COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

# BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS



RECORDS 1960 No. 109

# WATERHOUSE Nos. 2, 3, and 4 URANIUM PROSPECTS, GEOPHYSICAL SURVEYS N.T. 1957



by

J. Daly and K.H. Tate

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CONTENTS



ILLUSTRATIONS

## 1. INTRODUCTION

The Administrative Division of the Hundred of Waterhouse is in the Northern Territory, immediately south of the Hundred of Goyder in which the Rum Jungle Uranium Mines lie.

Airborne radiometric surveys in the Rum Jungle district by the Bureau of Mineral Resources (Wood and McCarthy, 1952), and subsequent ground radiometric investigations, led to the selection of four places in the hundred of Waterhouse (this will be referred to as the Waterhouse area) as being worthy of detailed investigation as possible sources of uranium ore. These areas are known as Waterhouse Nos.1, 2, 3, and 4 Uranium Prospects. The ground investigations included radiometric gridding, geological mapping, geochemical testing, and magnetic surveys. A small amount of exploration based on the investigations did not lead to any production of ore. The location of the prospects is shown on Plate 1. Investigation at Rum Jungle has shown that extensive sulphide mineralisation occurs and that the known uranium deposits are associated with that mineralisation. Although the sulphide mineralisation is largely pyritic, important bodies of lead and copper sulphides occur. As the geological setting of the Waterhouse Uranium Prospects appears very similar to that of the Rum Jungle deposits, it is possible that deposits of sulphide minerals of economic importance may occur also in the Waterhouse area.

The surveys over Prospects Nos.2, 3, and 4 described in the present report, were made by the Bureau in 1957 as part of an intensified programme of uranium search in the Rum Jungle - Waterhouse area. The surveys were designed to test for indications of the presence of sulphide deposits. A similar survey over No.1 Prospect has been described in a separate report (Daly and Tate, 1958).

## 2. SURVEY AT WATERHOUSE No.2 URANIUM PROSPECT

### 2.1 Description of Prospect.

The Waterhouse No.2 Prospect is about 70 miles south of Darwin, and about 6 miles south of the township of Batchelor and 10 miles south of Rum Jungle.

The geology of the Waterhouse area has been described in broad outline by Joklik (1953) and in more detail by Malone (1958). Detailed examination by the Bureau in 1952 consisting of radiometric gridding, detailed geological mapping, geochemical testing, some magnetic surveys, and three bulldozed costeans on the No.2 Prospect, has been described by Wyatt and Alle (1953).

Subsequent to that examination, the area was held under lease by United Uranium N.L.; that company sank a shaft to 41 ft, drilled one diamond drill hole to 280 ft, and bulldozed ten costeans. Plate 1 shows the position of the prospect, the results of Wyatt and Alle's geological mapping, the geophysical grid, and the various exploratory works.

Later work by the Bureau of Mineral Resources included a low-level radiometric survey using a light aircraft (Livingstone, 1959) and a carborne radiometric survey. The results of this survey are shown on Plate 4.

The salient features of the investigations up to 1955 are the following :-

(a) The rocks are sedimentary (slate, shale, and quartzite) and considered to belong to the Golden Dyke formation of the Brocks Creek Group. The geological setting is very similar to that of White's deposit at Rum Jungle.

(b) The strike of the rocks is approximately northerly, and the dip is to the east at angles ranging from 30 to 65 degrees.

(c) The radiometric anomalies included a large area giving intensities of twice background and upwards, within which were a very few small areas with intensities up to twelve times background. The positions of the small areas are shown on Plate 1. The area of strongest radioactivity was at the shaft. Three of the small areas were tested by costeans excavated by the Bureau, but no strongly radioactive material was discovered. No radioactive mineral has been identified.

(d) The geochemical survey partly outlined two areas (Plate 1) in which the rocks contain medium to very high copper content. Malachite staining is visible near the shaft.

(e) Complete records of the results of the exploration carried out by United Uranium N.L. are not available. From records in the Mines Branch of the Northern Territory Administration, it appears that the shaft was 41 ft deep, and that between 29 and 38 ft it passed through a graphitic slate lode formation which dipped to the east at about 45 degrees. The formation was radioactive, the highest readings being obtained from 34 to 38 ft. Assays of samples are not available, but from recorded readings it appeared that the formation carried uranium in concentrations approaching ore grade.

The approximate position of the collar of the drill hole is shown as DH (1954) on Plate 1. Information as to its azimuth and depression is not available, but it is considered that it was drilled on a bearing of about 270 degrees, and passed underneath the shaft. It is recorded that the drill intersected slate carrying sulphide mineralisation between 150 ft and 225 ft, and breccia between 226 ft and 280 ft, where it was stopped. The hole was logged radiometrically, but showed no radioactivity. No records of core assays are available, and it is not known if any were made. A heap of abandoned drill cores was found and probably indicates the collar of the hole. Some specimens of weakly mineralised core were collected at random, and examined in the Bureau's geological laboratory. The report on this examination is attached as an appendix to the present report. The mineralisation was mainly pyritic, with copper, lead, zinc, and nickel in trace amounts.

The costeans dug by the company apparently showed nothing of interest. However, from the results of the 1957 geophysical survey it seems likely that most of the costeans were dug to the west of the mineralised area.

(f) The magnetic survey made by Wyatt and Alle (1953) covered only a small area, and was merely sufficient to show that there are strong anomalies somewhat west of the radioactive area. The later aeromagnetic survey showed that these are portions of an extensive anomaly which extends in a south-westerly direction from No.1 Prospect to No.2 Prospect; this trend is generally parallel to the regional strike. The geological significance of this anomaly is not clear, but its presence is a further point of similarity between the geological setting of the Waterhouse prospects and that of the Rum Jungle deposits. This matter has been briefly discussed by Daly (1957).

## 2.2 Technical details

The electromagnetic method was the main one used on the 1957 survey. This method requires the application of a primary electromagnetic field to the ground, and measurement of the field at points on the ground surface. If the conductivity is uniform throughout the area the distribution of the field at the surface may be calculated. However, if formations of higher conductivity than the surrounding rocks are present, secondary currents are induced in them; the effects of these are observed at the surface as anomalies in the electromagnetic field.

The method was used in two forms -

(1) The "Slingram" method, in which the primary field is a 500 c/s field produced by a horizontal transmitting coil, driven by a small oscillator. The field is detected by another horizontal coil kept at a fixed distance from the transmitting coil. The two coils are moved systematically along the traverse.

(2) The "Turam" method, which uses a field of 440 or 880 c/s produced by a motor generator, and coupled to the ground, either inductively by means of a large loop, or directly by means of a long cable grounded at each end. The detecting element consists of two horizontal coils kept at a fixed separation. The quantities measured are the intensity ratio and phase difference of the currents induced in the two coils.

In both methods, measurements of vertical component only were made.

The Slingram method was used for reconnaissance purposes on Traverse 100S. As the results showed that a very strong anomaly was present, the grid shown on Plate 1 was laid out for Turam work. The primary field was applied by a rectangular loop, of which the eastern side was laid out along the base line; the other sides, with west, south and east bearings, were laid out with aid of a Landrover and odograph. Four other traverses shown on Plate 1 as 500N "A", 650N "A", 800N "A" and 1000N "A" were read with the Slingram equipment, to check the course of the anomaly at the northern end of the area.

Traverses 100S and 800N were extended, each to a length of about 3 miles, and were surveyed by Slingram, magnetic, and gravity methods.

Some tests were also made using the self-potential method.

An area surrounding the No.2 Prospect was mapped radiometrically, using a vehicle-borne ratemeter and odograph.

## 2.3 Results and interpretation

The results of the electromagnetic survey are shown on Plates 2 and 3.

The Turam survey disclosed two main anomalies arising from narrow bodies of high conductivity. The main anomaly (Anomaly A) is a very intense one centred approximately at the shaft. The central part of the anomaly has a general southerly strike. However, it bends to the east at both the north and south ends, and is offset to the east, south of about 350S, by what is probably a minor fault. Owing to its easterly trend at each end, and to the effect of the fault, the costeans were generally not suitably placed to test the formation causing the anomaly. If the drill hole followed the course suggested earlier, it was well placed to test the anomaly, and the presence of sulphide mineralisation in the core is a reasonable proof that the anomaly arises from a sulphide body. However, as there is no record that the core was assayed, or even properly logged, there is no information as to the economic value of the body.

Owing to the easterly trend of the anomaly at its northern end, the original Turam layout is not well placed for tracing the anomaly farther to the north. As a preliminary test of the anomaly in this area, Slingram profiles were read over the traverses shown on Plate 1 as 500N "A", 650N "A", 800N "A", and 1000N "A". These profiles showed that the anomaly decreases rapidly in intensity to the north. It was therefore decided that a second Turam layout to follow the northern extension of the anomaly was not warranted.

The other anomaly (Anomaly B) is a less intense one, which extends from 100S to 650N and is centred at about 350E. There is no direct information as to the cause of this anomaly. The body causing it does not appear to have the same variations in strike as the body causing Anomaly A, but there is a possible minor cross fault at about 150N. However, although this anomaly is weaker than the main one, it still represents a body of moderately high conductivity, and is worthy of testing.

Although electromagnetic anomalies of comparable intensity in other parts of the Rum Jungle area are usually associated with strong self-potential anomalies, self-potential tests made over the present area showed no anomalies.

This is attributed to the fact that the prospect occurs on low-lying swampy ground. Wyatt and Alle (1953) record that water level was encountered in costeans at a depth of 6 ft. Under such circumstances, the sulphide zone would extend almost to the surface and there would be little or no active oxidation in progress. The results of the detailed radiometric and geochemical surveys are shown on Plate 1, and of the carborne reconnaissance radiometric survey on Plate 4. The positions of the main radiometric and geochemical anomalies are sufficiently close to that of the main electromagnetic Anomaly A to suggest that all three anomalies are connected with the same body. The reconnaissance radiometric survey showed that the strongest radioactivity over a considerable area occurs at the No.2 Prospect, and the trend of the radiometric contours is very similar to that of the electromagnetic anomaly, which strengthens the possibility that both anomalies are connected with the same source.

The results of the Slingram and magnetic profiles along traverses 100S and 800N are shown on Plate 5. The Slingram profiles show considerable variation and are considerably disturbed in particular portions. The disturbed portions occur roughly in the same position on each traverse, and could represent a feature with a northerly strike; such a feature could arise from a geological formation with a general northerly strike.

The magnetic profiles are disturbed and show sharp anomalies due to magnetic material at shallow depth. Such anomalies are almost invariably encountered in areas covered with laterite. In addition, an anomaly due to a deep-seated magnetic body is present, centred at 0 on each traverse. This is probably part of the large magnetic anomaly disclosed by the airborne survey.

The gravity profiles along traverses 100S and 800N are shown on Plate 6. The profiles are plotted to an arbitrary datum, but readings were tied into the pendulum station at Darwin. On this basis, the observed value of the gravity at 100S/0 is 978,312.35 milligal, and using a surface density of 2.8 the Bouguer anomaly at this point is calculated as + 14.55 milligal.

The two gravity profiles are closely similar in general character, although there are some differences in detail. Each profile shows a number of minor fluctuations superimposed on a strong general gradient. The Darwin-Katherine area generally has been covered by a reconnaissance gravity survey (Stott and Langron, 1959). This reconnaissance survey revealed that the area contains strong gravity anomalies, whose cause is to some extent a matter of speculation because geological mapping is not possible, owing to lack of outcrop in sufficient detail.

However, the width of the gravity anomalies is so large that some at least must be attributed to very deep-seated causes.

Comparison of the Waterhouse gravity profiles with the contour map prepared by Stott and Langron suggests that the station spacing of the reconnaissance survey (generally two miles) may be too great to give anything like a complete picture of the actual gravity distribution in some parts of the area.

Stott and Langron give values for the density of various types of rock, and these show that there is a considerable range of densities among the country rocks. For example, limestones of the Golden Dyke formation generally have densities of 3.0 or higher, as against the density of about 2.65 for the various granites. It is considered that the minor irregularities along the profiles may be attributed to variations in density such as those for the rocks quoted above.

## 2.4 Note on results of previous testing

As mentioned previously, it is considered that the testing performed by United Uranium N.L. is of little value as a test of the sulphide body, beyond establishing with reasonable certainty that such a body is present. It is desirable, however, to draw attention to the favourable character of the indications of the presence of uranium.

It is commonly found in the Katherine-Darwin region that surface evidence of radioactivity is not a reliable indication of the presence or position of uranium mineralisation at depth. This arises from two causes -

(1) the extensive lateritisation. Areas of high radioactivity exist over the laterites, but these have no apparent connection with any radioactivity in the rock underlying the laterite.

(2) the near-surface rocks are extensively leached. Even when radioactive minerals are visible at the surface, there may be immediately below it an impoverished zone extending to depths as great as 50 ft. For this reason, it is generally agreed that costeans are not a suitable means of prospecting in this area. The most suitable means of testing is systematic wagon drilling or percussion drilling, which should extend to depths of about 70 ft at least. For such drilling to be economically justifiable, some better indication is needed than a surface showing of radioactive minerals; the most attractive indication is a recognisable geological formation at some depth, carrying radioactive minerals. It is considered that the radioactive formation encountered in the United Uranium shaft is just such an indication. This shaft intersected a radioactive band between 29 and 38 ft, which appeared to dip with the country, and which carried uranium in concentrations possibly approaching ore grade. This appears to be a prospect which is worthy of detailed investigation. It is understood that the company ceased operations on the prospect owing to a change in its organisation, which led it to transfer its activities to the South Alligator region.

## 2.5 Recommendations

(a) The radioactive prospect should be tested by a pattern of wagon or percussion drilling to a depth of about 70 ft, commencing down dip (easterly) from the shaft.

(b) The electromagnetic indications should be tested by diamond drilling. In the first instance, five drill holes are recommended. Drill holes Nos. 1, 2, 3, and 5 (Plate 1) are designed to test Anomaly A which, on the result of the previous drill hole, can be confidently attributed to a sulphide body. Drill hole No.4 is designed to test the possibility that the Anomaly B is due to sulphide mineralisation. If a favourable intersection is obtained in No.4 hole, further drill holes on this anomaly would be required. Specifications of the drill holes are as follows :-

| Drill Hole | Collar | Bearing | Depression | Length |
|---|---|---|---|---|
| 1 | 200S/850E | 270° | 55° | 250 ft |
| 2 | 400S/900E | 270° | 55° | 250 ft |
| 3 | 0/875E | 300° | 55° | 250 ft |
| 4 | 200N/600E | 270° | 55° | 250 ft |
| 5 | 600S/900E | 270° | 55° | 250 ft |

## 3. SURVEYS AT WATERHOUSE URANIUM PROSPECTS Nos. 3 and 4

The positions of the prospects are shown on Plate 1. Previous geophysical work on the No.3 Prospect has been described by Alle (1953), and a brief description of the geology is given by Matheson (1953). During the course of the present investigations the geology was mapped in detail by O.N. Warin, of the Darwin Office of the Bureau. The results of this mapping are shown on Plate 7. Alle's work consisted of radiometric gridding and magnetic readings. The radiometric gridding showed several extensive areas of anomalous radioactivity which did not, however, exceed four times background at any point. Large magnetic anomalies occur close to the prospect, and are parts of the major anomaly detected by aeromagnetic survey.

Previous work on the No.4 Prospect is described by Rosenhain (1953). As the area is almost completely covered by soil and laterite, very little geological information could be obtained. Radiometric testing showed only small areas of slightly anomalous radioactivity. No testing has been done on either prospect.

At No.3 Prospect, Slingram profiles were observed over four traverses, whose positions are shown on Plate 7. At No.4 Prospect, the survey was confined to two traverses, shown on Plate 8.

No anomalies were observed at either prospect. As the Slingram equipment is less sensitive than the Turam, the fact that no anomalies were obtained by the Slingram tests does not rule out the possibility that a Turam survey might disclose some indications. However, it is certain that, if any indications were detectable, they would be very much weaker than the indications observed at the No.2 Prospect. Because of this, and of the fact that neither radiometric gridding nor geological examination has given encouraging indications, no detailed surveys were undertaken.

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WOOD, F.W., and McCARTHY, E., 1952 - Preliminary report on scintillometer airborne surveys over the Rum Jungle area and other portions of the Northern Territory. Bur. Min. Resour. Aust. Records 1952/79.

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## APPENDIX

### (a) ASSAY OF DRILL-CORE
Lab. No. 58/425

A drill-core from the Waterhouse No.2 Prospect, N.T. submitted by the Geophysical Section has been assayed by J.R. Beevers of the Chemical Lab., B.M.R. Section, Canberra, for various minerals with the following results :-

| | | | |
|---|---|---|---|
| Ash on Air Dried Sample | | 91.6% | |
| Major Elements | | | |
| | Fe | 5.26% | |
| | S | 3.47% | |
| Minor Elements | | | |
| | Cu | 460 p.p.m. | = 0.05% approx. |
| | Pb | 140 p.p.m. | |
| | Zn | 920 p.p.m. | = 0.1% approx. |
| | Ni | 74 p.p.m. | |
| | Co | Not detected. | |

### (b) EXAMINATION OF A DRILL-CORE SECTION FROM THE WATERHOUSE PROSPECT No.2, N.T. (W.M.B. Roberts)

The section submitted by Dr. J. Horvath, of the Melbourne Office, is a highly graphitic, fine-grained schistose rock containing some patches of quartz and veins of sulphide.

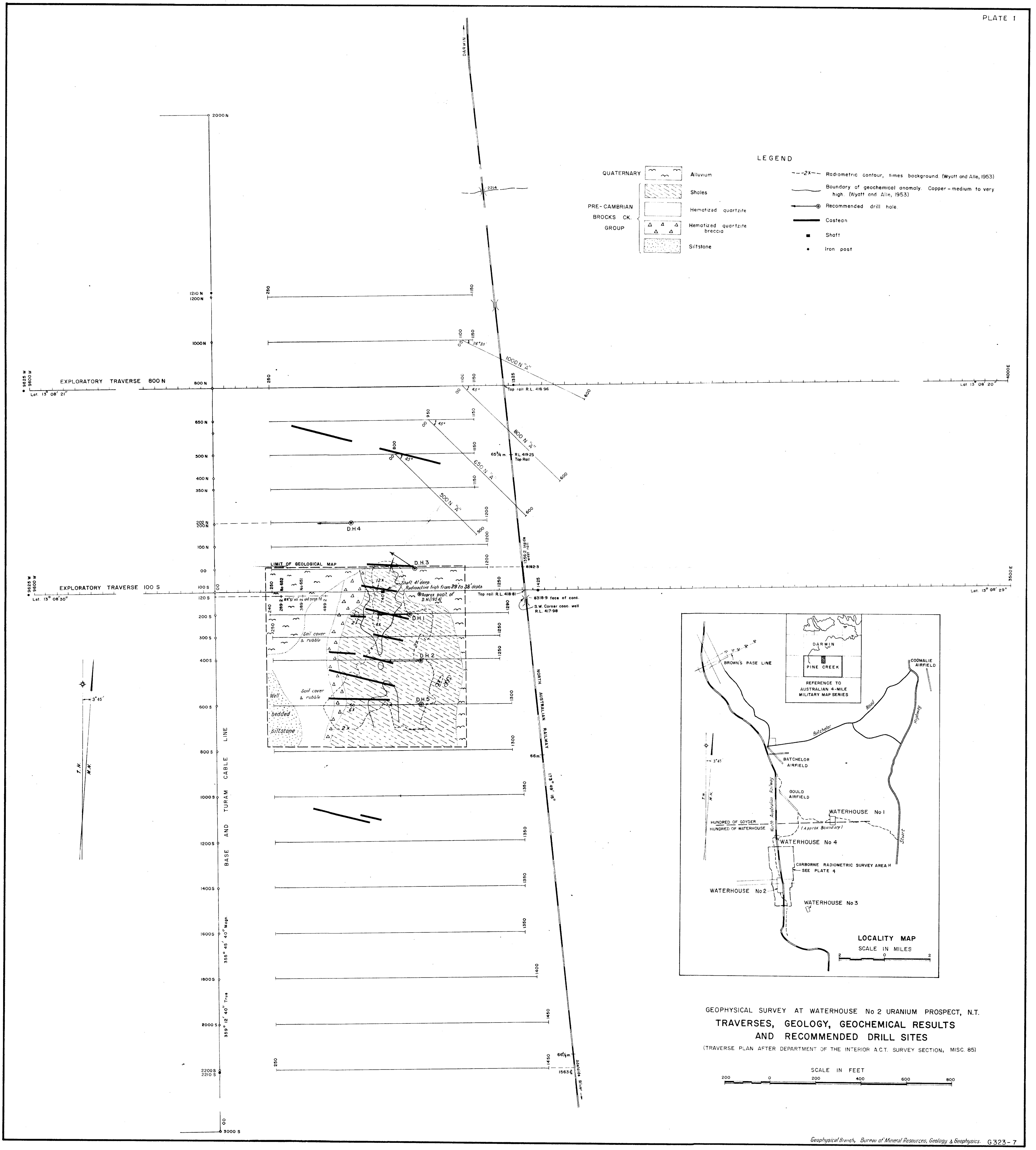
The rock is composed of quartz, graphite, sericite, and some tourmaline. Graphite and quartz are the major constituents, the quartz being generally fine-grained - ranging up to 0.1 mm across - and, with the exception of a few isolated patches, is distributed fairly evenly throughout the rock.

The graphite is extremely fine-grained, and does not show up in polished section, but thin films of it can be seen along small shears in the rock.

Sericite is intimately intergrown with graphite as small blades ranging up to 0.25 mm in length, their presence being the only indication of the probable nature of the original rock, i.e. probably a shale. Tourmaline is a very minor constituent; it forms small crystals the largest of which measures 0.05 mm in length. The sulphide minerals in the core are pyrite, chalcopyrite, and sphalerite. A small speck having reddish-gold colour and measuring 0.004 mm across was thought to be gold; KCN turned it black, tending to confirm this suggestion. Although in hand specimen pyrite appears to be present only as rather coarsely crystalline veins in the core, in polished section it is shown to be evenly distributed throughout the rock as very small blebs of fairly uniform size - 0.006 mm across.

The veins are, as previously mentioned, coarsely crystalline and are composed of strongly fractured euhedral crystals of pyrite ranging up to 1.0 mm in length. Chalcopyrite occurs only as sporadic patches measuring up to 0.25 mm across and associated with the pyrite veins. Sphalerite is a minor constituent, occurring as small irregular masses filling fractures in the pyrite crystals.

The rock appears to have been a shale which has contained veins or segregations of crystalline pyrite. It has been subjected to a low degree of dynamic metamorphism during which the pyrite has been extensively fractured. The large percentage of graphite in the rock suggests that there has been some introduction of carbon during or after metamorphism, probably as some volatile organic carbon compound. This has been accompanied also by the introduction of silica. It is impossible to state with certainty whether the fine-grained sulphide disseminated throughout the core belongs to the period before or after the metamorphism.



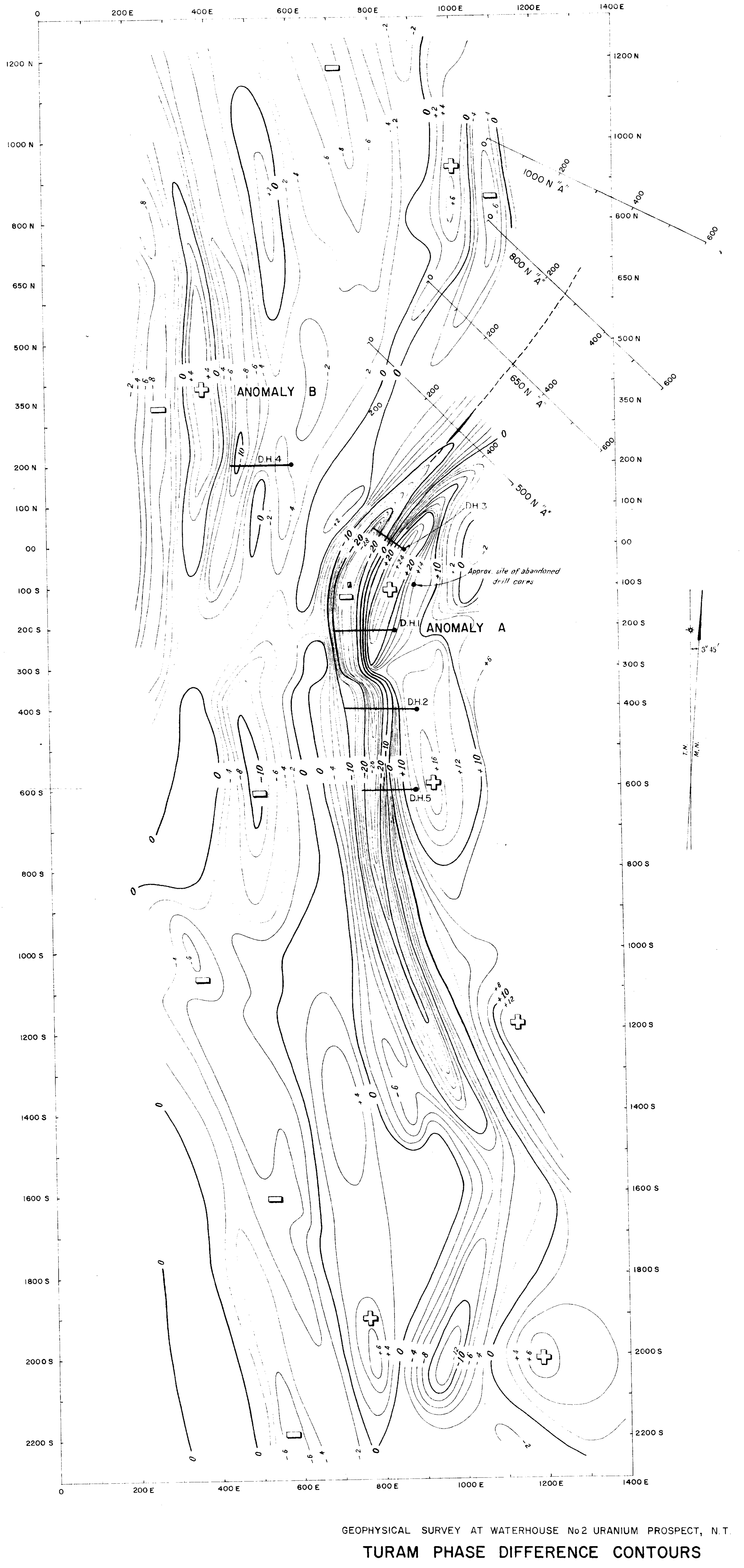

GEOPHYSICAL SURVEY AT WATERHOUSE No 2 URANIUM PROSPECT, N.T.

## TRAVERSES, GEOLOGY, GEOCHEMICAL RESULTS AND RECOMMENDED DRILL SITES

(TRAVERSE PLAN AFTER DEPARTMENT OF THE INTERIOR A.C.T. SURVEY SECTION, MISC. 85)

*Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics.* G323-7

To Accompany Records 1960, No. 109




GEOPHYSICAL SURVEY AT WATERHOUSE No 2 URANIUM PROSPECT, N.T.

# TURAM PHASE DIFFERENCE CONTOURS AND TREND OF SLINGRAM ANOMALY

TURAM FREQUENCY 440 CYCLES/SEC. SLINGRAM FREQUENCY 500 CYCLES/SEC.

SCALE IN FEET

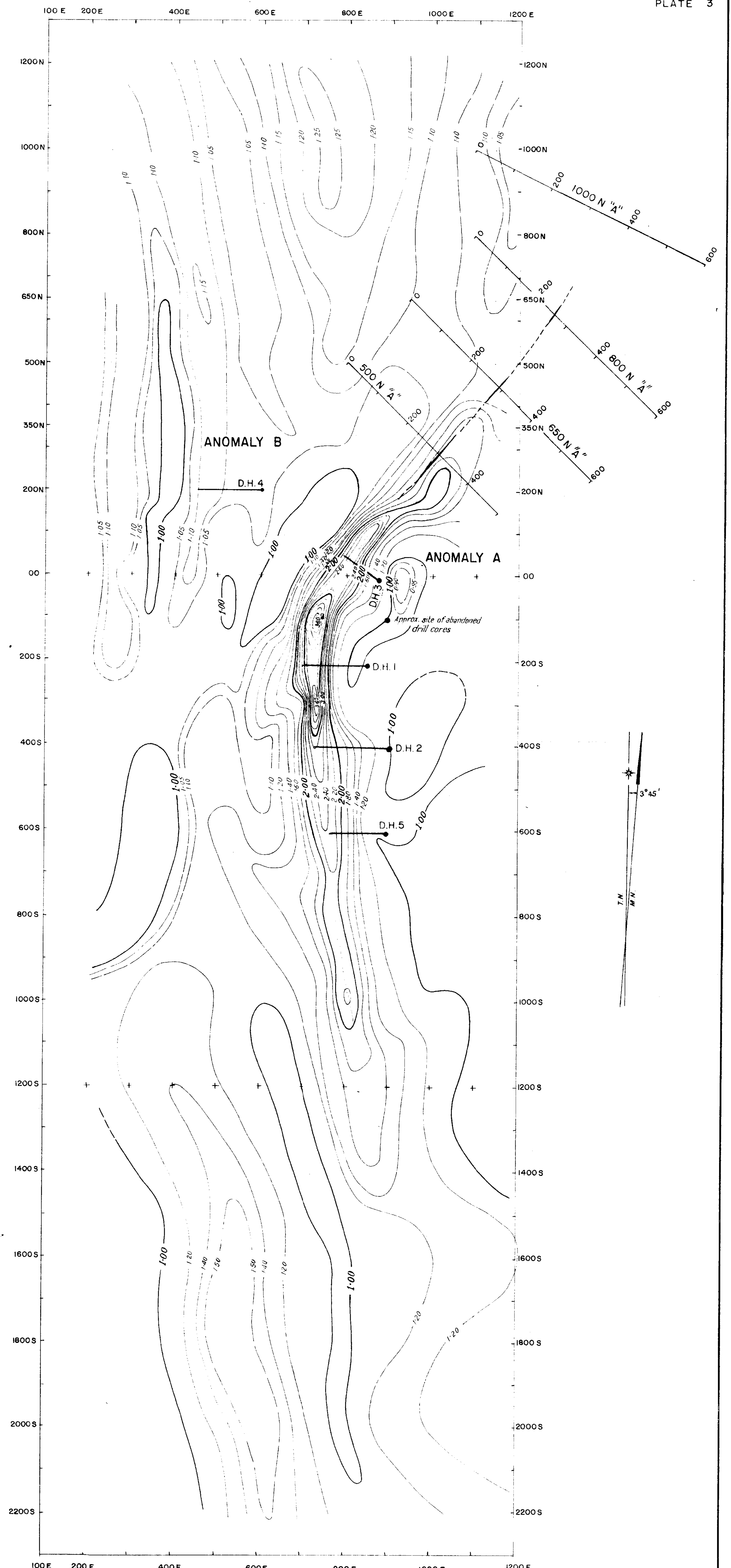
200 0 200 400 600

CONTOUR INTERVAL 2°

LEGEND

Strong } Slingram anomaly
Weak }
Shaft
Slingram traverse
Recommended drill site

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics. G 323-8




GEOPHYSICAL SURVEY AT WATERHOUSE No 2 URANIUM PROSPECT, N.T.

# TURAM RATIO CONTOURS AND TREND OF SLINGRAM ANOMALY

TURAM FREQUENCY 440 CYCLES/SEC. SLINGRAM FREQUENCY 500 CYCLES/SEC.

LEGEND

- Strong } Slingram anomaly
- Weak }
- Proposed drill site
- Slingram traverse
- Shaft

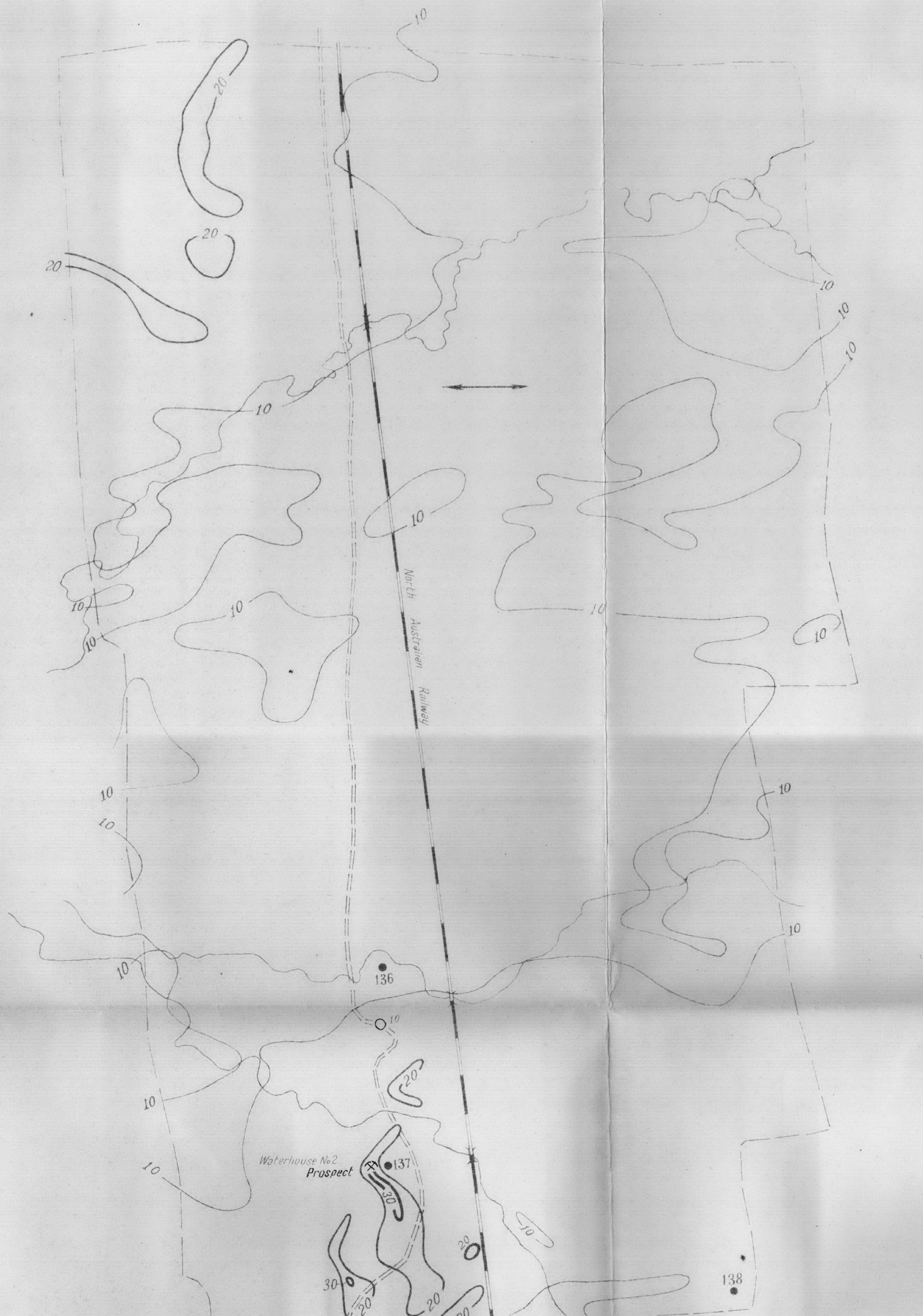
SCALE IN FEET

200 0 200 400 600

CONTOUR INTERVAL AS SHOWN

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 323-9

To Accompany Records 1960, No 109




GEOPHYSICAL SURVEY AT WATERHOUSE No 2 URANIUM PROSPECT, N T

AREA H

# RADIOMETRIC CONTOURS BY CARBORNE RATEMETER

APPROXIMATE SCALE IN FEET

800 0 800 1600 2400

Contour interval 10,000 counts/minute

LEGEND

10 / 20 — Radiometric contours in 1000 counts/minute (Average background count 10,000).

136 — Radioactive anomaly detected by Airborne Survey (Livingstone, 1959)

Vehicle track directions recorded by Odograph

Boundary of surveyed area

Track

Railway

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GEOPHYSICAL SURVEY AT WATERHOUSE No2 URANIUM PROSPECT, N.T.

TRAVERSES 800 N AND 100 S

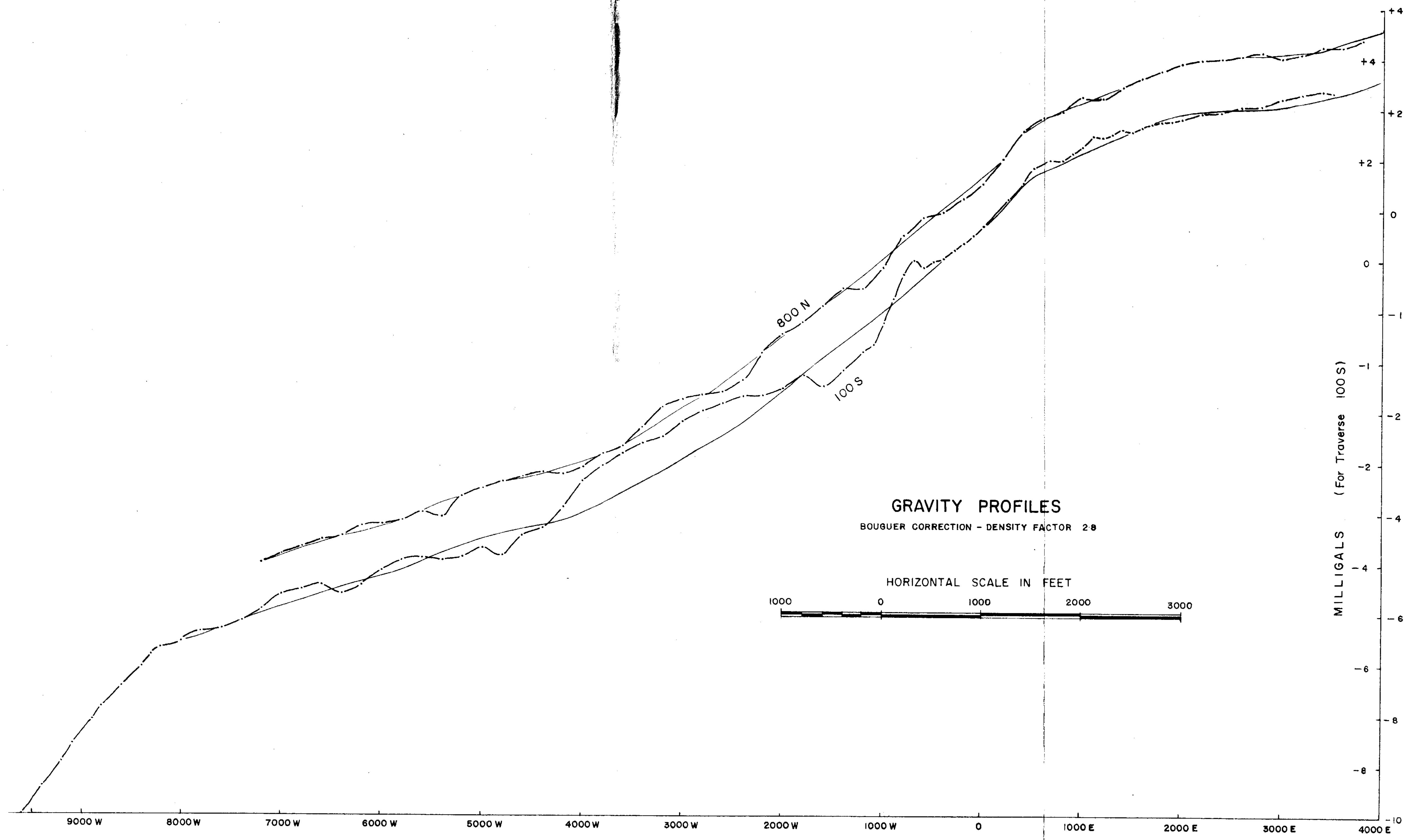
## LONG EXPLORATORY SLINGRAM AND MAGNETIC PROFILES

(SLINGRAM COIL SEPARATION 150 FEET)

*Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.* G 323 - 11

To Accompany Records 1960, No.109

PLATE 6

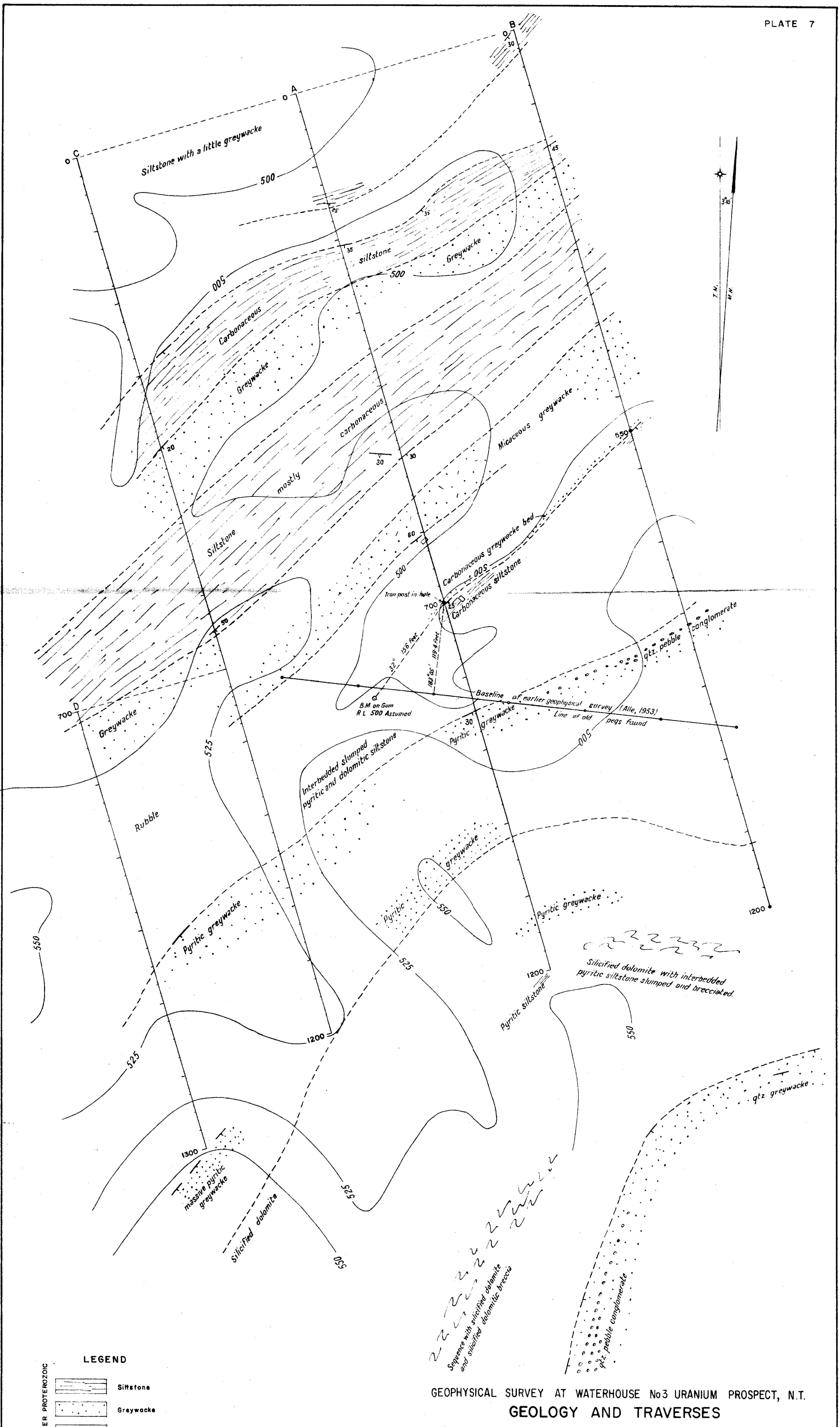



GEOPHYSICAL SURVEY AT WATERHOUSE No2 URANIUM PROSPECT, N. T.

# GRAVITY PROFILES
# ALONG TRAVERSES 100S, 800N

*Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.* G 323 – 12

To Accompany Records 1960, No 109




LEGEND

LOWER PROTEROZOIC

- Siltstone
- Greywacke
- Pebble conglomerate
- 500 / 525 Approximate topographic contours, from traverse levels.
- Small pit
- Iron post

GEOPHYSICAL SURVEY AT WATERHOUSE No3 URANIUM PROSPECT, N.T.

## GEOLOGY AND TRAVERSES

(TRAVERSE PLAN AFTER DEPARTMENT OF THE INTERIOR A.C.T. SURVEY SECTION MISC. 86)

GEOLOGY BY O.N. WARIN

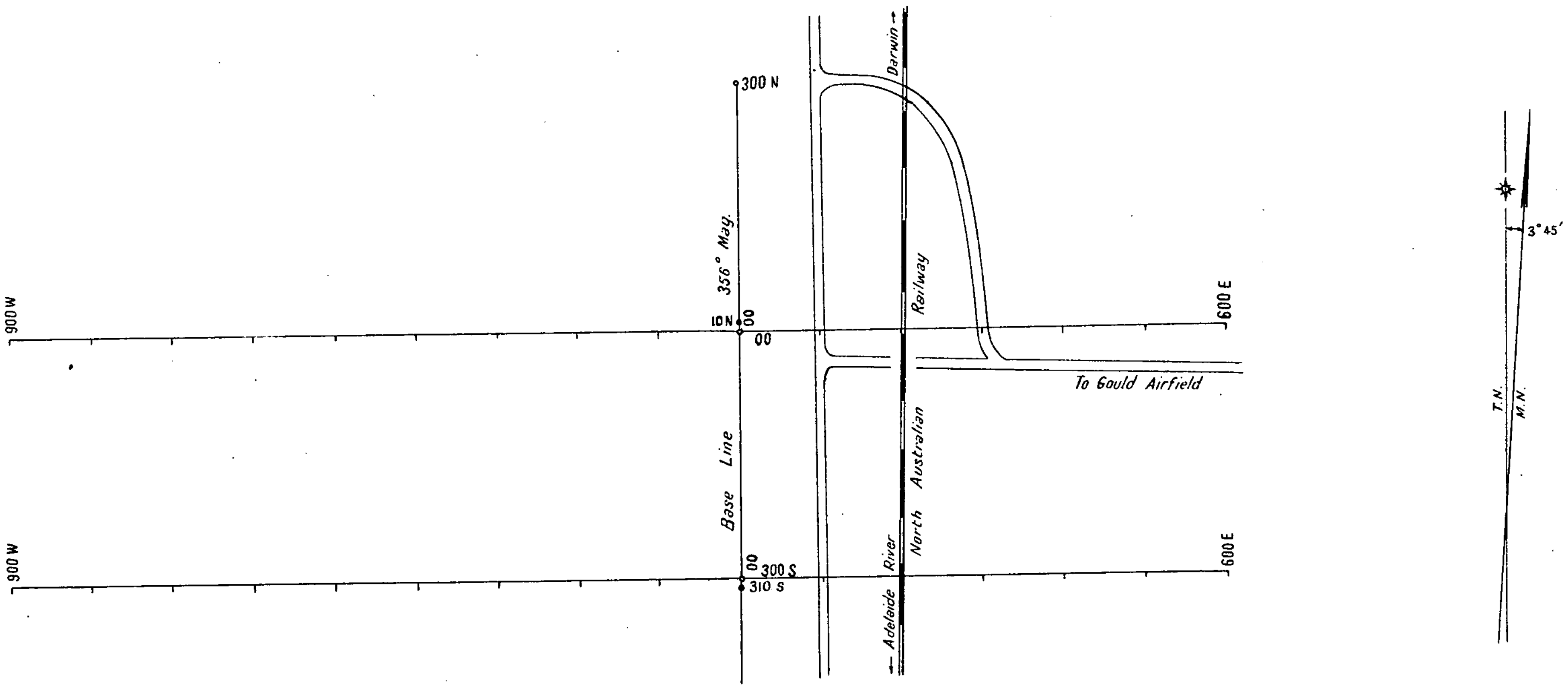
SCALE IN FEET

100 0 100 200 300

CONTOUR INTERVAL 25 FEET

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 323-13

To Accompany Records 1960, No 109




GEOPHYSICAL SURVEY AT WATERHOUSE No 4 URANIUM PROSPECT, N.T.

# GEOPHYSICAL TRAVERSES

(AFTER DEPARTMENT OF THE INTERIOR, MISC. 83)

SCALE IN FEET

200 0 200 400 600

LEGEND

Road

Iron post

*Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.*

G 323-14



To Accompany Records 1960, No.109