COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1961 No. 33

KOOLPIN CREEK AND EL SHERANA GEOPHYSICAL SURVEYS, SOUTH ALLIGATOR RIVER, N.T. 1960

by

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ABSTRACT

During October 1960 brief geophysical surveys were made in the South Alligator Uranium Field to determine whether or not the self-potential and electromagnetic methods could delineate the major shear zones in the area. It was believed that the uranium mineralisation is sometimes localised at the intersections of the major shears and cross features.

Both methods proved the existence of conducting bodies in the Koolpin Creek area and near the El Sherana open cut, and these are considered to be graphitic rocks associated with the main shears. Cross faulting was also indicated by the geophysical results.

The self-potential method is recommended for future investigations, as the electromagnetic technique is difficult to apply in the rugged terrain.

1. INTRODUCTION

A brief geophysical survey using electromagnetic and self-potential methods was made over selected areas on the leases of United Uranium N.L. during October 1960. The surveys were conducted by the author assisted by two other officers of the Bureau of Mineral Resources, to test the efficacy of these methods as an aid to uranium search in the South Alligator River area. The South Alligator Uranium Field is situated some 170 miles by all-weather road from Darwin (Plate 1) and is the second most important uraniferous locality in the Northern Territory.

United Uranium N.L. is engaged in a vigorous prospecting campaign, and any geophysical method of selecting drilling targets would be a most useful adjunct to the normal geological and radiometric exploration. This applies in particular to those areas where overburden inhibits the detection of mineralisation by radiometric methods.

After discussion with Company geologists, two areas, Koolpin Creek and El Sherana, were selected for testing.

2. THE GEOPHYSICAL PROBLEM AND METHODS

In a recent assessment of the uranium ore-bodies in the South Alligator field, R.S. Matheson (personal communication) recognised several important controls to ore deposition, and of these controls, the following three would possibly display features which may be detected by geophysical methods:

(a) The pitchblende is usually associated with graphitic rocks close to the Upper-Lower Proterozoic unconformity,

(b) the ore-bodies in general lie on major north-west shears, and

(c) these ore-bodies are probably localised by the intersection of the major shears with north to north-easterly cross features.

Many of the shears show graphitic or other carbonaceous bands. Qualitative tests of samples of the graphitic rocks showed their electrical conductivity to be much higher than that of other rocks in the area. Samples from the vicinity of the ore-bodies had very high conductivity, but the graphite in these localities tends to be patchy and therefore probably would not be directly detectable by normal geophysical methods unless these were applied in extreme detail. However, it seemed likely that the shears and possibly also any cross features might be detected by either the electromagnetic or self-potential techniques. Both methods were therefore tested.

The two electrical methods employed are fully described in the standard texts such as Jakosky (1950) and Heiland (1952) and only a brief outline of each need be given here.

(a) Electromagnetic Method (Turam)

A primary electromagnetic field is established in the area to be investigated, by means of a long straight insulated cable earthed at each end and connected in series with an audio-frequency alternating-current generator. If this normal primary field is in a homogeneous medium, its distribution can be calculated.

If sub-surface conductors occur within the limits of the primary field, secondary fields are set up and combine with the primary to give a resultant field at the surface. The Turam technique measures, between two points, the intensity ratio and phase difference of the vertical component of the resultant field. The two detecting elements are coils kept a constant distance apart and moved to successive points along a traverse. The currents induced in the coils are applied to an A.C. bridge which allows the ratio and phase difference to be read directly.

In the absence of secondary fields, the phase difference readings are practically zero, so that the presence of anomalies is indicated directly by the readings; the intensity ratio readings, however, must be corrected for the primary field disturbance in order to detect anomalies. A conducting body is indicated by a positive anomaly in the ratio component and a negative anomaly in phase difference. Such conducting bodies may be sulphide concentrations, graphitic beds, shear zones, etc.

At Koolpin Creek the primary cable was laid along the baseline 00 and earthed at K0 and K40 (Plate 1). A frequency of 440 c/s and coil separation of 100 feet were employed throughout the survey.

(b) Self-potential Method

Many graphitic or sulphide bodies produce self-potentials when undergoing oxidation. Current passing through the conducting body and returning via the surrounding country rock, gives rise to a potential distribution which can be measured at the ground surface. A characteristic negative centre or minimum indicates the upper end of the body. In the present survey, potential measurements were made using a Bureau-pattern S-P. meter and non-polarising electrodes.

3. OPERATIONS

Prior to the arrival of the Bureau party the Company surveyed and pegged a baseline in the Koolpin Creek area. The company also provided field assistants during the geophysical survey, which occupied the week commencing 14th October.

The Koolpin Creek Prospect was selected as the initial testing ground because of its comparatively flat topography and the presence of a small ore-body located on a shear which links the Monolith and Palette Prospects. The grid layout was pegged as shown on Plate 1 and comprised thirteen traverses about 1100 ft long numbered K7 to K20. On completion of this grid with the electromagnetic (Turam) and self-potential methods two short traverses were surveyed in rugged country near the El Sherana open cut.

4. DISCUSSION OF RESULTS

Koolpin Creek Area

Encouraging results were obtained by both electromagnetic and self-potential methods at Koolpin Creek. These results, in the form of Turam phase, Turam ratio, and self-potential contours are shown on Plates 2, 3, and 4. The axes of the anomalies are given on Plate 1.

Detailed geological mapping of the grid area has not been done, but the lithology comprises carbonaceous siltstones of the Koolpin Formation of Lower Proterozoic age. The beds strike roughly north-west and have near-vertical dips.

The Turam ratio and phase contours show a broad zone of high conductivity about 300 ft wide extending from traverse K7 to about K18; the zone is roughly contained within the 1.1-ratio and minus-5-degree contours. A strong anomaly was observed along the north-eastern boundary of this zone between traverses K9 and K17 at about 600 and a lesser one between K7 and K11 at about 900. These anomalies are ascribed to highly conductive graphitic beds in the siltstones and these beds probably delineate the shear. A somewhat uncertain asymmetry in the profiles suggests a steep westerly dip. The Turam survey shows no definite anomaly in the immediate vicinity of the Koolpin Creek ore-body but the main indication is directly in line with the shaft. A cross fault or shear striking approximately north-east is indicated by the sudden drop in conductivity between traverses K16 and K20. If the controls postulated by Matheson are correct, the areas warranting closer investigation are those where disruptions of the main shear occur, for example along traverse K18.

Topographic evidence suggests another cross fault along the Koolpin Creek watercourse but the geophysical work was not extended over this section.

The self-potential results (Plate 4) were in good agreement with the Turam indications. A sharply-defined S-P. anomaly was measured in the same place as the main Turam anomaly, but there was no S-P. anomaly corresponding to the lesser Turam anomaly between K7 and K11 at about 900. Because there is a depression there, it is thought that the water table level may be high enough to inhibit active oxidation and its associated electric currents. The S-P. anomaly follows the line of the Turam anomaly; it commences at the Koolpin Creek shaft and continues strongly to K17 where it terminates abruptly. The anomaly seems to be appearing again on K20 and if this is so, there is little or no lateral displacement due to the cross fault or shear along K18. The contours suggest that the conducting body has a steep south-westerly dip. The slight displacement in the strike at 600 on K13 could be due to a minor fault or flexure in the bedding.

El Sherana and High Road Prospects

Turam work was tested in the vicinity of the El Sherana Prospect but the country proved too steep to allow safe operation of the equipment. Also it was difficult to lay the primary cable and earth the ends. Eventually the method was discontinued and deemed unsuitable for the particular area.

The self-potential tests were successful, however, and the results of the traverses A and B (Plate 5) are sufficient to prove the method effective in defining the graphitic beds in the area.

Traverse A was surveyed across the general strike and south-west from the end of the open cut at El Sherana as shown on the locality map on Plate 5. The profile of measured potentials shows a strong negative anomaly which evidently marks the continuation, beneath the scree cover, of the graphitic beds exposed in the open cut.

The profile appears to be compounded from the effects of three narrow, near-vertical conductors and this is in agreement with geological cross-sections across the open cut.

Traverse B was roughly parallel to the adit at the No. 1 (High Road) Prospect and the self-potential profile and sketch cross-section are shown on Plate 5. Two separate anomalies are apparent in the profile. The northernmost anomaly occurs at the boundary between banded iron formation (B.I.F.) and slate, and was not fully outlined because the topography was too rough for the traverse to be extended farther north. The High Road adit was originally driven to investigate the source of a surface radiometric anomaly. However, the increase in radioactivity within the adit was not high enough to account for the surface anomaly, and it was suspected that the adit was too high and had possibly missed the target. The southern S-P. anomaly at 100N may well define this target beneath the scree slopes. The graphitic bed responsible for the anomaly dips steeply to the south and could readily be investigated by a shallow wagon-drill hole sited to intersect the S-P. axis at a depth of about 75 ft.

5. CONCLUSIONS

At Koolpin Creek the self-potential and electromagnetic results outlined a narrow near-vertical conductor considered to be related to the prominent north-west shear. The abrupt termination of the anomalies in the south-east is probably due to a north-easterly cross fault. Assuming the ore controls recognised by Matheson, the intersection of the major shear and cross shear may define an area which warrants a closer geological search for uranium mineralisation.

At El Sherana both test traverses indicated graphitic slates and thus the probable continuation of the major north-westerly shear that passes through the open cut. It is considered that further traverses could accurately outline the shear where it is concealed by overburden; a detailed survey might also locate cross features of interest in the search for uranium. Further electromagnetic work at El Sherana is not recommended because of the extreme difficulty in laying cables and the hazard to men and equipment on the steep slopes.

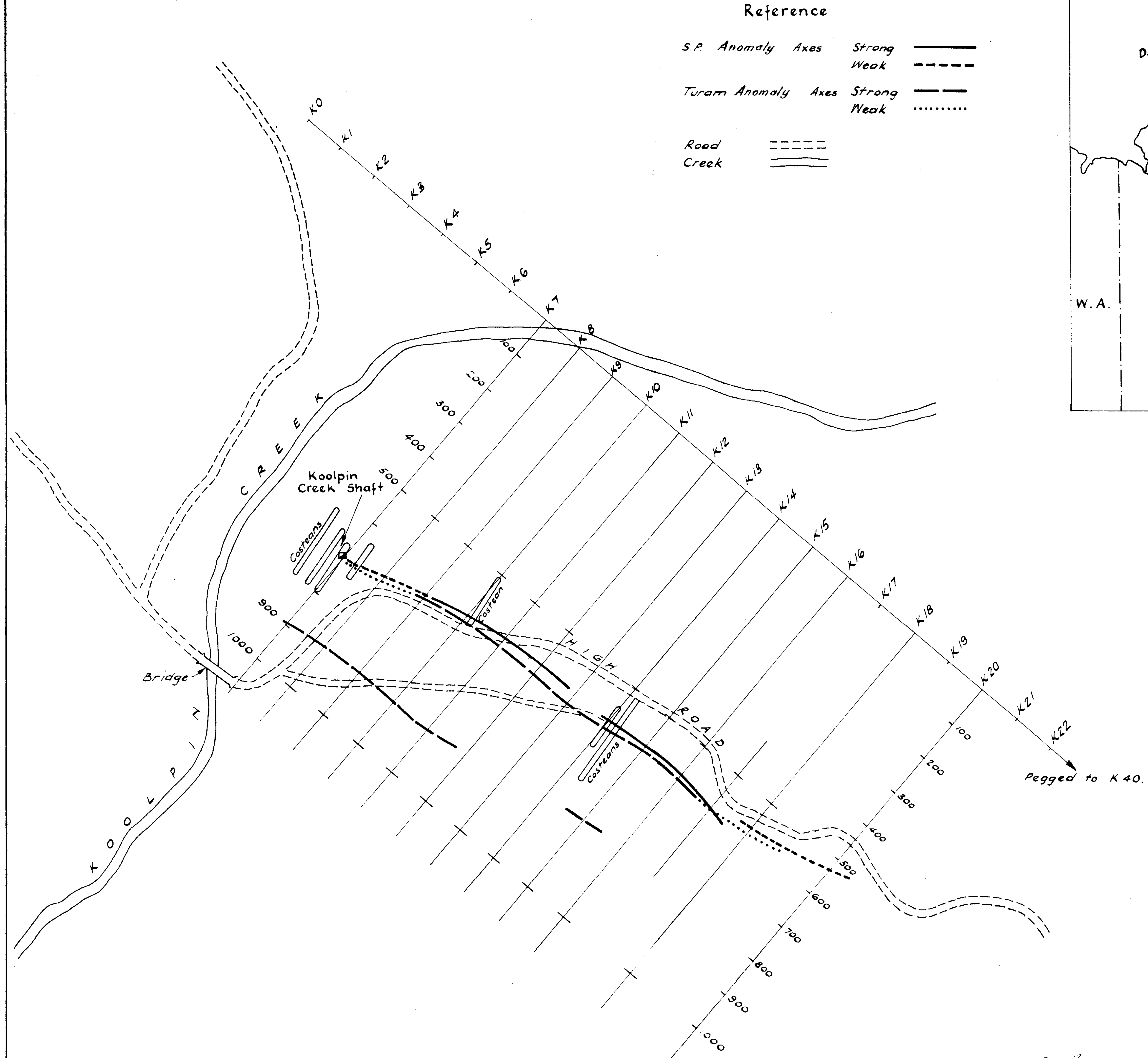
6. ACKNOWLEDGEMENT

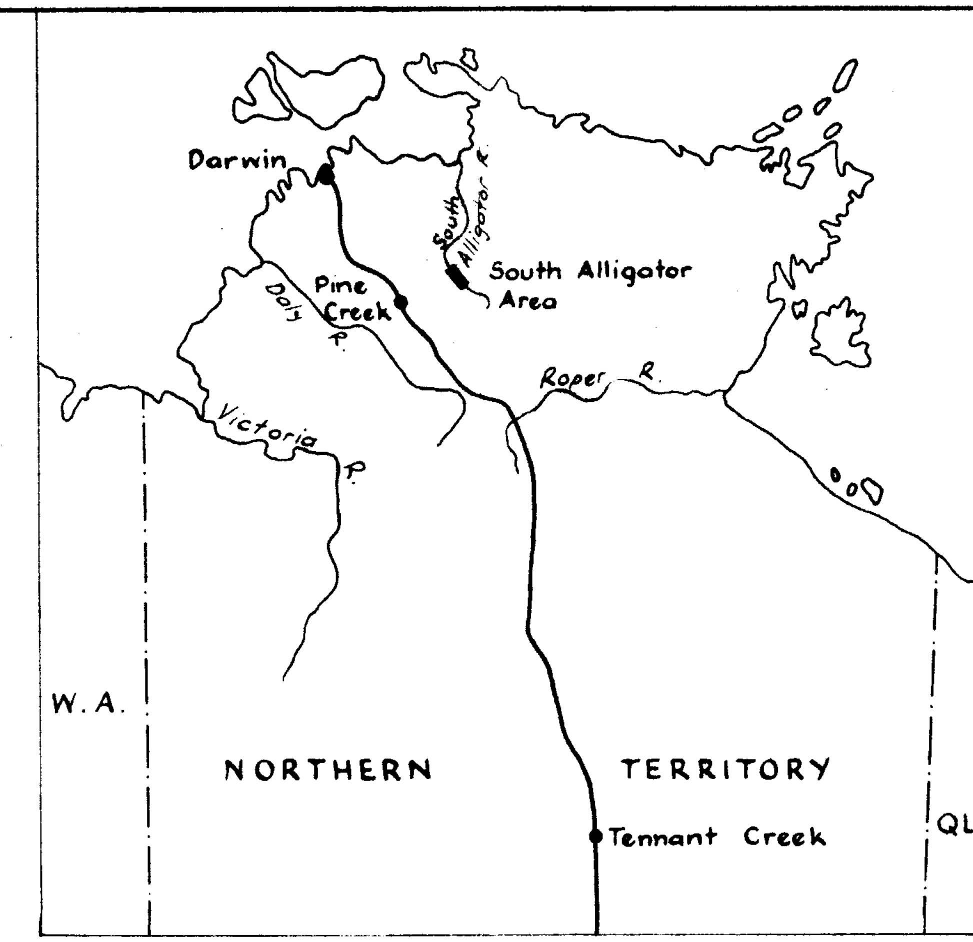
The willing cooperation of the staff of United Uranium N.L. is gratefully acknowledged.

7. REFERENCES

HEILAND, C.A.,	1951	GEOPHYSICAL EXPLORATION. Prentice Hall Inc., New York.
JAKOSKY, J.J.,	1950	EXPLORATION GEOPHYSICS. Times Mirror Press.
MATHESON, R.S.,	-	Personal communication.

PLATE I





LOCALITY MAP

Scale

100 0 100 MILES

LOCALITY AND GRID MAP GEOPHYSICAL INDICATIONS

KOOLPIN CREEK PROSPECT

GEOPHYSICAL TEST SURVEY IN SOUTH ALLIGATOR AREA, N.T.

Scale

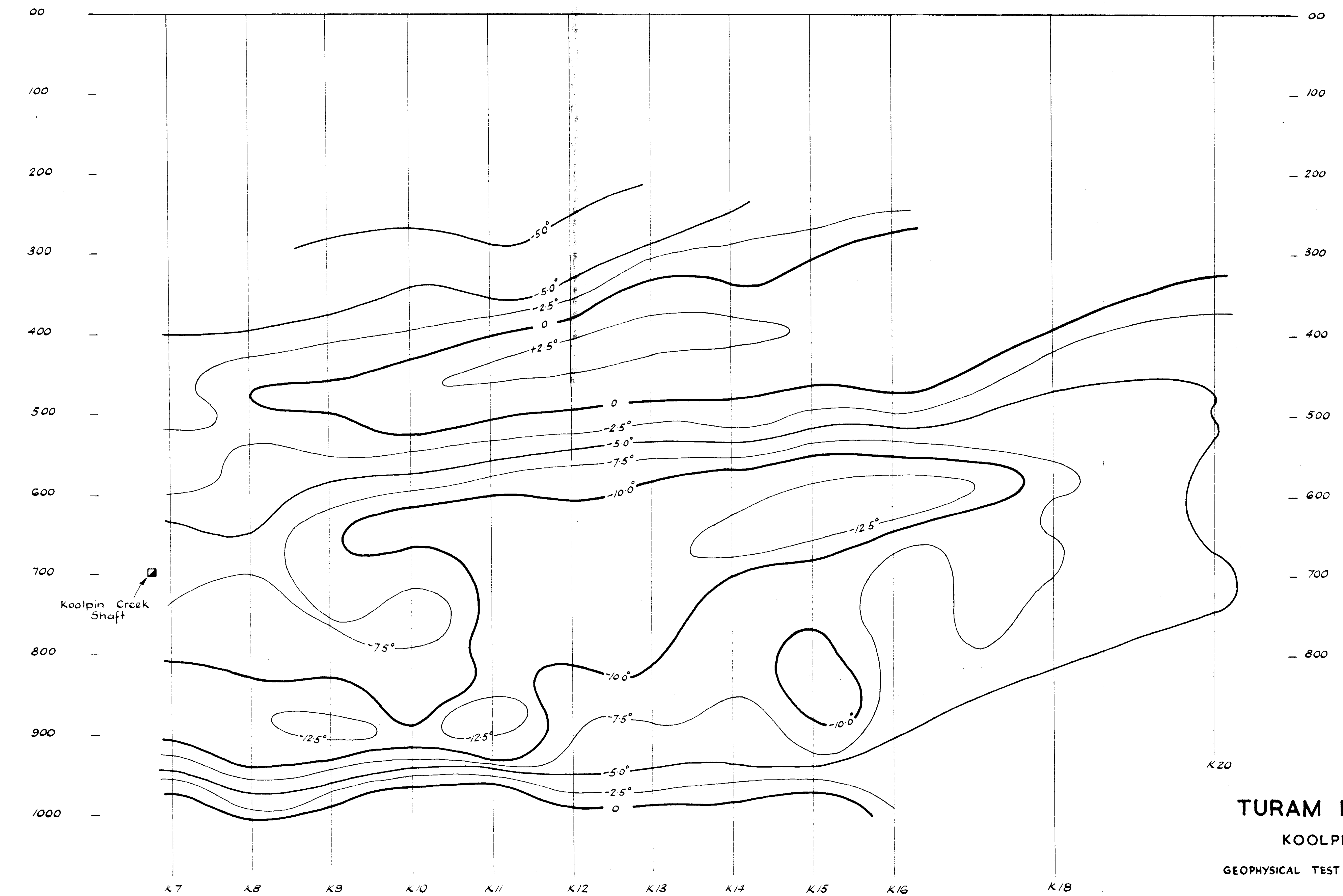
200 0 200 400 FT.

Bureau of Mineral Resources, Geology and Geophysics, G380-1
Darwin November 1960.

Geophysicist: [signature]

To Accompany Records 1961, No. 33

PLATE 2



TURAM PHASE CONTOURS

KOOLPIN CREEK PROSPECT

GEOPHYSICAL TEST SURVEY IN SOUTH ALLIGATOR AREA

CONTOUR INTERVAL 2·5 DEGREES
FREQUENCY 440 C.P.S.
COIL SEPARATION 100 FT.

Scale

100 0 100 200 FT.

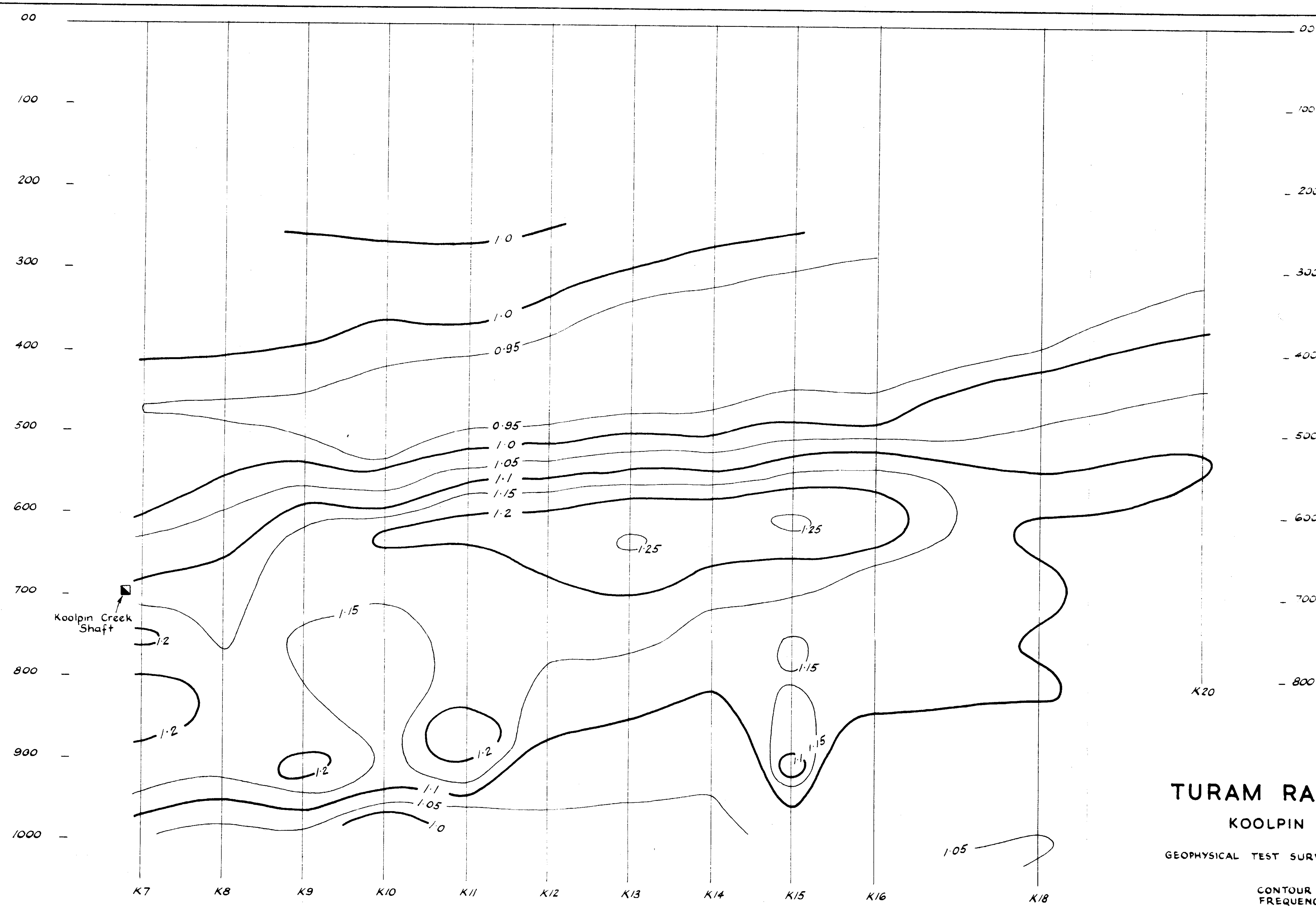
Bureau of Mineral Resources, Geology and Geophysics, Darwin October 1960.

G380-2

Geophysicist: [signature]

To Accompany Records 1961, No 33

PLATE 3



TURAM RATIO CONTOURS

KOOLPIN CREEK PROSPECT

GEOPHYSICAL TEST SURVEY IN SOUTH ALLIGATOR AREA

CONTOUR INTERVAL 0·05 UNITS
FREQUENCY 440 C.P.S.
COIL SEPARATION 100 FT.

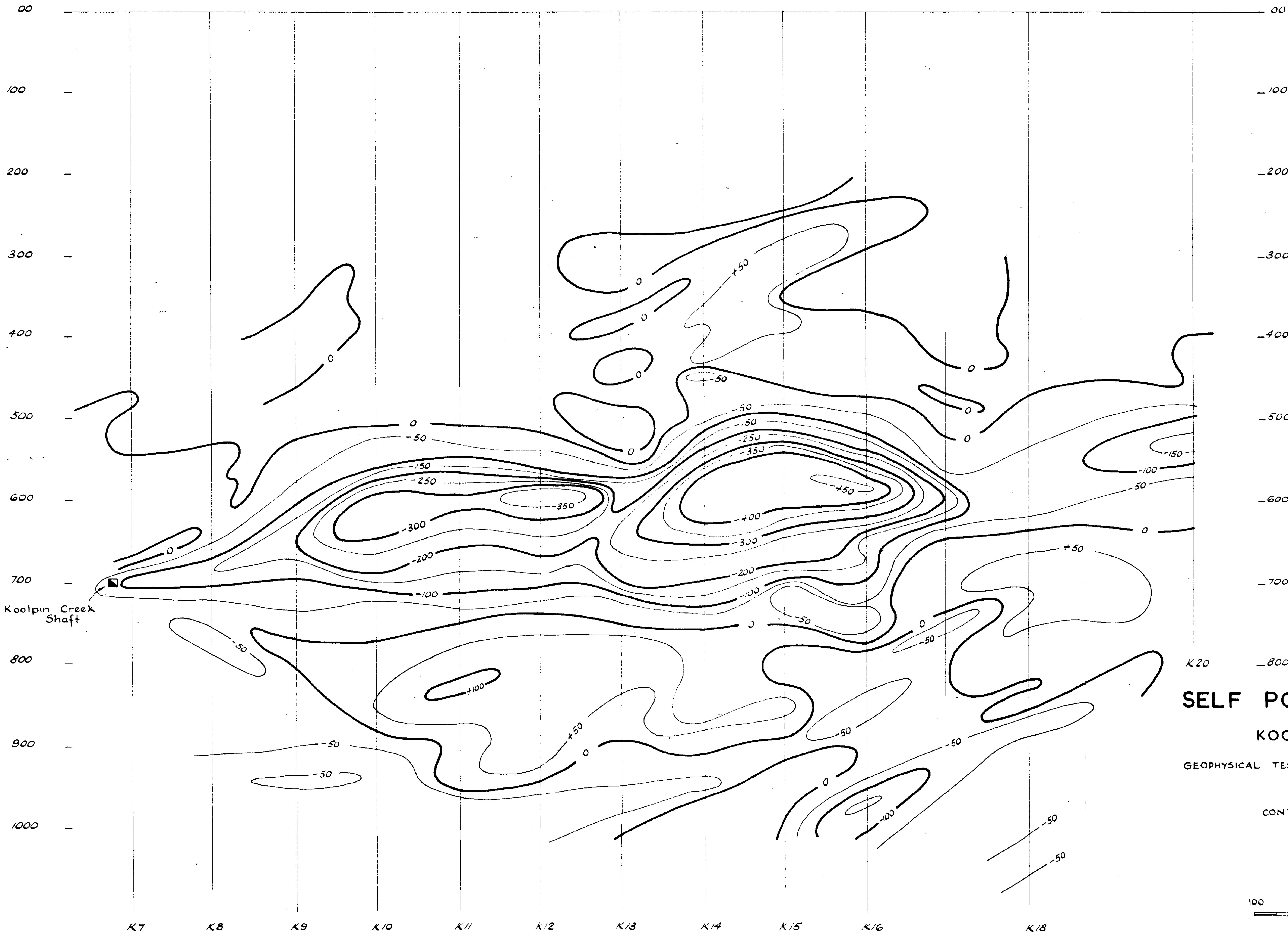
Scale

100 0 100 200 FT

Bureau of Mineral Resources, Geology and Geophysics G330-3
Darwin, October 1960.

Geophysicist: D.L. Rowston

To Accompany Records 1961, No 33



SELF POTENTIAL CONTOURS

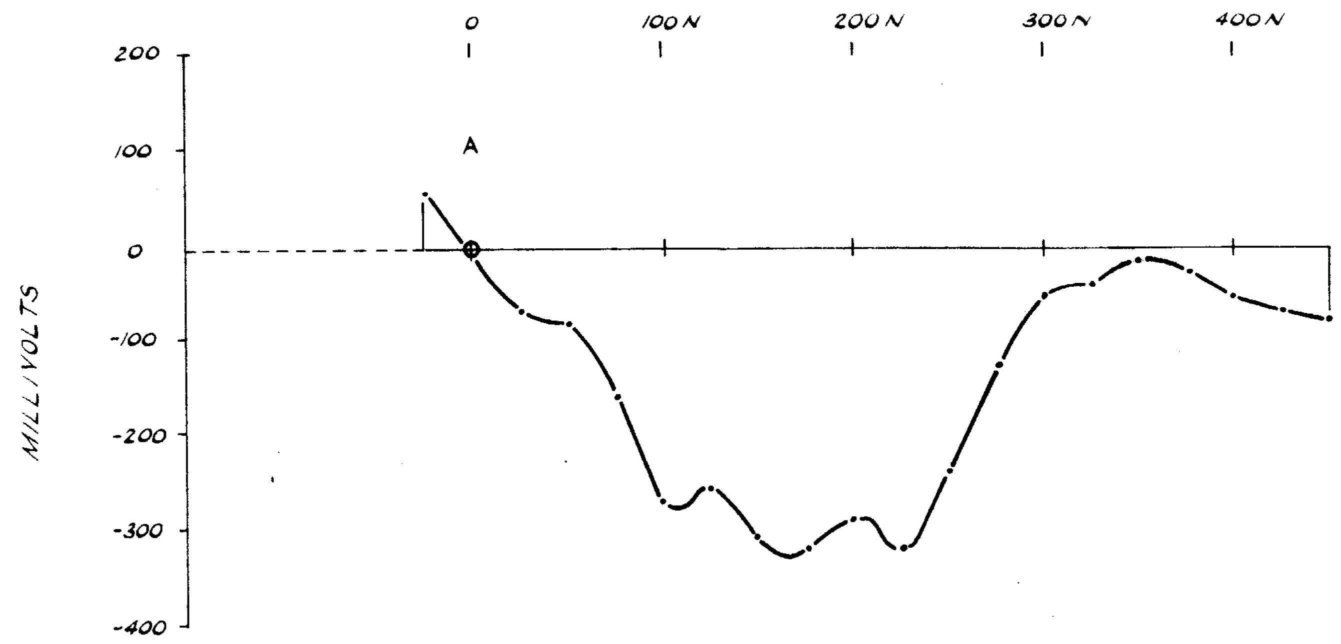
KOOLPIN CREEK PROSPECT

GEOPHYSICAL TEST SURVEY IN SOUTH ALLIGATOR AREA.

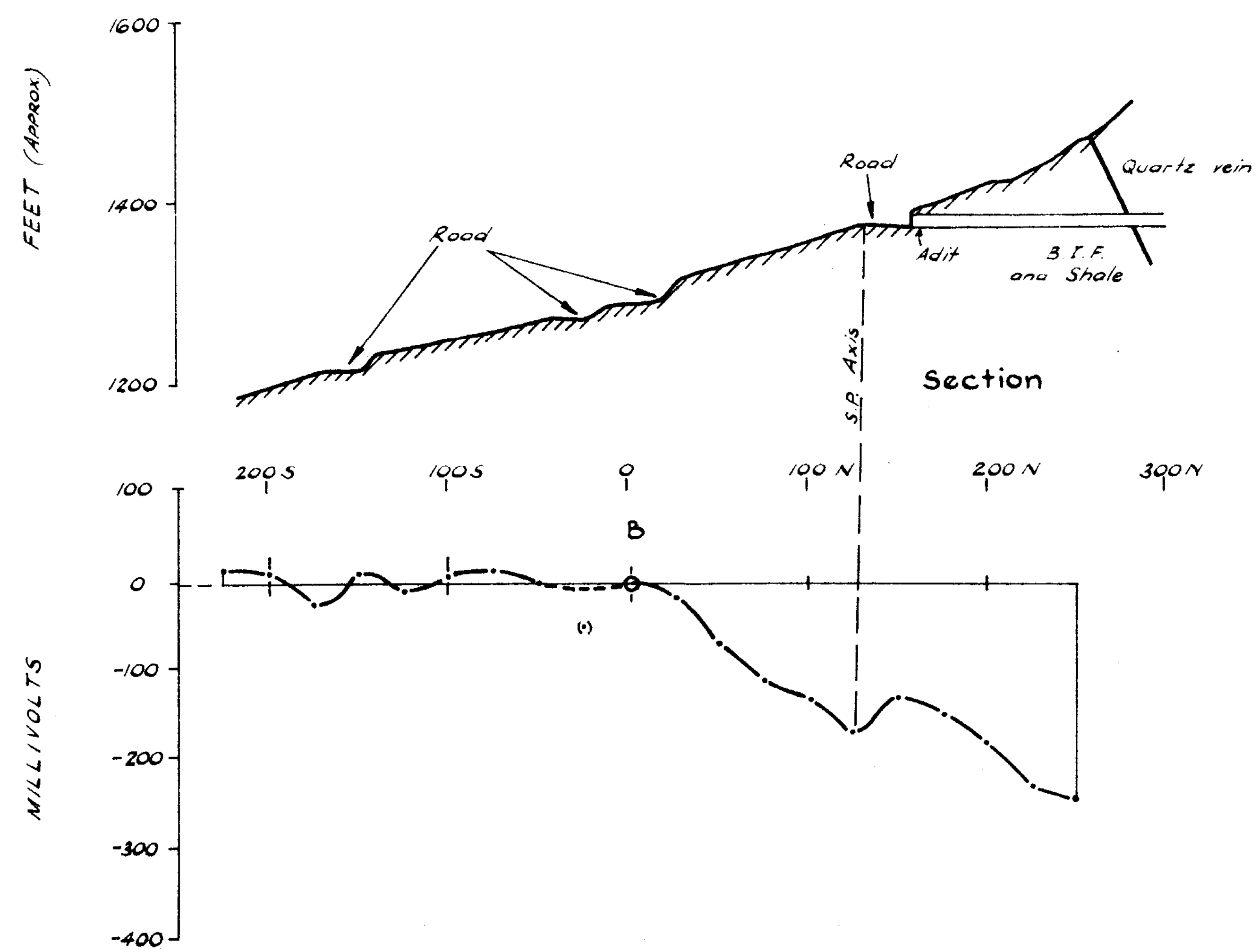
CONTOUR INTERVAL 50 MILLIVOLTS

Bureau of Mineral Resources, Geology and Geophysics, G380-4
Darwin, October 1960.

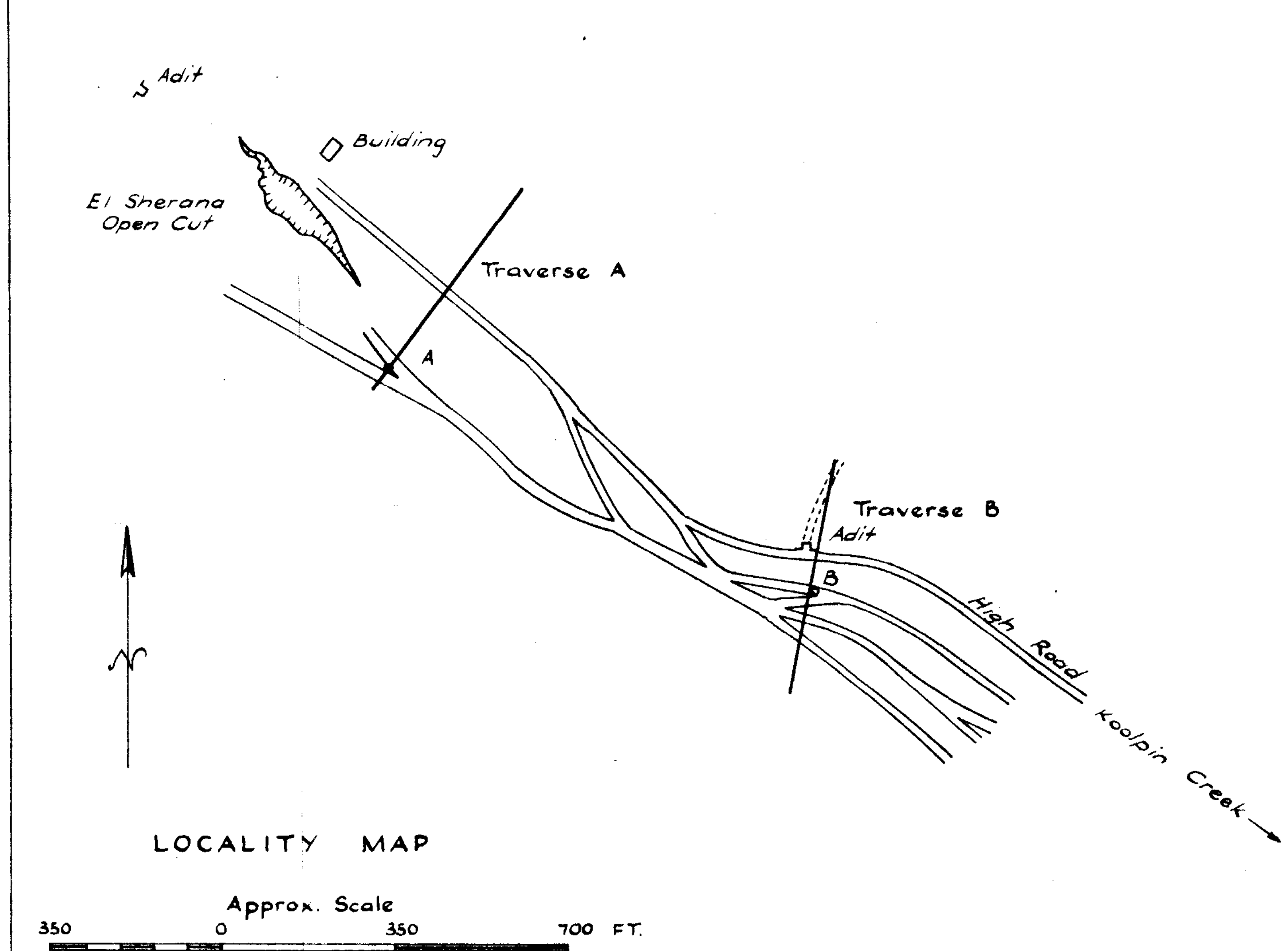
Geophysicist: D.L. Rowston



TRAVERSE A



TRAVERSE B



SELF POTENTIAL PROFILES

EL SHERANA AND NO.1 (HIGH ROAD) PROSPECT

GEOPHYSICAL TEST SURVEY IN SOUTH ALLIGATOR AREA, N.T.

HORIZONTAL SCALE : 1 INCH = 100 FEET

Bureau of Mineral Resources, Geology and Geophysics G 380-5
Darwin, N.T. November 1960.

Geophysicist: D.K. Rowston