COMMONWEALTH OF AUSTRALIA

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1961 No. 66

RED TANK BORE GRAVITY SURVEY, PLENTY RIVER, N.T. 1960

by

A. Douglas

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ABSTRACT

This Record describes a geophysical survey in the Plenty River area to test the efficacy of the gravimetric method in locating buried river channels. The results appear to indicate such a buried feature but the evidence is inconclusive. If subsequent bore-hole evidence confirms the presence of this buried channel the gravimetric method may be more widely used for this type of work.

1. INTRODUCTION

A geophysical survey to test the possibility of using the gravimetric method to locate buried river channels was carried out at Red Tank Bore on the Plenty River, N.T. during November 1960. The work was performed by W.J. Langron and A. Douglas of the Bureau of Mineral Resources in conjunction with the staff of the Resident Geologist's office in Alice Springs. The Resident Geologist is actively engaged in the search for water, and considers such buried channels to be likely reservoirs.

Red Tank Bore lies approximately 115 miles N61°E of Alice Springs (see Plate 1) in the broad flat-bottomed valley of the Plenty River. The bedrock of the area is Precambrian schist and pegmatite which are overlain in the valley by river sand and gravel of unknown and probably variable thickness. The object of the survey was to determine whether the gravimetric method could outline a zone of increased thickness of the river deposits, thus indicating a buried channel.

2. THE GRAVIMETRIC METHOD

Variations in the force of gravity throughout an area, when suitably corrected (for details see Jakosky, 1950), indicate subsurface changes in the distribution of rocks of differing densities. For example, the presence of dense material close to the surface increases the force of gravity; a great thickness of low density material, on the other hand, decreases the force of gravity.

A gravity minimum is to be expected over a buried river channel, as the density of river deposits is considerably less than that of the bedrock. Such a minimum, however, will probably be small; assuming a density difference of 0.6 g/c.c between bedrock and river deposit, the magnitude of the anomaly that could result from a channel 100 feet deep would be only 0.77 milligals. Further, the gravity minimum will, in general, be superimposed on a regional gravity gradient, which results from deep-seated variations in mass distribution. If this gradient is steep it will mask the small effect of a buried channel.

This test survey was carried out to ascertain whether the location of such channels by the gravimetric method is practicable in view of the small gravity variations to be expected.

3. GEOPHYSICAL RESULTS AND INTERPRETATION

One traverse 14,400 feet long crossing the valley was pegged at 200-foot intervals. The pegs were numbered 19N to 53S, the zero peg being close to the southern edge of the dry watercourse of the Plenty River (see Plate 1). The traverse terminated on bedrock at both ends. A 50-ft bore-hole close to the 00 peg intersected bedrock (schist) at a depth of 16 feet.

The geophysical survey was carried out with the Wordon Gravimeter No.260. The 00 peg was used as the base station and base readings were taken at approximately hourly intervals to allow corrections to be made for instrument drift.

The results after correction for elevation and latitude are shown in profile in Plate 2, Fig. 1. The 00 peg has been assigned a value of 10.00 milligals and an elevation of 0 feet*. The elevation correction was carried out for most stations assuming a density of 2.0 g/c.c, as this seems to be an average value for sand, clay, gravel, and alluvium (see Jakosky, 1950) which are probably all constituents of the superficial deposits in this river bed.

For Stations 51S to 53S and 13N to 19N a density of 2.0 g/c.c is considered to be too low, as schist is very close to the surface over these sections. Laboratory measurements show the schist has a specific gravity of 2.7; 2.6 g/c.c has been taken therefore as a likely value for the bulk density.

The main feature shown by the corrected profile (Plate 2, Fig. 1) is the regional gravity gradient, the gravity values decreasing towards the south. However, a local anomaly superimposed on this regional variation is suggested by a change of slope at 19S. An attempt has been made to isolate this anomaly by removing the regional effect.

As any local anomaly is obviously very small it is necessary to estimate the regional gradient as accurately as possible. For this reason the best-fitting parabola has been computed assuming that the anomalous area lies between 4N and 19S and using only the measured gravity values for stations 12N to 4N and 19S to 50S inclusive. Stations 51S to 53S and 13N to 19N have been omitted from these calculations, as schist is near the surface in these areas and there is some uncertainty as to the most suitable density to be used in the reductions.

The assumed regional gradient as shown on Plate 2, Fig. 1 indicates a small local gravity anomaly between 3N and 19S reaching a value of -0.27 milligals in the vicinity of 15S. This anomaly after removal of the regional effect is shown in Plate 2, Fig. 2.

Assuming that this anomaly indicates a buried river channel, it is possible to estimate this channel's size and shape. As only one profile is available for this calculation, it must be assumed that the buried feature extends to infinity at right angles to the traverse and has a uniform cross-section. However, considerable deviations from this ideal case are possible without appreciable effect on the interpretation. In addition it is necessary to have a value for the difference in density between the superficial deposits and the schists; this has been taken as 0.6 g/c.c.

On these assumptions the most probable size and shape of the channel causing the anomaly can be found by assuming a likely depth profile and calculating its gravitational effect. The assumed cross-section is then varied until the computed and measured anomalies agree. This modified profile is the most probable form of the buried feature. A profile constructed in this way is shown in Plate 2, Fig. 3. It shows that the superficial deposits have their maximum thickness of 39 feet in the vicinity of the 15S peg.

* The nearby regional gravity station No. 68-20 (Plate 1) has an elevation of 1402.4 ft above mean sea level. Its Bouguer gravity value, based on a density of 1.9 g/c.c, is -6.9 mgal.

4. CONCLUSIONS AND RECOMMENDATIONS

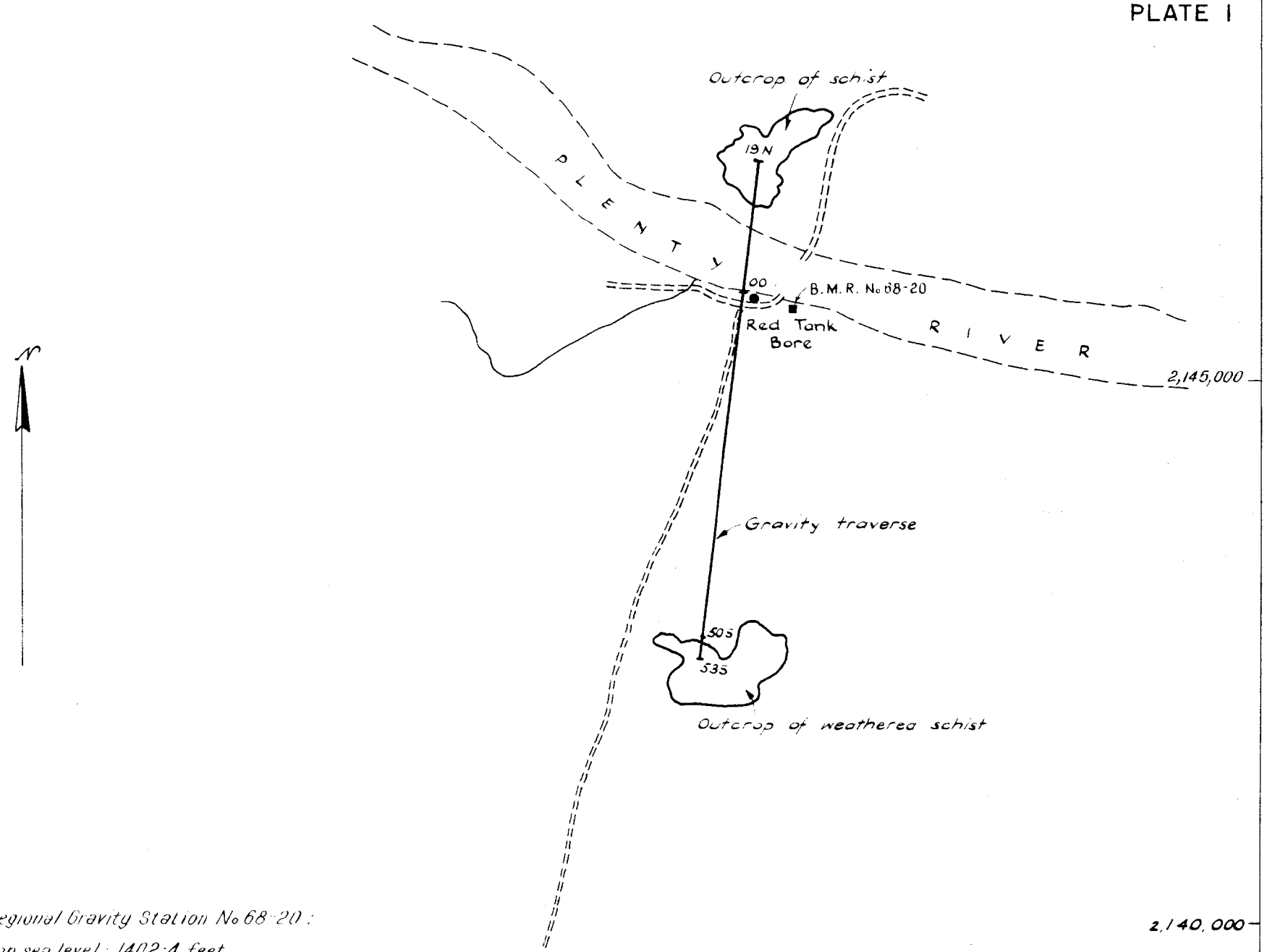
The results suggest that the buried channel is a broad shallow feature, reaching a maximum depth of about 40 feet at 15S. Owing to the shallowness of the channel, the maximum anomaly is not large, and because of this fact, and the strong regional effect, the estimate of depth cannot be as reliable as would be expected if the channel were deeper and more sharply defined. However, the suggested shape and depth are consistent with geological knowledge in the area.

It is recommended that a bore be put down to bedrock at 15S to test the above conclusions. If satisfactory agreement is found, it will be a strong indication of the value of the gravity method for this type of investigation. For the reasons given above, conditions in this area must be considered relatively unfavourable, and much more definite results may be expected in areas where channels are deeper and more sharply defined.

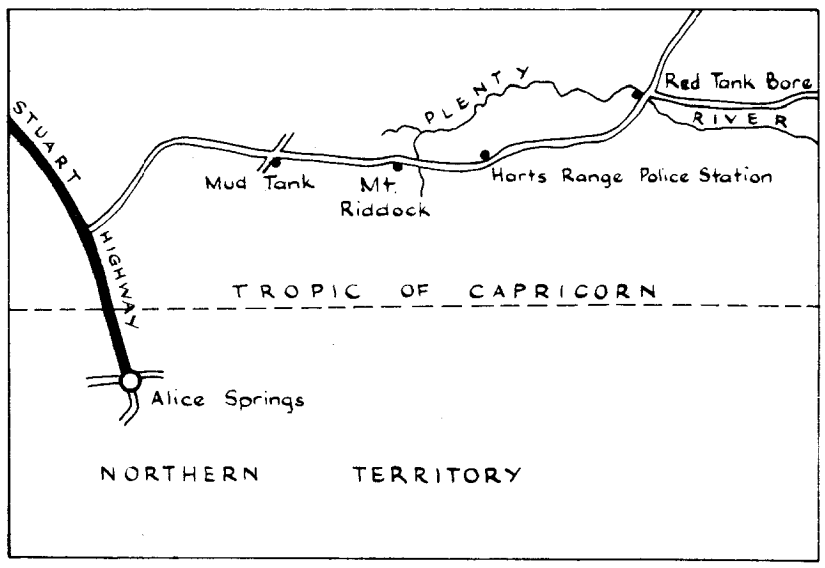
5. REFERENCE

JAKOSKY, J.J. 1950 EXPLORATION GEOPHYSICS. Trija, Los Angeles.

PLATE 1



Details of B.M.R. Regional Gravity Station No 68-20:
Elevation above mean sea level: 1402·4 feet
Bouguer gravity value (1·9 g/c.c.): -6·9 mgal.
(Ref. Huckitta 4-mile gravity map)



LOCALITY MAP

Scale

4000 0 4000 8000 FT.

Geophysicist: A. Douglas

SKETCH MAP SHOWING

LOCATION OF GRAVITY TRAVERSE

IN RELATION TO ARMY GRID

GRAVIMETRIC SURVEY NEAR RED TANK BORE

PLENTY RIVER, N.T. 1960

Bureau of Mineral Resources, Geology and Geophysics
Darwin N.T. January 1961.

330,000 340,000 135°30' 23°00

G305-4

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PLATE 2

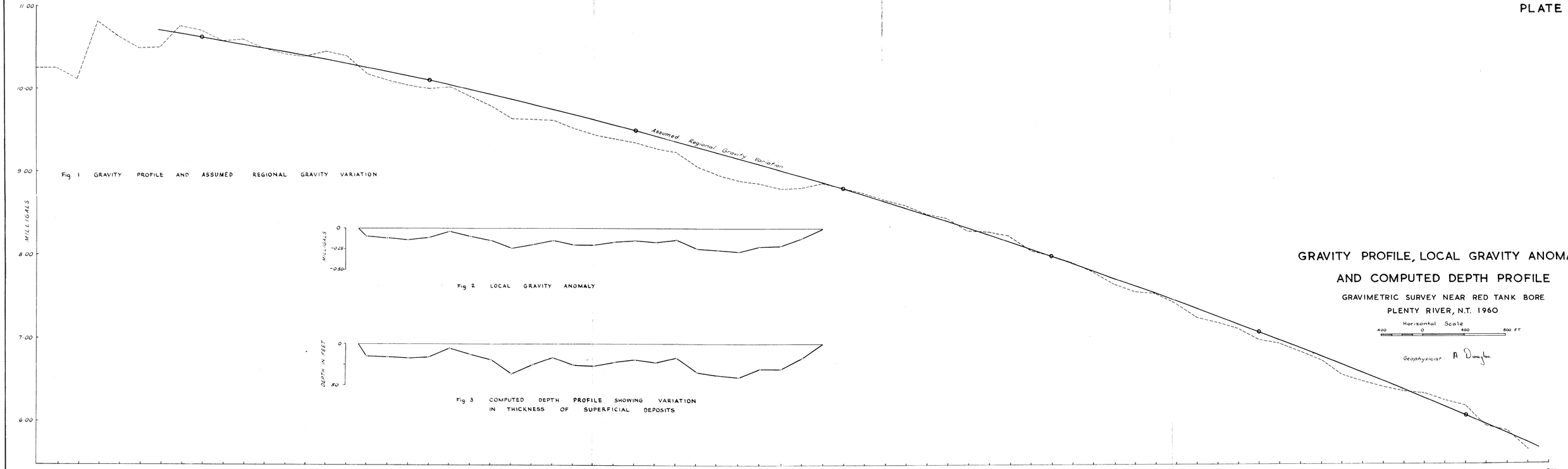

Fig 1 GRAVITY PROFILE AND ASSUMED REGIONAL GRAVITY VARIATION

Fig 2 LOCAL GRAVITY ANOMALY

Fig 3 COMPUTED DEPTH PROFILE SHOWING VARIATION IN THICKNESS OF SUPERFICIAL DEPOSITS

GRAVITY PROFILE, LOCAL GRAVITY ANOMALY AND COMPUTED DEPTH PROFILE

GRAVIMETRIC SURVEY NEAR RED TANK BORE
PLENTY RIVER, N.T. 1960

Horizontal Scale
400 0 400 800 FT.

Geophysicist: A Dwyer

Bureau of Mineral Resources, Geology and Geophysics, Darwin, January 1961.

G305-5

To Accompany Record 1961/No.18