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Rio Tinto Exploration Pty. Limited
A.C.N. 000 057 125
A member of the Rio Tinto Group

EL 9318 – Branch Creek
Partial Relinquishment Report
for the Period Ending 4 November 1998

G. M. Rheinberger
November 1998

Report No. 24130

RIO TINTO EXPLORATION PTY. LIMITED

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Date: November 1998

Report No.: 24130

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Principal Geologist

Accepted By: G.J. Drew
Chief Geologist
Eastern District

ABSTRACT

Exploration Licence 9318 Branch Creek was granted to CRA Exploration Pty Limited (now Rio Tinto Exploration Pty Limited) on the 5th of November, 1995 for a period of 6 years. The tenement is located adjacent to the Northern Territory/Queensland border, approximately 35 km south of Wollogorang Station.

The licence area is considered prospective for U-(Au) mineralisation similar to identified U resources at Westmoreland, Qld. Proximity to the major northwest trending Calvert Fault also raises the potential for diamoniferous kimberlitic diatremes within the EL.

Statutory tenement reductions have been completed in 1997 (96 sub-blocks) and 1998 (48 sub-blocks).

48 sub-blocks (157 km^2) remain under title. This report details exploration activities on the area relinquished in November 1998.

Exploration activities on the relinquished sub-blocks have comprised diamond sampling, stream sediment sampling, reassay of existing stream sediment sample pulps, rock chip sampling, and helicopter spectrometry.

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1. CONCLUSIONS AND RECOMMENDATIONS

EL 9318 Branch Creek was granted to CRA Exploration Pty Limited (now Rio Tinto Exploration Pty Limited - RTE) on the 5th of November, 1995 for 6 years. The licence area is considered prospective for U-(Au) mineralisation, particularly at the Seigal Volcanics-Westmoreland Conglomerate contact and for diamoniferous diatremes. Statutory tenement reductions have been completed in 1997 (96 sub-blocks) and 1998 (48 sub-blocks).

Three –2mm gravel and -80# geochemical samples were collected within the relinquished area. An additional three –80# samples from a previous survey (on a different title) were reassayed for selected elements.

High grade copper / silver mineralisation reported from rock chip sampling of the Dianne workings is considered to be vein-style and breccia-hosted within basalt of the Seigal Volcanics.

A total of 19.3 km^2 over two areas was flown with detailed helicopter spectrometry. Eight anomalies were recognised from this survey with five associated with known uranium workings. The remaining anomalies are not considered significant.

No further work is recommended within the relinquished area.

2. INTRODUCTION

EL 9318 Branch Creek was granted to CRA Exploration Pty Limited (now Rio Tinto Exploration Pty Limited - RTE) on the 5th of November, 1995 for 6 years. The tenement is located adjacent to the Northern Territory/Queensland border, 35km south of Wollogorang Station (Plan Ntd 6850).

The licence area is considered prospective for U-(Au) mineralisation, particularly at the Seigal Volcanics-Westmoreland Conglomerate contact and for diamoniferous diatremes.

Statutory tenement reductions have taken place in November 1997 (96 sub-blocks; 50 %) and November 1998 (48 sub-blocks; 50 %). This report details exploration completed on the area relinquished in November 1998.

3. GEOLOGY

Branch Creek EL covers a sequence of Middle Proterozoic sediments and volcanics (Tawallah Group) of the McArthur Basin sequence which flank the northern margin of the Early Proterozoic Murphy Metamorphic Inlier. A detailed description of the regional geology and metallogy can be found in Jackson et al

(1987) and Ahmad and Wygralak (1989). The stratigraphic succession is summarized in Table 1 and is outlined below.

The Murphy Metamorphics are a sequence of isoclinally folded and greenschist facies metasediments which are conformably overlain by felsic volcanic/pyroclastic sequence (Cliffdale Volcanics), both of which are intruded by granite/adamellite of the Nicholson Granite Complex. The Cliffdale Volcanics are restricted to the south-eastern portion of the EL.

The igneous and metamorphic complexes of the Murphy Inlier are overlain with angular unconformity and disconformity by the Tawallah Group, the basal part of the McArthur Basin sequence.

The Westmoreland Conglomerate is the oldest unit of the Tawallah Group and consists of a thick sequence (up to 1800m) of fluvial arkosic conglomerate and quartz arenite. Permeable lithofacies within the Westmoreland Conglomerate host uranium mineralisation. The unit forms northwest trending dip slopes in the southern portion of the EL where it is largely confined to northwest trending fault zones.

The Seigal Volcanics outcrop throughout the majority of the licence area forming a northeast trending belt of tholiitic basic lavas with minor tuff interbeds which conformably overlie the Westmoreland Conglomerate. A thin (up to 20m) arenaceous and conglomeratic sequence called the Carolina Sandstone Member occurs as lenses within the Seigal Volcanics.

The McDermott Formation conformably overlies the Seigal Volcanics in the north-western portion of the EL and is characterised by alternating beds of shallow-water marine arenites, shale and dolostone.

The McDermott Formation is conformably overlain by the Sly Creek Sandstone sequence which grades upwards into the glauconitic sandstones of the Aquarium Formation.

The entire Proterozoic sequence has undergone gentle flexuring and fault reactivation. The Phanerozoic records minor Cambrian and Cretaceous marine transgressions during which thin veneers of sediment were deposited.

Cretaceous siltstones and sandstones of the Mullaman Beds are scattered across the western and southern portions of the EL. Tertiary and Quaternary aged soil, sand and feruginous detritus cover areas in the northern and western portion of the EL.

The Calvert Fault is a major northwest-trending wrench fault occurring in the south west corner of the EL.

Table 1: Stratigraphy of EL 9318, Branch Creek

Cretaceous			Mullaman Beds	Siltstone, sandstone
	Mid-Proterozoic	Tawallah Group	Aquarium Formation	Glauconitic sandstone, shale and dolomite
			Sly Creek Sandstone	Quartz arenite, conglomerate interbeds
			McDermotts Formation	Arenite, dolostone, siltstone and chert
			Seigal Volcanics	Basic lavas; sandstone and siltstone interbeds
			Westmoreland Conglomerate	Quartz - feldspathic sandstone; conglomerate
Lower Proterozoic	Murphy Metamorphic Inlier		Cliffdale Volcanics	Dacite; rhyodacite and rhyolite
			Nicholson Granite	Coarse-grained porphyritic biotite granite

4. EXPLORATION COMPLETED ON RELINQUISHED SUB-BLOCKS

Exploration by Rio Tinto on the relinquished sub-blocks has focused on regional exploration for U-(Au) of similar style to that known at Westmoreland, Queensland and for diamond bearing intrusives.

Helicopter supported gravel and stream sediment sampling was undertaken and pulps from previous stream sediment samples were re-assayed for U, Bi and Mo. Detailed helicopter spectrometry over 19.3 km^2 was also completed.

4.1 Gravel Sampling

A regional helicopter-supported gravel sampling programme was conducted during the 1996 field season. Three -2mm samples were collected from heavy mineral trap sites. All samples were processed at

the Rio TInto laboratory in Perth for kimberlitic indicator (KI) mineral observation. Gravel sample co-ordinates and results are listed in Table 2. Sample locations are presented on Plan NTm 185.

Table 2: Gravel Sample Results

Sample	AMG (E)	AMG (N)	Zone	DPO	KI Result	Size
5594433	798894	8064380	53	87659	Negative	
5594434	807800	8060400	53	87659	3 Chromite 6 Chromite	0.4 0.25
5594438	815250	8061800	53	87659	1 Chromite 7 Chromite	0.4 0.25

4.2 Stream Sediment Sampling

Three -80# stream sediment samples were collected throughout the relinquished area of the tenement in conjunction with the gravel sampling. Stream sediment from an active part of the drainage was dry sieved to -80# and approximately 100g of sample collected. The samples were sent to AMDEL Laboratory in Darwin for preparation and assay. A suite of 25 elements were assayed as follows; Au by Fire Assay, Ag, As, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, La, Mg, Mn, Mo, Na, Ni, P, Pb, Sb Ti, Th, U and Zn by ICP-OES/ICP-MS; and Ba by XRF. Sample sites are shown on plan NTm 185. Sample ledgers and assay results are included in Appendix I.

4.3 Sample Re-assay

Previous -80# stream sediment samples collected by CRAE in conjunction with gravel samples during the early 1990s (EL 7187) were not assayed for U. Pulps of eight samples were recovered from storage. These were submitted to Amdel Laboratories in Adelaide and assayed for U, Bi and Mo by ICPMS. Three samples came from relinquished ground. Sample location are shown on plan NTm 185 and results are presented in Appendix 2.

4.4 Rock Chip Sampling

Five mineralised rock chip samples taken from a small vein-style Cu working (Dianne) were analysed to assess the possibility of associated high Co. Results returned high Cu (up to 15.5% Cu and 41.5 ppm Ag) with no significant Co. Mineralisation appears to be vein-style and breccia-hosted within basalt of the Seigal Volcanics.

Sample locations are shown on plan NTm 185. Rock chip sample ledgers and assay results are presented in Appendix 3.

4.4 Helicopter Spectrometry

A total of approximately 433 line kilometres of 50 m spaced, 25 m elevation helicopter spectrometry was completed over two areas (30.2 km^2 in total) within EL 9318. The areas were selected to cover sections of the Main Range Fault (McArthur Basin/Murphy Inlier contact), the Seigal Volcanics/Westmoreland Conglomerate contact and known significant workings.

The areas are located on Plan NTm 186. The survey was part of a larger program completed within Queensland by World Geoscience Corporation for Rio Tinto Exploration.

Survey details, technical specifications and processing details are contained within Appendix 4 but in summary :

Flight line spacing	50 m
Flight line direction	various
Tie line spacing	500 m
Tie line direction	orthogonal to flight lines
Sensor height	25 m
Magnetometer model	Scintrex CS-2 Caesium vapour
Magnetometer sample interval	2.5 - 3.5 m
Spectrometer model	Picodas PGAM 1000 Ver 6.11
Detector volume	33.56 litres
Spectrometer sample interval	25 - 35 m

Data for each area are presented at 1 : 25000 contour plots for total magnetic intensity, potassium, uranium and thorium. Flight line maps are also presented at 1 : 25000 scale.

Table 2 gives the approximate centre co-ordinates and maximum uranium counts for each uranium anomaly recognized. Anomalies are located on Plan NTm 186.

Table 3 : Uranium Anomaly Details

Anomaly	AMGE	AMGN	Order	Max U cps	Comment
30/1	801667	8063200	2	121	Co-incident with McGuiness workings (uranium)
30/2	800416	8062925	3	42	Co-incident with White Horse workings (uranium)
30/3	801626	8061135	3	52	Intersection of north and north-east trending faults
30/4	801985	8062697	3	60	El Hussen Fault
31/1	807592	8061038	1	295	Cobar II workings
31/2	807558	8060796	1	320	Cobar II workings
31/3	807632	8060433	2	130	Cobar II workings
31/4	805818	8059728	3	75	Contact Westmoreland Conglomerate and Seigal Volcanics

Area 30

Area 30 encompasses 11 km^2 (244 line kilometres) covering approximately 10.2 km of contact between Westmoreland Conglomerate and the overlying Seigal Volcanics. One second order and three third order uranium anomalies, all at or near this contact are evident.

Area 31

Area 31 encompasses 8.3 km^2 (189 line kilometres) covering approximately 6.7 km of contact between Westmoreland Conglomerate and the overlying Seigal Volcanics. The first and second order anomalies are associated with the Cobar II workings. The third order feature is located at the above contact.

5. REHABILITATION

No rehabilitation was necessary as there was no significant surface disturbance associated with the 1996 or 1997 work programmes. All fieldwork was helicopter supported.

6. REFERENCES

Ahmad M. & Wygralak A.S., 1989. 1:250 000 metallogenic map series explanatory notes and mineral deposit data sheets Calvert Hills SE53-8 NTBME/NTGS pub. NT Govt printer

Mackenzie, P.H., 1996. EL 9318 Branch Creek NT, First Annual Report for Year Ending 4th November 1996. CRAE Report 22573.

Pietsch, B. A.,. Plumb, K.A., Page, R.W., Haines, P.W., Rawlings, D.J. and Sweet, I. P., 1994. A Revised Stratigraphic Frame work for the McArthur Basin, N.T. in *Proceedings The AusIMM Annual Conference* pp 135-138 (The Australasian Institute of Mining and Metallurgy, Melbourne).

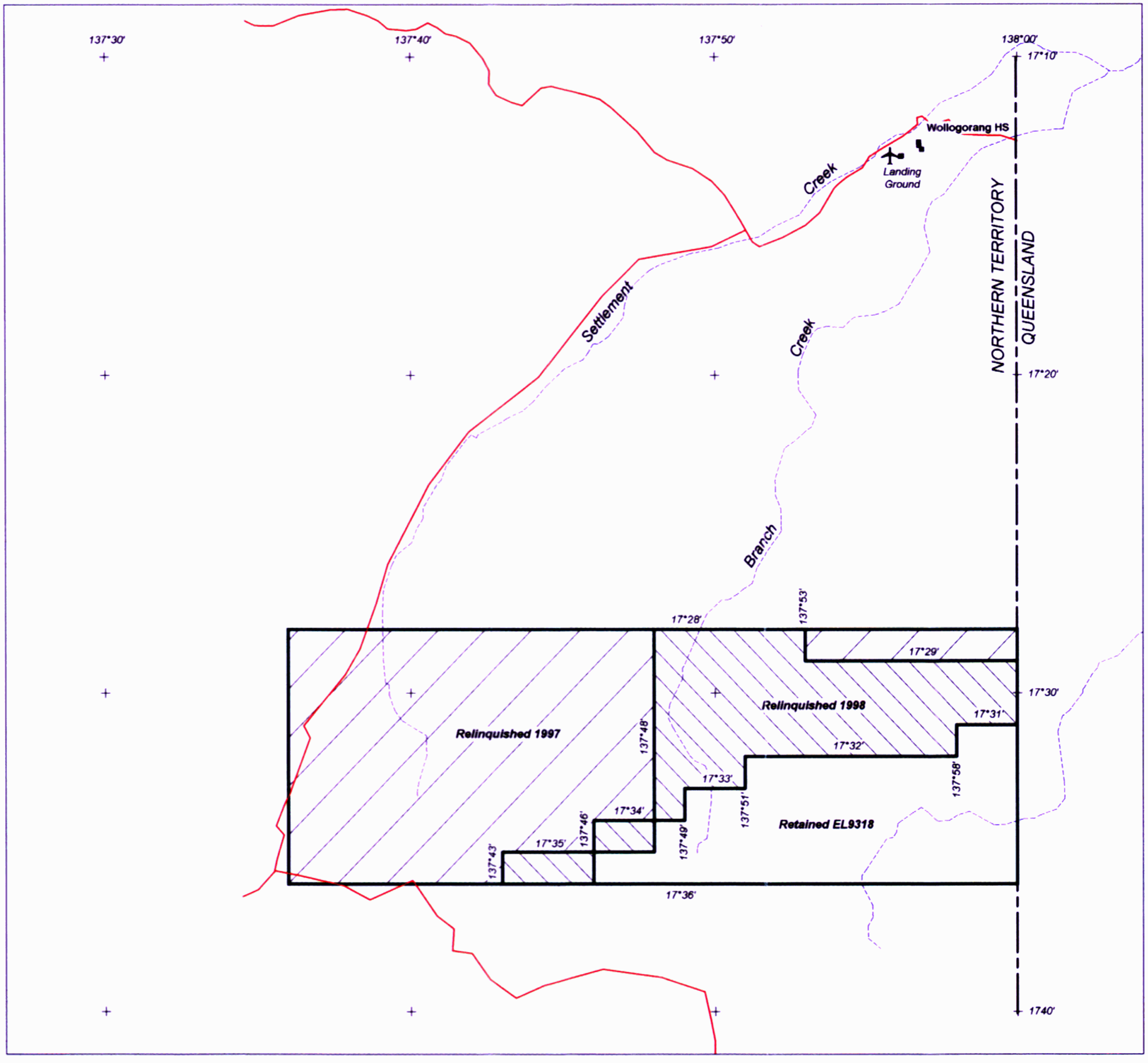
Wall, N.M. and Rheinberger, G., 1997. EL 9318 Branch Creek, Second Annual Report for the Year Ending 4th November 1997. RTE Report 23575.

7. LOCATION

Calvert Hills	SE53-08	1:250,000
Wollogorang	6463	1:100 000
Seigal	6362	1:100 000

8. KEYWORDS

McArthur Basin; Wearyan Shelf; Murphy Inlier; Proterozoic; Geochemistry - Stream Sediment Sampling; Gravel Sampling; Rock Chip Sampling; Basemetals; Diamonds; Kimberlite; Copper; Uranium; Gold.



Creek or River

Road

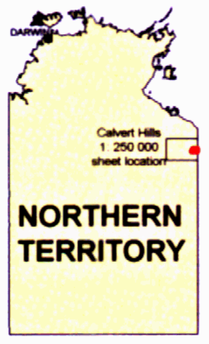
Building

Retained EL boundary

Relinquished EL Boundary 1997

Relinquished EL Boundary 1998

Locality Plan



0 10 20

Kilometres

RIO TINTO EXPLORATION PTY. LIMITED

EL 9318 BRANCH CREEK

LOCATION PLAN

(Reduction of Area)

Author :	N. Wall	Ref :	SE 53-08 Calvert Hills
Drawn :	T. Nguyen	File Ref :	Murphy\BranchCk\WTd6650 wor
Date :	19 - 9 - 1998	Report No :	24130
Scale :	1:250 000	Plan No :	NTd 6650

780000 mE 785000 mE 790000 mE 795000 mE 17°28' 800000 mE 805000 mE 810000 mE 815000 mE

8065000 mN

8060000 mN

8055000 mN

138°00'

5594773 (SS)
5594430 (G)

5594776 (SS)
5594433 (G)

5594443 - 446 (R)
5475949 (R)

Landing Ground

5594439 (G)

5594768 (SS)
5594425 (G)

5594770 (SS)
5594427 (G)

5594769 (SS)
5594426 (G)

3482871

3482867

5594777 (SS)
5594434 (G)

5594781 (SS)
5594438 (G)

3482866

Caterpillar Spring

5594771 (SS)
5594428 (G)

Crocodile Hole

5594775 (SS)
5594432 (G)

5594774 (SS)
5594431 (G)

5594772 (SS)
5594429 (G)

Retained EL 9318

Creek
Branch
Douglas
Debbil
Bearneck
Lagoon

780000 mE 785000 mE 790000 mE 795000 mE 17°36' 800000 mE 805000 mE 810000 mE 815000 mE

Legend

- Creek or River
- Vehicular Track
- Fence
- ×(SS) Stream Sed. Sample
- ×(G) Gravel Sample
- ⊙ (R) Rock Sample
- ▲ Pulp Reassay (-80# Stream Sediment Sample)
- Retained EL boundary
- Relinquished EL Boundary 1997
- Relinquished EL Boundary 1998

GN

-2 0 2 4 6 8 10km

RIO TINTO EXPLORATION PTY. LIMITED

EL 9318 Branch Creek
Relinquished Areas
Sample Location Plan

Author :	G.Rheinberger	Ref :	Calvert Hills SE53-08
Drawn :	G.O'Connell	File Ref :	NTm 185.wor
Date :	15/1/1999	Report No :	24130
Scale :	1:100,000	Plan No :	NTm 185

800000 mE
802500 mE
805000 mE
807500 mE
810000 mE
812500 mE
815000 mE
817500 mE
138°00'
-17°30'
8062500 mN
8060000 mN
8057500 mN
8055000 mN
8052500 mN
-17°36'

30/1
30/2
30/3
30/4

Area 30

31/1
31/2
31/3
31/4

Area 31

EL 9318 Area Relinquished Nov. 1998
EL 9318 Area Retained Nov. 1998

Northern Territory
Queensland

WH
Lagoon

EL 9318
Map Area
EL9318
Mt Isa

Branch Creek EL9318

1997 Helispec Survey
1997 Uranium Anomaly

Projection : UTM AMG Zone 53
Datum : AGD66
Digital drainage supplied by AGSO (Seigal 6462 1:100,000 sheet)

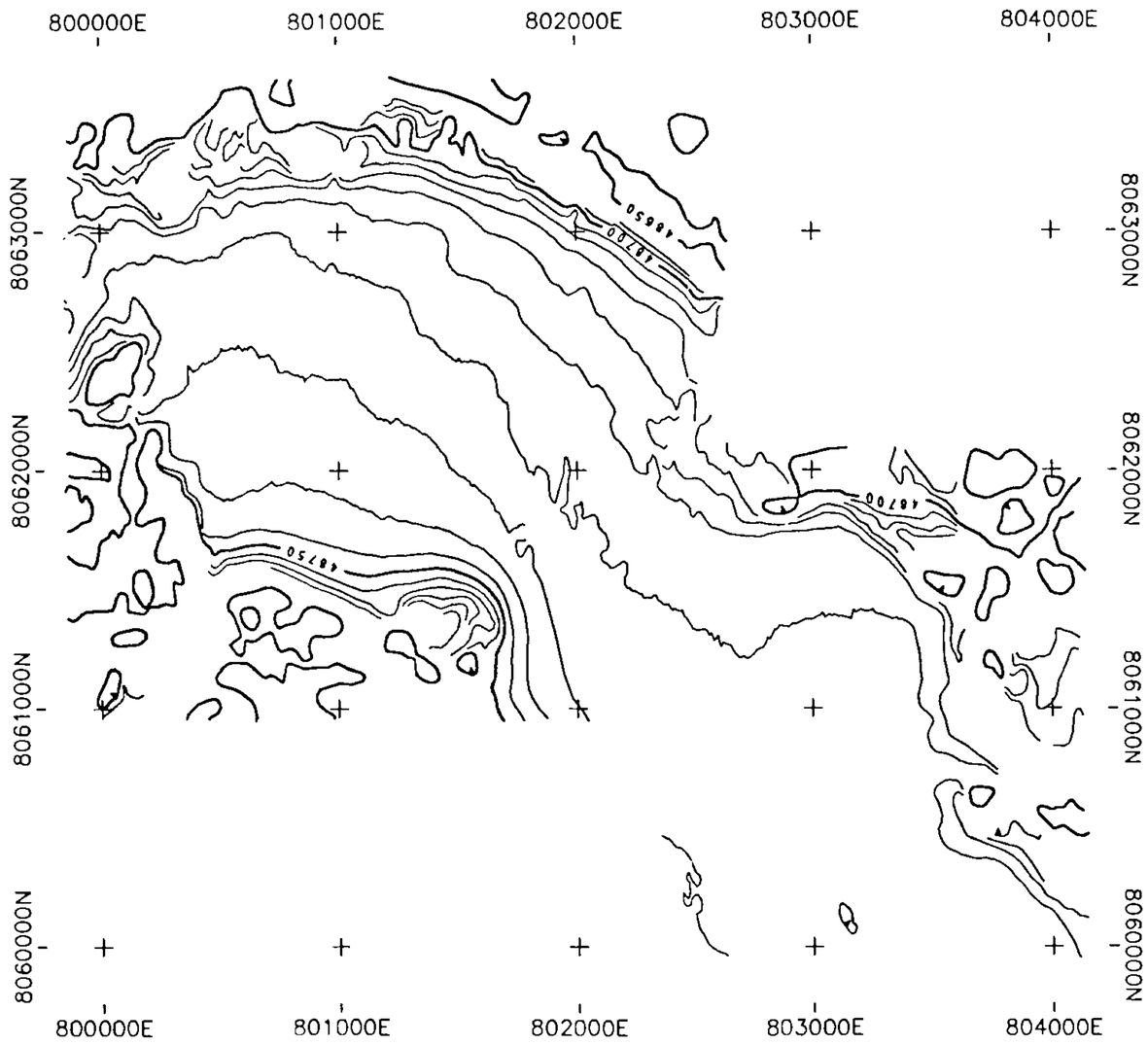
1000 0 1000 2000 3000
metres

RIO TINTO EXPLORATION PTY LIMITED

Branch Creek EL9318 - Relinquished Area

Helispec Survey Areas and Uranium Anomalies

Author: G. Rheinberger	Ref: Calvert Hills SE53-08
Drawn: G. O'Connell	File Name: NTm186.wor
Date: 15-1-99	Report No.: 24130
Scale: 1:50,000	Plan No.: NTm186



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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 30

Magnetic / Radiometric Survey

Q187mr

Magnetic Contours

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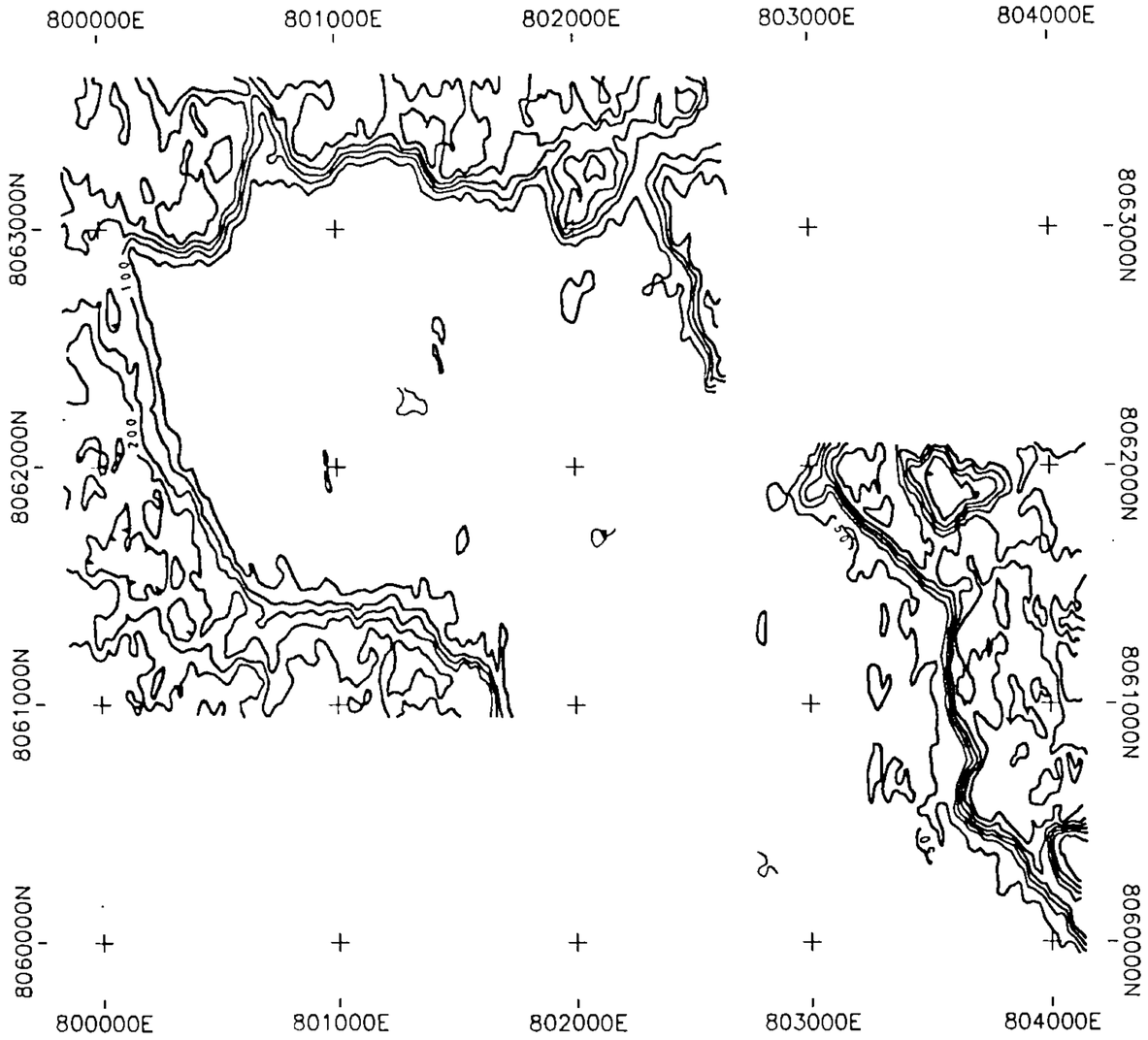

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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 30

Magnetic / Radiometric Survey

Q187mr

Potassium Contours

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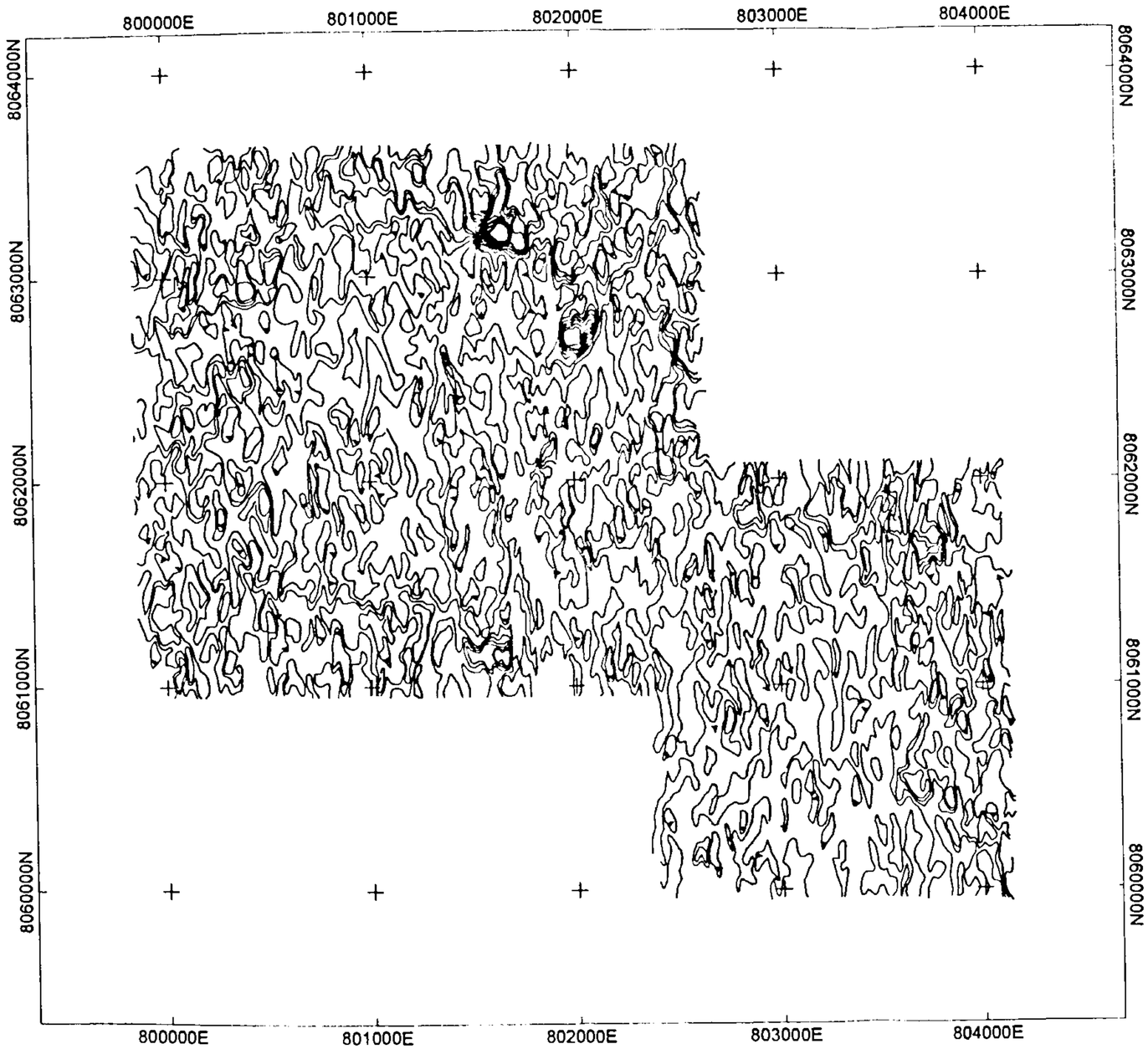

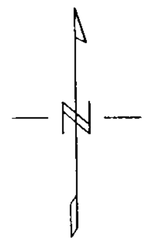

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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 30
Magnetics / Radiometic Survey
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Uranium Contours

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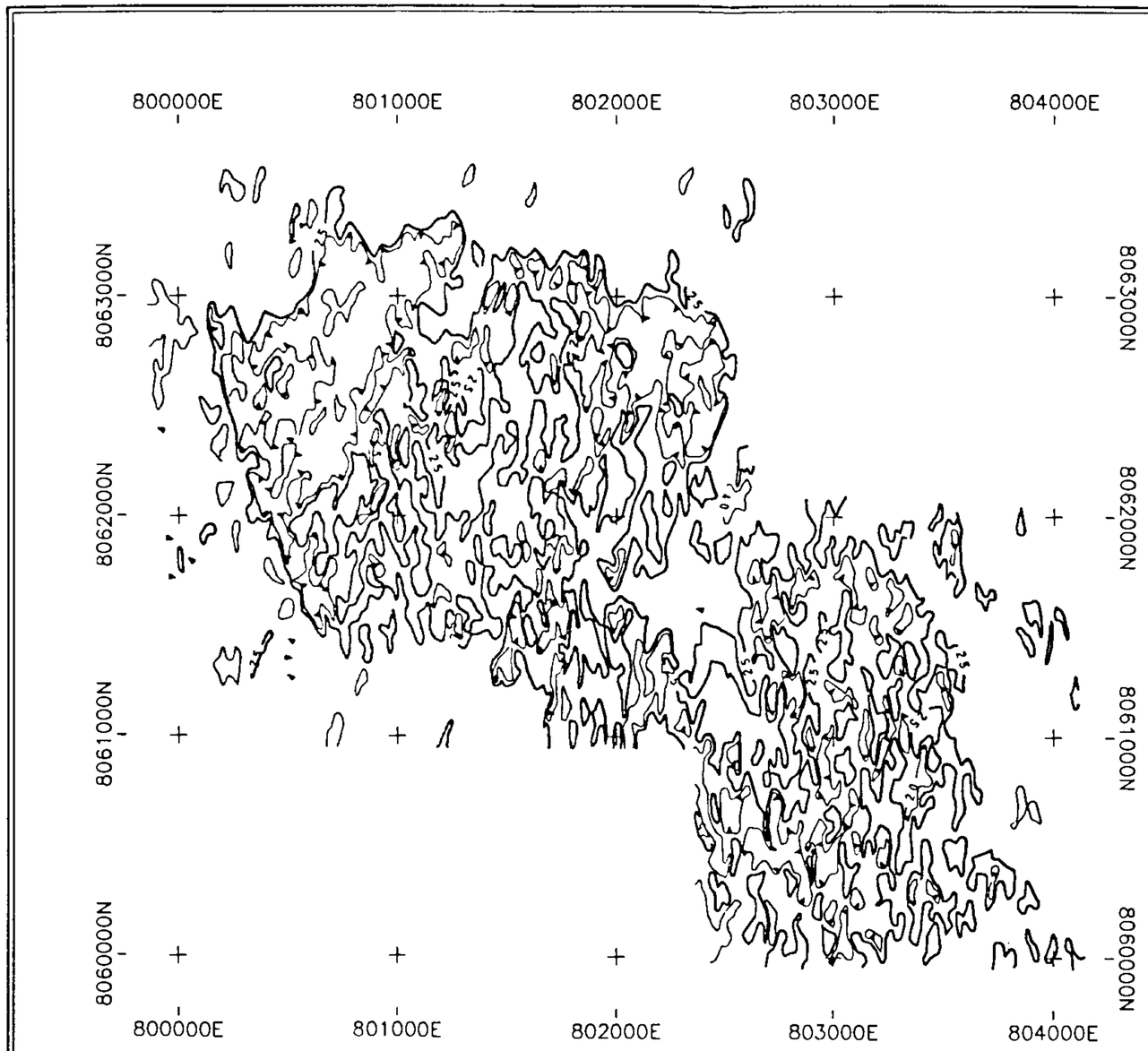

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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 30

Magnetic / Radiometric Survey

Q187mr

Thorium Contours

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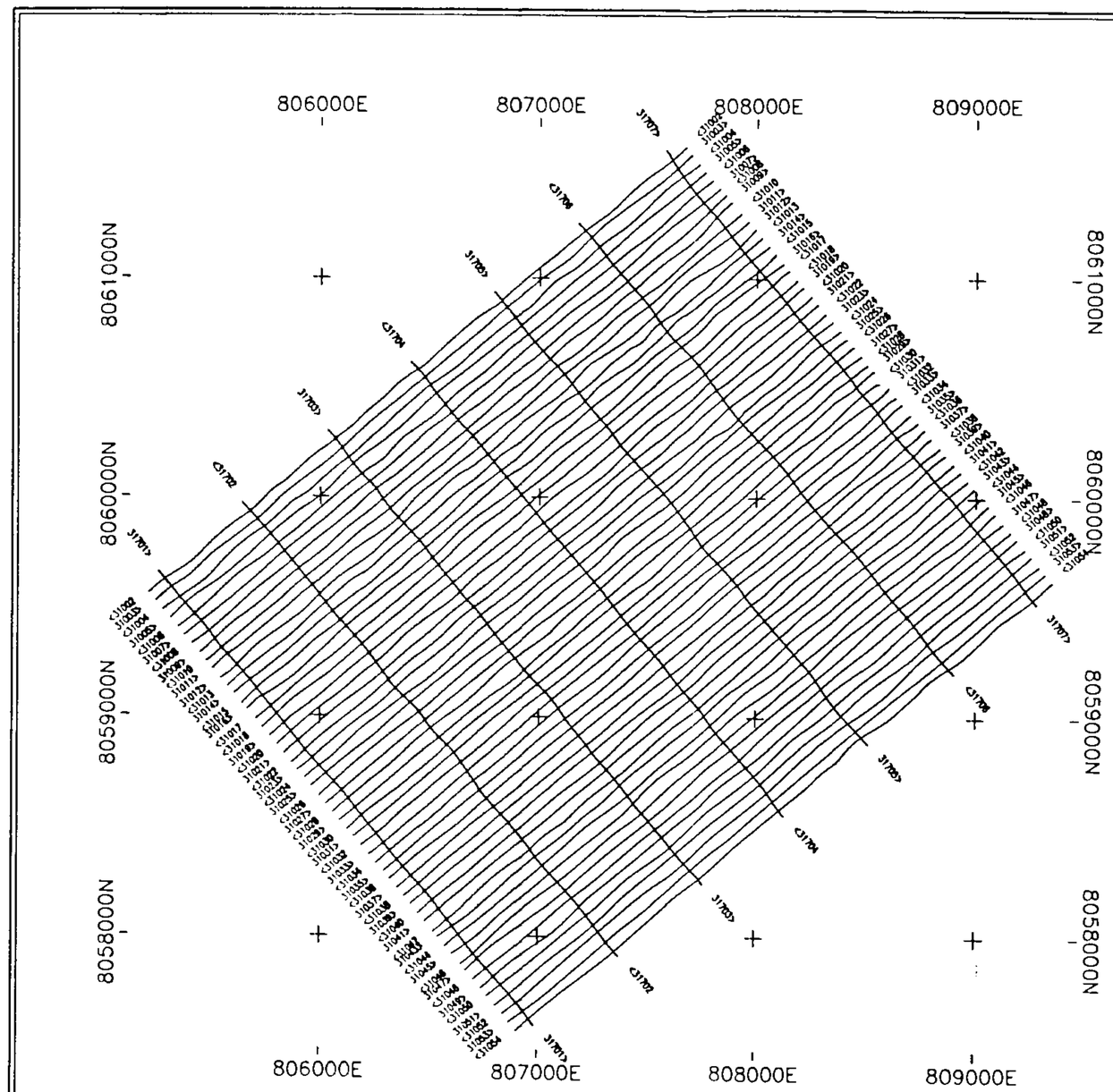

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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 31

Magnetic / Radiometric Survey

Q187mr

Flight Lines

AUTHOR	DRAWN	DATE	SCALE	REPORT
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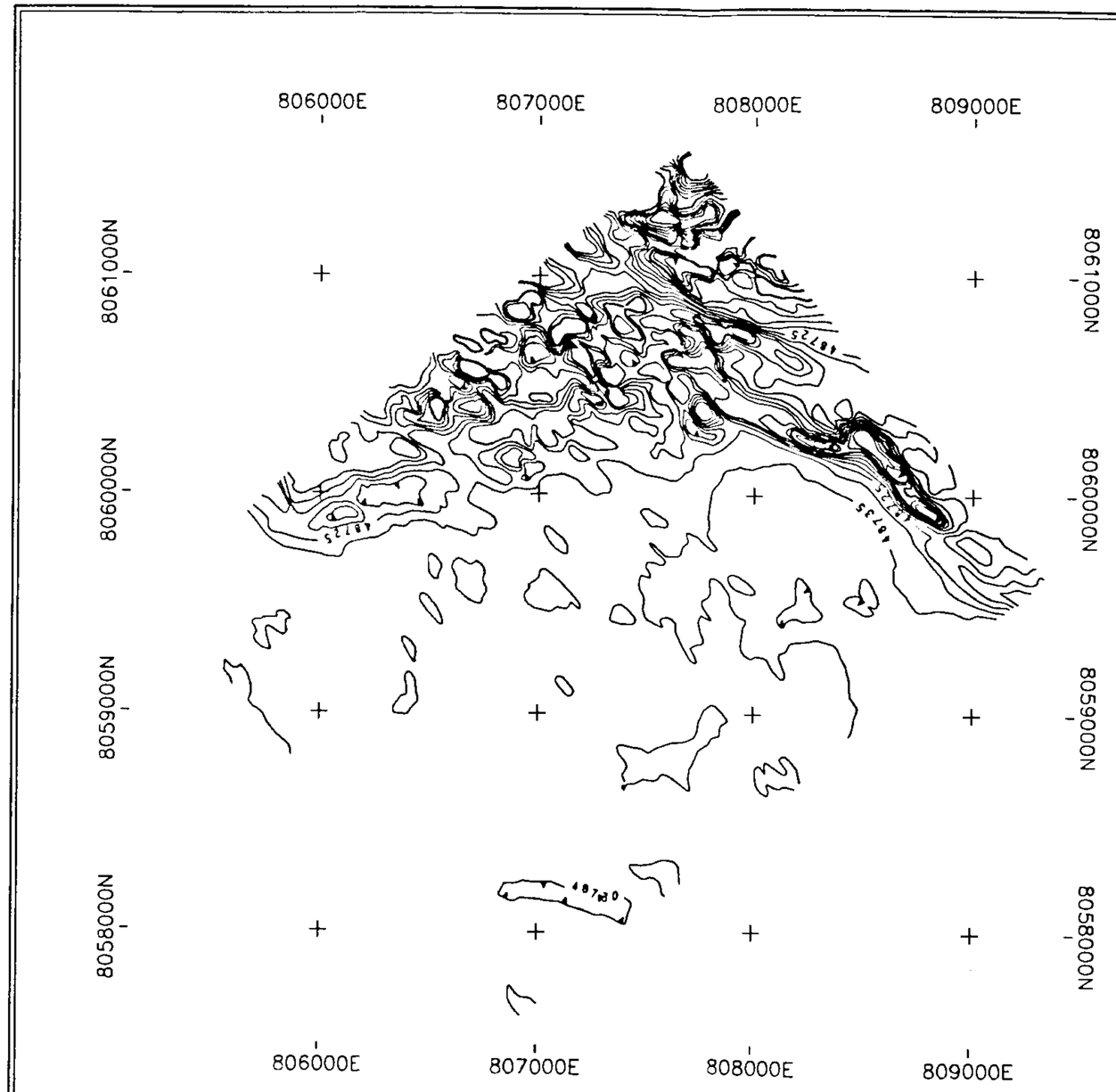

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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 31

Magnetic / Radiometric Survey

Q187mr

Magnetic Contours

AUTHOR	DRAWN	DATE	SCALE	REPORT
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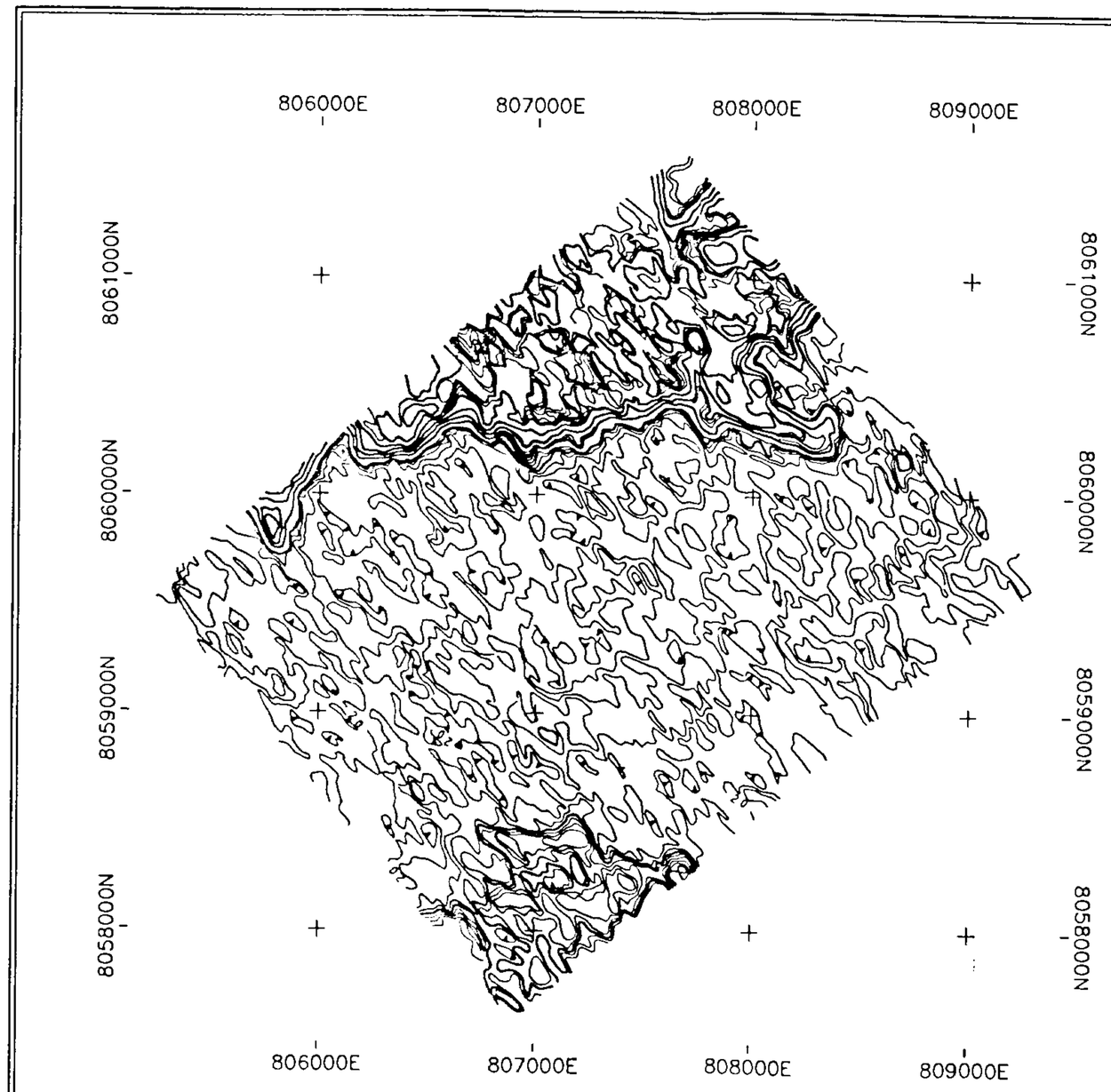

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CLIFFDALE AREA 31

Magnetic / Radiometric Survey

Q187mr

Potassium Contours

AUTHOR	DRAWN	DATE	SCALE	REPORT
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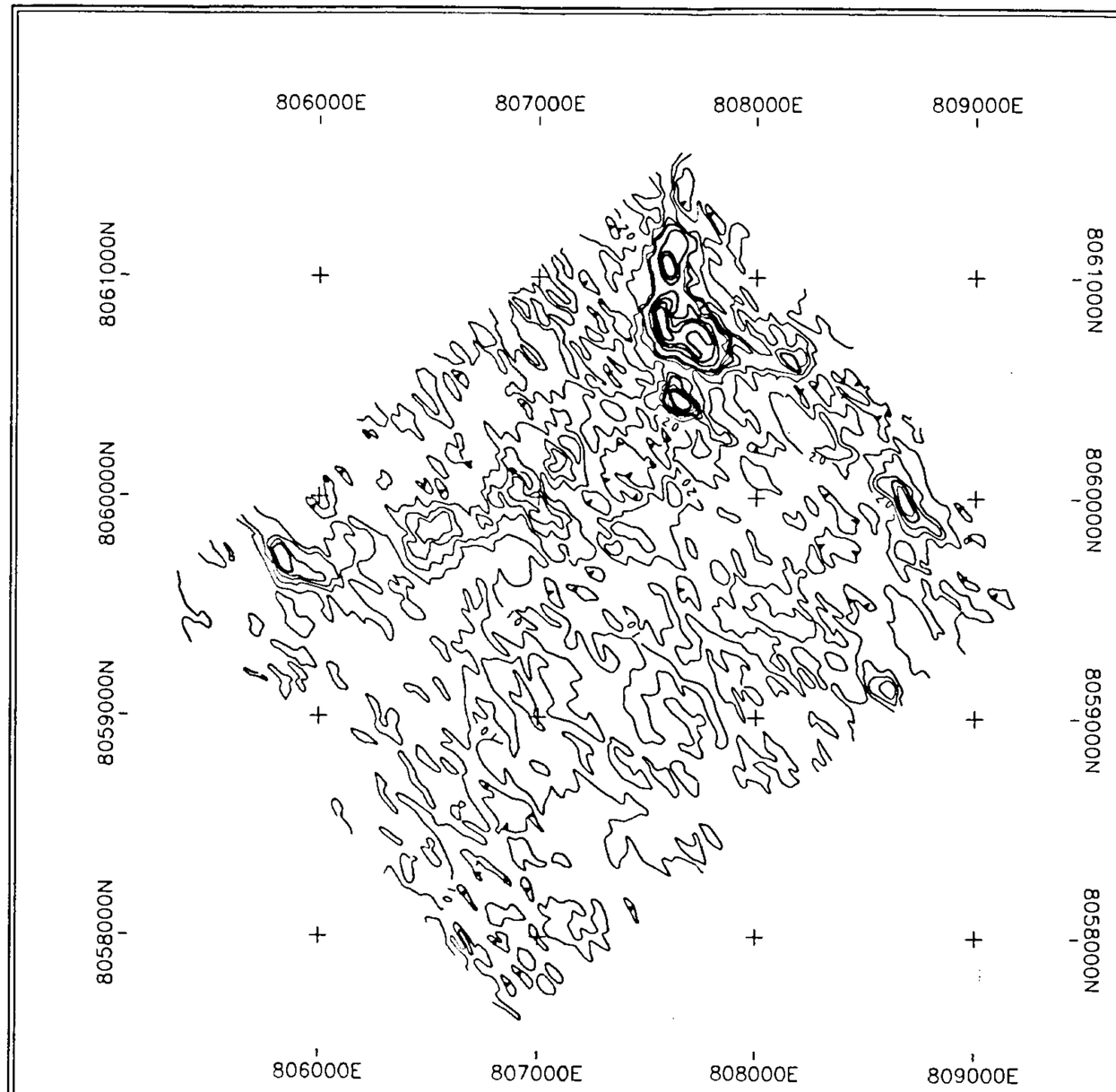

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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 31

Magnetic / Radiometric Survey

Q187mr

Uranium Contours

AUTHOR	DRAWN	DATE	SCALE	REPORT
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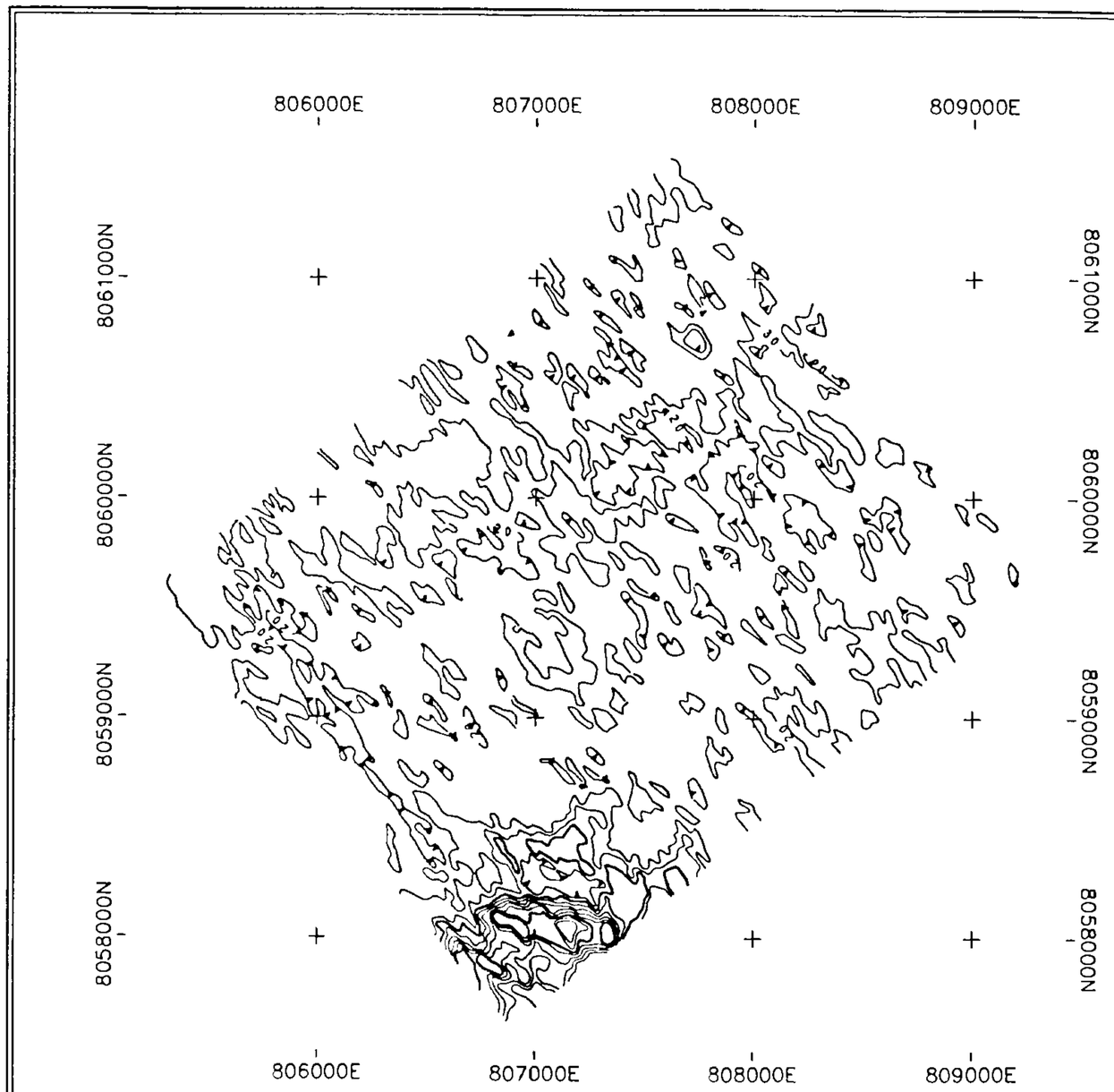

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(meters)

RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 31

Magnetic / Radiometric Survey

Q187mr

Thorium Contours

AUTHOR	DRAWN	DATE	SCALE	REPORT
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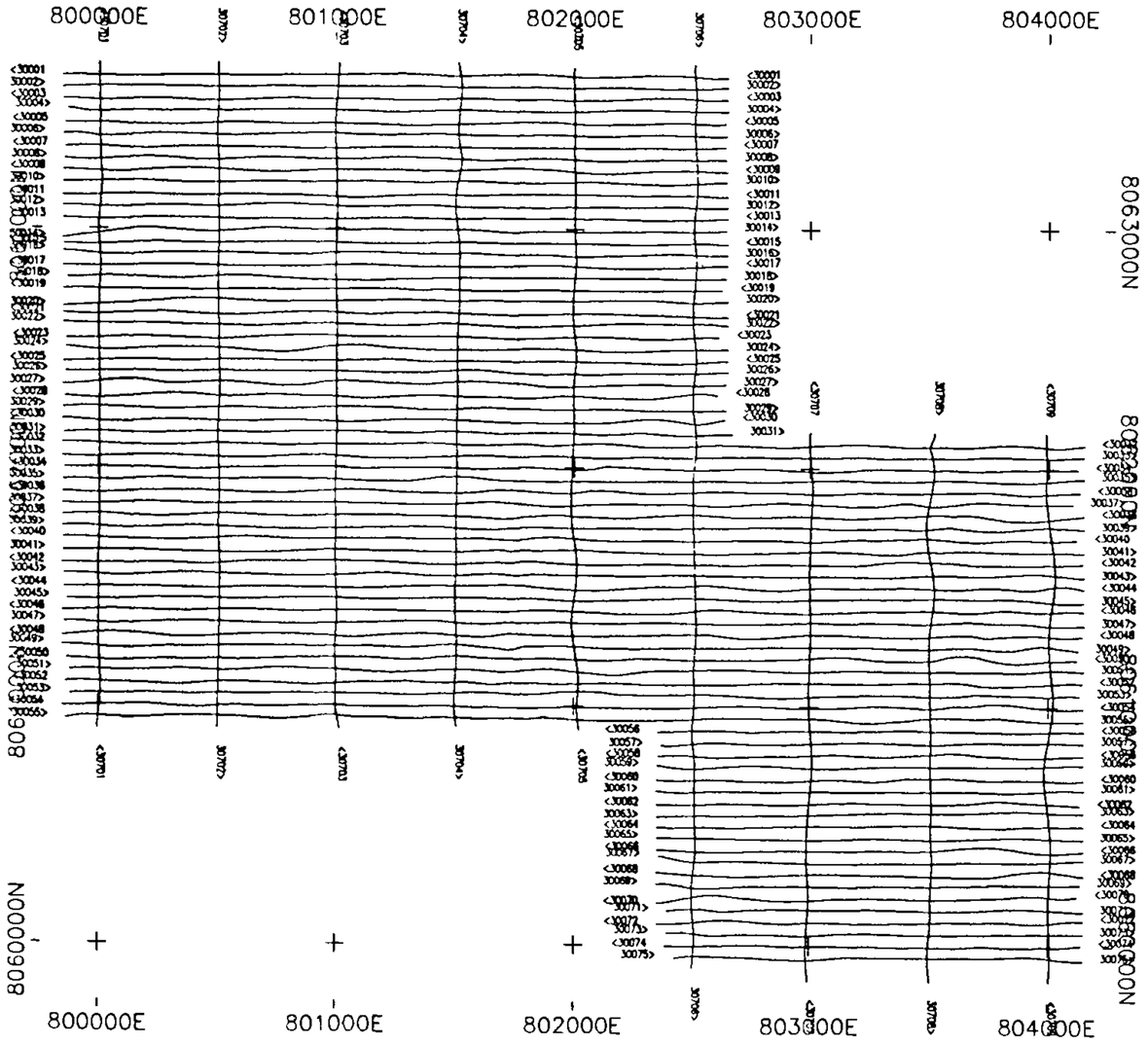

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RIO TINTO EXPLORATION PTY LIMITED

CLIFFDALE AREA 30

Magnetic / Radiometric Survey

Q187mr

Flight Lines

AUTHOR	DRAWN	DATE	SCALE	REPORT
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REF. Calvert Hills SE53-08		FILE	PLAN No NTd6659	

Appendix 1

EL 9318 – Branch Creek

Stream Sediment Sample Ledger and Results

Branch Creek Relinquished Area Stream Sediment Locations and Results

Sample	AMGE	AMGN	DPO	Size	Ag	As	Au	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	La	Mg	Mn	Mo	Na	Ni	P	Pb	Sb	Th	Ti	U	Zn
					ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	pp	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
5594776	798894	8064380	87657	80#	0.2	4	0	390	0.3	4600	0.2	41	99	180	59400	21400	31	13200	540	0.4	3450	54	200	16	0.6	13	7950	2.4	150
5594777	807800	8060400	87657	80#	-0.1	3	0	155	0.3	520	0.1	15	140	56	35900	4050	18	1300	370	1.7	220	39	300	9.5	0.4	7.5	5750	4.2	50
5594781	815250	8061800	87657	80#	-0.1	2	-0	460	0.2	5000	0.1	22	200	99	56700	21500	18	15500	490	-0	7250	79	340	14	0.2	5.5	8000	2.1	98

Appendix 2

EL 9318 – Branch Creek

Reassay Ledger and Results

Relinquished Area Reassayed StreamSediment Samples

Sample	AMGE	AMGN	Zone	Type	DPO	BI_PPM	MO_PPM	U_PPM
3482866	810225	8059400	53	-80#SS	75420	0.4	0.9	4
3482867	798650	8061250	53	-80#SS	75420	0.5	0.4	5
3482871	804100	8062775	53	-80#SS	75420	0.6	0.3	-4

Appendix 3

EL 9318 – Branch Creek

Rock Chip Sample Ledger and Results

CRA EXPLORATION PTY. LIMITED : ROCK SAMPLE ASSAY RESULTS

ELNAME BRANCH CK
ELNUMBER 9318
PROSPECT DIANNE

250,000 SHEET SE5308
100,000 SHEET 6462

SAMPLED BY PHM
DPO 87656

DATE 9/07/96
LAB AMDEL

SAMPLE	Ag	As	Au	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Pd	Pt	Th	U	V	Zn
5594443	0.3	3	-0.01	980	0.4	860	0.1	10	52	35	70100	14800	3450	600	2.1	430	18	155	15.5	0.001	-0.005	8	2.5	185	65
5594444	41.5	1.5	0.27	210	720	140	0.4	-2	34	122000	38600	15200	1350	45	28.5	210	4	320	24	0.012	-0.005	6	6	230	45
5594445	21.5	1.5	0.06	210	760	95	0.6	6	52	138000	25200	17700	13900	65	55	210	12	520	20	0.006	-0.005	6	8.5	330	30
5594446	13	8	-0.01	155	1000	200	0.3	-2	26	111000	284000	18200	760	120	18	130	3	1150	16.5	0.015	-0.005	3	18	1150	30
5475949	37.5	1.5	0.16	220	760	210	0.3	-2	46	155000	19300	39600	9000	5	48	35	13	250	25.5	0.002	-0.005	7	10	175	-5

Rockchip Detection Limits

	Ag	Au	As	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Pd	Pt	Th	U	V	Zn
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DET.LIM	0.1	0.01	0.5	5	0.2	10	0.1	2	2	2	100	10	10	5	0.2	50	2	10	0.2	0.005	0.001	2	0.02	2	5
SCHEME	IC3M	FA	IC3M	XRF1L	IC3M	IC3E	IC3M	IC3M	IC3E	IC3M	IC3E	IC3E	IC3E	IC3E	IC3M	IC3E	IC3E	IC3E	IC3M	FA	FA	IC3M	IC3M	IC3M	IC3M

CRA EXPLORATION PTY. LIMITED : ROCK SAMPLE LEDGER

EL NAME BRANCH CK
TENEMENT 9318
PROSPECT DIANNE

1:250,000 MAPSHEET CALVERT HILLS SE5308
1:100,000 MAPSHEET SEIGAL 6462
TECTONIC DOMAIN Mcarthur Basin

DATE 9/07/96

SAMPLE	TYPE	GEOL.	EAST	NORTH	ZONE	REG STRAT	LITHOLOGY	LITHOLOG DESCRIPT	COLOUR	TEXTURE	ALTERATN	MINERALN	CPS	MAG SUS (S.I. UNITS)	COMMENTS
5594443	ROCK	PHM	803400	8064647	53	PTS	ARN		BR	FER	HM				Collected near costean
5594444	ROCK	PHM	803405	8064650	53	PTS	BLT		B/V/N	BR		MAL/CCT			Collected near costean
5594445	ROCK	PHM	803404	8064650	53	PTS	BLT		B/V/N	BR		MAL/CCT			Collected near costean
5594446	ROCK	PHM	803405	8064655	53	PTS	BLT		B/V/N	BR		MAL/CCT			Collected near costean
5475949	ROCK		803410	8064650	53	PTS	BLT		B/V/N	BR		MAL/CCT			" sample by J. Fisher

CRA Exploration Pty Ltd

List of Codes Used

REGIONAL STRATIGRAPHY

PTS - Proterozoic McArthur Group - Seigal Volcanics

LITHOLOGY

ARN - Arenite
BLT - Basalt

COLOUR

B - Brown
V - Green
N - Black

MINERALISATION

MAL - Malachite
CCT - Chalcocite

TEXTURE

BR - Brecciated
FER - Feruginous

RIO TINTO

Facsimile Transmission

To: Gerard R. Fax: Brisbane

Copy:

From: Steve H.

Date:

Pages: 1 of 4. File:

As requested,

Cheers Steve.

Rio Tinto Exploration Pty. Limited (ACN 000 057 125)
18 Kilometre Post Stuart Highway, Berrimah NT 0828 Australia
Telephone +61 8 8932 2766 Facsimile +61 8 8932 3286
Postal Address: PO Box 39598, Winnellie NT 0821 Australia

Appendix 4

EL 9318 – Branch Creek

Survey Details, Technical Specifications and Processing Details Contractor Report (World Geoscience)

HELICOPTER GEOPHYSICAL SURVEY
CLIFFDALE AREA
QUEENSLAND

SURVEY DETAILS, TECHNICAL SPECIFICATIONS AND PROCESSING SUMMARY

Undertaken for:

CRA EXPLORATION PTY. LTD.

Survey Flown May – June 1997

By

World Geoscience Corporation Limited
65 Brockway Road, Floreat. W.A. 6014, Australia
Tel: (61-8) 9273 6400 Fax: (61-8) 9273 6466

WGC JOB# 1272

TABLE OF CONTENTS

1. INTRODUCTION

This report summarizes the Cliffdale Helicopter Geophysical Survey flown by World Geoscience Corporation Ltd. (WGC) for CRA Exploration Pty.Ltd. (CRAE) between 14 May and 2 June 1997.

The survey acquired aeromagnetic and radiometric data over 32 small areas. A total of 5,112 line kilometres of data was acquired and processed. The base of operations for the Survey was CRAE's camp Ridgeway adjacent to the survey areas. WGC crew and the helicopter pilots were accomodated at CRAE's camp.

The helicopter for the survey work (VH-JWE) was supplied by Heli-Aust of Bankstown airport NSW. The helicopter was supplied under a joint contract between WGC/CRAE/Heli-Aust.

1.1 PROJECT CREW

The following personnel were employed for this project:

Contracts Manager	-	Brad Larson
Operations - Australia (Perth)	-	Tim Webber
Processing Perth	-	Ray Skeet
Field Operators / Processors	-	Matt Lawrence
		Rick Sargeant
Pilots	-	Brad Graves
	-	Rob Feller

2. PRODUCTION SUMMARIES

Date	Flight	Areas Flown	Total Flying Time	Production Kilometres	Scrub Kilometres	Cummulative Kilometres	Remain	Comments
14/05/97	-	-	-	-	-	-	-	WGC crew arrived in Mt Isa. Heli-Aust helicopter not yet arrived.
15/05/97	-	-	-	-	-	-	-	Heli-Aust helicopter and two pilots arrived in Mt Isa late afternoon.
16/05/97	-	-	-	-	-	-	-	Installation of heli survey equipment
17/05/97	001	-	3.3	-	-	0	5112	Two test flights in Mt Isa before heli and WGC crew flew to camp in pm
18/05/97	002	12, 7	6.6	212	3	212	4900	Comp box and survey flown today.
19/05/97	003	3,8,15	8.9	378	4	590	4522	Survey and tie-lines flown.
20/05/97	004	2,5,6,14,16	9.7	393	2	983	4129	Sruvey and tie-lines flown.
21/05/97	005	1,9	10.1	669	34	1652	3460	Survey and tie-lines flown.
22/05/97	006	1,10,17,13	11.2	608	15	2260	2852	Survey and tie-lines flown.
23/05/97	007	1,13,11	8.3	434	8	2694	2418	Survey and tie-lines flown.
24/05/97	008	4,11	7.6	450	10	3144	1968	Survey and tie-lines flown.
25/02/97	009	4,22,27,24	10.0	543	8	3687	1425	Survey and tie-lines flown.
26/02/97	010	18,19,23,24,25,28	10.7	496	8	4183	929	Survey and tie-lines flown.
27/02/97	011	20,21,26,29	9.8	267	15	4450	662	Survey and tie-lines flown in am. Equipment calibrations flown in afternoon.
28/05/97	012	32	5.0	232	4	4682	430	Survey and tie-lines flwon in morning. Heli 100hrly maint. In p.m.
29/05/97	013	31	3.4	125	10	4807	305	Heli 100hrly maintenance completed in morning. Survey in afternoon.
30/05/97	014	30,31,4,7,20,21,24,27,32	8.8	297	7	5104	8	Survey and tie-lines flown.
31/05/97	015	4,6,13,15,21,22,27	2.1	8	2	5112	0	Remaining reflight lines flown today – job completed.
1/6/97	016	-	2.0	-	-	-	-	Heli and WGC crew flew to Mt Isa where demobilisation of heli took plance.
2/6/97	-	-	-	-	-	-	-	WGC and Heli-Aust crew departed Mt Isa today.
		TOTAL	**117.5**	**5112**				

#KMS/HR = 43.5

3. SUMMARY OF SURVEY PARAMETERS AND TOLERANCES

The specifications for the survey were necessarily tight to ensure the highest quality data was collected. WGC's in-field processing and verification system allowed immediate checking of the acquired data and allowed reflights to be readily identified.

Following field verification, the data was immediately sent to WGC's Perth office where it underwent further stringent QC tests.

3.1 SURVEY PARAMETERS

Flight line spacing	-	50 m
Flight line direction	-	Various
Tie line spacing	-	500 m
Tie line direction	-	Orthogonal to flight lines
Sensor height	-	25 m
Magnetometer sample interval	-	2.5 – 3.5 m
Magnetometer cycle rate	-	10Hz (0.1 sec), less than 3.5m
Magnetometer resolution	-	0.001 nT
Radar altimeter cycle rate	-	10Hz (0.1 sec), less than 35m
Barometric altimeter cycle rate	-	10Hz (0.1 sec), less than 35m
Humidity sensor cycle rate	-	10Hz (0.1 sec), less than 35m
Temperature sensor cycle rate	-	10Hz (0.1 sec), less than 35m
3 Axes Fluxgate Magnetometer	-	10Hz (0.1 sec), less than 35m
Spectrometer sample interval	-	25 – 35 m
Spectrometer cycle rate	-	1Hz (1 sec), less than 35m
GPS cycle rate	-	1Hz (1 sec), less than 35m
Base station magnetometer cycle rate	-	5 seconds
Spheroid	-	AGD66
Zone	-	54
Central Meridian	-	141 degrees East

3.2 SYSTEM NOISE

The maximum permitted total magnetometer noise envelope from all sources for the survey was +/- 0.3nT peak to peak.

3.3 NAVIGATION TOLERANCE

Where flight lines crossed, that portion of the line was reflown.

Where the terrain clearance varied by more than ± 10 metres from the nominal survey height for more than one continuous kilometre on any line then that portion of the line was reflown.

3.4 MAGNETIC DIURNAL

Data was reflown when the magnetic diurnal exceeded 5nT in 5 minutes as a non linear effect.

4. AIRBORNE DATA ACQUISITION EQUIPMENT AND SPECIFICATIONS

The Airborne Data Acquisition system utilised on this project consisted of the following sub-systems:

- Data Acquisition System
- Navigation System
- Magnetometer Sensors
- Gamma Ray Spectrometer System
- GPS System
- Altimeter Systems
- Temperature and Relative Humidity System

4.1 DATA ACQUISITION SYSTEM

4.1.1 PDAS 1000 Data Acquisition System

The Picodas PDAS 1000 Data Acquisition System (PDAS) was the central airborne data logging system used. The PDAS is based on the IBM PC architecture and was configured with the following processing boards:

- magnetometer processor board
- frequency processor board
- 12 channel, 16-bit analogue processor board
- PGAM spectrometer master transputer board
- 10 channel GPSCard
- GPS 1 PPS interface board
- disk, parallel, serial I/O board
- EL screen display adaptor

The PDAS computer executes a proprietary Survey program for data acquisition and recording. This data is presented both numerically and graphically in real time on an electro-luminescent or liquid-crystal display for verification and quality control.

Specifications

Model	-	Picodas PDAS 1000
Processor	-	Intel i486 DX33
Operating System	-	MS-DOS 6.2
Storage		
Hard disk	-	240 MB
Floppy disk	-	1.44 MB
Tape Backup Drive	-	120 MB QIC-80 format

4.1.2 PDAS 1000A Power Console

A PDAS 1000A power console is used in conjunction with the PDAS 1000. This console contains the power supplies for providing regulated power to instruments such as caesium and fluxgate magnetometers, humidity, temperature, and barometric pressure transducers. It also provides the interconnect to all analogue signals.

4.2 NAVIGATION SYSTEM

The Picodas PNAV 2001 Navigation Computer was used for real time navigation. The PNAV computer loads a preprogrammed flight plan from disk which contains boundary coordinates, line start and end coordinates, local coordinate system parameters, line spacing, and cross track definitions. The WGS-84 latitude and longitude positional data received from the NovAtel GPSCard contained in the PDAS 1000 computer is transformed to the local coordinate system for calculation of the cross track and distance to go values. This information, along with ground heading and ground speed, is displayed to the pilot numerically and graphically on a two line LCD display, and on an analog HSI indicator. It is also presented on an EL screen in conjunction with a pictorial representation of the survey area, survey lines, and ongoing flight path. The PNAV is interlocked to the PDAS computer for autoselection and verification of the line to be flown.

Specifications

Model	-	Picodas PNAV 2001
Update Rate	-	2 Hz

4.3 MAGNETOMETER SENSORS

4.3.1 Caesium Vapour Magnetometer Sensor

Caesium Vapour magnetometer sensors were utilised on the helicopter for the project. The sensor consists of the sensor head and cable, and the sensor electronics. The sensor head was housed at the end of a three metre kevlar stinger, and held by a rotatable clamp that permits orientating the sensor head for optimum coupling with the ambient magnetic field direction. The sensor electronics were mounted in the base end of the stinger. The magnetometer was powered by a dedicated power supply in the PDAS 1000A power console. Power was connected to the magnetometer using coaxial cable. The Larmor frequency output of the magnetometer is modulated onto this power cable for input to the magnetometer processor board in the PDAS 1000 computer.

Specifications

Model	-	Scintrex CS-2
Operating Voltage	-	30 Vdc
Operating Range	-	15,000 - 100,000 nT
Heading Error	-	± 0.25 nT
Gradient Tolerance	-	40,000 nT/m

4.3.2 Magnetometer Processor Board

Picodas magnetometer processor boards were used for decoupling and processing the Larmor frequency output of the magnetometer sensor. The processor board interfaces with the PDAS 1000 computer, which initiates data sampling and transfers for precise sample intervals.

Specifications

Model	-	Picodas Mag Processor MGP193
Sample Rate	-	10 Hz
Bandwidth	-	2 Hz
Resolution	-	0.001 nT

4.3.3 Fluxgate Magnetometer

Bartington three axis fluxgate magnetometers were used for determination of the helicopter attitude. This data is used in the reduction of noise on the measured magnetic total field. This noise comes from the complex, three dimensional magnetic signature of the airframe. This changes with the airframe attitude, pitch, roll, yaw and rates of change of these elements in the Earth's magnetic field. Permanent, induced, and eddy current effects are compensated by this method, as are the residual heading effects of the caesium vapour magnetometer.

Specifications

Model	-	MAG-03MC
Sample Rate	-	10 Hz
Output Signal Scaling	-	10μT/V
Measuring Range	-	±100μT

4.4 GAMMA RAY SPECTROMETER SYSTEM

The Picodas PGAM 1000 Gamma Ray Spectrometer system was utilised for the airborne radiometric data acquisition. The system consisted of two shock mounted fibreglass/perspex casings, each containing four NaI(Tl) crystals, giving a system volume of 33.56 litres. Each crystal has its own low and high voltage power supplies, analog to digital conversion unit, EEPROM for calibration coefficients, and supporting circuitry for peak detection, adjustable threshold, and coincidental recognition, fitted to the neck of its photomultiplier tube. Each casing contains a sub transputer for event processing and transfer of individual crystal spectra to a master transputer contained in the PDAS 1000. The master transputer performs real time gain corrections on the individual spectra based on the tracking of the Tl-208 or K-40 photo peaks. Real time non-linearity corrections are applied according to individual coefficients determined during calibration under controlled conditions. For normal survey operation the summed 256 channel spectrum is transferred to the PDAS 1000 for display and recording. For pre and post flight calibrations, the 256 channel spectra for individual crystals are transferred for resolution determination and verification. In addition to the 256 channel summed spectra, individual energy windows may be defined for display and recording on the PDAS 1000.

Specifications

Model	-	Picodas PGAM 1000 Ver. 6.11
Detector Volume	-	33.56 litres
Energy Channels Processed	-	1024
Energy Channels Recorded	-	256
Lower Energy Threshold	-	410 KeV
Cycle Rate	-	1 Hz

4.5 GPS SYSTEM

4.5.1 GPS Receiver

The NovAtel GPSCard 951R was utilised for airborne positioning and navigation. The GPSCard is contained in the PDAS 1000 computer and provides positional and satellite range data via the PDAS bus for display and recording, and positional data via a serial port to the PNAV 2001 for navigation. The GPSCard accepts RTCM 104

differential corrections via a serial port for real time differential solutions. Satellite range data is recorded for generating post processed differential solutions.

Specifications (GPS Receiver)

Model	-	NovAtel GPSCard 951R
Channels	-	10 Channels dedicated tracking
Position Update Rate		
	-	PDAS 1000 @ 1 Hz
	-	PNAV 2001 @ 2 Hz
Raw Data Update Rate	-	1 Hz
Datum for Positional Data	-	WGS-84
Time Sync	-	1 PPS output

4.5.2 Differential GPS Demodulator

The Racal Surveys' LANDSTAR differential GPS service was utilised for providing real time differential corrections. The LANDSTAR system broadcasts RTCM 104 format corrections via the Optus satellite for nine reference stations around Australia. These corrections are received at the aircraft using an OmniSTAR demodulator and the data for the user selected reference station are provided to the GPSCard via a serial link.

Specifications

Model	-	LANDSTAR Mk3
Typical Received Update Rate	-	1 - 5 seconds
Data Format	-	RTCM 104 Ver. 2
Reference Stations Used	-	Australia - Virtual

4.6 ALTIMETER SYSTEMS

4.6.1 Radar Altimeter

A Sperry RT100 radar altimeter was utilised for determining absolute altitude. The altimeter outputs a voltage proportional to height above terrain. This output has two scales for the indicated heights of 0 - 500 feet, and 500 to full scale output. This signal is available to a dashboard analog indicator for the pilot, and to the PDAS 1000 computer for display and recording. Prior to commencement of the project, coefficients are determined for accurately converting the two stage output signal to equivalent height. The calculated height and the measured signal are both recorded.

Specifications

Model	-	Sperry RT100
Accuracy	-	40 to 200 ft± 6 ft
	-	200 to 500 ft± 3%
	-	500 to 2000 ft± 3.5%
	-	2000 to 2500 ft± 4.5%
Sample Rate	-	10 Hz

4.6.2 Barometric Altimeter

The output of a Digiquartz pressure transducer was used for calculating the barometric altitude of the helicopter. The atmospheric pressure is taken from a gimble mounted probe projecting 0.5 metres from the wing tip of the helicopter and fed to the

transducer mounted in the helicopter fuselage. The transducer uses a precise quartz crystal resonator whose frequency of oscillation varies with pressure induced stress. A Picodas frequency processor board in the PDAS 1000 computer is used to measure the frequency of the output, and in combination with the QNH pressure and ambient temperature, the barometric altitude is calculated. This calculated altitude and the raw frequency are recorded to enable levelling to the post flight QNH pressure.

Specifications

Model	-	Digiquartz 215A-101
Range	-	0 - 0.10 Mpa
Accuracy	-	0.01%
Resolution	-	$1x10^{-8}$
Sample Rate	-	10 Hz

4.7 TEMPERATURE AND RELATIVE HUMIDITY SYSTEM

Vaisala humidity and temperature transmitters were utilised for measuring the relative humidity and temperature of the atmosphere external to the helicopter. These transmitters produce a linear voltage that is measured by the analogue processor board in the PDAS 1000 computer.

Specifications

Model	-	Vaisala HMP133Y
Sample Rate	-	10 Hz
<u>Relative Humidity</u>		
Measuring Range	-	0 - 100 %RH
Accuracy	-	±1 %RH (0..90 %RH)
Sensor	-	HUMICAP® H-sensor
<u>Temperature</u>		
Measuring Range	-	-20 .. +60 °C
Accuracy	-	±0.2 °C
Sensor	-	Pt 100 RTD

4.8 SYSTEM TIMING

The system time is syncronised to the GPS time. Data sampling is syncronised to the Pulse Per Second output from the GPS receiver.

5. GROUND DATA ACQUISITION EQUIPMENT AND SPECIFICATIONS

The Ground Data Acquisition equipment utilised on this project consisted of the following systems:

- GPS Base Station System
- Base Magnetometer System

5.1 GPS BASE STATION SYSTEM

The GPS base station was located on the roof of the field office at Camp Ridgeway.

5.1.1 Ashtech Ranger XII Base GPS Specifications

Receiver	-	auto all in view, 12 channel C/A code tracking
Position accuracy	-	Differential mode = 1-3m (PDOP<6) SEP
Receiver(s) update rate	-	2 per second
Velocity	-	>1200m / sec.
Antenna	-	Kinematic
Power Required	-	10 Watts

5.2 BASE MAGNETOMETER SYSTEM

The aircraft had two Geometrics G-856 memory Proton magnetometers operating for this project. The units were located at Camp Ridgeway. Small areas surrounding these locations were "mini surveyed" to determine a magnetically quiet position for each sensor.

The units were time checked prior to each survey flight commencement against the GPS receiver time in the aircraft, which is the time base for all acquired data.

Specifications

Model	-	G-856AX memory magnetometer
Displays 0.1nT or time	-	Six digit display of Magnetic field to resolution of to nearest second.
	-	Additional three digit display of station, day of year, and record number.
Resolution	-	0.1 nT
Accuracy	-	1 nT, limited by remnant magnetism in sensor and crystal oscillator accuracy.
Internal Clock	-	Julian clock with stability of ~1 second per day.
Data Memory	-	Approximately 12,500 readings.
Output	-	RS-232 serial output in Ascii format.

6. EQUIPMENT AND DATA ACQUISITION CALIBRATIONS

Prior to commencement of the survey, a series of calibrations were performed. The results of these calibrations are provided to the data processor who makes adjustments to the raw data as required.

6.1 DAILY SPECTROMETER CALIBRATION

The resolution of each crystal was calculated daily throughout the duration of the survey with a thorium source placed at least 50cm from each detector pack. The calculated system resolution remained less than 7%.

Average spectra for each flight line were plotted daily. PhotoPeak positions of Potassium, 1461KeV and Thorium, 2615 KeV were calculated to one tenth of a channel and indicated on the Average spectrum plot. For flight lines less than 1000 seconds duration, dependent on the initial accuracy of the calculated peak position for the average spectra on the flight line, spectra from pre and post acquired lines were used to average spectra for 1000 seconds

duration. If the Thorium photopeak 2615KeV and Potassium photopeak 1461KeV were found to shift by more than +/-0.5 channels respectively then the spectra were energy calibrated prior to sampling the conventional channels.

A test line was flown each day to monitor the sensitivity of the system in the air. WGC had the capability to determine real-time statistics on every test or survey line. The test line was flown before and after each day's production at survey altitude to monitor the effects of soil moisture and verify that the system was functioning correctly. If the background and height corrected rate in the thorium window varied by more than +/- 15% from the mean of the previous measurements, flights were suspended until the count rate returned to acceptable levels.

6.2 RADAR ALTIMETER CALIBRATIONS

The radar altimeter is calibrated every 12 months and involves the aircraft flying a line over water to allow an accurate calibration of the radar altimeter height. This line consists of several climbs and decents, as one line, between 50 feet and 3000 feet. A look-up table is generated which relates the raw output from the Radar Altimeter in mV to altitude in metres. The results of the calibration are plotted in Appendix 1.

6.3 PARALLAX CHECK

Parallax error is caused by the physical difference in distance between the various sensors, the electronic delay and software timing in the acquisition system. Hence all variables are subjected to a displacement from the GPS coordinates. If these variables are processed without a position offset a parallax error will occur. The most suitable way to treat this problem is to use the 1 second radiometric data as a base with a zero correction. This will prevent interpolation of important variables (a filtering process). The coordinates were moved by linear interpolation and other data variables were displaced onto the radiometric data, without change, in multiples of 0.1 seconds.

VARIABLE	PARALLAX DELAY
Mag.	0.2 Seconds
Rad Alt.	0.4 Seconds
Baro. Alt	0 Seconds
Radiometrics	0 Seconds
GPS Positioning	1.8 Seconds

TABLE 1: PARALLAX VALUES

6.4 DYNAMIC MAGNETOMETER COMPENSATION

To eliminate aircraft manoevure effects from the magnetic data whic can be of the same frequency as the geology, a compensation box was flown in a low magnetic gradient area close to the survey. This involves flying a series of tests on the survey line heading and also 15^{o} either side to accommodate cross wind flying conditions. The data for each heading consists of a series of aircraft manoeuvres, pitches, rolls and yaws. This is done to artificially create the worst possible attitude the aircraft may encounter whilst on survey and compensate for any magnetic noise induced by the aircraft's attitude in the naturally occurring magnetic field. This data is down loaded to the field PC and processed, using software developed by WGC, to obtain the best possible magnetic dynamic compensation coefficients in the form of 16 mathematical terms. These coefficients are applied in real time as well as in post processing.

6.5 HEADING ERROR CHECKS

Historically, heading error checks have been part of the aeromagnetic data acquisition procedure but their use nowdays is negligible. WGC now calculates these effects using the aircraft magnetic compensation system and specially developed software. The precision to which these effects are now calculated and corrected for is far in excess of what is measurable using the manual technqiues for the past.

6.6 CALIBRATION NUMBERING SYSTEM

The following line numbering formula was employed for this survey:

C1501	CAESIUM SOURCE	180 Secs	Daily	AM SPEC CALS
C1502	URANIUM SOURCE	180 Secs	Daily	" " "
C1503	THORIUM SOURCE	180 Secs	Daily	" " "
C1504	BACKGROUND	180 Secs	Daily	" " "
C1507	REVERSE TEST LINE	5 Kms	if required	" " "
C1508	LOW LEVEL TEST LINE	5 Kms	Daily	" " "
C1509	HIGH LEVEL TEST LINE	200 Secs	Daily	" " "

C1511	Pre	#1 SORTIE BARO CAL	BARO GROUND CALS
C1611	Post	#1 SORTIE BARO CAL	" " "
C1512	Pre	#2 SORTIE BARO CAL	" " "
C1612	Post	#2 SORTIE BARO CAL	" " "
C1513	Pre	#3 SORTIE BARO CAL	" " "
C1613	Post	#3 SORTIE BARO CAL	" " "
C1514	Pre	#4 SORTIE BARO CAL	" " "
C1614	Post	#4 SORTIE BARO CAL	" " "

C1800 - C1810 HEADING CHECKS

C1811 - C1820 COMP BOXES

C1821 BARO ALTIMETER STACKS (one line 100,200,300,400,600,800,1000,1200,1500,2000 ft) for 30 secs

C1826 - C1830 PARALLAX CHECKS

C1831 - C1847 HIGH LEVEL SPEC STACKS (5000 - 10000 ft @ 1000 ft Increments up then down) for 300 secs.

C1848 - C1860 LOW LEVEL SPEC STACKS (150,200,250,300,350,400,450,1000,1500,2000ft) over DTR.

C1861 - C1865 PAD CALS (PACK #1) Background , Pottassium , Uranium , Thorium
C1866 - C1870 PAD CALS (PACK #2) " " " "
C1871 - C1875 PAD CALS (PACK #3) " " " "

C1881 - C1890 RADAR ALTIMETER CHECKS (100,200,300,400,600,800,1000,1500,2000,2500 ft) for 30 secs.

C1607	REVERSE TEST LINE	5 Kms	if required	PM SPEC CALS
C1608	LOW LEVEL TEST LINE	5 Kms	Daily	" " "
C1609	HIGH LEVEL TEST LINE	200 Secs	Daily	" " "
C1601	CAESIUM SOURCE	180 Secs	Daily	" " "
C1602	URANIUM SOURCE	180 Secs	Daily	" " "
C1603	THORIUM SOURCE	180 Secs	Daily	" " "
C1604	BACKGROUND	180 Secs	Daily	" " "

S1990 - S1999 TEST AND SCRUB LINES
T1701 etc TIE LINES

The last three numbers of the line number (eg 501) is the line number.
The first number of the line number (eg 1) is the area number, this could be two digits (eg 12).

If any line is scrubbed then the next attempt is entered as the same line number with an increment of one decimal point.

7. FIELD DATA PROCESSING

The following data processing steps were applied by WGC's crew on location at Camp Ridgeway.

- Download raw aircraft data from 120 MB QIC-80 fomat tapes on to the Field Processing PC.
- Back-up GPS base station data from the GPS logging computer on to 120 MB QIC-80 fomat tapes and then down load on to Field Processing PC.
- Dump Mag base station data on to Field Processing PC.
- Edit line headers to correct wrong line numbering or directions entered in real time by the operater.
- Process GPS data.
- Check flight path.
- Check magnetometer noise levels.
- Backup all data.
- Fill reports and fax to Perth office.

To check the magnetometer noise levels the following quality control checks were run on each days data:

- Vertical derivative to verify compensation.
- Backward difference to detect level shifts and diurnal problems.
- Polynomial residual to detect instrumentation noise.
- 4^{th} difference to detect spikes.

8. FINAL DATA PROCESSING

There are three separate streams of raw data collected by separate acquisition systems. All three sets of data are treated as discrete units and are post-processed accordingly before being merged.

8.1 RAW DATA COLLECTION

8.1.1 Aircraft Data

Data collected by the aircraft includes:

- TMI via the Cesium Vapour Magnetometer
- 256 Channel spectrometer
- 3 axis fluxgate magnetometer
- radar altimeter
- pressure
- humidity
- temperature
- fiducial
- time
- GPS Positioning information (including time and satellite info.)

8.1.2 Magnetic Base Station Data

Whilst the aircraft was collecting data, two Geometrics G-856 memory Proton magnetometers were collecting data from the base station at Ballarat airport. Small areas surrounding these locations were "mini surveyed" to determine a magnetically quiet position for each sensor.

8.1.3 Global Positioning System Base Station Data

An Ashtek Ranger II 12 channel GPS receiver was used for the GPS base station at the crew headquarters. This instrument recorded variables such as location, time and satellite information to be used later for post processing of the aircraft location.

8.2 Aircraft Location

The aircraft's location each second was determined by differentially post processing the syncronised GPS data recorded on both the aircraft and GPS base station. Where small gaps occurred in the differential data, positions were calculated using the GPS velocities. This data is recorded in the WGS-1984 datum and merged with the aircraft data.

8.3 Magnetic Data Processing

Data collected by each of the 3 sources above is checked for spikes and noise by complex procedures. A stringent series of quality checks were carried out daily on all aspects of the data. Whenever these checks proved that the data was unacceptable the affected lines or part lines were reflown. The process is summarized below:

a. Apply any spike corrections to the raw magnetic variables.

b. Interpolate undefined magnetic values.

c. Coordinate the data with post processing AMG coordinates.

d. Apply fluxgate corrections and compensate the data with post-processed compensation files.

e. Diurnal values were appropriately filtered and subtracted from individual magnetic readings. A diurnal base of 49,226nT was used.

f. IGRF (1995 Model). Regional effects of the earth's magnetic field were removed by subtracting the calculated IGRF value from each reading. An IGRF base of 48,781nT was used.

g. Apply parallax correction

8.4 Levelling Magnetic Data

The high quality of the final data was assured through WGC's in-house processing system which offers some of the most powerful levelling capabilities available in the industry. The tie lines are used to level the dataset after the removal of the diurnal, parallax and heading errors.

Using the tie lines (flown at 90 degrees to the traverse lines) a set of miss-tie values were determined. These miss-tie values reflected the differences in the magnetic value between the tie lines and the traverse lines over the same geographical point. Using a least squares fit algorithm, which also takes into account the statistical variation inherent in DGPS positioning, a series of corrections were applied to the traverse line data. These allowed the data to be levelled to the same base value.

Following this, a WGC proprietary micro-levelling process was applied in order to more subtly level the data. This process removes sub-gamma pulls evident only under image enhancement algorithms. Since the correction values applied were based upon a least squares fit equation, the tie lines were then re-levelled to the traverse lines. This eliminated any "bulls-eyeing" effect which may be found when tie lines and traverse lines are used to generate a single grid.

The altitude variation between the flight lines and tie lines was accounted for when computing line corrections. A proprietary algorithm was applied to the magnetic data and a correction was made to remove this height effect.

8.5 Radiometric Data Processing

The radiometric data was processed WGC's proprietary Spectra Plus technique.

8.5.1 Spectra Plus Processing Technique

The radiometric data was separately processed using WGC's proprietary 256 Channel radiometric processing technology - *Spectra Plus*™.

SPECTA + PLUS is based on mathematical modelling of a radiation field above expected sourceS and the response of the spectrometer from such a field. Modelling is performed using Monte Carlo photon-transport code. This accounts for all possible photon-matter interactions between the source and detector.

The result of the modelling is a set of unit response spectra functions for particular radioelements at various altitudes. The unit response function represents the spectrum shape which would be collected in a spectrometer at a given altitude above the source composed of only one particular nuclide of unit activity. Effects like height attenuation and stripping corrections are included in the design of the response function. The response functions are also calibrated to the spectrometer (PGAM) and detectors (NaI) used for individual installations.

SPECTA + PLUS fits the response functions to the measured spectra (background removed) over the full 256 channels. This results in the mass and surface activities or radioelement concentration for each one second spectrum.

This technique is not subject to the statistical error inherent in the IAEA technique and offers superior sensitivity when compared to the window processing.

8.6 Digital Elevation Model

The radar altimeter data were subtracted from the GPS heights to provide a digital elevation model which is height above the WGS84 spheroid.

8.7 Gridding and Projections

A proprietary gridding algorithm using bi-directional polynomial interpolation was used.

The final data was projected to a Transverse Mercator projection using the AGD66 datum (ie. Australian Map Grid - AMG).