map with a contour interval of 100 gammas.

The following interpretation is qualitative. It has been assumed that, if the dolerite sill can be considered as a horizontal sheet of uniform thickness with an overburden of uniform thickness, then the measured vertical magnetic intensity (caused by an induced magnetisation and a remanent magnetisation vector) is also uniform.

The anomalies may therefore be ascribed to:-

(i) Variation in the thickness of the dolerite sheet caused by a structural feature such as a fault, or a local thinning or thickening of the dolerite.

(ii) Change in thickness of the overburden as a result of weathering and the accompanying effect of demagnetisation.

(iii) Topographical terrain effects, although these effects rarely exceed 50 gammas (Heiland, 1946, p.376). As the observed anomalies are of the order of 500 gammas or more, the terrain effect of the valley may be disregarded.

The magnetic pattern shows a major minimum axis which coincides approximately with the axis of the valley. The values also decrease down stream. No explanation for this pattern can be given at present. However, it may be that the river follows shear zones in which the magnetite concentration is lower than it is in the surrounding rock.

Alternatively, the river may have cut into a thin dolerite sill. This would result in a vertical magnetic intensity pattern similar to that shown on Plate 5. However, it is not known whether the dolerite sill is thin, and it is felt that the qualitative interpretation is not sufficiently reliable for such a deduction to be made.

On profile A-A' near station 371, on B-B' near station 368, and on C-C' near station 345, (see Plate 3) the magnetic profiles show a steep upward trend towards the south. This could be due to variations in the magnetite content, or possibly to a fault in the river bed with easterly strike, also assuming a relatively thin dolerite sill.

The magnetic minimum between the intersection of traverses H and F, and traverses Y and G (see Plate 5) can be explained by a weathered shear zone. This interpretation is confirmed by the seismic data. The magnetic minimum coinciding with Rocky Creek (see Plate 5) appears to continue on the southern bank of the Huon River. This minimum could be explained by a shear zone in which the content of magnetic minerals is less than it is in the surrounding rock.

5. CONCLUSIONS

The geophysical survey provided information on the depth to the bedrock at possible dam sites on the Huon river. The overburden consists of soil, sand and gravel and decomposed and weathered dolerite, and attains a maximum thickness of 94 ft. The bedrock consists of dolerite, partly jointed and weathered along the joints.

The seismic survey indicated that the thickness of the overburden in general increases upstream from Rocky Creek especially on the left bank of the river but decreases again towards traverse G-G'. The increase in thickness is accompanied by a higher degree of decomposition of the overburden, indicated by a decrease in seismic velocities.

The positions of some shear zones have been eatablished from seismic and magnetic evidence.

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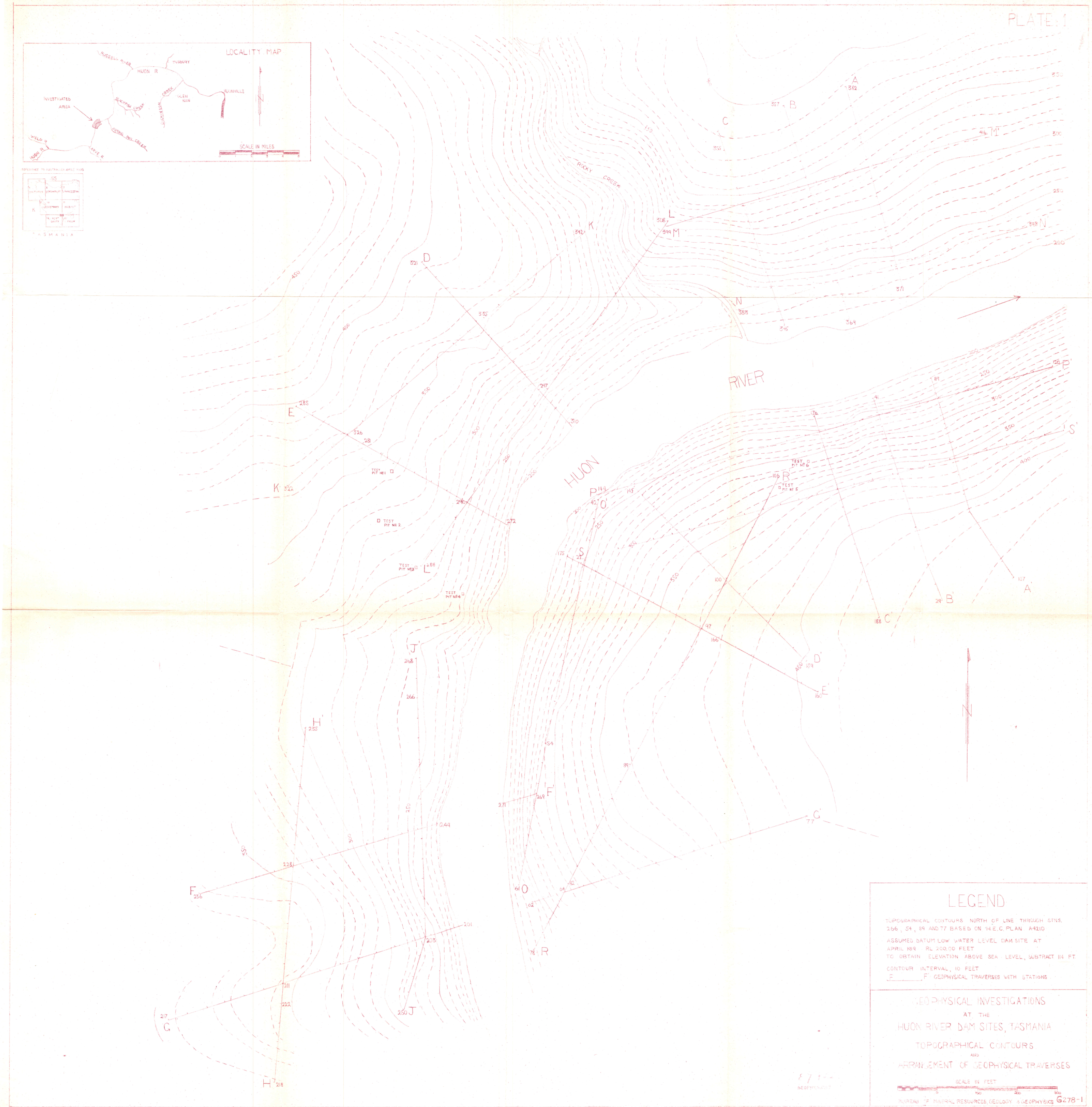
PLATE 1
LOCALITY MAP
HUON R.
INVESTIGATED AREA
SCALE IN MILES
RICKY CREEK
HUON
RIVER
LEGEND
TOPOGRAPHICAL CONTOURS NORTH OF LINE THROUGH STNS. 266, 54, 89 AND 77 BASED ON H.E.C. PLAN A4210
ASSUMED DATUM LOW WATER LEVEL DAM SITE AT APRIL 1919 RL 200.00 FEET
TO OBTAIN ELEVATION ABOVE SEA LEVEL, SUBTRACT 114 FT.
CONTOUR INTERVAL, 10 FEET
F F' GEOPHYSICAL TRAVERSES WITH STATIONS
GEOPHYSICAL INVESTIGATIONS
AT THE
HUON RIVER DAM SITES, TASMANIA
TOPOGRAPHICAL CONTOURS
AND
ARRANGEMENT OF GEOPHYSICAL TRAVERSES
SCALE IN FEET
0
100
200
300
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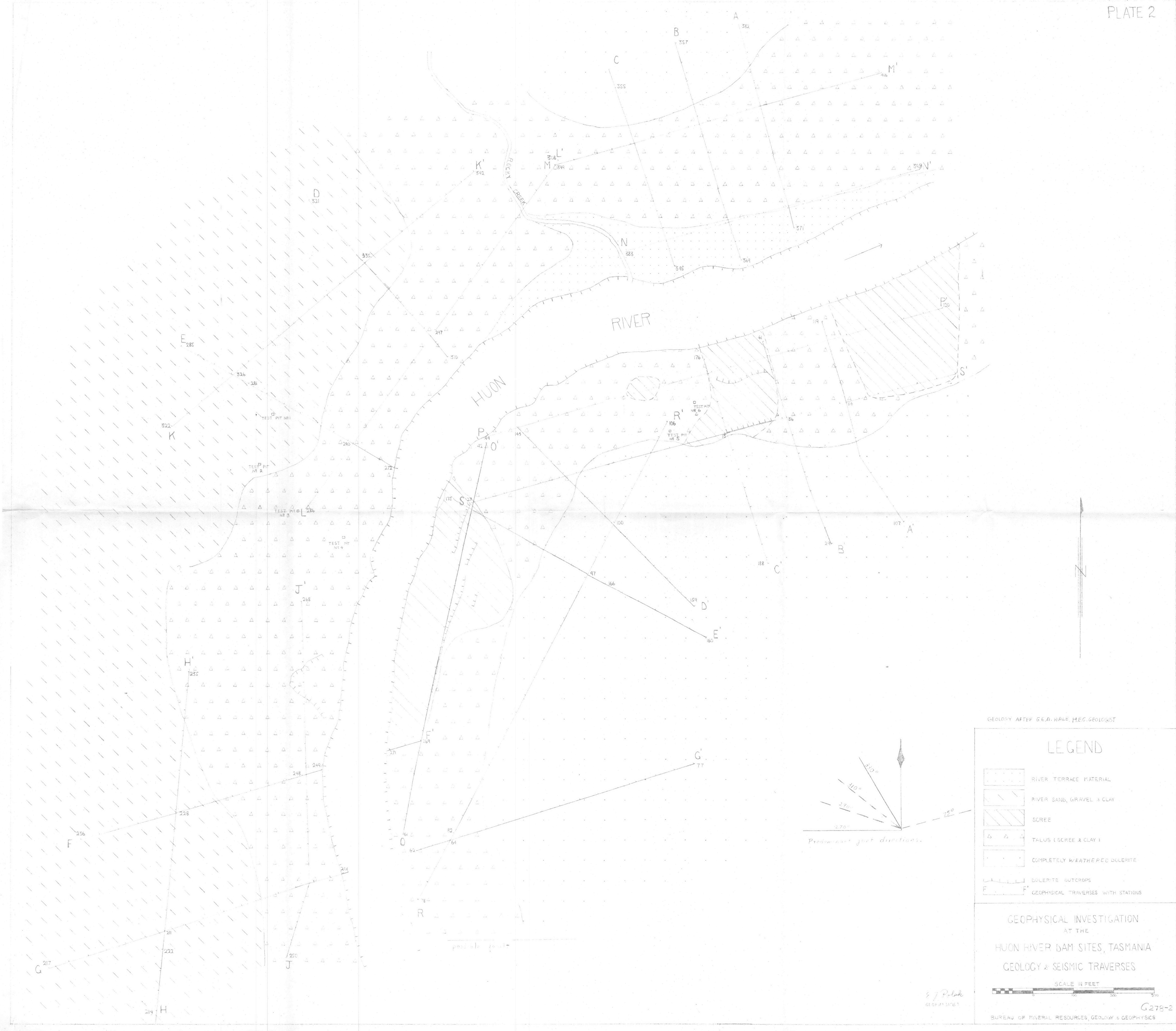
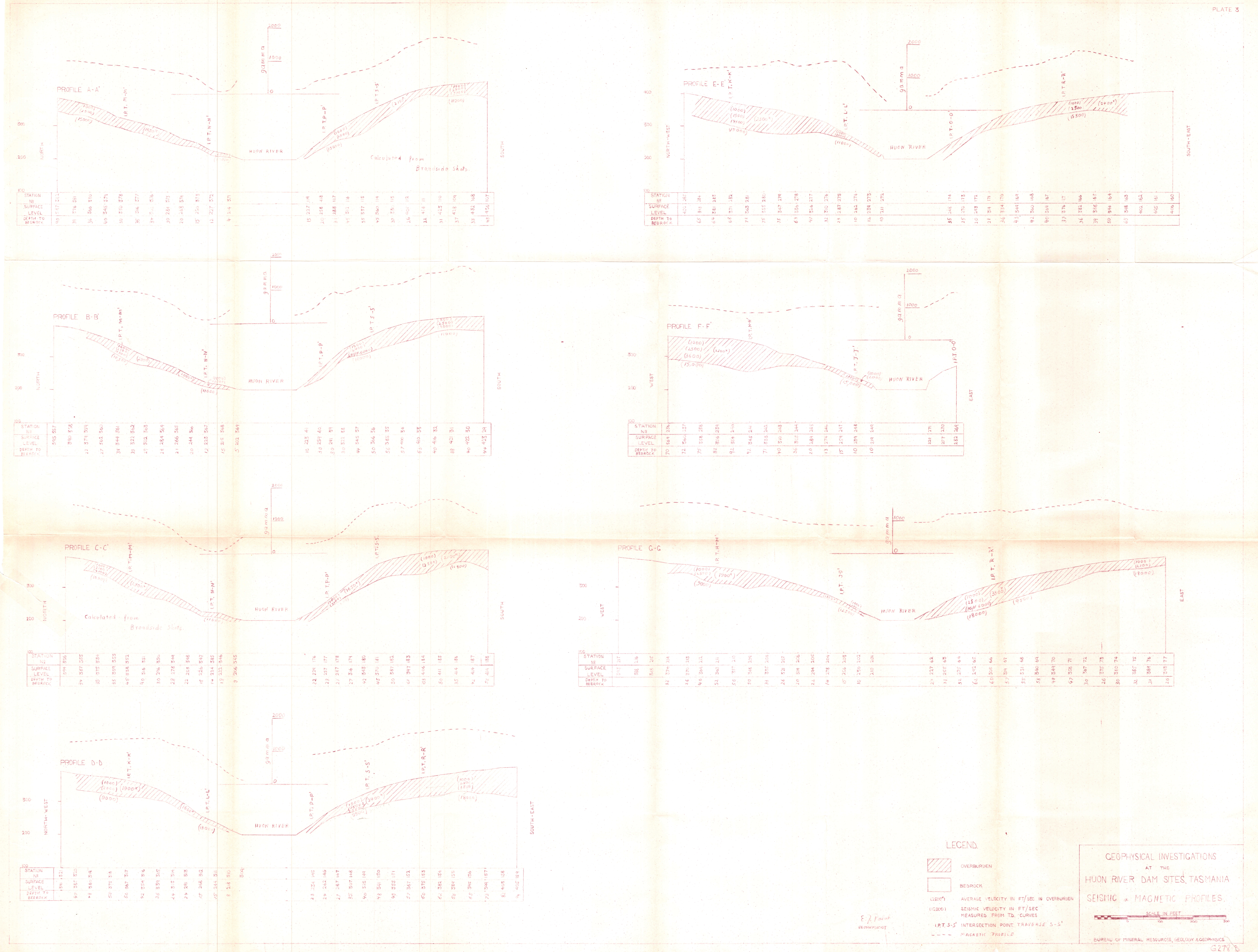
G278-1

PLATE 2



GEOPHYSICAL INVESTIGATION AT THE HUON RIVER DAM SITES, TASMANIA

GEOLOGY & SEISMIC TRAVERSES



GEOPHYSICAL INVESTIGATIONS AT THE HUON RIVER DAM SITES, TASMANIA

SEISMIC & MAGNETIC PROFILES.

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G274-3


PROFILE H-H'
PROFILE M-M'
PROFILE R-R'
PROFILE J-J'
PROFILE N-N'
PROFILE S-S'
PROFILE K-K'
PROFILE O-O'
PROFILE L-L'
PROFILE P-P'
STATION No
SURFACE LEVEL
DEPTH TO BEDROCK
gamma
SOUTH
NORTH
WEST
EAST
SOUTH-WEST
NORTH-EAST
RIVER CREEK
E. J. Polak
GEOPHYSICIST
LEGEND
OVERBURDEN
BEDROCK
(2500*) AVERAGE VELOCITY IN FT/SEC IN OVERBURDEN
(15,000) SEISMIC VELOCITY IN FT/SEC MEASURED FROM T.D. CURVES
I.P.T. S-S' INTERSECTION POINT TRAVERSE S-S'
MAGNETIC PROFILE
GEOPHYSICAL INVESTIGATIONS
AT THE
HUON RIVER DAM SITES, TASMANIA
SEISMIC & MAGNETIC PROFILES.
SCALE IN FEET
0
100
200
300
G 278-4
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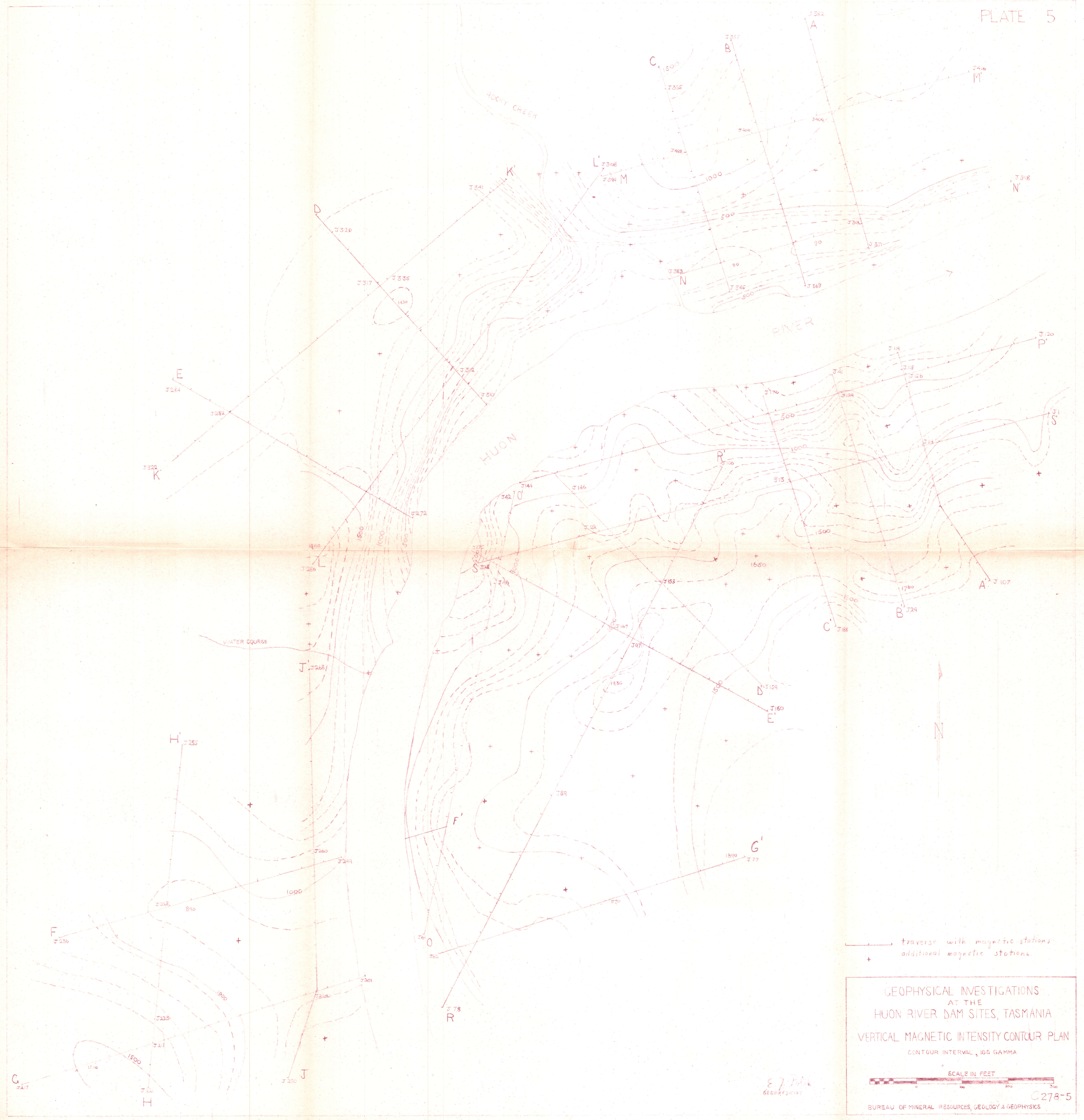
PLATE 5
ROCKY CREEK
HUON
RIVER
WATER COURSE
N
traverse with magnetic stations
additional magnetic stations
GEOPHYSICAL INVESTIGATIONS
AT THE
HUON RIVER DAM SITES, TASMANIA
VERTICAL MAGNETIC INTENSITY CONTOUR PLAN
CONTOUR INTERVAL, 100 GAMMA
SCALE IN FEET
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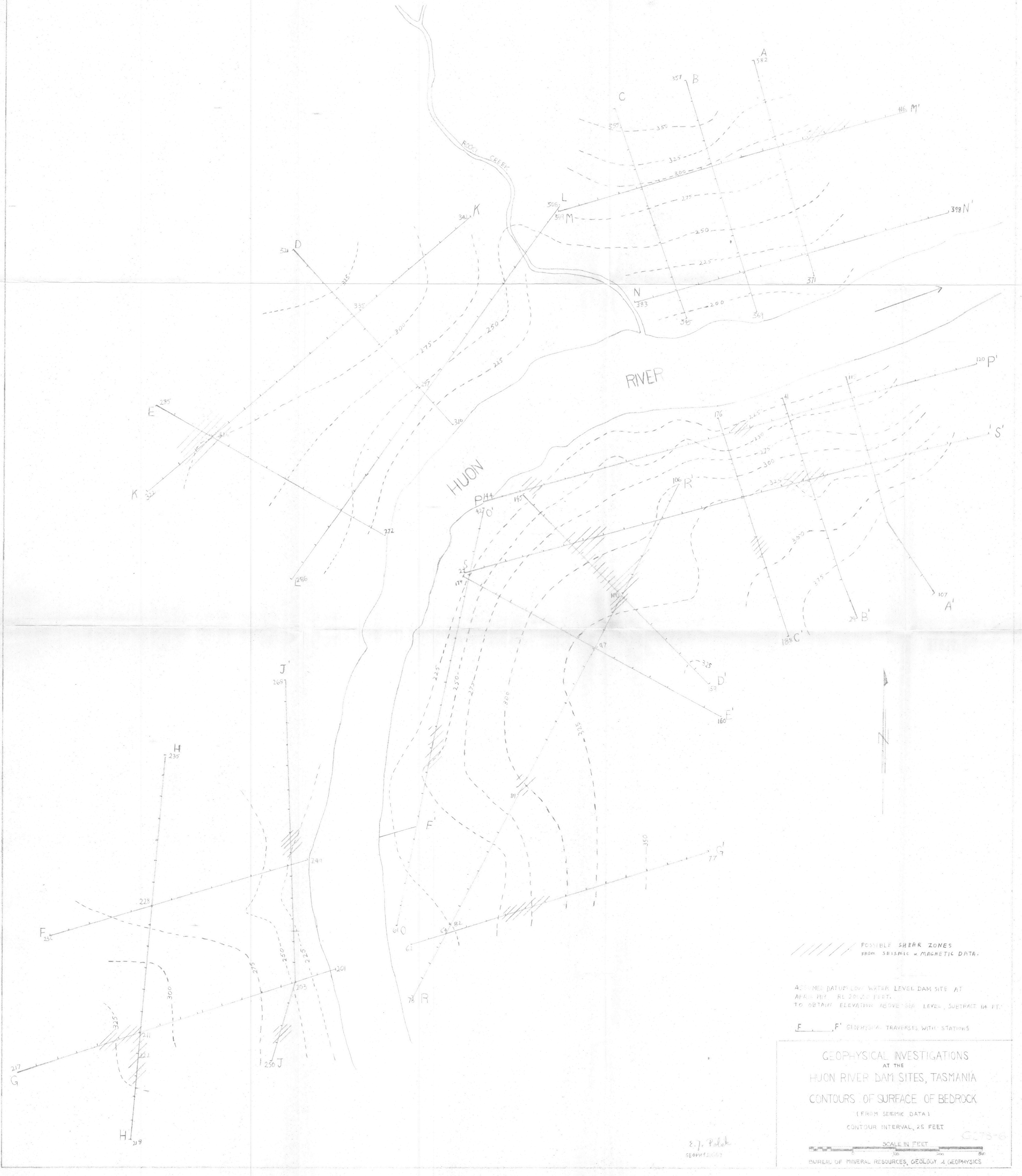

HUON RIVER
ROCKY CREEK
N
POSSIBLE SHEAR ZONES FROM SEISMIC & MAGNETIC DATA.
ASSUMED DATUM LOW WATER LEVEL DAM SITE AT
APRIL RL 200.00 FEET.
TO OBTAIN ELEVATION ABOVE SEA LEVEL, SUBTRACT 114 FT.
F F' GEOPHYSICAL TRAVERSES WITH STATIONS
GEOPHYSICAL INVESTIGATIONS
AT THE
HUON RIVER DAM SITES, TASMANIA
CONTOURS OF SURFACE OF BEDROCK
(FROM SEISMIC DATA)
CONTOUR INTERVAL, 25 FEET
SCALE IN FEET
0 100 200 300
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