BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1981/10

RESULTS OF GAMMA-RAY SPECTROMETER AND RADON SURVEY, AUSTATOM PROSPECT, NORTHERN TERRITORY, 1979

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CONTENTS

FIGURES

TABLES

SUMMARY

During October 1979 the Bureau of Mineral Resources (BMR) carried out radon (Alphanuclear "Alphameter" and emanometer), and surface and down-hole gamma-ray spectrometer surveys, at the Austatom 1 uranium prospect in the Alligator Rivers area, Northern Territory. The work was carried out to document the surface and down-hole radiometric effects of this small body of buried uranium mineralisation.

The results show a close similarity between the relative amplitude and shape of surface radon, total gamma, and gamma-spectrometer (uranium) anomalies except in areas contaminated by drill cuttings. The prospect is associated with a broad radiometric anomaly which is more than 5 times background and covers an area of over 200 square metres. Within this zone the maximum anomaly occurs over low-grade shallow mineralisation. In the contaminated area, large gamma-ray anomalies are observed but the radon results appear to be unaffected by the contamination.

Gamma methods were shown to be more efficient than the radon techniques at Austatom. Of the radon methods, emanometry proved to be more efficient than Alphameter surveys provided the emanometer readings were normalised.

Down-hole spectrometer results proved to be of only qualitative value owing to problems of calibration, instrument drift, and geological noise. However, the results indicate the grade and thickness of the deposit and show a rapid drop in uranium concentration away from the mineralised zone.

1. INTRODUCTION

During October 1979 the Bureau of Mineral Resources (BMR) carried out surface and down-hole gamma-ray spectrometer surveys and surface radon surveys over the Austatom 1 uranium prospect in the Alligator Rivers area, Northern Territory.

The work was carried out as part of a broader investigation by BMR into the use of radiometric techniques in mineral exploration and geological mapping. At the Austatom prospect, the work was intended to document the surface and down-hole radiometric effects of this small body of buried uranium mineralisation, to investigate the relations between surface and bedrock radio-element concentrations, and to compare the emanometer and Alphanuclear "Alphameter" methods of monitoring the concentration of radon in soil gas.

2. GEOLOGY

The Austatom prospect was discovered by the Australian Atomic Energy Commission (AAEC) in 1974 and is located about 1 km north of the Arnhem Highway at approximately latitude $12^{\circ}37'S$ and longitude $132^{\circ}40.3E$ (Fig. 1). The prospect occurs on a north-trending belt of magnetic highs which flank the western side of the Nanambu basement complex and are thought to indicate the presence of prospective Cahill Formation rocks, which are the host to the major uranium deposits in the East Alligator area about 30 km to the east.

No outcrop occurs in the vicinity of the Austatom prospect, but the prospect is believed to occur within a thin wedge of Cahill Formation several hundred metres wide which overlies basement rocks of the Nanambu Complex to the east, and is unconformably overlain by Cretaceous sediments to the west.

Full details of the discovery, the geology, and the results of drilling and radiometric surveys conducted by AAEC are not available.

However, work by AAEC included auger and core drilling which indicated uranium mineralisation at depths of from 1.5 m to 13.5 m (Louthean, 1980). BMR auger drilling and radiometric logging in 1979 indicated that the mineralisation dips or plunges to the northwest. The best BMR intersection was between 12 m and 16 m at 2025E/700N (Fig. 1). The zone of mineralisation was also intersected between 1 m and 4 m depth at 2075E/650N but the mineralisation there appears to be of lower grade.

3. MEASUREMENT TECHNIQUES

Surface and down-hole gamma-ray spectrometer and radon measurements were made over a portion of a grid previously established by AAEC. The survey grid, and the location of BMR auger holes in which spectrometer measurements were made, are presented in Figure 1. Holes drilled previously by AAEC were not accessible.

Gamma-ray surveys

Four-channel gamma-ray spectrometer readings were made above the surface with an Exploranium DISA-400A spectrometer, and in the boreholes with a Geometrics GR-410A spectrometer. Details of spectrometer make and type, crystal dimensions, energy windows, stripping ratios, and sensitivity and background constants used in the processing of the raw 4-channel data are presented in Appendix I. Calibration constants for the DISA-400A spectrometer were determined at the Uplands pads at Ottawa, Canada. The GR-410A down-hole system was calibrated at the AMDEL pits in Adelaide and by comparison of down-hole logs with sample assays.

The derivation of radio-element concentrations from the survey data has been made with the assumption of secular equilibrium and the validity of the spectrometer characteristics described in Table 1. However, the spectrometer characteristics (particularly the down-hole system) could not be determined accurately and problems

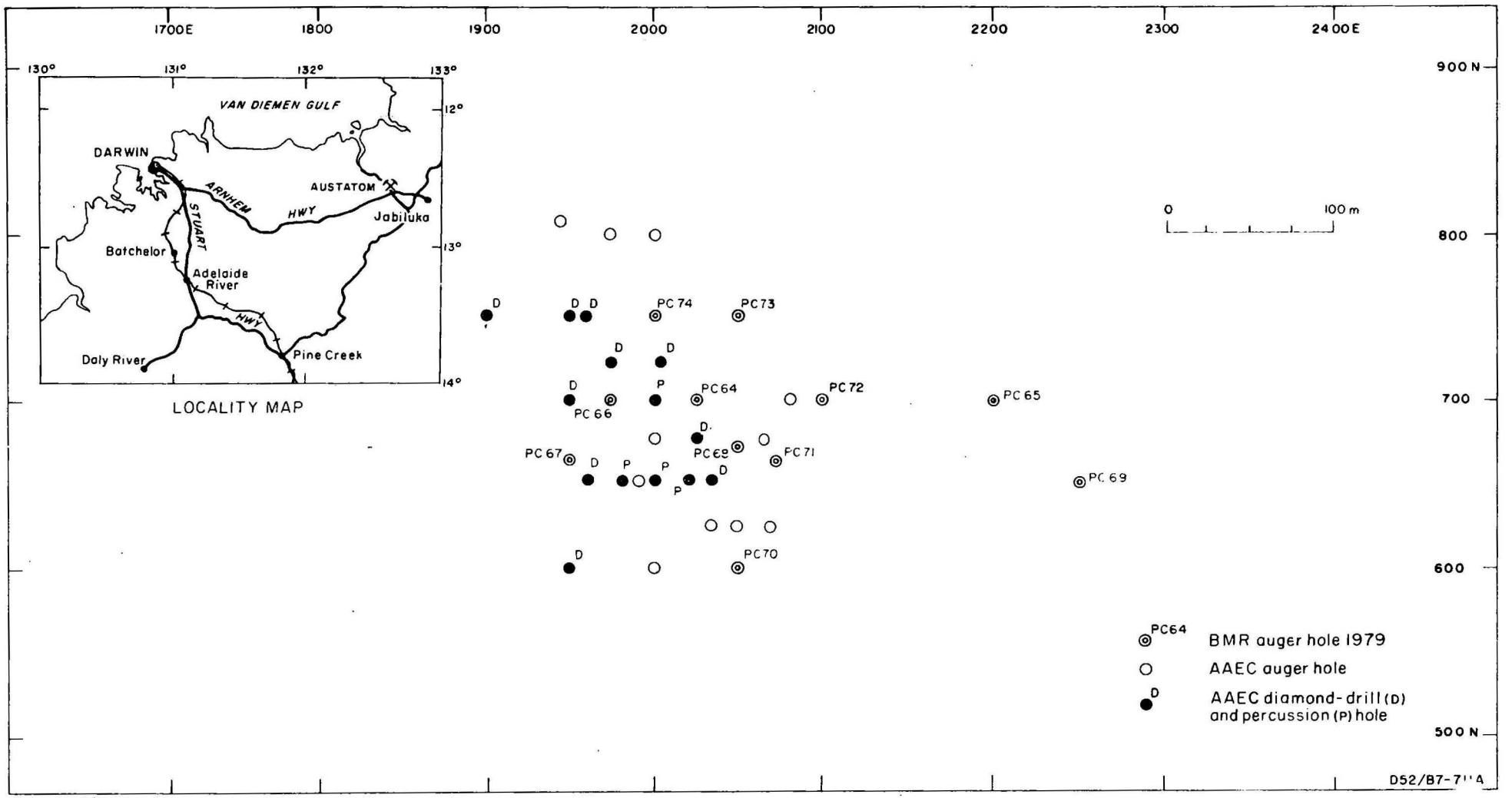

Fig. 1 Locality map, survey grid and location of BMR auger holes

such as instrument drift, non-linear calibration in areas of high radioactivity (Killeen & Carmichael, 1970), and the fact that background values were determined over deep water in Manton Dam about 200 km west of the survey area, add to the uncertainty of derived radio-element values.

Surface gamma-ray measurements were made with the spectrometer detector supported on a tripod such that the detector was 60 cm above ground level. Down-hole spectrometer measurements were made at 1 m intervals in each hole. Owing to the need for long sampling times for the spectrometer measurements, continuous logging of the holes was not attempted. Typical sampling times were 2 minutes for surface measurements and 1 minute for down-hole measurements.

Radon surveys

Radon measurements were made over a limited portion of the grid using Alphanuclear Alphameters and an EDA RD-200 radon emanometer. The Alphameter indicates the level of alpha radiation of soil gas at 0.3 m below the surface, and counting was carried out over a period of several days to average diurnal fluctuations in radon concentrations caused by barometric pumping. The emanometer sampled a volume of soil gas pumped from a depth of 0.4 m below the surface, and counts were corrected for background and recorded for one minute intervals over a period of five minutes.

The source of the alpha particles can be either the gaseous radionuclides Rn-222 (radon derived from U-238) or Rn-220 (thoron derived from Th-232) and their immediate daughter products Po-218 and Po-216 respectively. For the emanometer, the decay in total alpha counts recorded over a period of 5 minutes from the time of gas extraction provides a good guide to the ratio of radon to thoron in the soil gas owing to the rapid decay of thoron compared to radon. A comparison of the decay also provides a means of normalising for the effects of changes in soil condition and gas sampling techniques. Note that use of the emanometer requires consistent sampling, sample times, and background corrections.

Magnetic surveys

Total magnetic field measurements were also made, using a Geometrics G-816 proton magnetometer with the detector 2 m above ground. It was expected that magnetic anomalies associated with Cahill Formation rocks might assist in the delineation of geological contacts.

4. SURFACE GAMMA-RAY SPECTROMETER RESULTS

The processed results of ground spectrometer measurements are presented as contours of apparent thorium, apparent uranium, and total count (exposure rate) in Figures 2, 3, and 4.

The distribution of thorium shown in Figure 2 is fairly constant over the survey area and no patterns indicative of a localised radioactive source are evident. The somewhat lower values recorded west of 2000E probably reflect the Cretaceous cover rocks in this area. Similarly the southeast-trending contour pattern through 2000E/900N may reflect lithology or structure.

The distribution of uranium is indicated in Figure 3, which reveals a localised anomalous pattern centred on the prospect, surrounded by a low background uranium level. An apparent uranium concentration of greater than 10 ppm eU occurs in an east-west zone approximately 200 m long, which encompasses an area to the east not tested by AAEC drilling. The very high uranium concentrations indicated at 2000E/700N and 2050E/650N are close to AAEC drillholes which are surrounded by cuttings. Hence, it is reasonable to attribute these localised high readings to surface contamination.

Apparent potassium concentrations were all less than 1% and do not exhibit any patterns that can be related to the geology of the area.

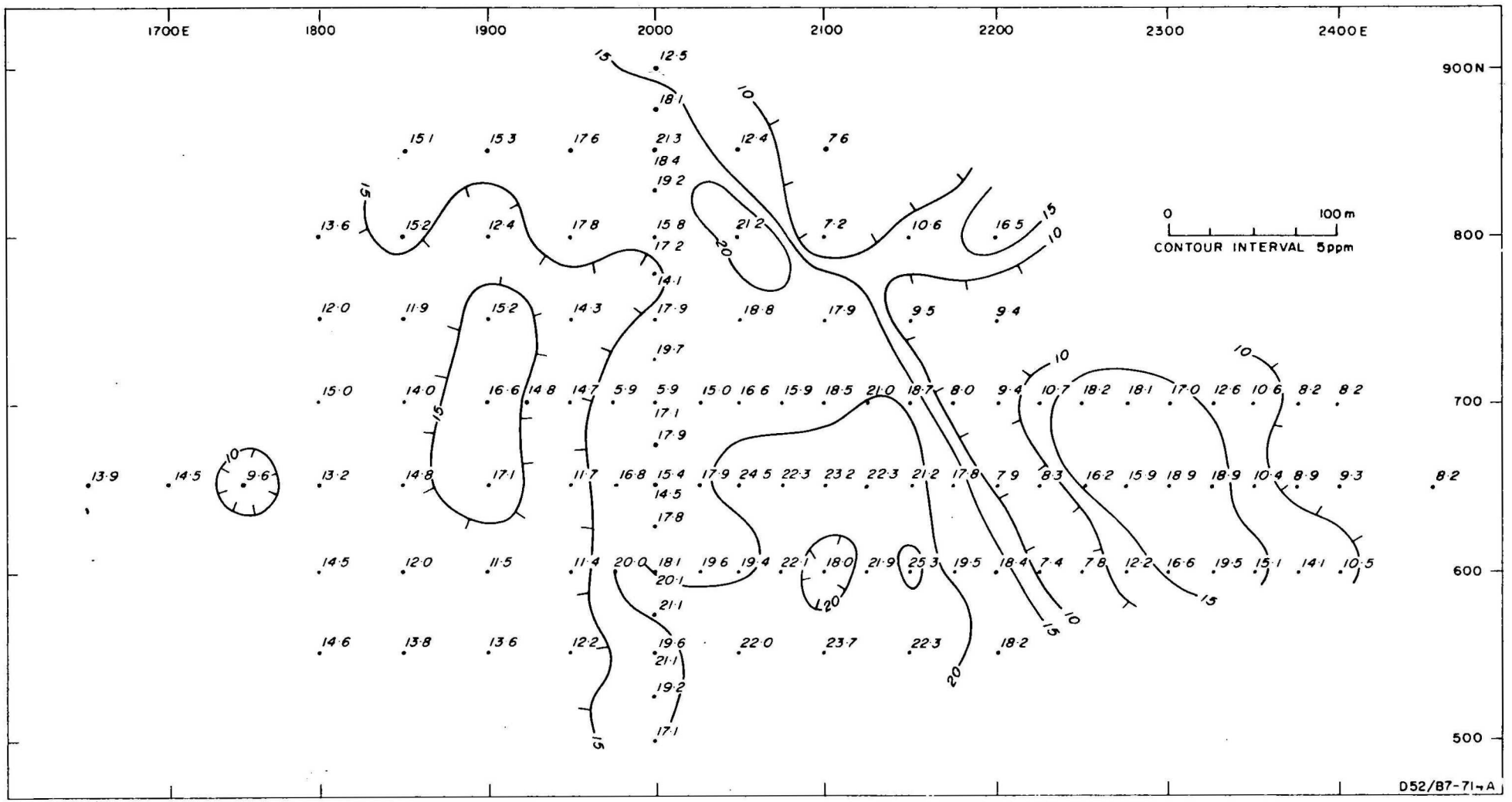

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Fig. 2 Ground spectrometer results - apparent thorium

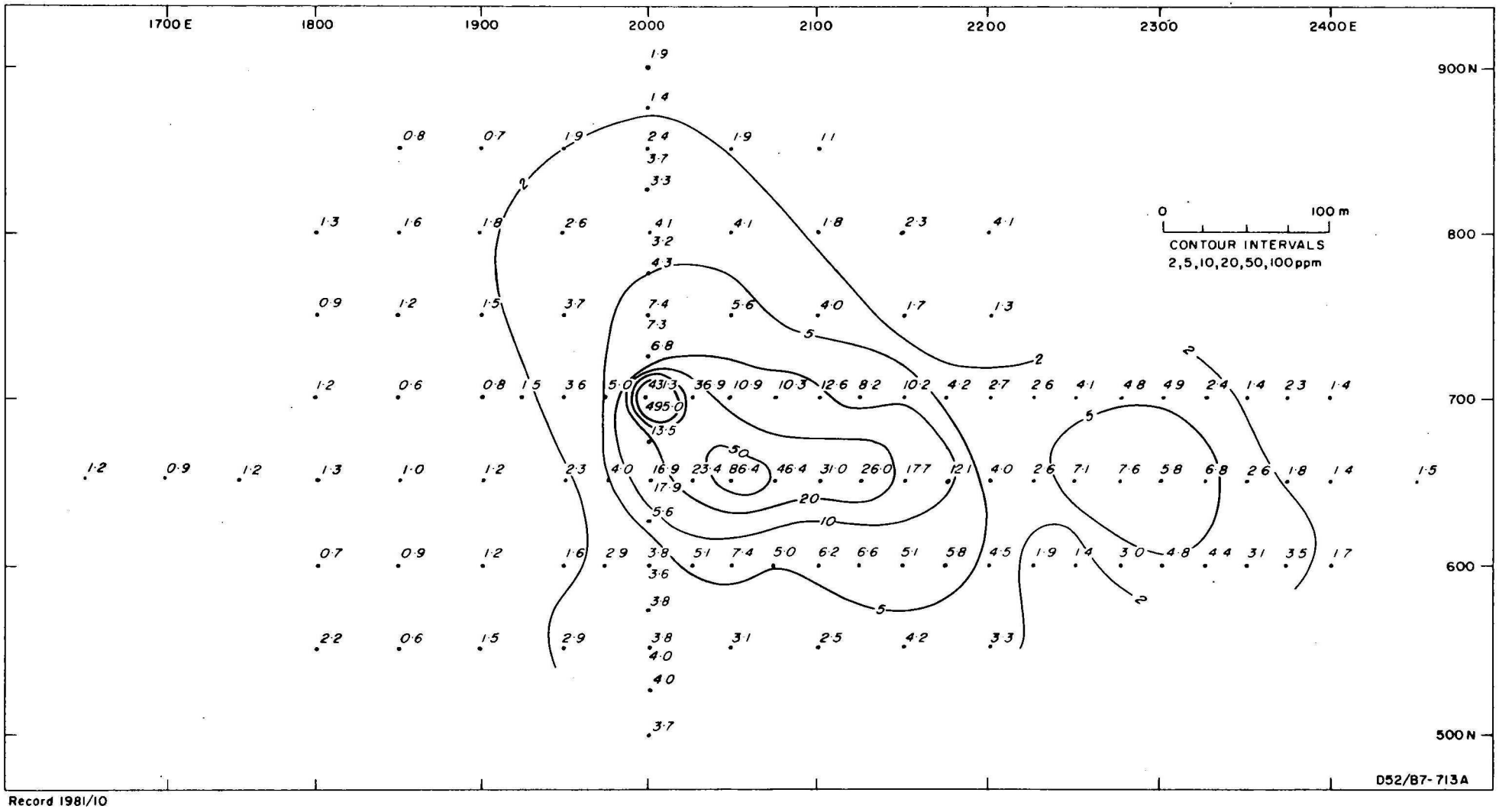

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Fig. 3 Ground spectrometer results—apparent uranium

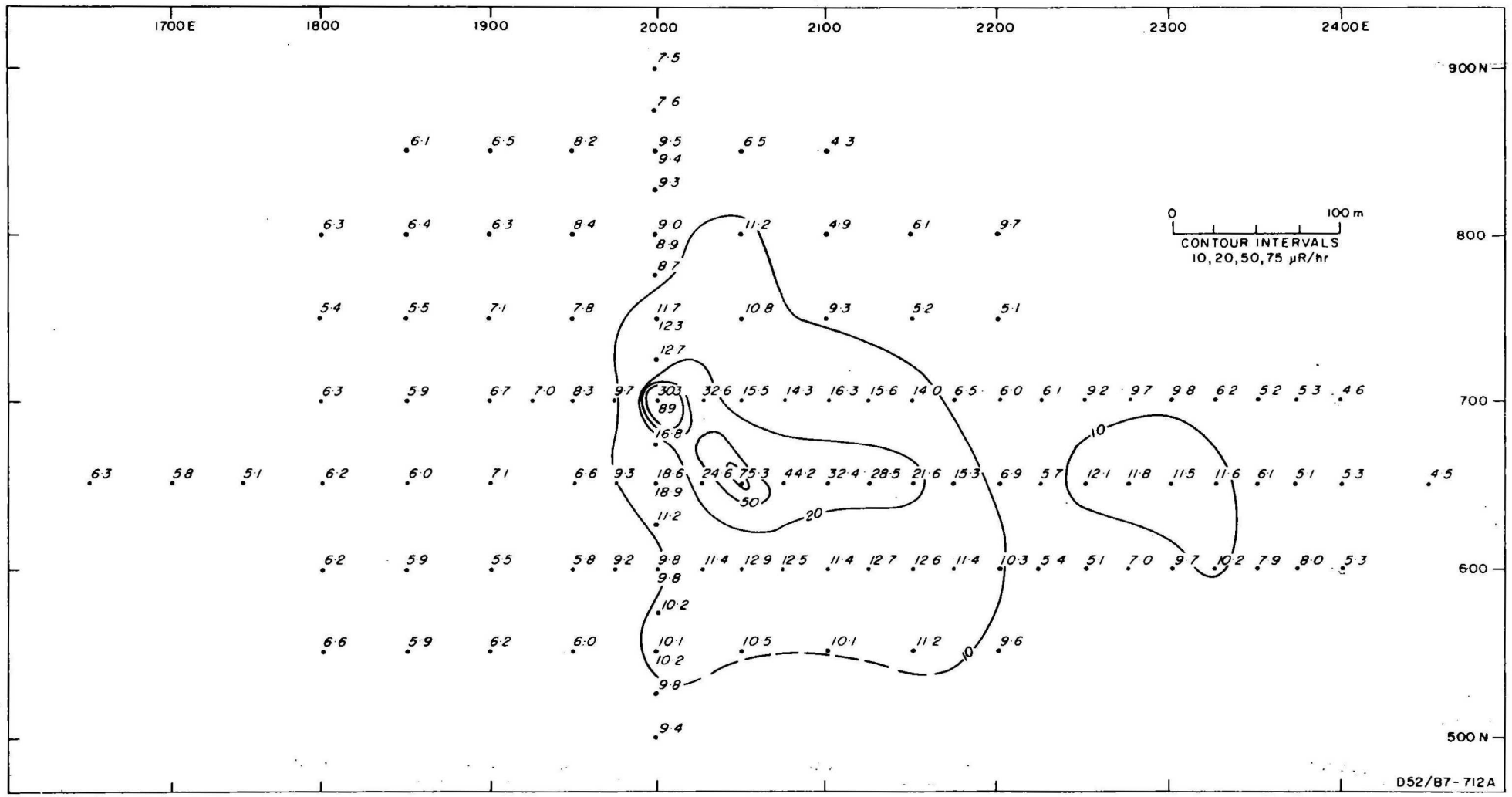

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Fig. 4 Ground spectrometer results – total count

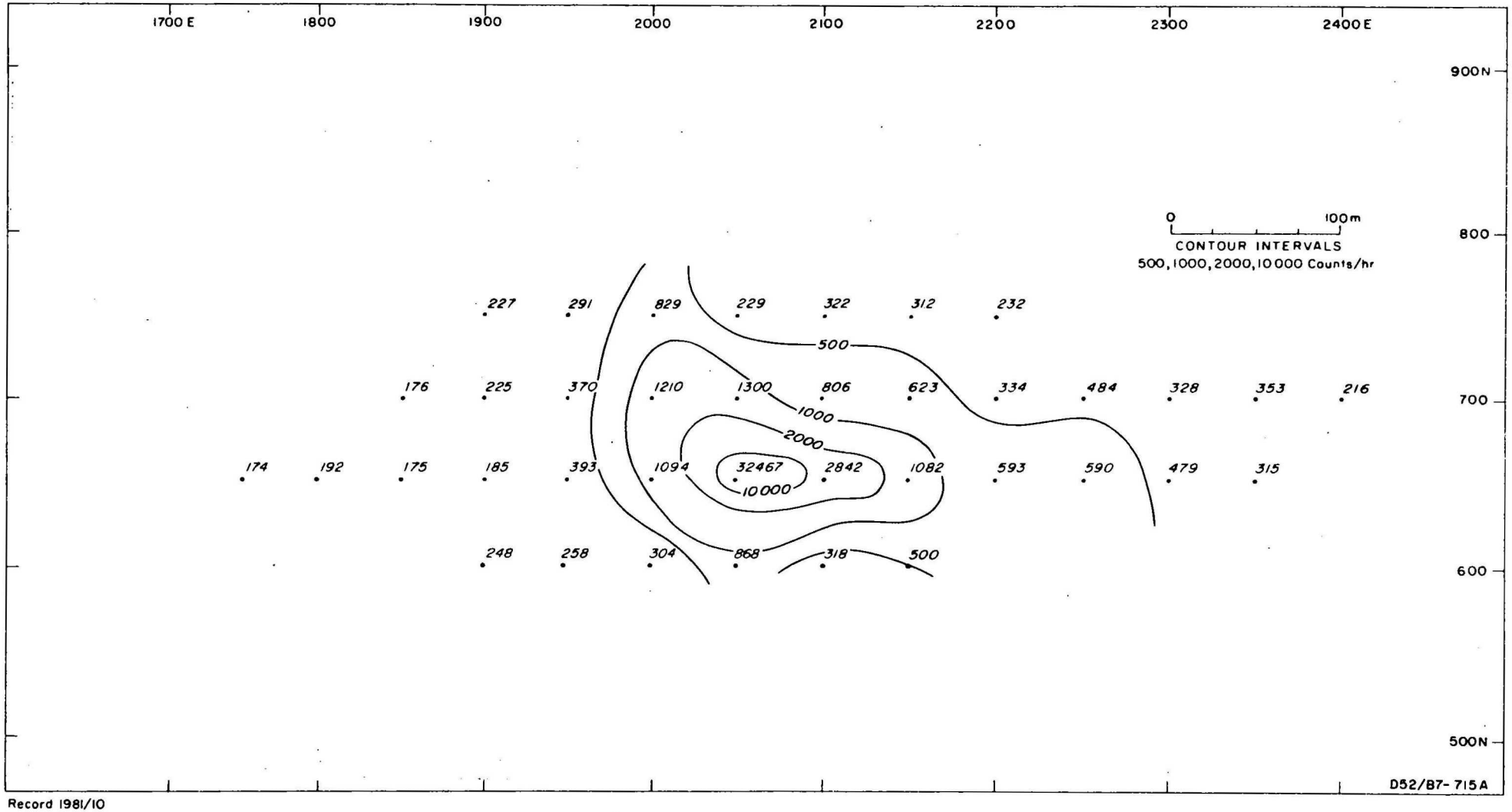

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Fig. 5 Radon results - total alpha contours (counts / hr)

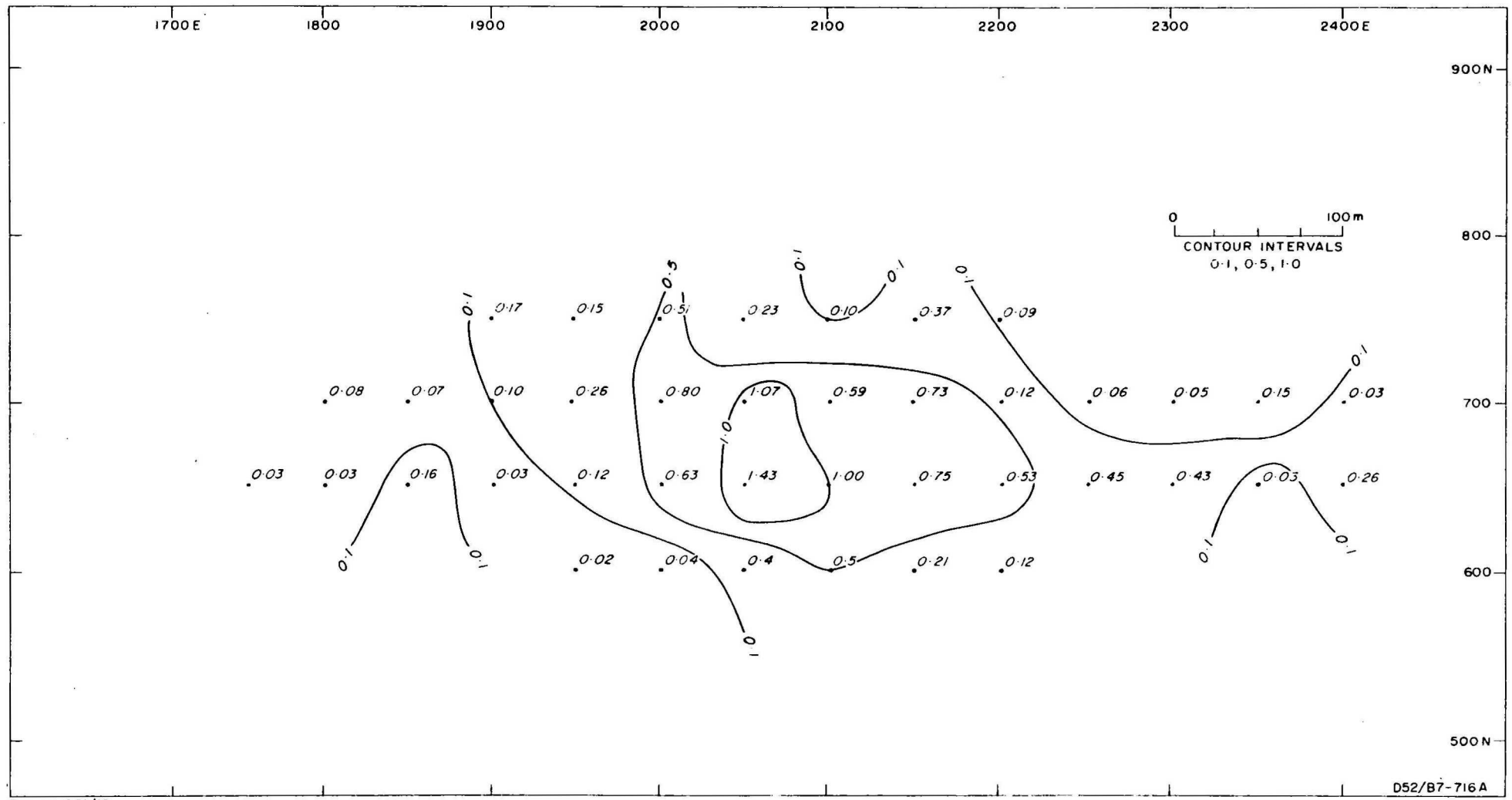

Fig. 6 Radon emanometer results, ratio of counts recorded in fifth and first minutes

Total-count results are shown in Figure 4 and indicate a similar pattern to the apparent uranium concentration data (as would be expected from the absence of pattern for apparent thorium and potassium).

5. RADON RESULTS

Results of the Alphameter and emanometer surveys are presented in contour form in Figures 5 and 6. The emanometer data are shown as the ratio of counts recorded in the 5th minute to counts recorded in the 1st minute for each sample. This procedure effectively monitors the ratio of radon to thoron and is preferable to plotting absolute values, which may depend on soil condition and the technique of gas sampling.

The east-west zone of high surface-uranium concentration observed in Figure 3 is reflected in both the total alpha counts (Fig. 5) and the radon-to-thoron ratios (Fig. 6). However, a significant difference between the gamma-ray spectrometer and radon measurements is the absence of a strong radon anomaly in the supposedly contaminated region around 2000E/700N. This observation can be explained by the fact that radon measurements are taken some 30 cm to 40 cm below ground level, and are probably below the influence of contamination. The coincidence of radon and apparent uranium anomalies at 2050E/650N suggests that contamination is not the source of the localised gamma-ray anomaly in this area. Note that the strongest radon anomalies are observed at 2050E/650N, where the mineralisation is close to the surface. The best mineralisation intersected by BMR drilling was at a depth of 12 m to 16 m near 2000E/700N, but here the radon anomaly is relatively small.

A comparison of the total alpha count and apparent uranium concentration results shows a fair scatter in the ratio of radon counts to apparent uranium. The average value is 140 counts per hour per ppm eU, and the standard deviation is at least 75 counts per hour per ppm eU. In general the ratio is lower over the anomaly than over the

background areas. However, the maximum ratio (375) was recorded at station 2100E/650N, which has the highest alpha count-rate. The scatter in the ratio of count-rate to apparent uranium can in part be explained by the different volumes of ground sampled by the two methods and by statistical variations. The decrease in the ratio over the anomalous zone could be explained by surface contamination, or perhaps by accumulation of radio-elements such as radium in the top few centimetres of the soil cover.

The counts recorded over one-minute intervals for the emanometer survey are small, and range from a minimum of 1 in the fifth minute for samples with a fast decay to a maximum of 1500 in the first minute. The average number of counts recorded in the first minute is approximately 60 compared with an average count rate for the alphameter survey of approximately 5 counts per minute. Owing to the low counts recorded over one-minute intervals for the emanometer survey, large statistical variations in the ratio of 5-minute to 1-minute readings can be expected. For example the ratio of the fifth to first-minute readings at station 2000E/650N has a value of 0.63 and a standard deviation of 0.15. However, as shown in Figure 6, the range of ratio varies by a factor of nearly 50, so anomalous trends are easily identified by a coarse contouring interval.

Simple modelling by Stuart & Major (in prep.) of the decay of systems containing the nuclides Rn-222 and Rn-220 provides some guide to the interpretation of the emanometer data. The modelling shows that a ratio of 0.04 is indicative of the decay of pure thoron, and ratios as high as 0.6 might be expected in rocks containing normal crustal concentrations of uranium and thorium. Ratios around 1.0 are indicative of systems where the ratio of radon to thoron exceeds normal crustal concentrations by a factor of at least 100. Ratios greater than 1.0 are indicative of systems where radon greatly exceeds thoron in concentration, and the radon is not in equilibrium with its daughter products. Note that ratios in excess of 1.0 imply very rapid movement of radon or scavenging of daughter products from the soil gas.

A comparison of the simple model results and the emanometer results from Austatom suggests that background readings are largely due to thoron, a deduction partly supported by the thorium-to-uranium ratios of greater than 10 indicated by the gamma-spectrometer survey. Similarly, emanometer ratios of 1.0 or more observed in the centre of the anomaly indicate a substantial increase in the relative concentration of radon.

6. DOWN-HOLE GAMMA-RAY SPECTROMETER RESULTS

As shown in Figure 1 eleven shallow holes were auger drilled at Austatom by BMR during October 1979. The holes were drilled on and around the radiometric anomalies delineated by the surface gamma-spectrometer and radon measurements, and varied in depth from 9 m to 18 m. Water was usually entered at a depth of 10 m. No corrections for the presence of water were made. Gamma-ray spectrometer measurements were made in each hole at 1 m spacings, and readings were made over a minimum time of 1 minute. The results of these measurements and the derived apparent uranium concentration are included as Appendix II. The results of chemical analyses on selected samples from the holes are included as Appendix III.

Unfortunately, a lack of proper calibration and instrument drift have introduced uncertainties into estimates of radio-element concentration. For example calculation of the concentration of thorium was not attempted owing to insufficient knowledge of the thorium sensitivity constant. Similarly calculation of potassium concentration was precluded by uncertainties in the stripping ratios and sensitivity constant for this radio-element. However, as the uranium sensitivity and stripping ratio for thorium into uranium are thought to be reasonably well known, a qualitative estimate of apparent uranium concentration was made.

The very low count rates observed in the thorium channel may reflect the low absorption of high-energy gamma-rays in the thin down-hole probe, but are more likely to be due to errors concerning the positioning of the thorium channel energy window. The thorium count rate appears to remain fairly constant over the length of all holes, and this observation is supported by the consistent thorium concentration determined by XRF analyses (Appendix III). Increases in the thorium count rate in zones with a high apparent uranium concentration are minor and may in part be explained by the effects of Bi-214 radiation observed in the thorium channel. It is extremely difficult to estimate the potassium concentration, but use of the crude calibration constants shown in Table 1 indicate that it is fairly constant and generally less than 1%. This is confirmed by the low potassium concentrations determined by atomic absorption measurements on selected samples (Appendix III). The ratio of total count-rate to apparent uranium concentration is fairly constant and confirms that Bi-214 is the principal radio-element.

The results of the total count-rate and apparent uranium concentration estimates in the holes along traverses 700N and 650N are shown in Figure 7 as a pseudo-section formed by projecting all the holes onto a single line. For comparison, the results of surface gamma-spectrometer and radon measurements along lines 650N and 700N are also shown. The results indicate that the mineralisation at Austatom 1 forms a thin wedge less than 5 m thick which deepens to the west and north. The mineralisation comes to within a few metres of the surface near 2075E/650N and is at a depth of about 14 m at 2025E/700N. Note that dead-time corrections for the highest count-rates recorded are less than 5% for the total count channel and less than 1% for the uranium channel.

A comparison of the apparent uranium concentration determined at the surface by the down-hole spectrometer with that determined by selected XRF analyses of down-hole samples is shown in Table 1, and reveals a wide scatter. However, the down-hole measurements

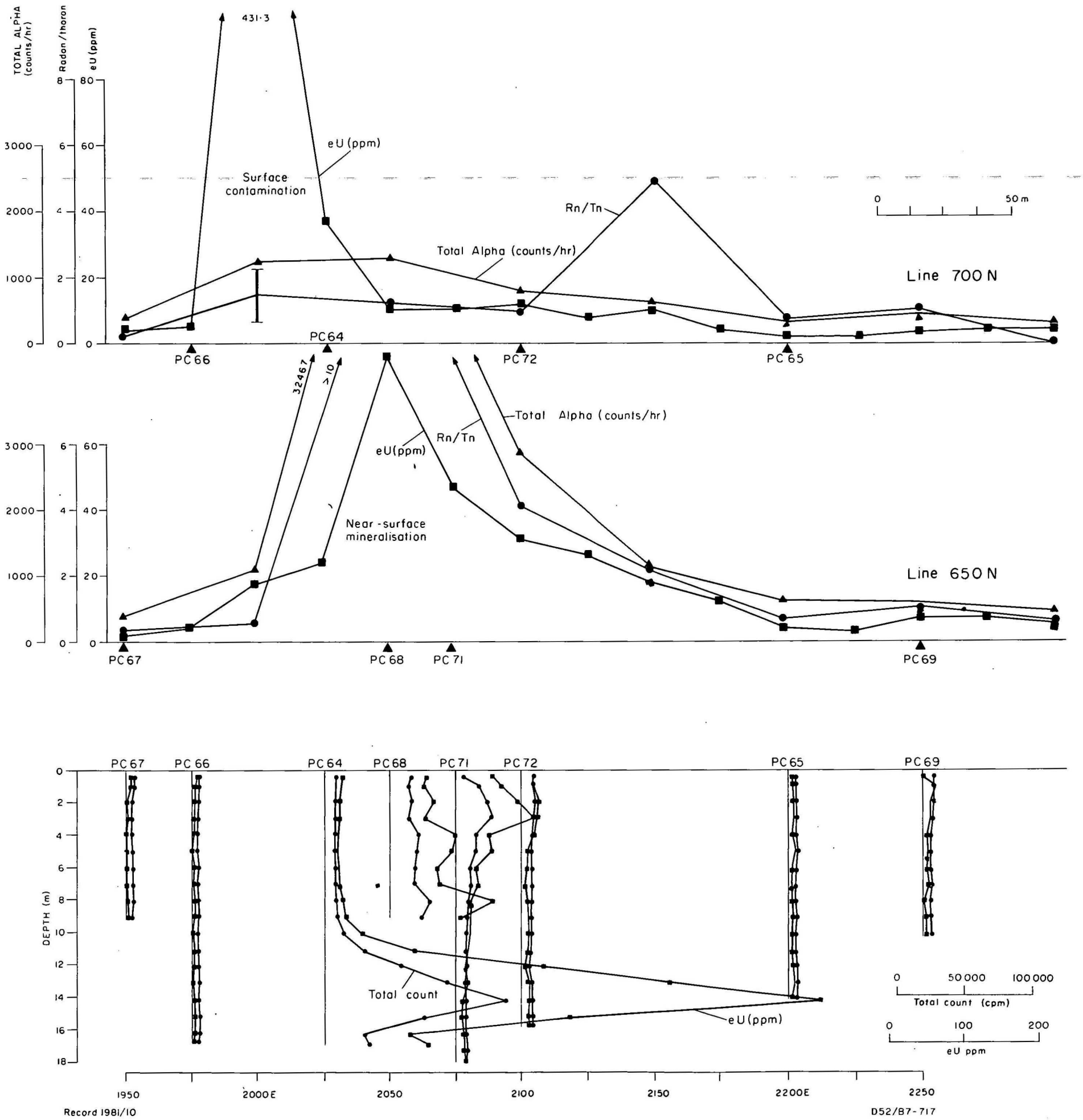

Fig. 7 Comparison between alphameter, enanometer, and surface and downhole spectrometer results

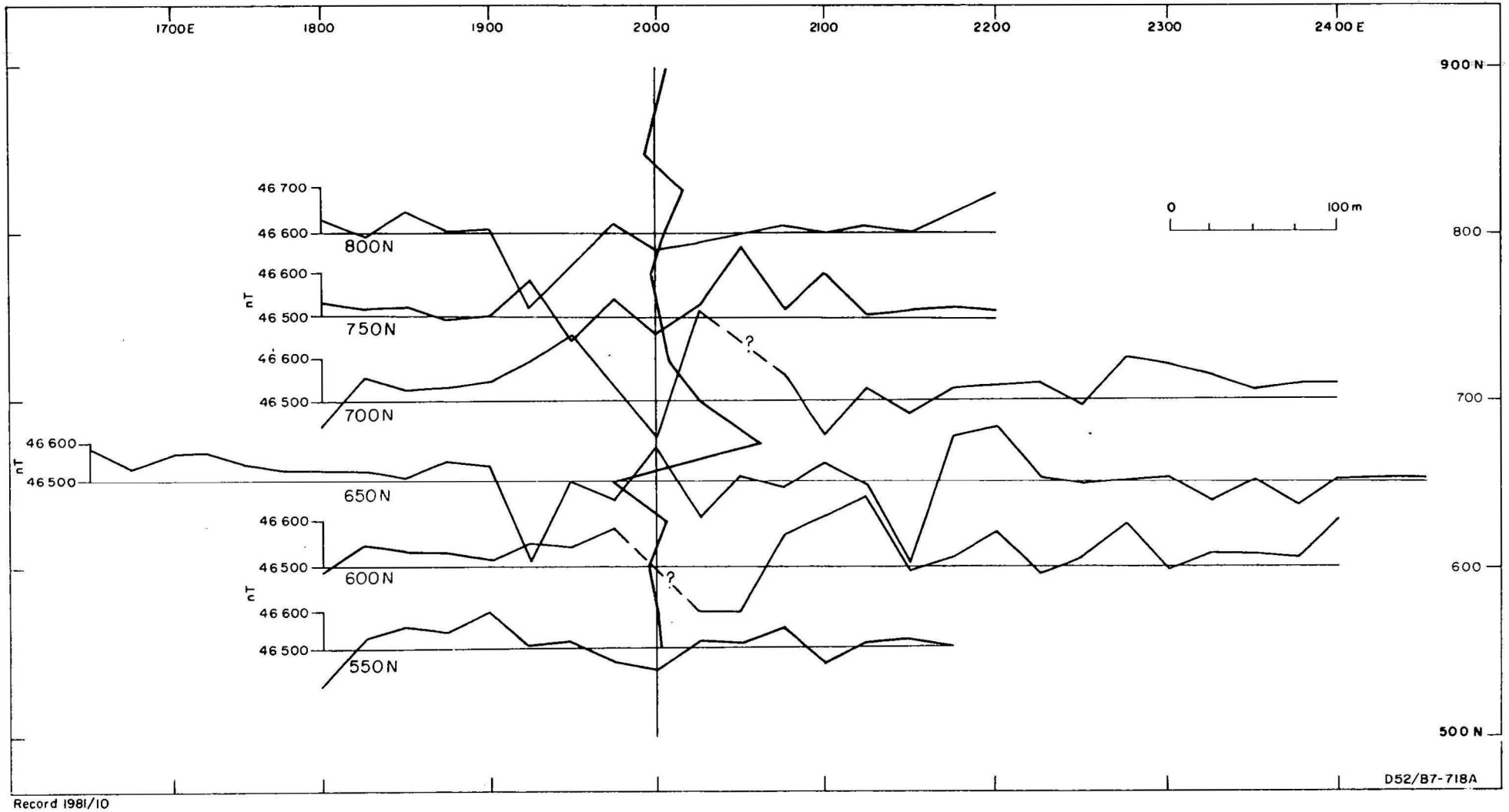

Fig. 8 Total magnetic intensity profiles

appear to be consistently higher than the surface measurements. The scatter may be due to a number of factors including differences in sample volume, calibration errors with the down-hole spectrometer, accumulation of radon in the drillholes, and effects of a thin cover of transported overburden.

Owing to the uncertainties inherent in calculating radio-element concentrations from the down-hole radiometric data, little confidence can be had in using the data to estimate the grade of the mineralisation at Austatom. However, the down-hole logs suggest a maximum apparent uranium concentration of approximately 700 ppm at 14 m in hole PC64, and this result compares reasonably well with the XRF assay of 520 ppm U for a sample collected over the depth 14 m to 15 m in the same hole (Appendix III). The shallow mineralisation intersected in hole PC71 appears to have a maximum apparent uranium concentration of approximately 100 ppm eU. Within the mineralised area a background of from 10 to 20 ppm eU was observed, compared with background values of from 3 to 5 ppm eU in holes PC67 and PC69, which are on the fringes of the mineralised zone. These results suggest a fairly sharp cutoff in the concentration of uranium away from the mineralised zone.

7. MAGNETOMETER SURVEY RESULTS

The results of total magnetic intensity measurements made with a proton-precession magnetometer and a sensor height of 2 m are presented in Figure 8. The results suggest a magnetically disturbed zone in the vicinity of the mineralised area, but a relatively undisturbed magnetic zone is observed over the Cretaceous sediments west of 1900E. The zone of disturbed magnetic field may be indicative of the presence of weakly magnetic schists within the Cahill Formation.

8. CONCLUSIONS

The results of surface radon and gamma-spectrometer surveys show that the Austatom prospect is associated with a broad radiometric anomaly which is more than 5 times background and covers an area of over 200 square metres. Although surface contamination contributes to the anomalies observed in the spectrometer data, the results of all the surface surveys indicate that the maximum anomaly occurs over the zone of shallowest mineralisation. The shape and relative amplitude of the anomalies detected by the radon, total-count gamma, and gamma-spectrometer (uranium) surveys are very similar. Neither the gamma nor alpha detection methods appears to reflect the size or grade of buried mineralisation.

Total-count gamma and gamma-spectrometer surveys proved to be more convenient prospecting tools than either of the radon methods used. However, a distinct advantage of the radon method was the avoidance of the effects of surface contamination. Emanometry proved to be more efficient than the Alphameter surveys provided the emanometer results were normalised by calculating the ratio of the counts in the 5th and 1st minutes.

The down-hole spectrometer proved to be unsatisfactory for quantitative, high-sensitivity analyses of radio-element concentrations. This problem is partly the result of inadequacies of the instrumentation used (particularly the lack of automatic gain stabilisation), inadequate knowledge of the calibration constants, and effects of geological noise such as radon accumulation and disequilibrium. However, the down-hole spectrometer results show that the mineralisation at Austatom forms a wedge up to 5 m thick which deepens to the west and north. The maximum grade of uranium mineralisation detected by BMR drilling was approximately 700 ppm. The down-hole spectrometer results also indicate a fairly sharp cutoff in the concentration of uranium away from the mineralised zone.

9. REFERENCES

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TABLE 1

COMPARISON OF APPARENT URANIUM CONCENTRATION DETERMINED BY SURFACE AND DOWN-HOLE SPECTROMETRY, AND LABORATORY ASSAY

Hole	eU ppm (surface spectrometry)	eU ppm (down-hole spectrometry)		U ppm (XRF analyses @ approx. 1 m)*
		1 m	10 m	
PC64	36.9	-	51.9	14.0 (approx. 2.5 m)
PC65	2.7	5.0	3.9	4.3
PC66	3.6	7.4	1.4	9.5
PC67	2.3	8.5	-	3.2
PC68	-	46.0	-	48.0 (approx. 1.5 m)
PC69	7.1	16.5	5.1	31.0
PC70	7.4	13.0	25.0	22.0
PC71	46.4	59.3	16.7	120.0 (approx. 3.5 m)
PC72	12.6	13.3	8.0	17.0
PC73	5.6	7.1	1.4	-
PC74	7.4	13.8	-	2.9

* Note samples were cuttings collected over an interval of approximately 1 m.

APPENDIX I: DETAILS OF GAMMA-RAY SPECTROMETER INSTRUMENTS

	Ground Spectrometer				Down-hole Spectrometer			
Type (Serial number)	DISA-400A portable 4-channel differential spectrometer (No. AE-071)				GR-410A 4-channel differential spectrometer (No. 2849)			
Manufacturer	Geometrics/Exploranium				Geometrics/Exploranium			
Detector	NAI-21				GBP-200			
NaI(Tl) xtal dimensions (volume)	7.6 x 7.6 cm (350 cm^3)				7.6 x 3.5 cm (73 cm^3)			
Stripping ratios	0.65, 0.80, 1.10, 0.06				2.85(?), 3.45(?), 1.15(?), 0.02(?)			
System deadtime	-				14 x 10^{-6} sec			
CHANNEL	1	2	3	4	1	2	3	4
Window (MeV)	+0.4	1.36-1.56	1.66-1.86	2.42-2.82	0.5-3.0	1.36-1.56	1.66-1.86	2.46-2.78
Principal isotope	-	K-40	Bi-214	Tl-208	-	K-40	Bi-214	Tl-208
Background (cpm)	570	19	11	7.5	-	-	-	-
Sensitivity constant	660 cpm/μR/hr	170 cpm/%K	19 cpm/ppm eU	8 cpm/ppm eTh		70(?) cpm/%K	6.9(?) cpm/ppm eU	0.9(?) cpm/ppm eTh

APPENDIX II - DOWN-HOLE SPECTROMETER RESULTS

Hole No.	Depth (m)	RAW COUNTS PER MINUTE				
		Ch 1	Ch 2	Ch 3	Ch 4	eU ppm
PC64	0.5	9040	199	196	11	24
	2.0	8450	241	157	6	20
	3.0	8070	172	158	5	20
	4.0	7690	174	141	3	19
	5.0	7985	160	126	4	16
	6.0	8520	194	144	4	19
	7.0	8140	182	146	3	20
	8.0	8910	216	178	2	25
	9.0	9680	213	221	8	29
	10.0	15035	471	367	7	50
	11.0	30120	1117	892	23	120
	12.0	62480	2508	2120	46	288
	13.0	97960	4226	3406	93	455
	14.0	138170	5911	4792	99	653
	15.0	74230	3018	2370	47	324
	16.0	29700	1053	819	14	113
	16.6	33160	1199	985	16	136
PC65	0.5	5100	59	34	2	4
	1.0	5260	58	42	1	5
	2.0	5500	61	54	1	7
	3.0	5940	75	68	2	9
	4.0	5820	67	48	3	6
	5.0	6430	109	80	4	10
	6.0	5780	83	63	8	6
	7.0	5360	70	40	3	4
	8.0	5300	55	37	2	4
	9.0	5510	61	59	4	7
	10.0	5095	43	43	4	4
	11.0	5000	45	38	4	4
	12.0	5500	62	61	5	7
	13.0	6010	79	64	1	9
	13.8	5960	70	51	7	4

Hole No.	Depth (m)	RAW COUNTS PER MINUTE				
		Ch 1	Ch 2	Ch 3	Ch 4	eU ppm
PC66	0.5	5870	95	66	2	9
	1.0	5900	83	63	3	8
	2.0	5165	63	44	2	5
	3.0	5060	50	37	2	4
	4.0	4830	54	35	2	4
	5.0	4850	38	28	6	2
	6.0	5140	56	36	2	4
	7.0	4850	38	24	2	3
	8.0	5330	58	45	3	5
	9.0	5560	65	54	5	6
	10.0	4965	39	27	4	2
	11.0	4690	39	31	2	4
	12.0	5290	51	24	1	3
	13.0	5480	57	48	9	3
	14.0	5220	50	34	2	4
	15.0	5710	48	54	6	5
	16.0	5320	35	33	1	4
	16.5	5015	32	32	3	3
PC67	0.5	5960	78	69	5	8
	1.0	5380	65	65	1	9
	2.0	4750	39	27	4	1
	3.0	4800	25	29	3	3
	4.0	4650	29	23	5	1
	5.0	4630	34	25	3	2
	6.0	4520	23	16	1	2
	7.0	4630	33	14	4	0
	8.0	5090	44	33	3	3
	9.2	4855	43	38	4	4
PC68	0.5	15240	483	357	9	48
	1.0	13200	370	323	5	44
	2.0	16060	510	425	7	59
	3.0	13810	397	336	8	45
	4.0	21590	751	634	9	88
	5.0	20155	685	611	15	82
	6.0	18400	583	486	16	64
	7.0	17870	637	484	14	64

Hole No.	Depth (m)	RAW COUNTS PER MINUTE				
		Ch 1	Ch 2	Ch 3	Ch 4	eU ppm
PC68 contd.	8.0	30070	1091	999	16	138
	9.0	23225	808	695	13	95
PC69	0.5	7880	150	29	7	1
	1.0	8010	152	140	9	16
	2.0	6825	110	95	4	12
	3.0	6830	108	87	3	11
	4.0	5700	63	58	6	6
	5.0	5610	65	64	4	8
	6.0	5430	70	52	4	6
	7.0	6670	118	88	9	9
	8.0	5030	53	34	4	3
	9.0	5290	51	41	1	5
	10.0	5685	52	48	3	6
PC70	0.5	8040	189	131	10	15
	1.0	7390	134	117	9	13
	2.0	7710	171	115	7	14
	3.0	6900	119	88	5	10
	4.0	6930	112	85	4	10
	5.0	7920	162	125	7	15
	6.0	17000	540	454	9	62
	7.0	13460	391	309	9	41
	8.0	10630	281	221	4	30
	9.0	10420	249	200	5	27
	10.0	9365	228	179	3	25
	11.0	7990	171	136	4	18
	12.0	7480	136	112	10	12
	12.6	8100	163	129	6	16
PC71	0.5	4355	471	355	9	47
	1.0	15840	470	424	10	57
	2.0	21050	670	589	10	81
	3.0	25960	925	741	13	102
	4.0	13160	400	316	12	41
	5.0	13110	392	330	5	46
	6.0	8970	186	186	9	23
	7.0	9670	253	199	5	27

Hole No.	Depth (m)	RAW COUNTS PER MINUTE				
		Ch 1	Ch 2	Ch 3	Ch 4	eU ppm
PC71 contd.	8.0	8270	194	134	3	18
	9.0	7840	165	141	7	17
	10.0	7490	146	130	5	17
	11.0	6560	110	108	3	14
	12.0	6500	113	90	3	12
	13.0	6750	114	106	2	14
	14.0	5810	85	58	2	7
	15.0	5960	86	61	4	7
	16.0	5680	72	74	3	9
	17.0	6390	98	88	4	11
	17.6	6405	104	93	4	12
PC72	0.5	7130	142	113	6	14
	1.0	7440	146	122	10	13
	2.0	8425	197	168	7	22
	3.0	7280	155	139	6	18
	4.0	6720	114	121	6	15
	5.0	5780	97	73	5	8
	6.0	5400	91	48	5	5
	7.0	5650	126	44	7	3
	8.0	6110	118	61	8	5
	9.0	5780	120	60	3	7
	10.0	5730	92	70	4	8
	11.0	5420	69	55	2	7
	12.0	5180	76	27	4	2
	13.0	5530	80	66	6	7
	14.0	5900	95	64	3	8
	15.0	5620	87	54	7	5
	15.4	5900	89	67	7	7
PC73	0.5	6170	93	93	8	10
	1.0	5860	77	76	8	8
	2.0	6055	94	86	7	9
	3.0	5670	72	61	9	5
	4.0	5080	57	36	6	3
	5.0	4830	48	29	4	2
	6.0	5250	57	51	5	5

Hole No.	Depth (m)	RAW COUNTS PER MINUTE				
		Ch 1	Ch 2	Ch 3	Ch 4	eU ppm
PCPC73	7.0	5460	61	40	8	2
	8.0	5190	38	54	5	6
	9.0	5350	67	63	6	7
	10.0	4545	25	24	3	2
	11.0	5150	51	57	4	7
	12.0	4870	39	32	2	4
	13.0	5235	47	40	3	4
PC74	0.5	7500	157	140	11	16
	1.0	7210	147	128	11	14
	2.0	6580	123	88	3	11
	3.0	6490	119	106	7	12
	4.0	5810	96	75	5	9
	5.0	5420	75	67	2	9
	6.0	5080	56	33	4	3
	7.0	4720	41	29	1	4
	7.3	4975	51	48	5	5

APPENDIX III - ANALYSES OF AUGER SAMPLES

Hole	Sample interval (m)	K%*	U**ppm	Th**ppm
PC 64	2 - 3	0.08	14	12
PC 64	14 - 15	0.17	520	22
PC 64	15 - 16	0.18	700	18
PC 65	0 - 2	0.05	4.3	12
PC 66	0 - 2	0.12	9.5	22
PC 67	0 - 2	0.10	3.2	22
PC 68	1 - 2	0.10	48	18
PC 68	8 - 9	1.12	61	28
PC 69	0 - 2	0.14	31	28
PC 70	0 - 2	0.10	22	32
PC 70	6 - 8	0.25	49	14
PC 71	3 - 4	0.08	120	16
PC 71	10 - 12	0.03	11	18
PC 72	0 - 2	0.09	17	28
PC 74	6 - 8	0.10	2.9	12

* Analyses by AAS

** Analyses by XRF