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AIRBORNE AND GROUND GEOPHYSICAL SURVEY

AT THE RAZORBACK M.L.

WESTERN TASMANIA, 1981.

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1. SUMMARY

An airborne electro-magnetic survey was flown over the Razorback M.L. and immediate surrounds. The survey indicated that the Razorback Tin Mine was detectable by the method as was the mineralisations extension to the south. A secondary anomaly, en echelon to the mine anomaly was also detected. Ground follow-up indicated this latter anomaly to be broad and moderately conductive.

Responses are also associated with many of the small mines in the area and with the serpentinite's eastern edge. No significant magnetic anomalies were distinguished.

Geochemical sampling of selected areas is recommended prior to any additional ground geophysics.

2. INTRODUCTION

In February 1981 an airborne electromagnetic (A.E.M.) survey was flown over the Razorback M.L. currently being held in joint venture with Minops Pty.Ltd.

The survey was designed to:

- i) test the response of the A.E.M. method to the known Razorback mineralisation,
- ii) test for logical extensions of the known mineralisation, and
- iii) delineate any further zones of interest in the area adjacent to the Razorback Tin Mine.

A total of 44 line kilometres were flown with a line spacing of 200 metres incorporating fifteen lines. Flight lines were oriented 250°/70° magnetic north in an endeavour to imitate the mine grid which is perpendicular to the general lithology strike direction. "Bird" heights were a nominal 40 metres (E.M.) and 55 metres (magnetic). An average ground speed of 33 metres per second was attained.

Limited ground follow-up was conducted over the more interesting A.E.M. anomalies using the Pulse Electromagnetic (P.E.M.) method.

3. CONCLUSIONS

The Multicoil II airborne E.M. survey has delineated a number of conductors, the majority of which are located within the serpentinite mass.

Many of the mines in the survey area have associated E.M. responses, although the amount of cultural contamination is not known. E.M. anomalies ascribed to the Razorback Tin Mine extend to the south along the "Razorback Shear". Any extension to the north was not detected. An en echelon conductor running parallel to the Razorback Shear but within the Hodge Slate was shown, by ground E.M. to be probably due to a thick conductive unit. Follow-up of two other major conductors within the serpentinite indicated a homogeneous earth as being the most likely cause.

Airborne magnetometer data recorded with the A.E.M. Survey indicated no significant responses, although the high bulk magnetic susceptibility of the serpentinite precluded recognition of any secondary anomalies.

4. RECOMMENDATIONS

1. Anomaly set 206A - 207A - 208A to be further investigated by geochem. Pending those results an I.P. survey designed to test a disseminated zone should be planned.
2. Anomaly set 208xA - 209A - 210B is currently being tested south of the mine by drilling on geological grounds. Downhole geophysics - pulse E.M. and mise-a-la-masse should be carried out if mineralisation is indicated.
3. Bedrock geochem covering anomaly 209B, particularly along line EME-2 would clarify the significance of this response.
4. Magnetite occurrences at the southern end of the M.L. may be associated with nickel mineralisation and should therefore be sampled. Anomalies 201A and 202B are recommended for this purpose.
5. Anomaly 205xB to be checked out on the ground by geochem.

5. DISCUSSION

5.1 Systems Specifications

The airborne survey was conducted using Dighem Ltd's Multicoil II E.M. System. D.C. Fraser (1979) describes this set-up and associated theory whilst a brief description follows:

The Multicoil II E.M. system consists of two sets of orthogonally mounted coils fitted into a 9 metre long bird. These coils are referred to as the standard coil pair (transmission and receiver coils are coaxial) and the Whaletail coil pair (transmission and receiver coils are coplanar). A frequency of 918Hz. and 882 Hz. is used to energise the two transmission coils. Both in-phase (or real) and quadrature (or imaginary) components are measured for each coil pair. Data is recorded in analogue and digital form using a half second data acquisition cycle.

The advantage of flying a two coil system is that the standard coil pair's primary field direction provides good coupling with steeply dipping bodies whilst the whaletail coil-pair's primary field direction provides good coupling with horizontal bodies. This is used to distinguish responses caused by conductive overburden from those caused by bedrock conductors. Ancillary equipment flown with the E.M. system consisted of a Geometrics 803 magnetometer, Sperry radio altimeter, Geocom sequence camera, Barringer 8 - channel hot pen analogue recorder, Geometrics G - 714 digital data acquisition system incorporating fiducial and inter-velometer systems and a Kennedy 9700 9 track, 800 bpi magnetic tape recorder. The system was mounted in a Lama Jet helicopter (VH-PDU).

5.1.1. Navigation and Flight Path Recovery

Positioning was by means of visual navigation using 1:10,000 colour aerial-photography of 1979 vintage. Flight paths were recovered onto these photos which were then used to provide a photo mosaic base map of the survey area.

As the survey was small it was considered of minimal benefit to merge data with A.M.G. co-ordinates. The standard North American practice of setting up an arbitrary co-ordinate system on the photomosaics was used instead.

5.1.2. Data Produced

Eight parameters are recorded in-flight: four E.M. channels, two noise monitor channels, a magnetometer channel and an altimeter channel. A further ten channels are produced by data manipulation, three of which are experimental and have no real significance at this stage. The channels, as they appear on the flight line records are:-

<u>Channel</u>		<u>Parameter</u>	<u>Scale</u>	<u>Noise *</u>
<u>Number</u>	<u>Label</u>		<u>Units/div</u>	
28	CXS	ambient noise monitor (coaxial coils)	1 ppm	1 ppm
29	CPS	ambient noise monitor (coplaner coils)	1 ppm	1 ppm
35	REC1	1st anomaly recognition function	1 ppm	2 ppm
36	REC2	2nd anomaly recognition function	1 ppm	2 ppm
21	ALT	E.M. bird height	3m	1.5m
20	MAG	magnetometer	10nT	2nT
22	CXI	co-axial coil pair in-phase	1ppm	2ppm
23	CXQ	co-axial coil pair quadrature	1ppm	2ppm
24	CPI	co-planar coil pair in-phase	1ppm	2ppm
25	CPQ	co-planar coil pair quadrature	1ppm	2ppm
37	SIGT	conductance	1mho	-
33	DIFI	difference function in-phase	1ppm	2ppm
34	DIFQ	difference function quadrature	1ppm	2ppm
40	RES	log resistivity	0.03 decade	-
41	DP	apparent depth	3m	-
44	EXP2	experimental 2	arbitrary	
43	EXPI	experimental 1	arbitrary	
42	CC	conductivity contrast (experimental)	arbitrary	

(* in parts per million of primary transmitted field)

5.1.3. Data Presentation

Data is presented in two forms: maps and flight line profiles. Maps produced are electromagnetic conductor traces and grades, total intensity magnetic contours, enhanced magnetic contours and resistivity.

E.M. anomalies are computer picked (using the anomaly recognition function) and graded into six conductivity-thickness product divisions. A seventh grade recognises anomalies which fall within the noise envelope of the system yet can still be recognised. These are known as X-type anomalies. Each anomaly is identified by a letter on the map and by a line number - letter combination in the text. X-type anomalies include X in this identifier.

The enhanced magnetics map represents data which has been filtered using a band-pass filter designed to imitate a downward continuation of the magnetics to ground level. The resistivity map results from fitting the E.M. data to a pseudo layer earth model.

A scale of 1:10,000 is used for all maps. Flight line profiles consist of the eighteen channels of recorded and derived data (as outlined in section 5.1.2) plotted at a horizontal scale of 1:10,000.

5.2 Geology

The general geology of the Dundas region has been described by many workers due to the mining history of the area. A.H. Blissett (1962) of the Tasmanian Department of Mines and, more recently, J.G.Purvis (1978, 1980) of CRAE, have covered the Razorback area specifically. That information is briefly covered here.

5.2.1. Lithology

The Razorback tin mine area basically consists of near vertical members of the Dundas Group separated from a serpentinite by the "Razorback Shear". The Dundas Group members comprise of Middle Cambrian sediments; in particular the Brewery Junction Formation (siltstones, shales and greywackes), Razorback Conglomerate (turbidites, chert and conglomerates), Hodges Slate (black pyritic laminated siltstones -mudstones), and Red Lead Conglomerate (grey-wacke conglomerate). These sediments comprise the major western block of the survey area.

The eastern block, which does not fall within the M.L. is similarly comprised of Dundas Group sediments whilst to the south-east lies a block of Pre Cambrian Oonah Quartzite and Slate, over lying the Crimson Creek formation (mudstones, greywackes and shales).

This sequence was intruded by a pyroxenite sill in the late Cambrian. Almost complete alteration of the pyroxenite to serpentinite has occurred. The Serpentinite mass forms the central portion of the survey area.

In the early Middle Devonian the section was folded along NW-SE axis as a result of the Tabberabberan Orogeny and subsequently faulted along NNW trends.

It is this faulting (the Razorback Shear) which brought the serpentinites into contact with the sediments by re-emplacement. Metasomatism along the fault contact caused alteration of serpentinite to a talc-carbonate zone. This zone forms the host for tin mineralisation which followed the intrusion of a porphyritic micro granite in the Middle Devonian.

5.2.2. Mineralisation

Mineralisation consists of fine grained cassiterite in association with pyrrhotite, pyrite, arsenopyrite, chalcopyrite, sphalerite and galena in a quartz gangue.

008

This assemblage occurs in massive sulphide pods (up to 50 per cent pyrrhotite) within the talc-carbonate zone. Heavy disseminations continue into the adjacent conglomerate unit (Red Lead Conglomerate) with rare cassiterite occurring in the Hodge Slate.

A weathered horizon some thirty metres thick and up to five metres wide is evident. A limonitic and haematitic gossan is exposed at surface. Mineralisation and host have a steep dip to the west.

The serpentinites carry asbestos and magnetite. Magnetite occurs as disseminations and irregular veins of variable thickness - generally not in excess of ten centimetres. Early work by Rio Tinto Australian Exploration Pty.Ltd. showed that high nickel values (up to 0.4 per cent) were obtained from magnetite sampling. Osmiridium is also present in minor amounts.

5.3 Previous Geophysics

5.3.1. Bureau of Mineral Resources

The sediment - ultrabasic contact was quite intensively investigated by the B.M.R. for the Tasmanian Department of Mines during 1959-1960 (Langron and Horvath, 1962). Electro-magnetic (E.M.), self (or spontaneous) potential (S.P.) and ground magnetics were used. The primary aim of the surveys was the direct detection of pyrrhotite associated with tin mineralisation along the contact. All three methods gave a distinct response over the Razorback tin mine.

Ground magnetics proved most successful in defining the exact position of the serpentinite margin because of its high magnetic susceptibility. The mine area was also anomalous due to the massive pyrrhotite pods present. The variability of the magnetic susceptibility of the ore (1.3×10^9 S.I. to 270×10^9 S.I.) and the effects of the nearby serpentinite make it difficult in recognising significant responses.

Surveying to the north of the area (at Grand Prize) indicated a similar magnetic response to that obtained at the Razorback mine and was recommended for investigation.

E.M. (Turam method) and S.P. gave more isolated responses. As with ground magnetics both these methods indicated the presence of mineralisation at Razorback due to the massive and weathered characteristics of the ore. The E.M. indicates a greater extent of the ore zone as does possibly the S.P. A significant E.M. anomaly 480 metres to the north of Razorback (along the fault zone) was found to coincide with a magnetic response. This was recommended for drilling. Whilst a number of E.M. anomalies were further delineated the majority of these reflected poor grade conductors, few of which were associated with magnetic or S.P. anomalies or resided in favourable lithologies.

Those that met any one criteria (i.e. in a favourable lithology or with a "back-up" anomaly) were recommended for sampling.

5.3.2. Minops Pty.Ltd.

A number of gradient array I.P. lines were surveyed across the mineralised zone. Apart from showing the dramatic change in rock properties across the "Razorback Shear" a small, but significant, resistivity low/chargeability high anomaly was attained. Results of testing this anomaly indicated massive, partly weathered pyrite with minor tin. A mise-a-la-masse hole survey confirmed a short strike extent of the zone.

5.3.3. CRA Exploration Pty.Ltd.

Two lines of dipole - dipole I.P. were surveyed immediately north of the Razorback mine to investigate extensions of the ore lode (Purvis, 1980). The survey was most successful in identifying lithological contacts and an anomalous zone within the talc-carbonates ("dolomite").

010

This anomaly was drilled to intersect an I.P. target at a depth of 130 metres; pods ranging 25-40 per cent pyrrhotite were intersected between 115 metres to 130 metres.

5.4 Discussion of Results -
Airborne Geophysics

5.4.1. Magnetics

The major feature of the total magnetic intensity contour map is the central zone of intense magnetic activity. This zone, directly attributable to the serpentinite occurrence, is of an arcuate shape trending in a south-south-westerly direction. It's closure to the south suggests either a synform plunging to the north-north-west or an antiform plunging in the opposite direction.

The western and eastern boundaries of the serpentinite are seen to be complexly faulted along small north-north-west and south-south-east trending faults. This is best witnessed on the enhanced magnetics map.

A line across the serpentinite structure was modelled to gain insight into it's geometry. The result of modelling line 208 is presented as plan TASH 530. Although the model is not perfect it does indicate an antiformal structure. A magnetic susceptibility contrast of 250×10^3 S.I. was fitted. This is far in excess of the 75×10^3 S.I. measured by the B.M.R. but well within the range of 3×10^3 to 750×10^3 S.I. published for similar serpentinites. (PARASNIS, 1971). The discrepancy could be simply due to the weathered state of samples measured, the presence of remanent magnetisation, or the discreteness of the samples. If remanent magnetisation is present then the model will be misleading.

Although sulphides at the Razorback Mine can exceed 40 to 50 per cent pyrrhotite the proximity of the magnetite rich serpentinites make any anomaly associated with them virtually indistinguishable.

Scrutiny of the enhanced magnetics map reveals that an anomaly can be discerned - if one knows where to look!

Sedimentary sequences to the east and west of the serpentinite are essentially non-magnetic containing perturbations easily explained by the natural variation in rock susceptibilities and dominated by magnetic lows associated with the serpentinite. Individual lithologies cannot be recognised on the basis of magnetics although faults have been inferred from the data. Two interesting magnetic anomalies are present - unfortunately both outside the M.L. They are the short linear high at the western ends of lines 207 and 208 and the small perturbation off the western edge of the serpentinite on line 204. Both are caused by small, shallow sources.

Serpentinites continue off the southern and northern sides of the survey areas as witnessed by the large scale anomalies on lines 200 and 214.

5.4.2 Electromagnetics and Resistivity

The majority of electromagnetic responses are primarily associated with the serpentinite mass. The resistivity contour map gives the reason as to why this is so. This map, like the magnetics map, shows that the survey area can be easily divided into two distinct zones. The first zone consists of the central area characterised by depressed and complex resistivities. Resistivity values within this zone range from 25 ohm-metres to 750 ohm-metres and may reflect the occurrence and distribution of conductive overburden, (i.e. the weathering profile) or the complex conductive nature of exposed bedrock.

The processed data, through it's derived depth parameter, indicates that conductive overburden is, in fact, quite prevalent over the serpentinites.

A feature of the resistivity contour map is that the depressed resistivities assigned to the serpentinite extend for some 200 metres westwards - over partially mineralised Hodge Slate and Razorback Conglomerate. This area is not only a topographic low, and so may have a thicker (conductive?) overburden, but is proximal to the Razorback Shear.

The second zone consists of the sedimentary rock sequences to the east and west. Whilst rocks to the west are, in general, very resistive those to the east are less so and seem to reflect the occurrence of faults and weathering due to drainage characteristics more dramatically.

Also of interest is the increase in resistivity within the serpentinite to the south. An increase in magnetic intensity and the prevalence of negative in-phase E.M. anomalies in the area suggest an increase in average magnetite content to be the cause.

Table 1 sets out the statistics and fitted models for all anomalies encountered in the survey. A brief description and interpretation of each anomaly, or anomaly set, follows. Observations were taken from aerial photography and published geology maps and are therefore subject to ground checking.

- a) Anomaly set 200A-201xD lies along a fault separating the Crimson Creek Formation and Oonah Quartzites. This set, together with 201xE, reside in a narrow conductive zone reflecting a poor to moderate quality bedrock conductor associated with, or consisting of, the fault. The zone is non-magnetic. Anomaly 210xE may be associated with the Banner Cross Mine (lead, silver, zinc).
- b) Anomaly set 204xA-205B is associated with the faulted eastern edge of the serpentinite. The conductor is thin, of moderate quality, resides in a narrow zone of depressed resistivities and is bounded to the west by a magnetite concentration.

- c) Anomaly set 206A-207B-208A reside within the Hodge Slate to the west of the serpentinite. This conductor ranges from excellent quality on line 206 to poor on line 208. A bedrock origin is postulated. The conductor is equivalent to the B.M.R.'s Turam Anomaly "C" whose interpretation was "a low conductivity body which over most of it's length is wide and thick becoming narrower towards its northern end" (Langron and Horvath, 1962). No obvious magnetic anomaly is associated with it. An S.P. anomaly may be present - unfortunately the B.M.R. survey did not completely cover it.
- d) Anomaly set 207B-208B-209C-210C-211A-212A-213D-214D is a thin conductor ranging from poor to excellent quality associated with the serpentinites eastern edge but slightly transgressing the magnetic high marking that edge.
- e) Anomaly set 208xA-209A-210B may be directly attributable to the Razorback Shear along which the Razorback Mine mineralisation took place. Anomaly 210B is situated on the western side of the mine's open cut. It is an excellent bedrock conductor with a small, but noticeable, magnetic response and represents the B.M.R.'s Turam Anomaly "A". Anomalies 208xA and 209A, here interpreted as being continuous with 210B, is equivalent to the B.M.R.'s Turam Anomaly "B" which was postulated to be offset from "A" by a fault. The reduction in the anomaly's quality to the south suggests either a deepening of the conductor or lowering in conductivity. Both the Turam and Dighem (by the computer fitted models) anomalies indicate a shallowing source. The conductor has a strong S.P. anomaly along it's entire length.
- f) Anomaly set 208xC-209B-210xB is a magnetic, excellent grade conductor. It is situated in an intense resistivity low with 209B occurring within the old mine's tailings dam. Even so, the psuedo-layer model does indicate a bedrock - and not conductive overburden - source. A weak Turam, weak to medium S.P., and strong magnetic anomaly is associated with it. The conductor is in serpentinites.

- g) Anomaly set 210D-211B-212B-213E-214E is a poor conductor paralleling the anomaly set 207B to 214D. It is situated on the eastern margin of the serpentinite within a resistivity high. This conductor has the potential of imitating the Razorback Mine situation but unfortunately lies outside the M.L.
- h) Anomaly set 213B to 214B is a moderate grade magnetic conductor trending off the survey area to the north. It occurs within the serpentinite along a creek. It is equivalent to Turam Anomaly "D" which had a medium strength response and interpreted to being a high conductivity body with a magnetic association.
- i) Anomaly 201A is a very poor grade conductor within the serpentinite and probably caused by conductive overburden. It is associated with a high magnetite concentration.
- j) Anomaly 201B is similarly a poor quality conductor. It occurs on the boundary of a small bleb of serpentinite and Crimson Creek Formation and adjacent to a magnetite concentration.
- k) Anomaly 202B is a poor to moderate conductor attributable to the Adelaide Mine (Lead, Silver) occurring on the serpentinite/Oonah quartzite contact. Magnetite is present.
- l) Anomaly 203A is a poor quality conductor caused by conductive overburden and magnetite within the serpentinite.
- m) Anomaly 205A is a very weak surficial conductor in the serpentinite.
- n) Anomaly 210A is a poor conductor occurring within the Hodge Slate and along a creek. It is probably of surficial origin.
- o) Anomaly 211C is a poor grade conductor occurring on the contact between Crimson Creek Formation and Oonah Quartzite. It is non-magnetic and of bedrock origin.

- p) Anomaly 202xA is probably a surficial conductor associated with a creek in the Oonah Quartzite. An isolated resistivity low is present.
- q) Anomaly 203xA is attributable to the Comet Mine (Lead, Silver) located on a fault separating the serpentinite and Oonah Quartzite. Magnetite is present.
- r) Anomaly 205xB is situated on the same fault as 203xA but further to the north-west within the serpentinite. A strong "bulls eye" resistivity low is coincident.
- s) Anomaly 209xA is attributable to the North Comet Mine which produces a very strong "bulls eye" resistivity low.
- t) Anomaly 210xA lies on the Hodge Slate/Brewery Junction Formation contact. Faulting may be present.
- u) Anomaly 212xB has a minor magnetic response and lies along a fault within the serpentinite.

Also included in Table 1 is an indication of the conductor geometry using Frazer's conclusion (Frazer, 1979). Table 2 summarizes the meaning of the numbers derived from the data to give the geometry.

5.5 Discussion of Results

Ground Geophysics

Ground follow-up of airborne E.M. anomalies was restricted to the lease area. Three anomalies were tested: 207A and continuation, 209B and continuation and 211A.

The anomalies were covered using the Pulse Electromagnetic (P.E.M.) method in the DEEP.E.M. mode. A transmitter feeding an 100 metre square single turn loop was used to provide a primary field. The secondary field was sampled at 25 metre intervals using a roving receiver reading lines orthogonal to one side of the transmitting loop. Both vertical and horizontal components of the secondary field were measured. Field data is presented as Appendix 1 whilst individual profiles are attached (plans TASH 504 to 511).

a) Anomaly 207B and continuation.

This anomaly was covered by three lines: EMW-4, (50mW to 300mW) EMW-5 (50mW to 250mW) and EMW-6 (50mW to 275mW). The main feature of the profiles is the migration to the west of the vertical component cross-over point (i.e. where the secondary field reverses sign). This may be indicative of two possibilities -

- 1) the conductor causing the response is dipping at a moderate angle (45 degrees to 60 degrees) to the west thus causing the observed shift due to the successive depths of the body being sampled at the latter channels (times) or

- 2) a homogeneous earth exists and all that is seen is the current "smoke-ring" expanding from the transmitter loop.

Unfortunately, the horizontal component does not provide conclusive evidence as to the cause. The short line length does not preclude the presence of a thick conductor (in excess of 150 metres thick). The slow decay which is evident, however, does indicate moderately conductive ground.

b) Anomaly 209B and continuation was covered by four lines:

EME-3 (00m to 225mE), EME-4 (50mE to 275mE), EME-5 (50mE to 150mE) and EMW-1 (50mE to 300mE). As with the previous anomaly the vertical component exhibits a migrating cross-over.

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Migration to the east again indicates either an easterly dipping conductor or a homogeneous earth. On line EME-5 migration is much less severe and may indicate a less ambiguous target. The horizontal component once again indicates a conductive zone-much more than the previous anomaly. This probably reflects the presence of serpentinite rather than sedimentary rocks.

c) Anomaly 211A was covered by line EMN-1 (50mE to 250mE). Its character is much the same as that seen in the other two anomalies.

General

All lines read with P.E.M. showed surprisingly similar results. Each exhibited a migrating cross-over in the vertical components and a slow decay in the horizontal component. These results would seem to indicate that the singular conductors detected by the airborne E.M. survey are seen on the ground as a homogeneous earth or, at best, a thick conductor seen by the ground E.M. survey as a homogeneous earth.

The reversal in the direction of migration witnessed between the profiles for anomalies 207A and 209B does in fact suggest that what is being seen is the "smoke ring" effect of current dispersion in homogeneous media.

The possibility of disseminated mineralisation occurring within the Hodge Slate is good. The chance of a high tonnage - low quality ore causing the observed response (207A) is therefore very real.

TABLE 1 EM ANOMALY STATISTICS

LINE & ANOMALY	COAXIAL COIL		COPLANAR COIL		VERTICAL DYKE		HORIZONTAL SHEET		CONDUCTIVE EARTH		CONDUCTOR QUALITY		ASSOCIATED MAGNETICS	REGIONAL HOST LITHOLOGY	CONDUCTOR GEOMETRY		
	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	COND MHOS	DEPTH FEET	COND MHOS	DEPTH FEET	RESIS CHM-M	DEPTH FEET	CXI CXQ	CPI CPQ			CPI CXI	CPQ CXQ	
200A	5	5	6	9	6	104	2	316	59	187	1	0.7		Buo	Fault Ck	1.2	1.8
201A	0	8	0	7	5	80	1	137	1035	0	0	0		Eb-Es	Fault S	-	0.9
201B	1	4	4	5	2	89	1	238	280	73	.25	0.7		Es	S?	4	1.5
202B	2	4	4	3	5	109	1	281	201	107	.5	1.3		Es-Buo	Adelaide Mine	2	0.8
203A	0	17	0	25	1	0	1	32	659	0	0	0	2600nT	Es	S?	-	1.5
205A	1	7	0	16	1	0	1	36	416	0	0.1	0	4240nT	Es	S	0	2.3
205B+	2	2	6	3	8	160	1	247	146	95	1	2		Es-Buo	Fault	3	1.5
206A	3	2	10	2	58	130	1	201	108	70	4	2.5		Eb		1.3	1.0
207A	7	9	0	11	3	0	1	152	89	22	.8	0		Qra/Eb-Eh	River Channel	0	1.2
207B	6	6	6	9	6	74	2	225	52	109	1.0	0.7		Es		1	1.5
208A	7	9	4	15	4	33	1	147	158	18	.8	.3		Eh-Eb	Ck.	0.6	1.7
208B+	2	4	6	9	3	59	1	212	72	84	.5	.7	200nT	Qra/Es		3	2.3
209A	4	5	2	4	4	0	1	213	92	63	.8	.5		Eh	Ck.	0.5	0.8
209B+	5	0	9	0	496	88	2	200	50	79	00	00	1450nT	Es	Tailings Dam	1.8	-
209C+	5	0	12	0	458	146	2	243	51	124	00	00		Es		2.4	-
210A	4	13	6	25	2	0	1	141	121	26	.3	.2		EH		1.5	1.9
210B+	5	1	4	0	24	177	1	277	99	130	5	00		Es/Eh	Razorback Mine	.8	0
210C+	1	5	7	11	3	51	1	196	90	71	.2	.6		Es	Ck.	7	2.2
210C	2	4	0	9	2	52	1	117	453	0	.5	0		Es		0	2.25
211A+	1	2	6	11	3	90	1	202	81	73	.5	.5	225nT	Es	Ck.	6	5.5
211B+	4	7	3	11	3	49	1	209	202	61	.6	.3		Es		.8	1.6
211C	4	4	3	5	5	49	1	328	91	169	1.0	.5		Buo-Es		.8	1.5
212A+	2	1	6	0	57	224	1	197	63	73	2	00		Es		3.0	0
212B	1	5	7	12	3	49	1	187	87	66	.2	.6	2300nT	Es	Ck.	7	2.4
213B	7	11	13	20	5	22	2	192	42	86	.6	.7	1750nT	Es	Ck.	1.9	1.8
213D+	1	0	3	0	8	299	2	257	35	153	00	00		Es		-	-
213E+	4	8	8	14	4	31	2	196	40	90	1.3	.2		Es		2	1.8
214B+	9	8	21	17	11	44	3	201	22	113	1.1	1.2	1600nT	Es	Ck. continuous with 213B	2.3	2.1
214D+	4	4	2	7	4	97	2	227	50	114	1.0	.3		Es		0.5	1.8
214E+	2	6	6	13	2	42	2	232	47	119	.3	.5		Es		3.0	2.2

+ Probable bedrock conductor

* Estimated depth may be unreliable because the stronger part of the conductor may be deeper or to one side of the flight line, or because of a shallow dip or overburden effects.

Qra : Recent Alluvium
 Buo : Onah Quartzite and Slate
 Eh : Hodge Slate
 Eb : Brewery Junction Formation
 Es : Serpentinite and Pyroxenite

019

830020

X Type Anomalies

<u>Line & Anomaly</u>	<u>Magnetics</u>	<u>Lithology</u>	<u>Remarks</u>
201xD		Quo	Ck. Fault 200A extended
201xE		Quo	Banner Cross Mine
202xA		Quo	Track
203xA		Quo-Cs	Comet Mine
204xA		Quo	205B extended
205xB		Es	Fault
208xA		Ch	Ck. 209A extended
208xC	260nT	Qra/Es	Tailings Dam. 209B extended.
209xA		Quo	Nth. Comet Mine
210xA		Ch-6b	
210xB		Es	209B extended
212xB	230nT	Es	Fault

Table 2 Interpretation of Conductor Geometry.

<u>Coplanar/Coaxial Ratio</u>	<u>Geometry of Conductor</u>
0 (at peak of standard)	Steeply dipping thin dyke.
0 to 1.9	Steeply dipping dyke of increasing thickness.
1.9 to 2.1	Horizontal conductor (e.g. overburden) or steeply dipping thick dyke.
2.1 to 4.5	Bottom-limited thick conductor such as a sphere, or a steeply dipping dyke at a small angle to the flight line.
4.5	Steeply dipping dyke sub-parallel to the flight line.

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KEYWORDS

Geophysics - E.M., Data Review, Ultrabasics

LIST OF PLANS

<u>Plan Number</u>	<u>Title</u>	<u>Scale</u>
Tv 303	Locality Plan	1:100,000
TASh 455	General Geology	1:10,000
TASh 500	Dighem II Survey - Electromagnetics	1:10,000
TASh 501	Dighem II Survey - Resistivity	1:10,000
TASh 502	Dighem II Survey - Enhanced Magnetics	1:10,000
TASh 503	Dighem II Survey - Magnetics	1:10,000
TASh 529	Razorback Geophysical Interpretation	1:10,000
TASh 530	Razorback Dighem Line 208 Aeromagnetic Model	As shown
TASh 504	Razorback M.L. PEM.Line EMW-4	"
TASh 505	" " " " EMW-5	"
TASh 506	" " " " EME-3	"
TASh 507	" " " " EMW-6	"
TASh 508	" " " " EMN-1	"
TASh 509	" " " " EME-4	"
TASh 510	" " " " EME-5	"
TASh 511	" " " " EMW-1	"

LOCATION

Queenstown 1:250,000 Sheet SK55-5

LIST OF APPENDICES

Appendix 1 P.E.M. (DEEP.E.M. Mode) Data

APPENDIX 1

P.E.M. (DEEP.E.M. MODE) DATA

RAZORBACK DEEP.E.M. DATA

Loop Geometry:- Tx: 100m x 100m horizontal loop laid out on EME-3 and EMW-1 2900mE to 3000mE. (Loop 1)
 Rx: Small roving loop reading vertical and horizontal components of secondary field.
 Gain 800, 20 msec timebase

Channel	VERTICAL COMPONENT								HORIZONTAL COMPONENT							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
EME-3																
0mE	-620	-400	-210	-96	-54	-32	-16	-7	290	110	26	5	1	1	2	2
25mE	-460	-330	-210	-100	-56	-29	-14	-5	700	320	130	48	20	9	4	2
50mE	-260	-260	-190	-94	-55	-29	-14	-7	560	280	105	40	16	8	4	3
75mE	-80	-190	-150	-81	-51	-28	-14	-6	640	350	150	65	28	11	4	2
100mE	86	-36	-68	-64	-46	-28	-14	-6	520	340	160	65	27	10	4	2
125mE	70	-30	-75	-63	-46	-27	-14	-6	480	300	160	76	35	15	6	2
150mE	120	11	-36	-41	-36	-24	-13	-6	320	240	130	66	31	11	2	1
175mE	130	45	-12	-28	-28	-19	-8	-5	260	210	120	69	35	16	5	2
200mE	150	67	7	-18	-21	-19	-8	-6	190	160	110	69	36	17	8	4
225mE	150	80	24	-5	-15	-15	-8	-4	120	110	92	59	34	16	6	3
EME-4																
50mE	-460	-380	-250	-140	-60	-30	-15	-5	800	390	150	56	22	8	4	3
75mE	-44	-160	-150	-88	-55	-30	-15	-5	690	380	170	72	29	11	4	1
100mE	94	-50	-84	-70	-49	-28	-15	-3	550	340	170	86	39	16	9	2
125mE	140	5	-48	-50	-39	-22	-10	-2	400	290	150	78	36	15	5	2
150mE	180	56	-11	-30	-30	-21	-9	-5	290	240	150	78	42	19	7	3
175mE	150	68	5	-24	-26	-20	-12	-5	140	130	94	55	29	13	5	2
200mE	150	84	23	-6	-20	-16	-8	-4	140	140	103	69	40	18	7	2

VERTICAL COMPONENT

HORIZONTAL COMPONENT

Channel	VERTICAL COMPONENT								HORIZONTAL COMPONENT							
EME-5	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
50mE	-600	-440	-260	-150	-68	-34	-15	-6	900	450	180	76	28	9	3	1
75mE	-220	-240	-190	-140	-60	-31	-12	-7	840	450	200	96	39	13	5	1
100mE	-72	-160	-150	-85	-50	-20	-10	-4	680	410	210	95	41	16	5	2
125mE	150	15	-45	-54	-45	-27	-12	-7	450	330	180	91	44	17	5	1
150mE	220	86	7	-22	-26	-19	-13	-7	310	260	150	90	45	19	7	2
EMW-1																
50mE	-460	-340	-220	-140	-66	-34	-15	-7	790	390	180	73	29	16	11	1
100mE	80	-45	-75	-69	-51	-31	-15	-6	560	340	170	88	39	16	6	3
150mE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
200mE	150	86	32	0	-14	-15	-7	-4	130	130	100	70	44	21	8	3
250mE	120	83	44	15	-2	-7	-6	-4	72	74	68	54	36	20	9	3
300mE	92	74	99	27	9	-1	-3	-3	32	36	36	35	28	17	9	4

RAZORBACK DEEP.E.M. DATA

Loop Geometry:- Tx: 100m x 100m horizontal loop laid out on EMW-4 and EMW-6 3000mE to 3100mE (Loop 2)
 Rx: Small roving loop reading vertical and horizontal components of secondary field.
 Gain 800, 20msec timebase.

Channel	VERTICAL COMPONENT								HORIZONTAL COMPONENT							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
EMW-4																
50mW	-590	-360	-220	-140	-69	-38	-18	-7	260	170	102	65	38	20	9	4
75mW	-450	-290	-180	-86	-55	-31	-16	-7	220	180	95	59	35	18	8	3
100mW	-430	-260	-150	-76	-49	-27	-13	-5	290	190	110	70	40	20	9	4
125mW	-440	-260	-150	-65	-42	-25	-10	-5	290	190	110	70	40	19	8	2
150mW	-320	-200	-89	-55	-36	-22	-9	-4	310	190	105	62	36	18	8	3
175mW	-210	-150	-66	-44	-30	-19	-8	-4	360	200	105	60	34	17	7	3
200mW	-58	-65	-46	-33	-24	-15	-7	-4	330	190	94	54	31	16	7	3
225mW	20	-26	-29	-25	-20	-11	-8	-3	240	150	80	48	28	14	6	2
250mW	54	-4	-16	-16	-15	-9	-6	-3	200	150	75	45	26	14	6	2
275mW	100	26	-4	-10	-10	-8	-5	-2	160	130	71	41	25	14	4	2
EMW-5																
50mW	-600	-370	-230	-120	-65	-36	-16	-6	180	120	81	50	28	13	6	2
75mW	-540	-340	-190	-96	-59	-31	-16	-7	340	220	120	78	45	23	9	4
100mW	-480	-270	-150	-67	-38	-14	-9	-2	340	220	120	74	42	21	8	4
125mW	-450	-250	-140	-64	-42	-25	-11	-7	400	240	120	72	43	23	11	6
150mW	-400	-220	-110	-54	-35	-19	-6	-3	500	250	120	70	40	20	9	2
175mW	-110	-100	-64	-44	-29	-19	-8	-4	500	250	120	65	36	19	7	1
200mW	8	-40	-40	-32	-25	-16	-7	-4	350	200	100	56	32	16	7	4
225mW	74	-1	-21	-21	-20	-14	-6	-3	250	160	85	48	29	15	7	4
250mW	90	14	-12	-16	-16	-12	-7	-6	190	140	70	41	25	13	5	2

VERTICAL COMPONANT

HORIZONTAL COMPONANT

Channel	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
EMW-6																
50mW	-510	-310	-190	-90	-55	-31	-13	-5	300	200	120	73	46	29	9	3
75mW	-490	-290	-160	-80	-51	-29	-12	-6	210	150	86	54	31	16	7	4
100mW	-450	-260	-150	-69	-48	-30	-11	-6	370	210	120	70	40	20	8	3
125mW	-340	-200	-90	-55	-38	-24	-11	-5	450	240	120	64	35	17	7	3
150mW	-120	-95	-64	-44	-31	-20	-8	-4	400	210	110	60	34	17	8	3
175mW	21	-30	-37	-33	-26	-18	-8	-4	360	200	100	51	25	15	5	-1
200mW	90	6	-20	-22	-20	-15	-6	-4	300	190	96	54	32	16	9	4
225mW	120	32	-6	-14	-14	-11	-6	-3	210	150	81	48	29	15	6	3
250mW	120	45	3	-10	-12	-8	-4	-3	130	110	64	38	23	12	5	2
275mW	105	45	7	-5	-8	-7	-4	-2	100	85	55	35	24	12	6	3

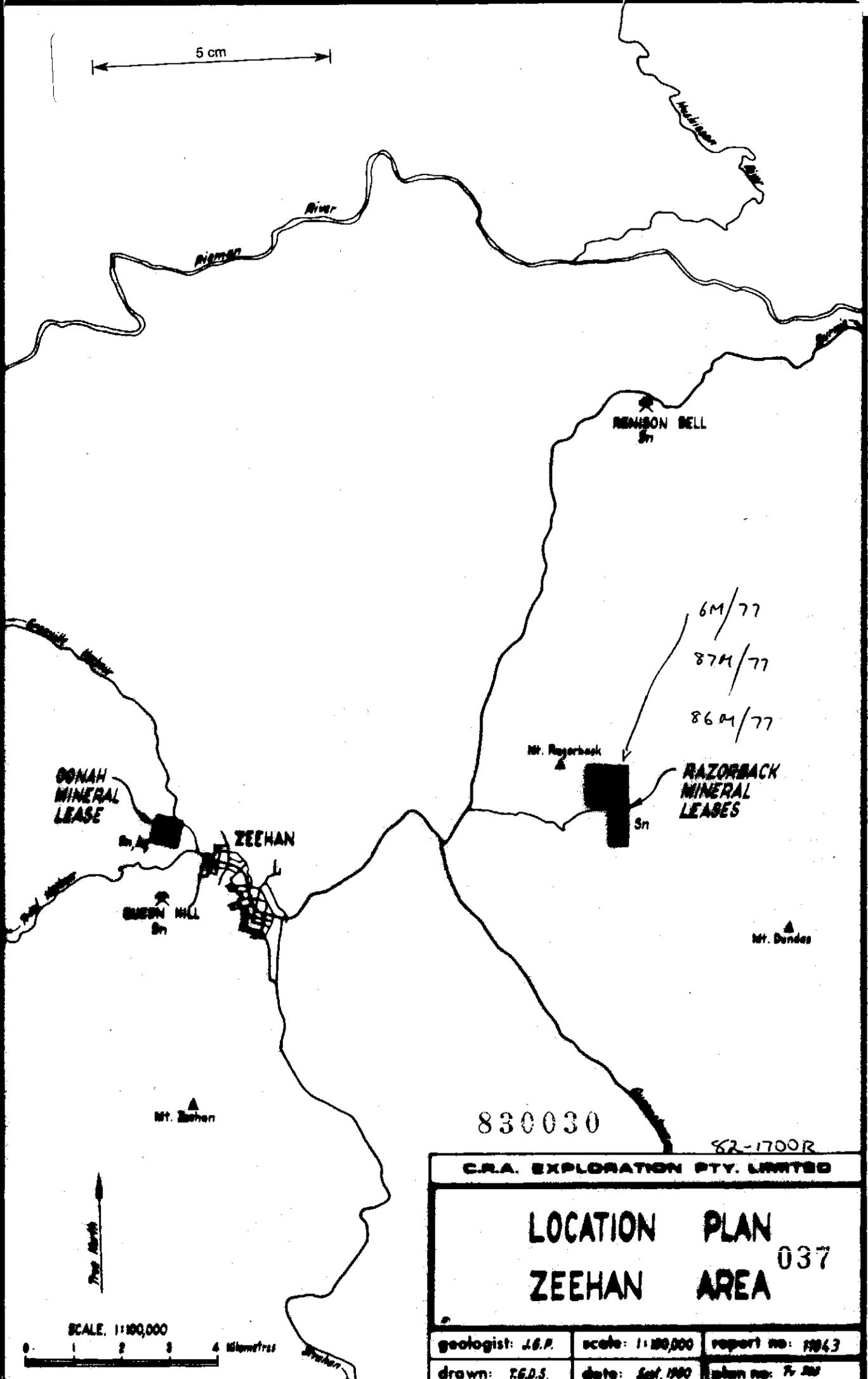
RAZORBACK DEEP.E.M. DATA

Loop Geometry:- Tx:100m x 100m horizontal loop liad out on (Loop 3)

Rx:Small roving loop rading vertical and horizontal componants of secondary field.
Gain 800, 20msec timebase.

Channel	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
EMN-1																
50mE	-460	-340	-210	-150	-80	-50	-28	-14	450	220	100	50	25	12	6	4
75mE	-290	-250	-160	-100	-65	-32	-26	-10	360	200	94	40	24	11	5	1
100mE	-150	-170	-150	-95	-68	-44	-25	-11	350	210	110	62	34	16	8	3
125mE	-35	-95	-100	-80	-60	-40	-25	-12	290	200	120	71	41	23	10	3
150mE	14	-54	-74	-70	-59	-44	-22	-11	220	190	120	76	46	25	15	6
175mE	47	-11	-40	-44	-40	-28	-19	-10	170	160	110	75	46	25	14	6
200mE	55	14	-19	-28	-29	-25	-14	-8	120	130	95	69	46	25	14	7

5 cm



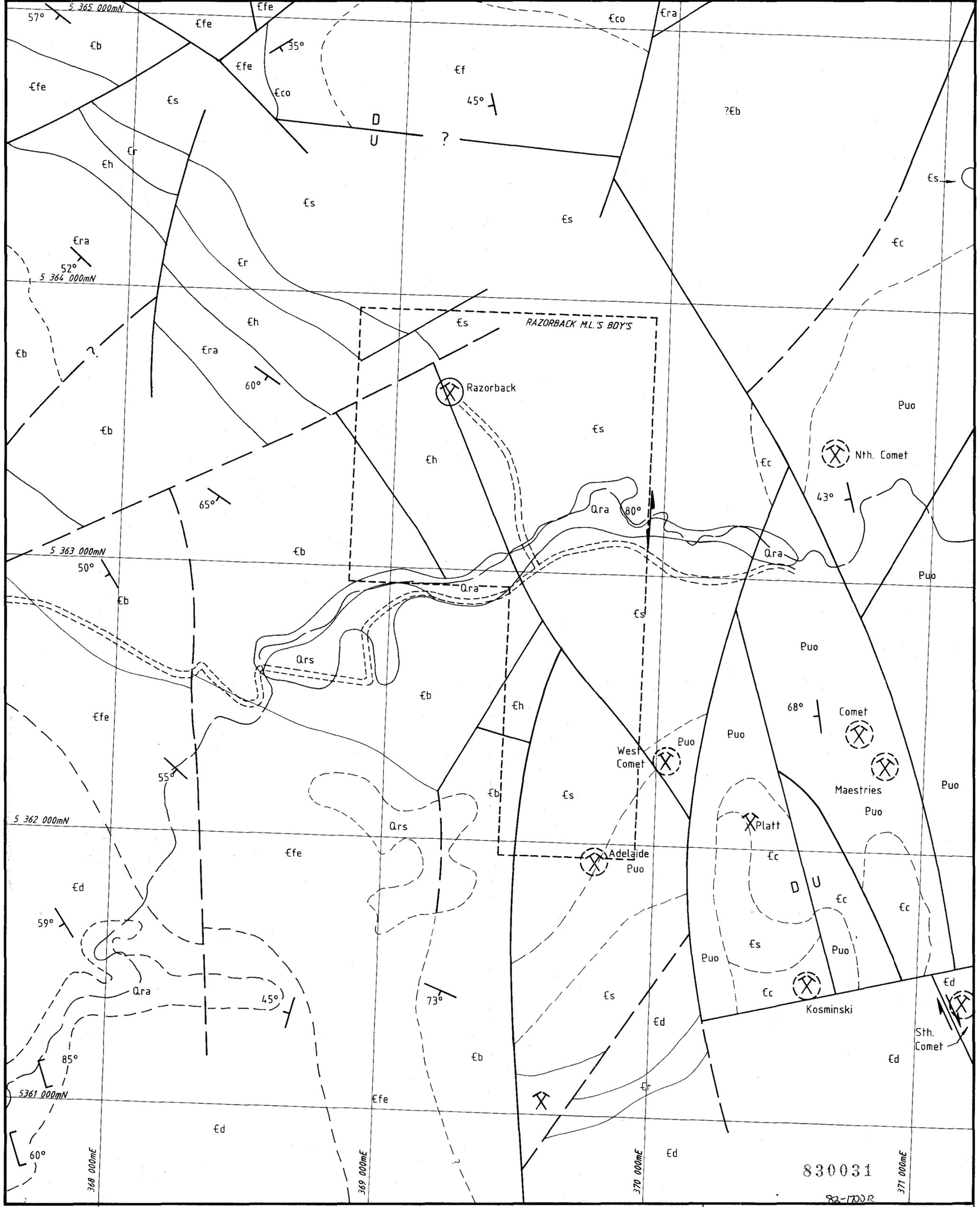
830030

82-1700R

C.R.A. EXPLORATION PTY. LIMITED

LOCATION PLAN
ZEEHAN AREA 037

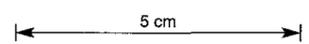
geologist: J.B.P.	scale: 1:100,000	report no: 1043
drawn: T.E.D.S.	date: Sep. 1960	plan no: 7-20



- Qra - Recent alluvium
- Qrs - Recent alluvium marsh deposits, downwash etc.
- Ef - Fernflow Fm.
- Efe - Fernfields Fm.
- Eb - Brewery Junction Fm.
- Era - Razorback Conglomerate
- Eh - Hodge Slate
- Er - Red Lead Conglomerate
- Es - Serpentine and Pyroxenite

- Ed - Dundas Group (unassigned)
 - Ec - Crimson Ck. Fm.
 - Puo - Oonah Quartzite and Slate
- Prospect
 Mine
 Abandoned Mine

NOTE:
 A.M.G. GRID &
 M.L.'S BDY'S
 were interpolated.

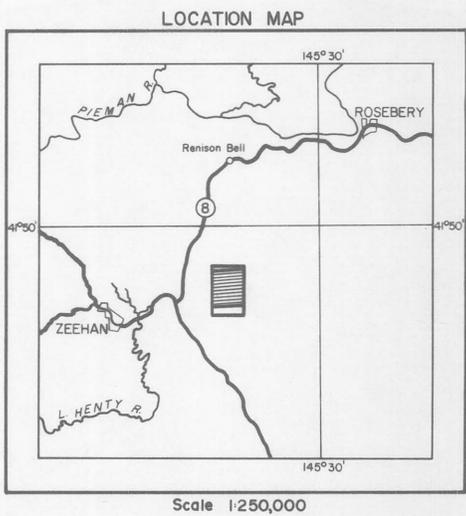


CRA EXPLORATION PTY. LIMITED

RAZORBACK M.L.
GENERAL GEOLOGY. 6845

From 1:63 360 Geology Map.
 September 1981

Ref. SK55-5	Scale: 1:10 000
Geol: M.F.F.	Report N°. 11043
Drawn R. T.	Plan N°. TASH 455



DIGHEM^{II} SURVEY

MT. RAZORBACK AREA, TASMANIA

ELECTROMAGNETICS

FOR

C.R.A. EXPLORATION PTY. LTD.

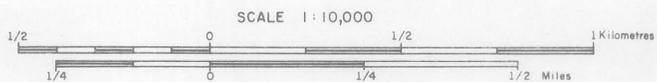
82-1700 R

Flight line

Fiducials and numbers

5 cm

830032



ANOMALY GRADE	EM GRADE SYMBOL	MHO RANGE	DIGHEM anomalies are divided into six grades of conductivity - thickness product. This product in mhos is the reciprocal of resistance in ohms. The mho is a measure of conductance, and is a geologic parameter. Most swamps yield Grade 1 anomalies but highly conducting clays can give Grade 2 anomalies. The multi-coil anomaly shapes often allow surface conductors to be recognized, and these are indicated by the letter S on this map. The remaining Grade 1 and 2 anomalies could be weak bedrock conductors. The higher grades indicate increasingly higher conductances. Examples: The ore bodies of the Magosi River camp yield Grade 4 anomalies, while Maitohi and Whistle give Grade 5. Graphite and sulphides can span all grades but, in this survey area, field work may show that the different grades indicate different types of conductors.
6	●	> 100	The actual mho value is plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal rows of dots indicate anomaly amplitude on the flight record, and the vertical column gives the estimated depth. This depth may be unreliable because the stronger part of the conductor may be deeper or to one side of the flight line, or because of a shallow dip or conductive overburden effects.
5	●	50-99	
4	●	20-49	
3	●	10-19	
2	●	5-9	
1	●	< 5	
	×	Possible conductor	
Identifier	— mho value	— mho value	
Depth is greater than:	— mho value	— mho value	
50 feet	— mho value	— mho value	
100 feet	— mho value	— mho value	
150 feet	— mho value	— mho value	
200 feet	— mho value	— mho value	
Refer to list of anomalies in survey report for the actual ppm values for all cells, and for conductor depths.			
—	Conductor axis		DIGHEM maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with geology when planning a follow-up program. The actual mho values are plotted for those who wish quantitative data. The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of all conductors in terms of length, strike direction, conductance and depth. The accuracy is comparable to an interpretation from a ground EM survey having the same line spacing.
S	Probable surface response		
SP	Possible surface response		
L	Probable line (power, telephone, pipe, or fence)		
LP	Possible line		
P	Questionable anomaly		
Q	Apparent thickness > 10m		
V	Dip		
100%	Direct magnetic correlation of 100 gauss		

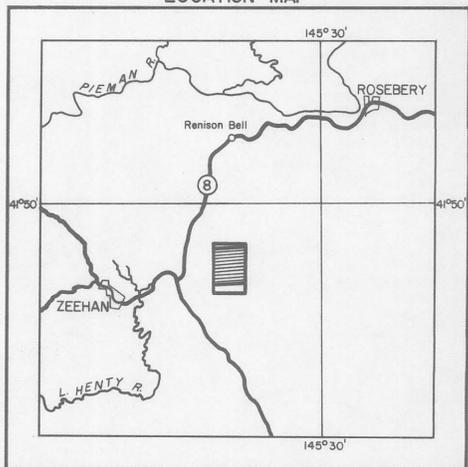
6848

Report No. 11043 Tash 500

JOB 327-1; MAY 1981



LOCATION MAP



Scale 1:250,000



DIGHEM^{II} SURVEY

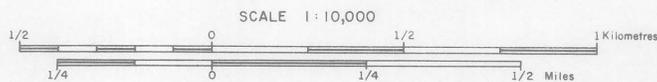
MT. RAZORBACK AREA, TASMANIA

RESISTIVITY

FOR

C.R.A. EXPLORATION PTY. LTD.

5 cm



82-1700R

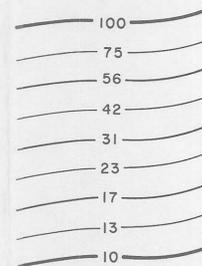
Flight line



Fiducials and numbers

LEGEND

Contours in ohm-m
at eight intervals per decade



Note

The numbers face in the direction of increasing value.

830033

6847

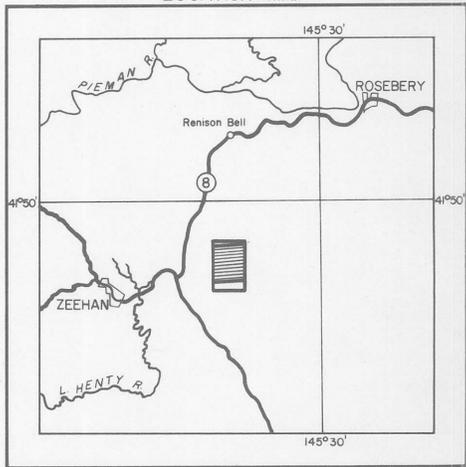
Report No. 11043

TASH 501

JOB 327-1, MAY 1981



LOCATION MAP



Scale 1:250,000



DIGHEM^{II} SURVEY

MT. RAZORBACK AREA, TASMANIA

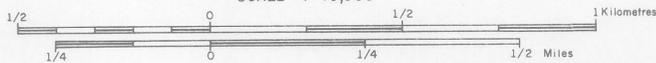
ENHANCED MAGNETICS

FOR

C.R.A. EXPLORATION PTY. LTD.

5 cm

SCALE 1:10,000



82-1700 R

Flight line

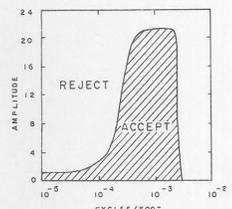
9881
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9896
9897
9898
9899
9900

Fiducials
and
numbers

ISOMAGNETIC LINES

(enhanced field)

- 5000 5000 gammas
- 1000 1000 gammas
- 200 200 gammas
- 100 100 gammas
- magnetic depression



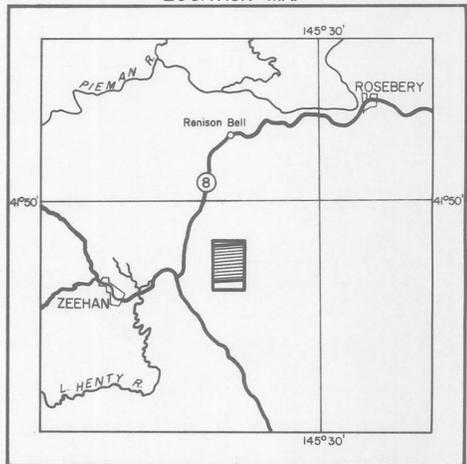
Frequency response of
magnetic operator
Report No. 11043

TASH 502

6846



LOCATION MAP



Scale 1:250,000



DIGHEM^{II} SURVEY

MT. RAZORBACK AREA, TASMANIA

MAGNETICS

FOR

C.R.A. EXPLORATION PTY. LTD.

82-1700 R

Flight line

8281
8282
8283
8284

Fiducials
and
numbers

ISOMAGNETIC LINES
(total field)

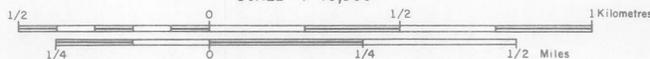
- 1000 gammas
- 200 gammas
- 50 gammas
- 25 gammas
- magnetic depression

Magnetic Inclination within
the survey area: 72°

5 cm

830035

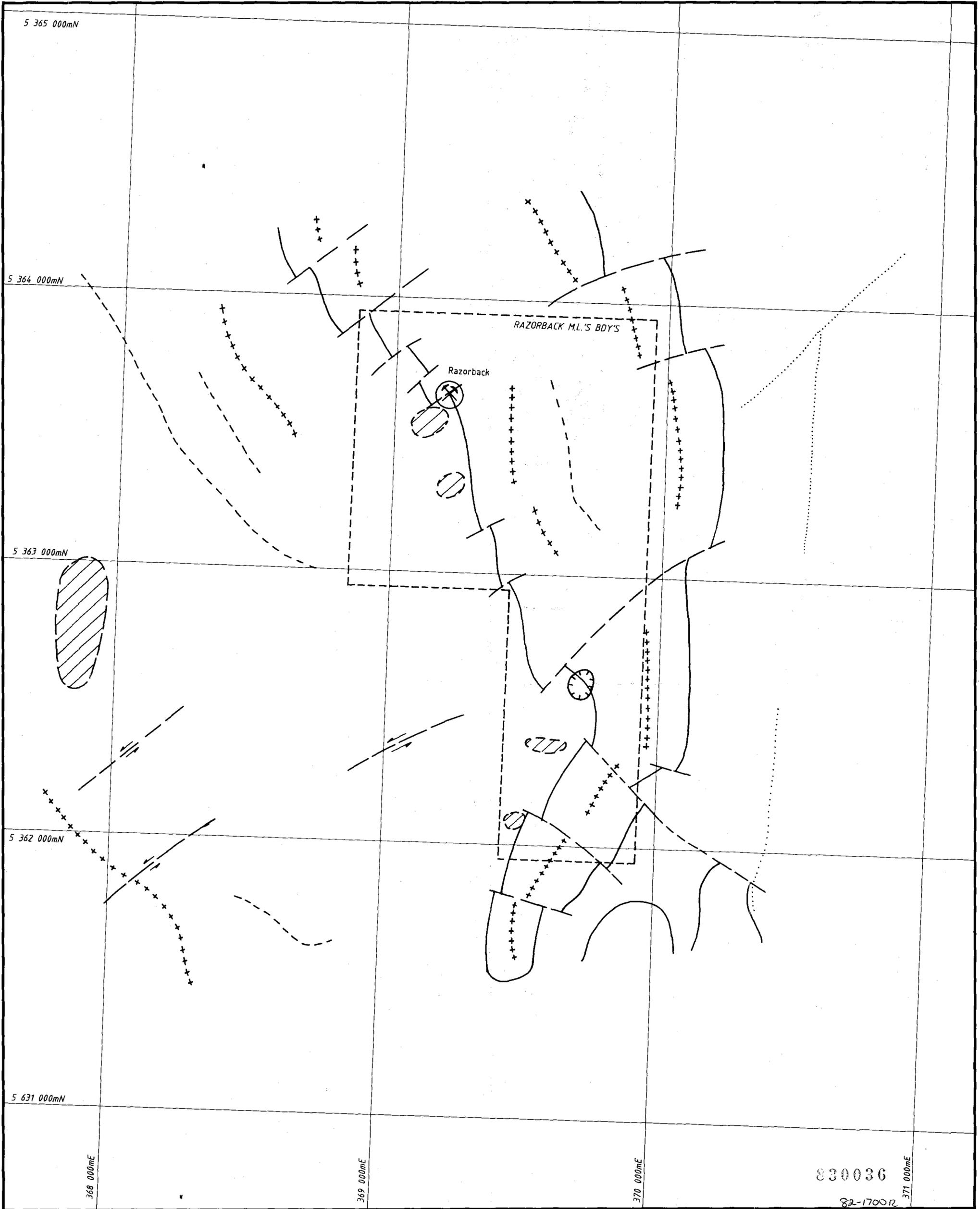
SCALE 1:10,000



6849

Report No. 11043
Tash 503

JOB 327-1, MAY 1981



830036

82-170012

CRA EXPLORATION PTY. LIMITED

RAZORBACK M.L.

6844

Geophysical Interpretation

- Interpreted serpentinite boundary (magnetic)
- Interpreted fault (from magnetics)
- ++++ Positive magnetic trend.
- Negative magnetic trend.
- Resistivity low trend (probable fault)
- Anomalous magnetic zone.
- Anomalous resistivity low.

5 cm

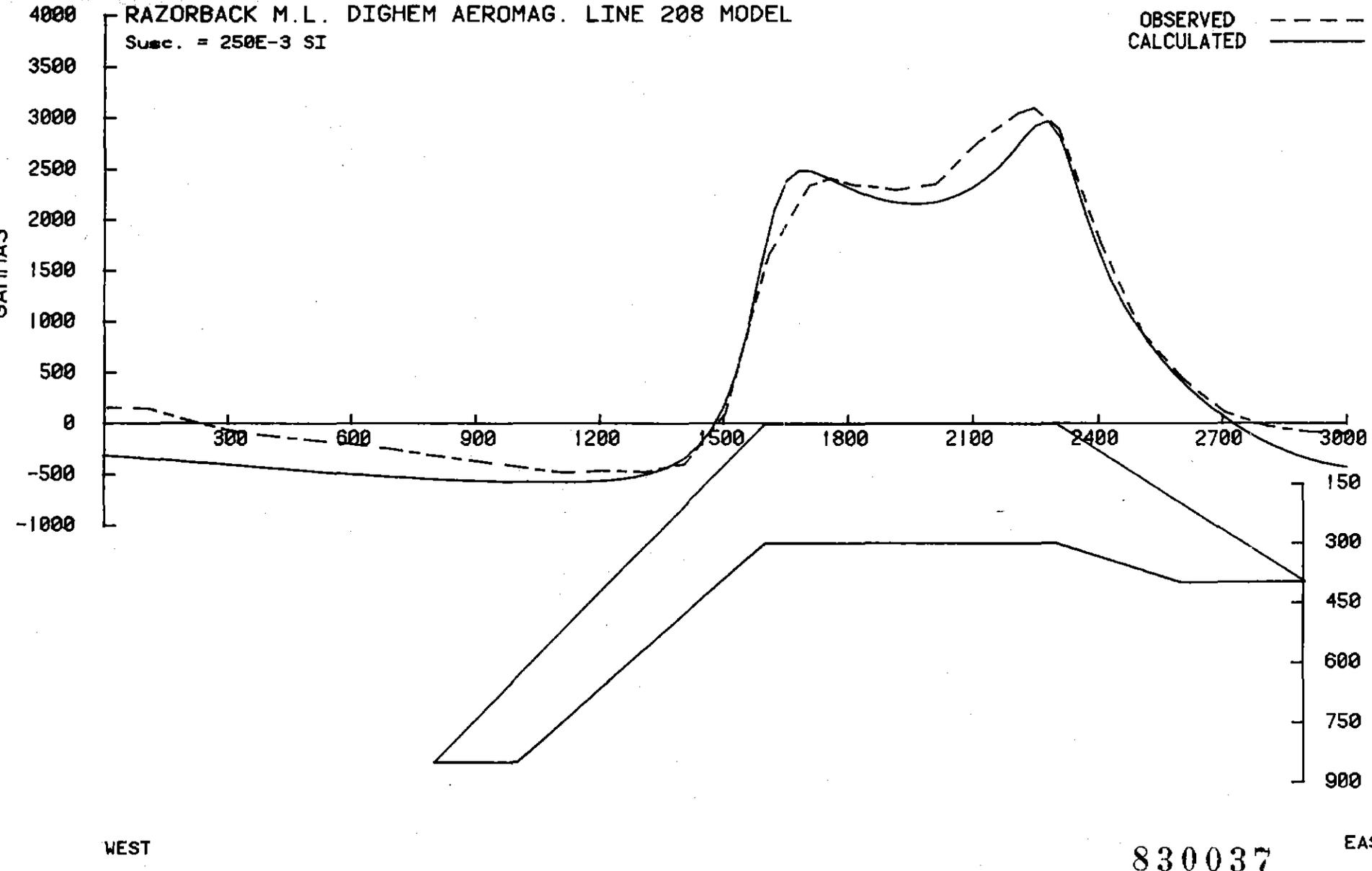
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Author:	M.F.F.	Report N°	11043
Drawn	R. T.	Plan N°	TASH 529

82-1700R

RAZORBACK M.L. DIGHEM AEROMAG. LINE 208 MODEL

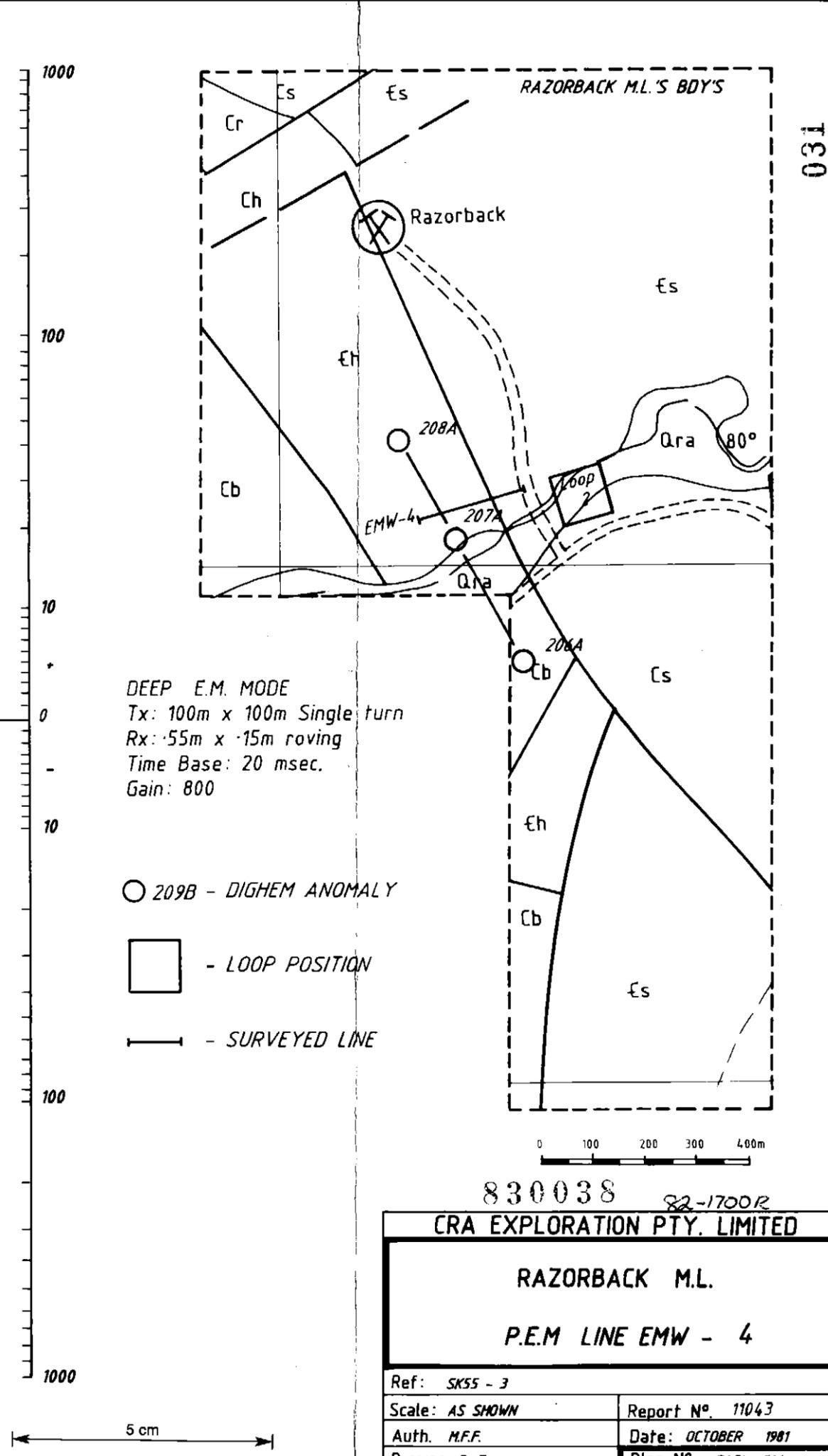
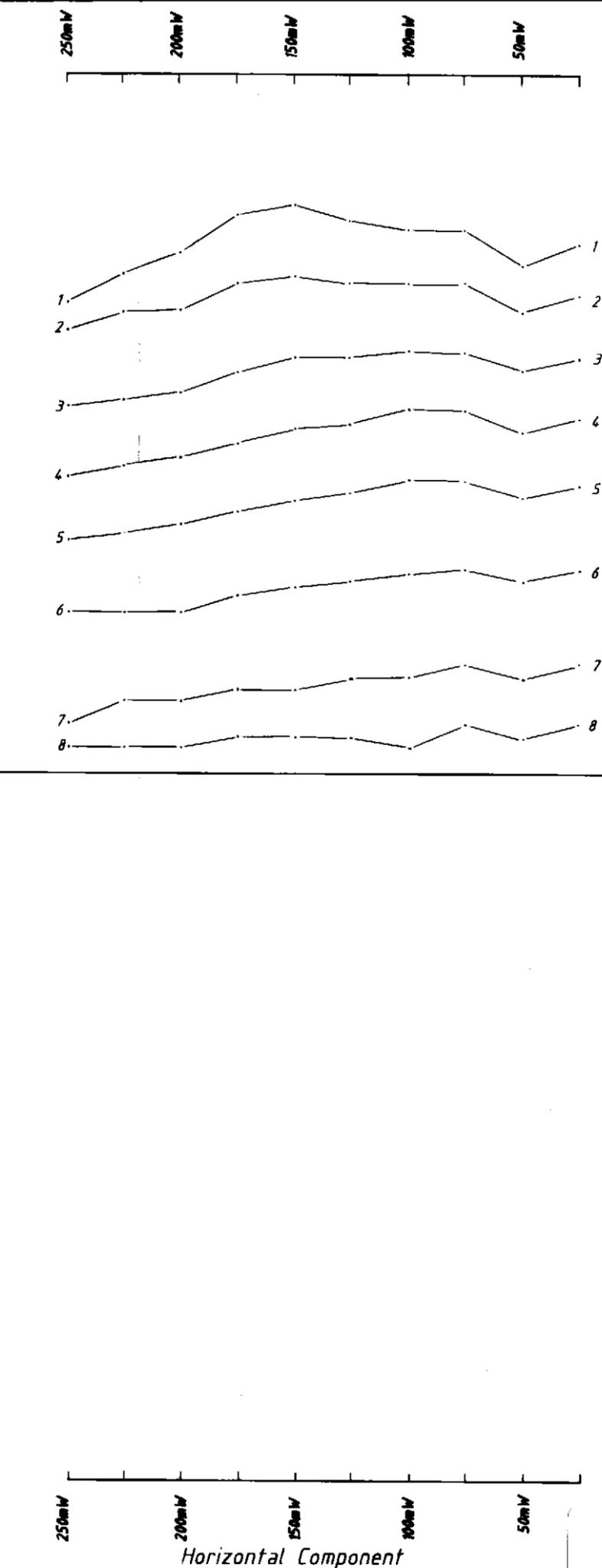
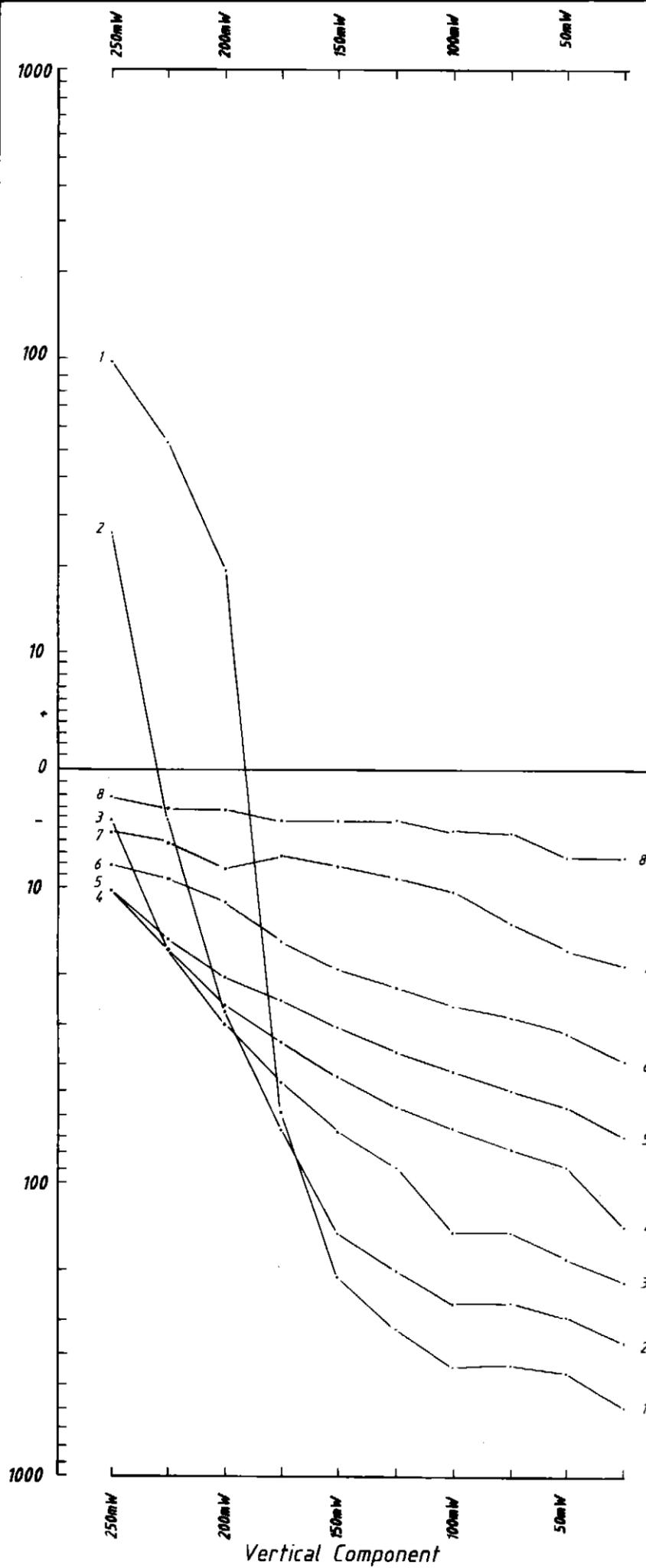
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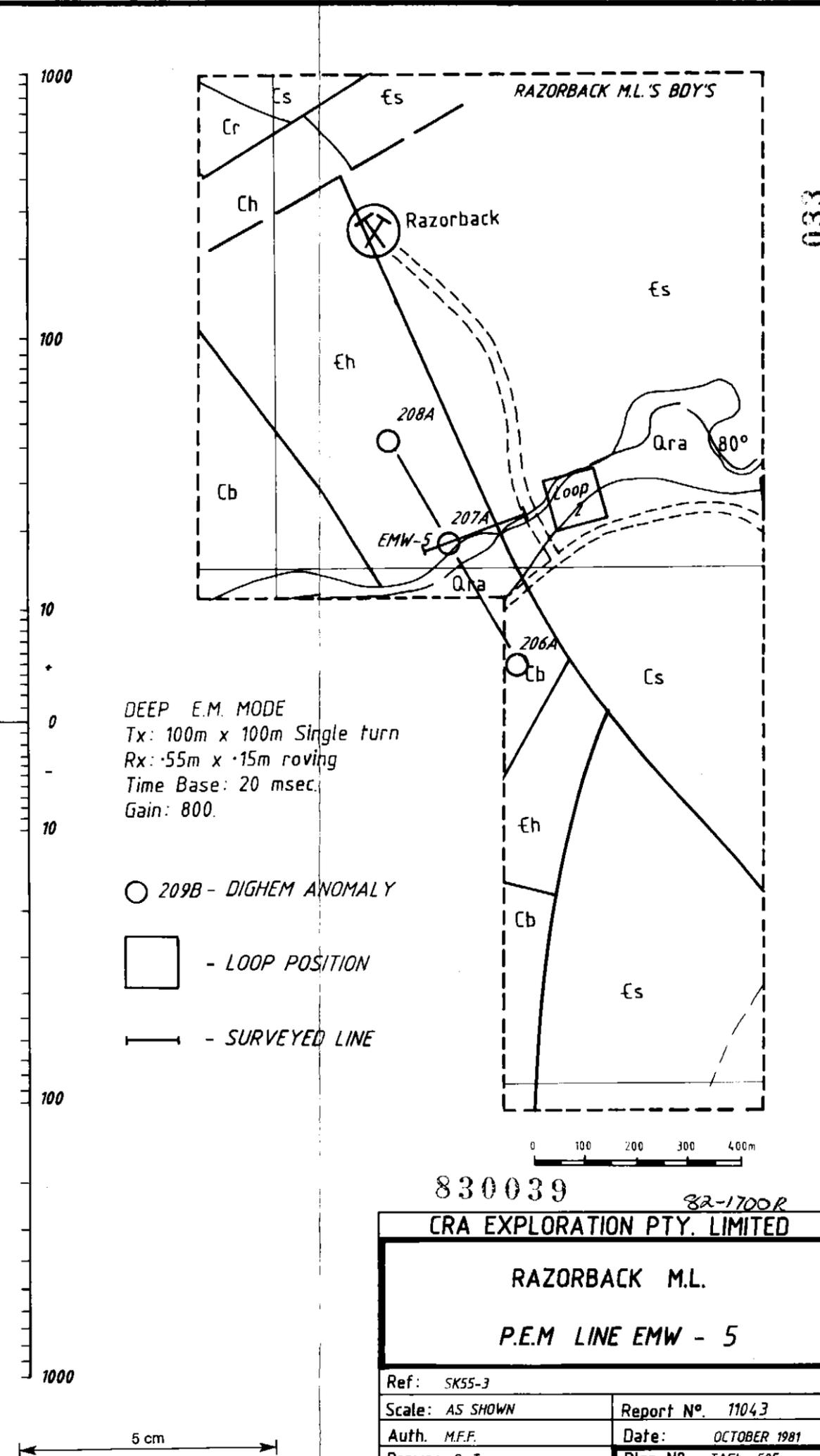
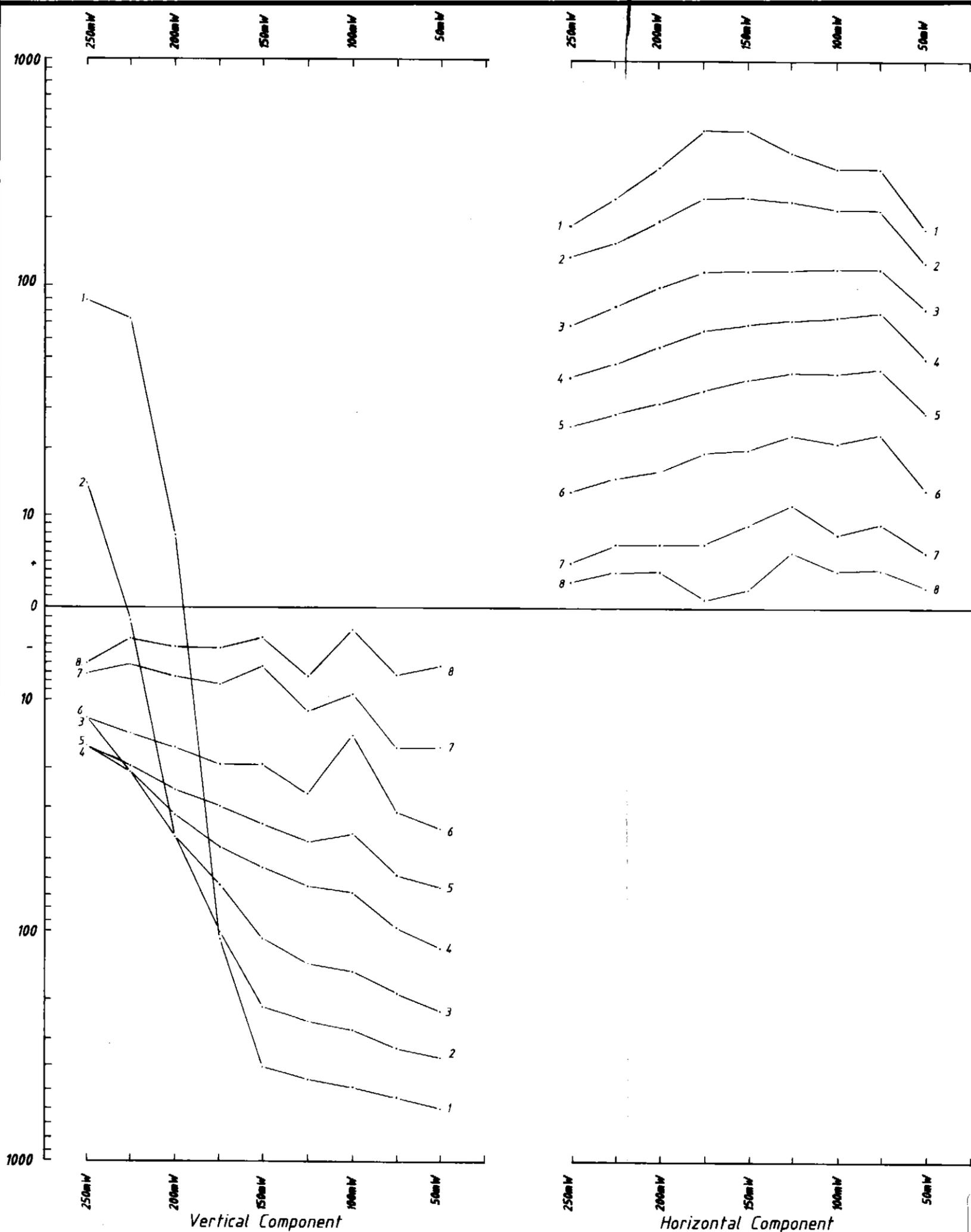
OBSERVED ---
CALCULATED ———



830037

5 cm





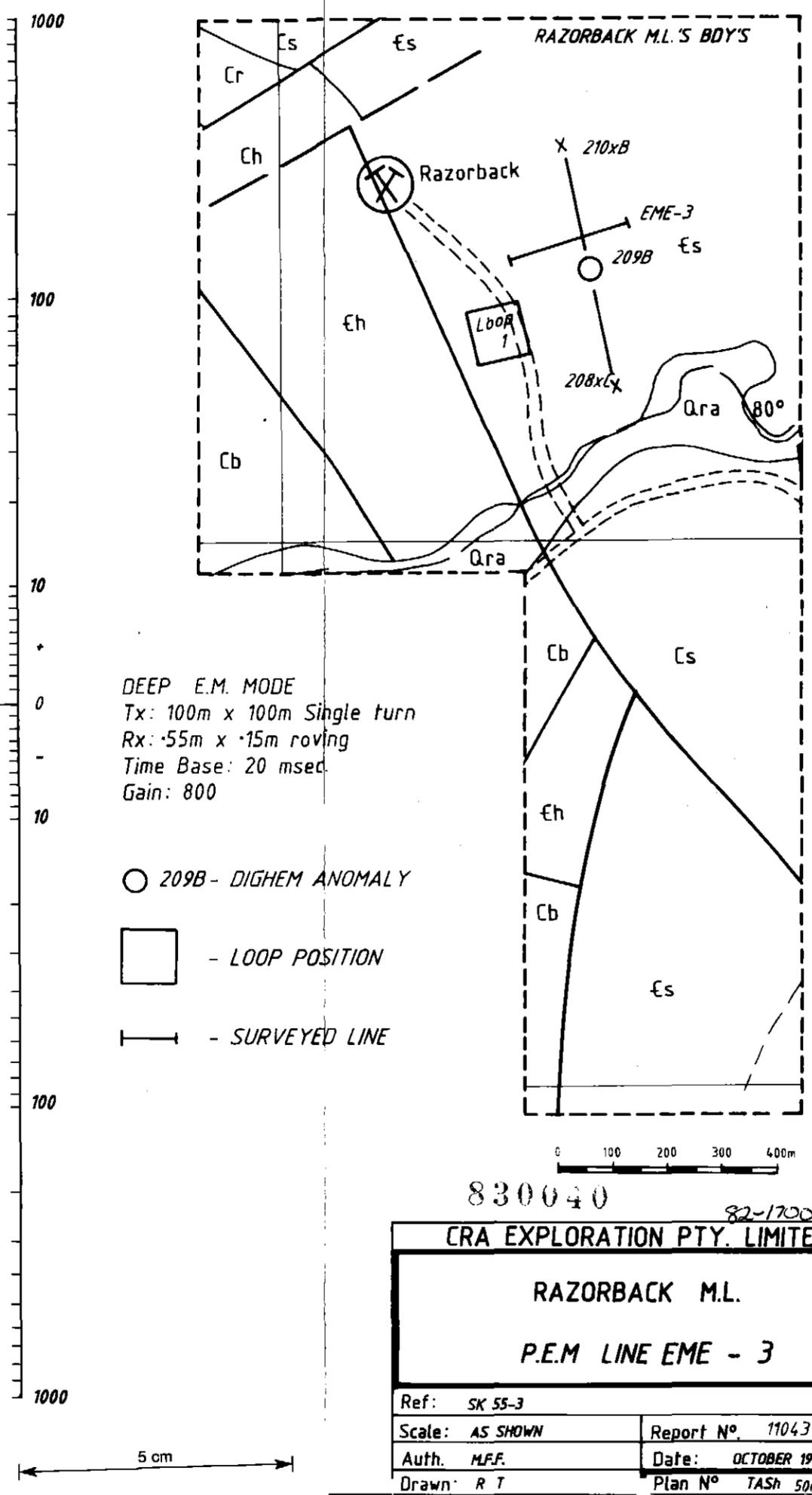
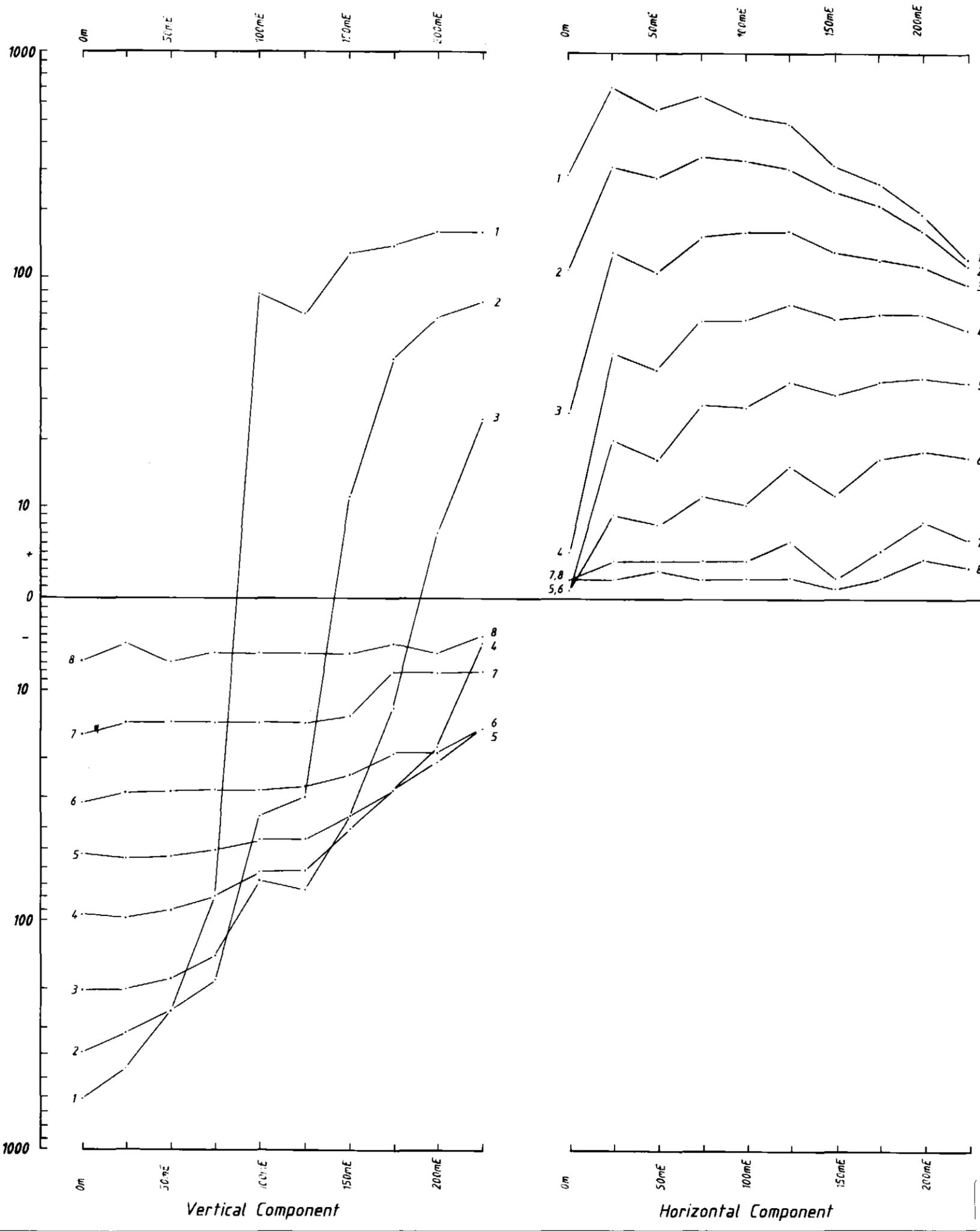
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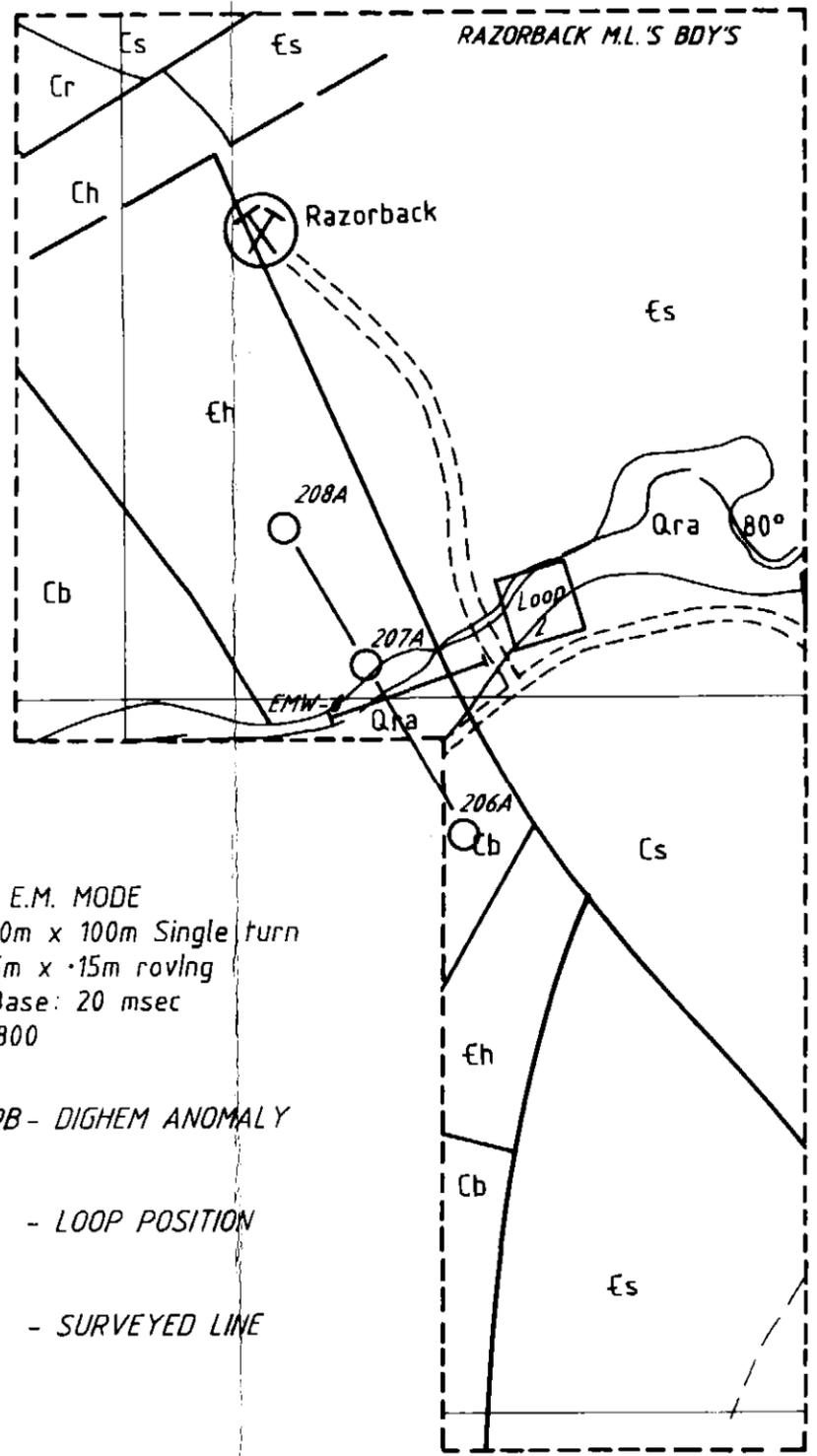
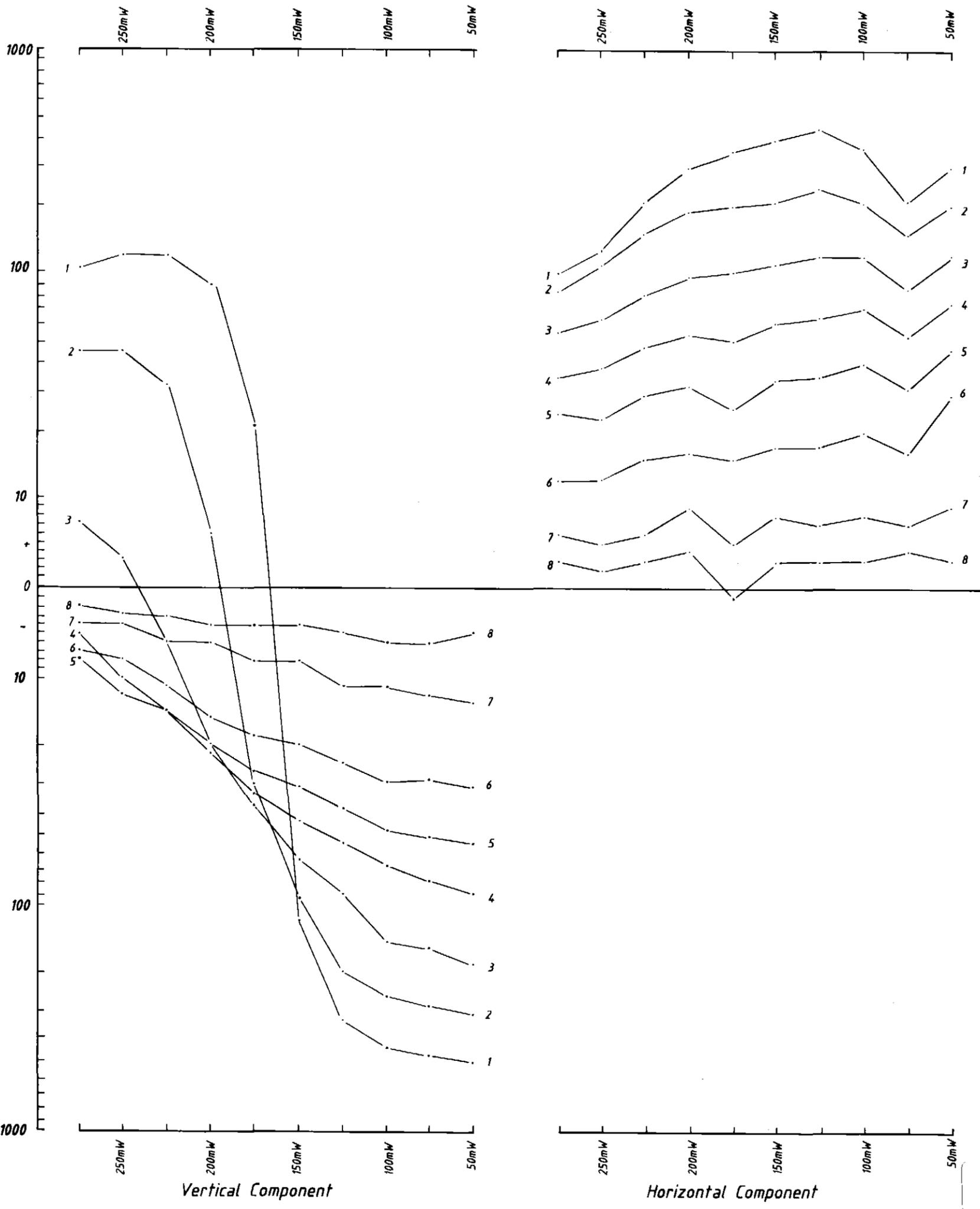
830039 82-1700R

CRA EXPLORATION PTY. LIMITED

RAZORBACK M.L.

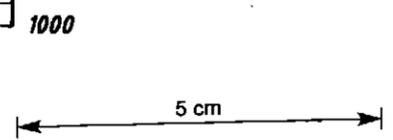
P.E.M LINE EMW - 5



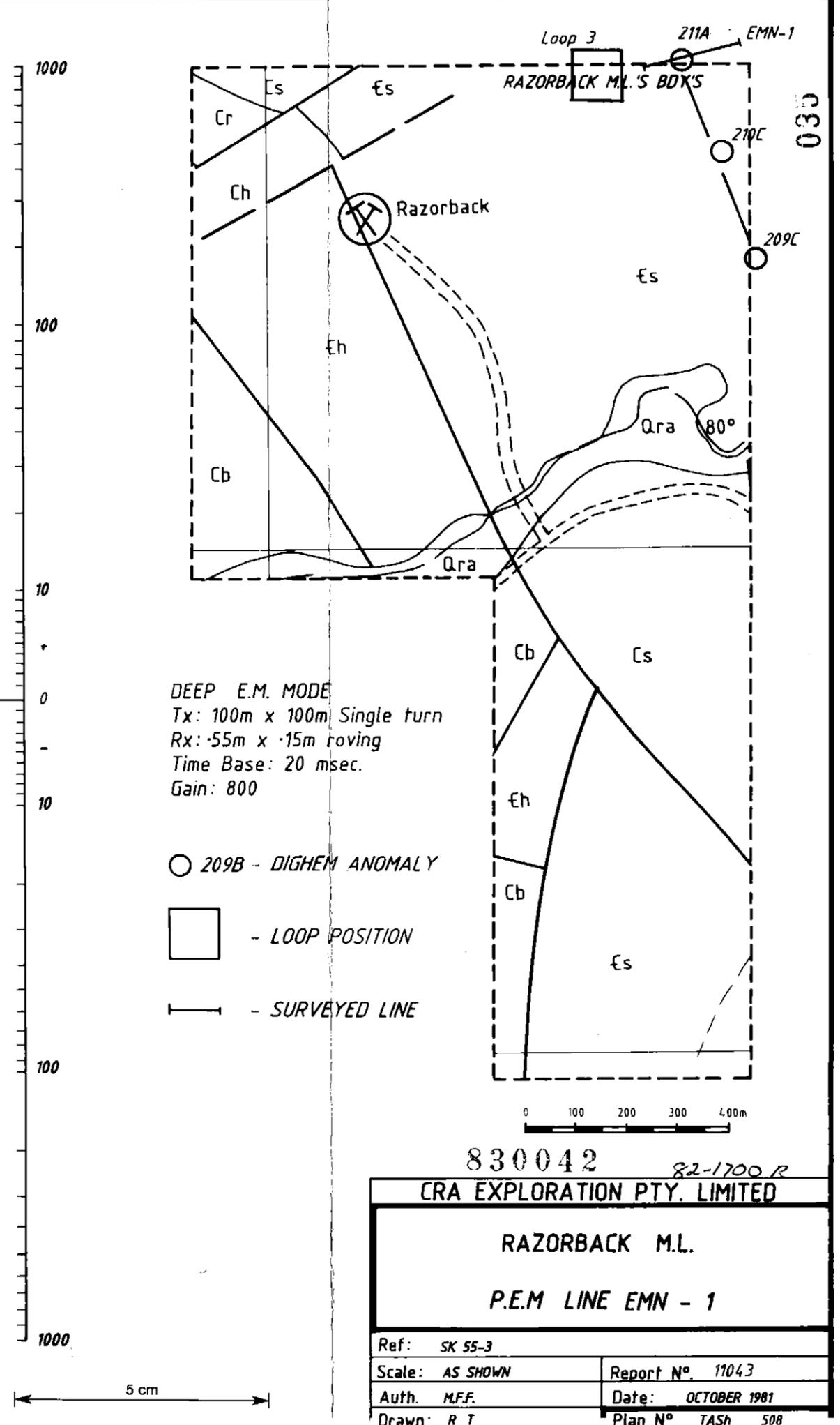
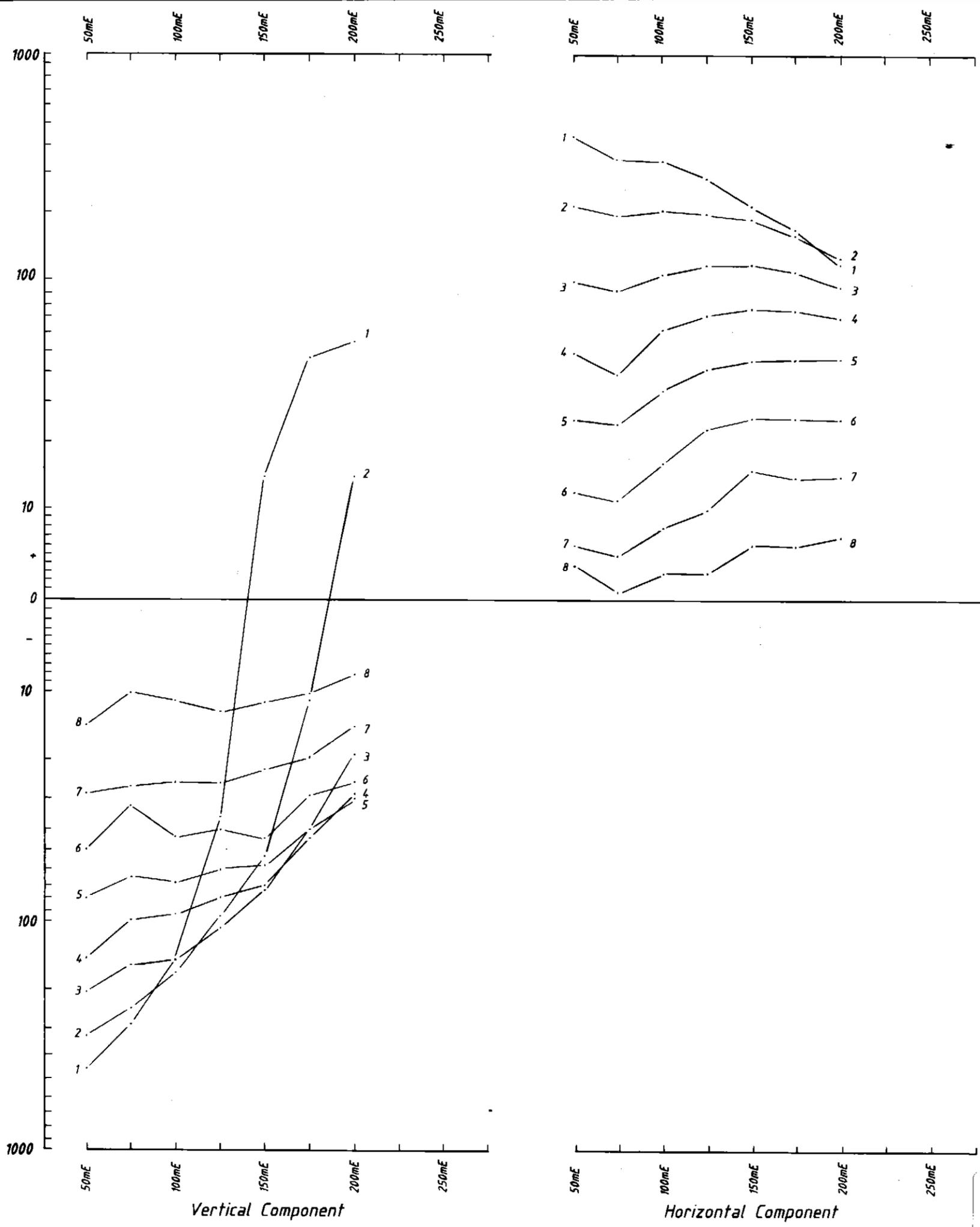


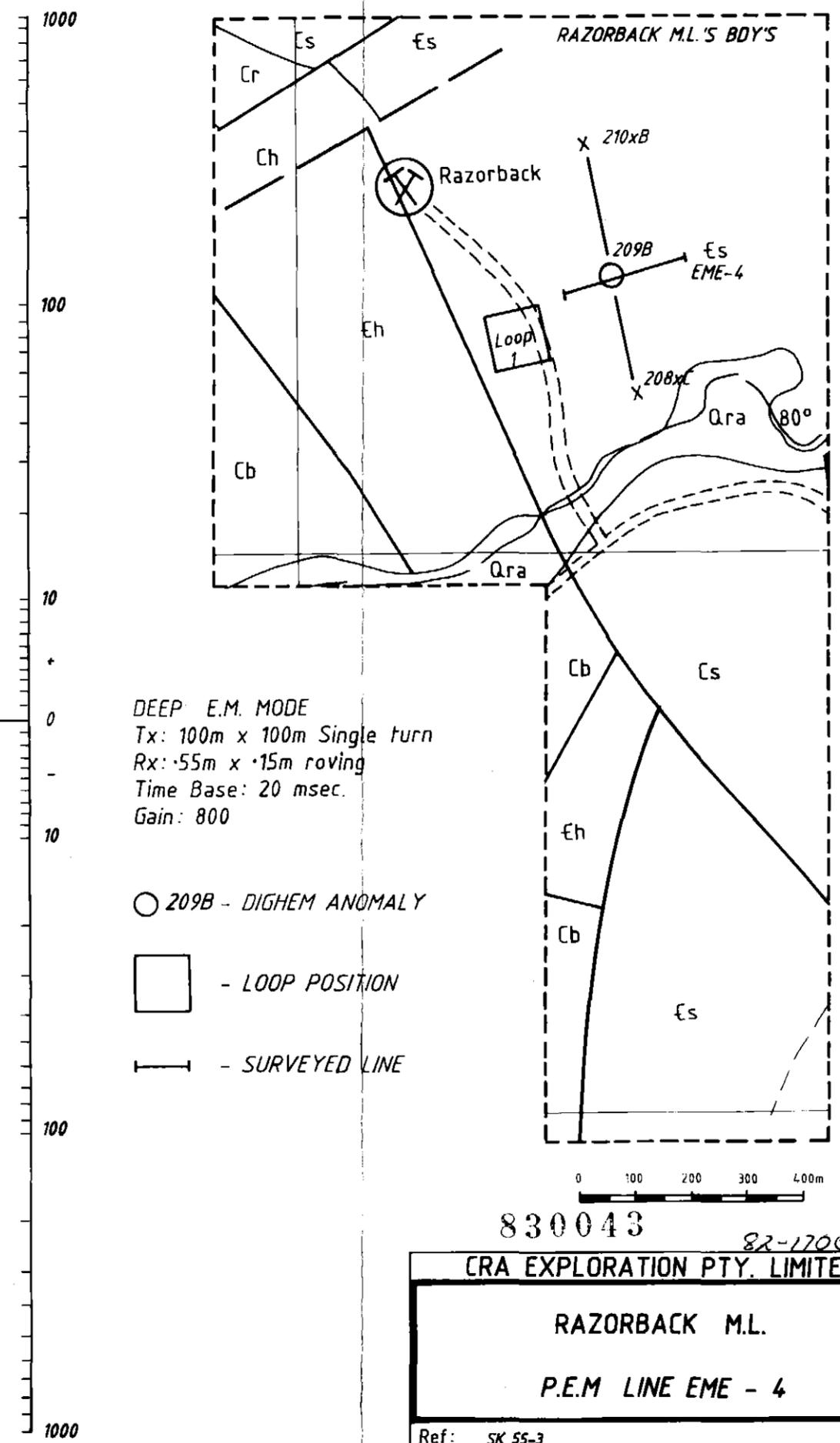
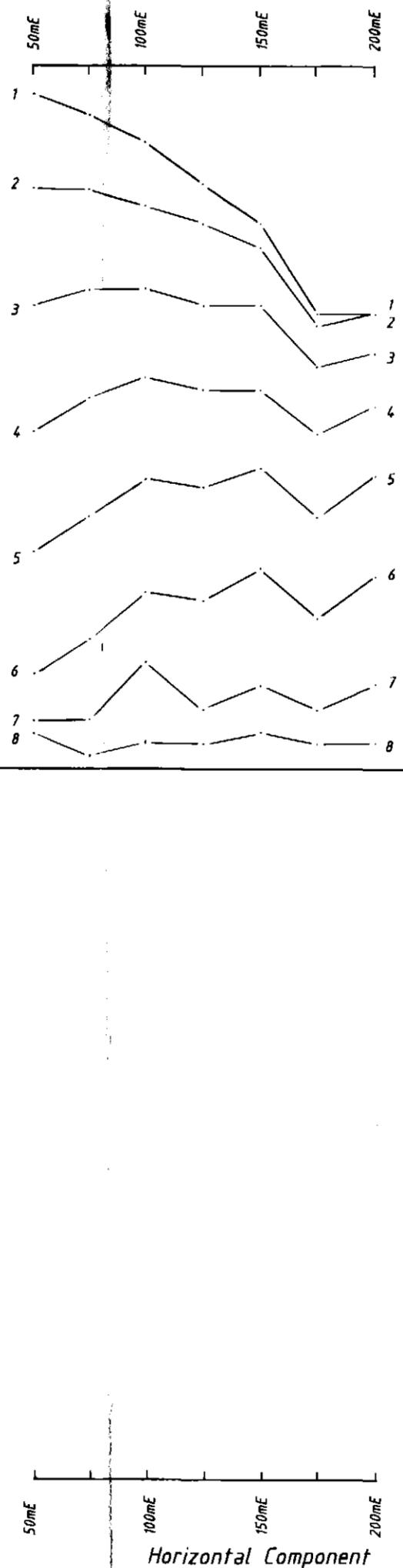
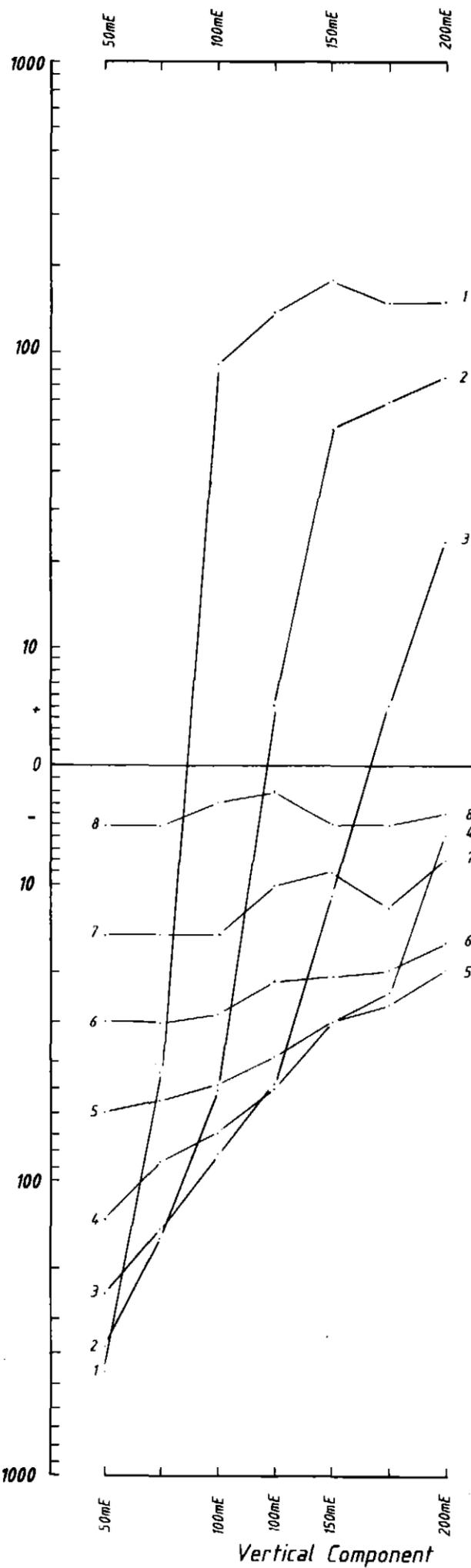
DEEP E.M. MODE
 Tx: 100m x 100m Single turn
 Rx: .55m x .15m roving
 Time Base: 20 msec
 Gain: 800

- 209B - DIGHEM ANOMALY
- - LOOP POSITION
- SURVEYED LINE



830041 82-1700R	
CRA EXPLORATION PTY. LIMITED	
RAZORBACK M.L.	
P.E.M LINE EMW - 6	
Ref: SK 55-3	Report N° 11043
Scale: AS SHOWN	Date: OCTOBER 1981
Auth: M.F.F.	Plan N° TASH 507
Drawn: R T	





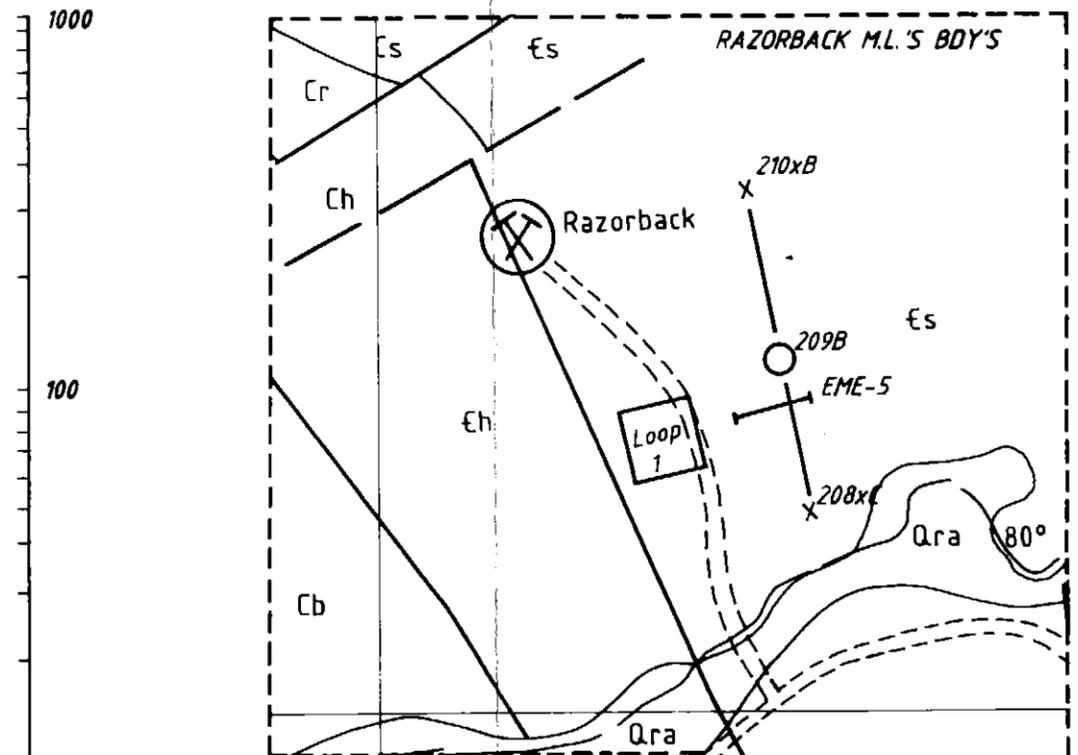
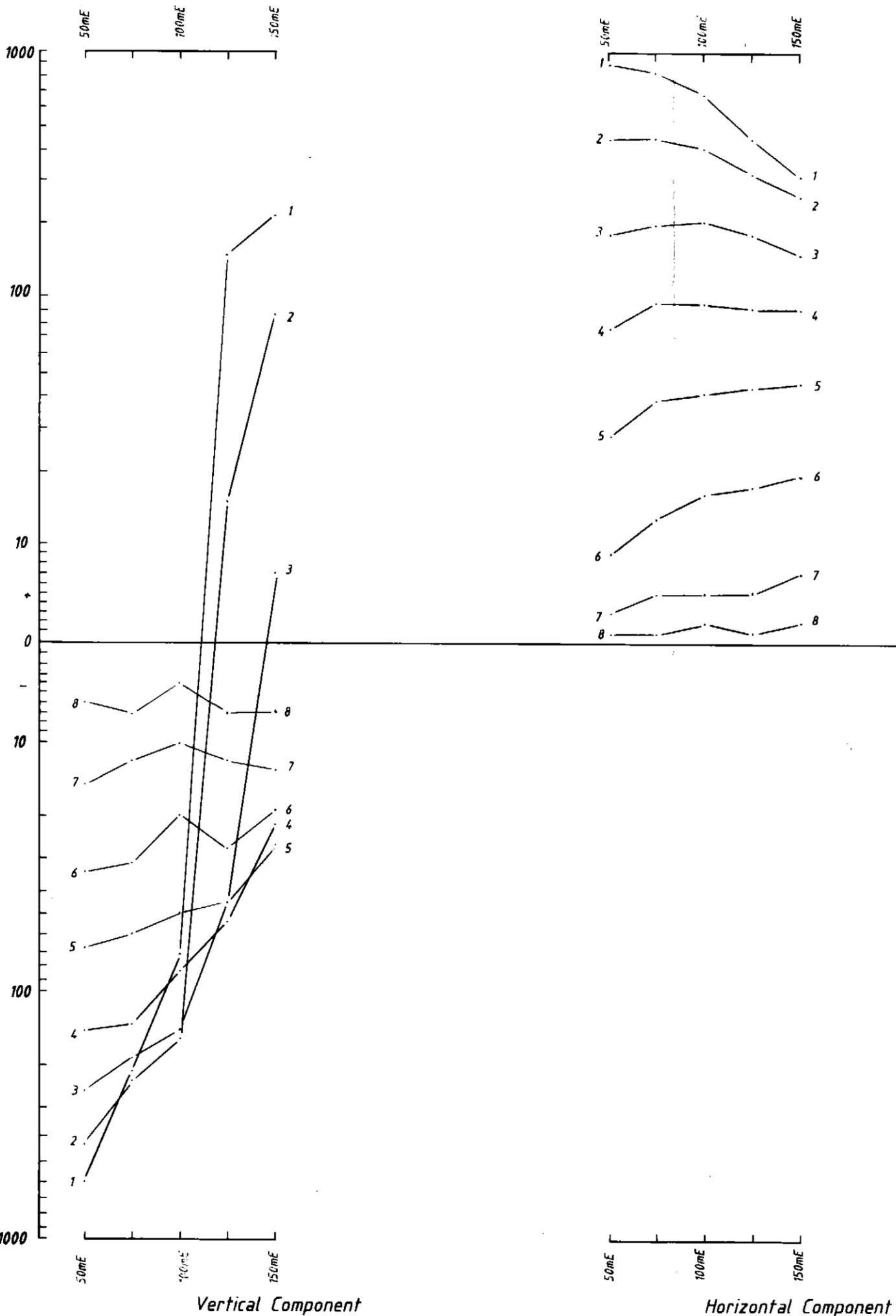
DEEP E.M. MODE
 Tx: 100m x 100m Single turn
 Rx: 55m x 15m roving
 Time Base: 20 msec.
 Gain: 800

- 209B - DIGHEM ANOMALY
- - LOOP POSITION
- SURVEYED LINE

5 cm

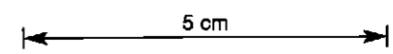
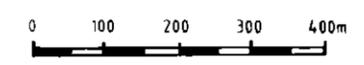
830043 82-1706R

CRA EXPLORATION PTY. LIMITED	
RAZORBACK M.L.	
P.E.M LINE EME - 4	
Ref: SK 55-3	Report N ^o . 11043
Scale: AS SHOWN	Date: OCTOBER 1981
Auth. M.F.F.	Plan N ^o . TASH 509
Drawn: R. T.	



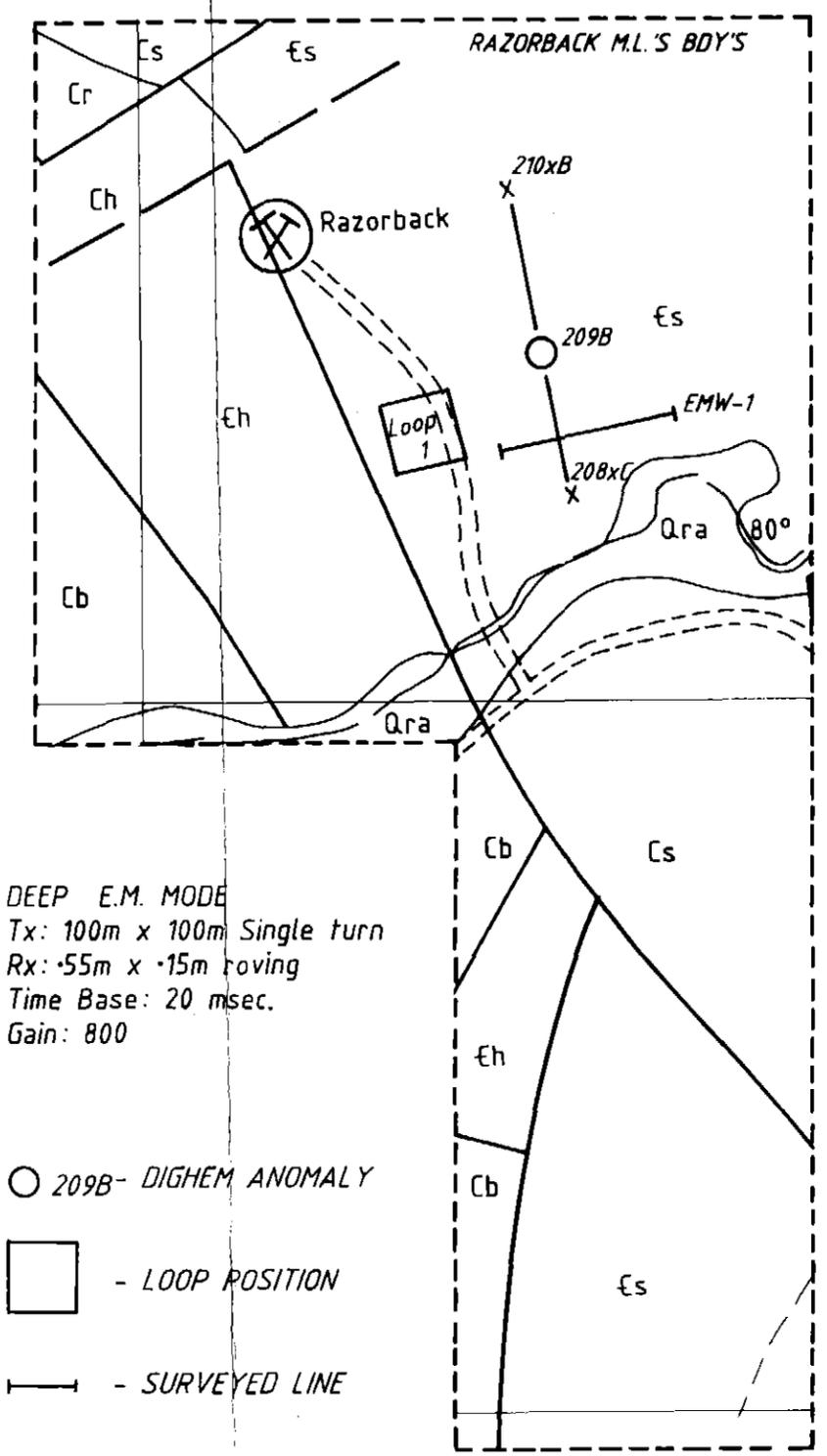
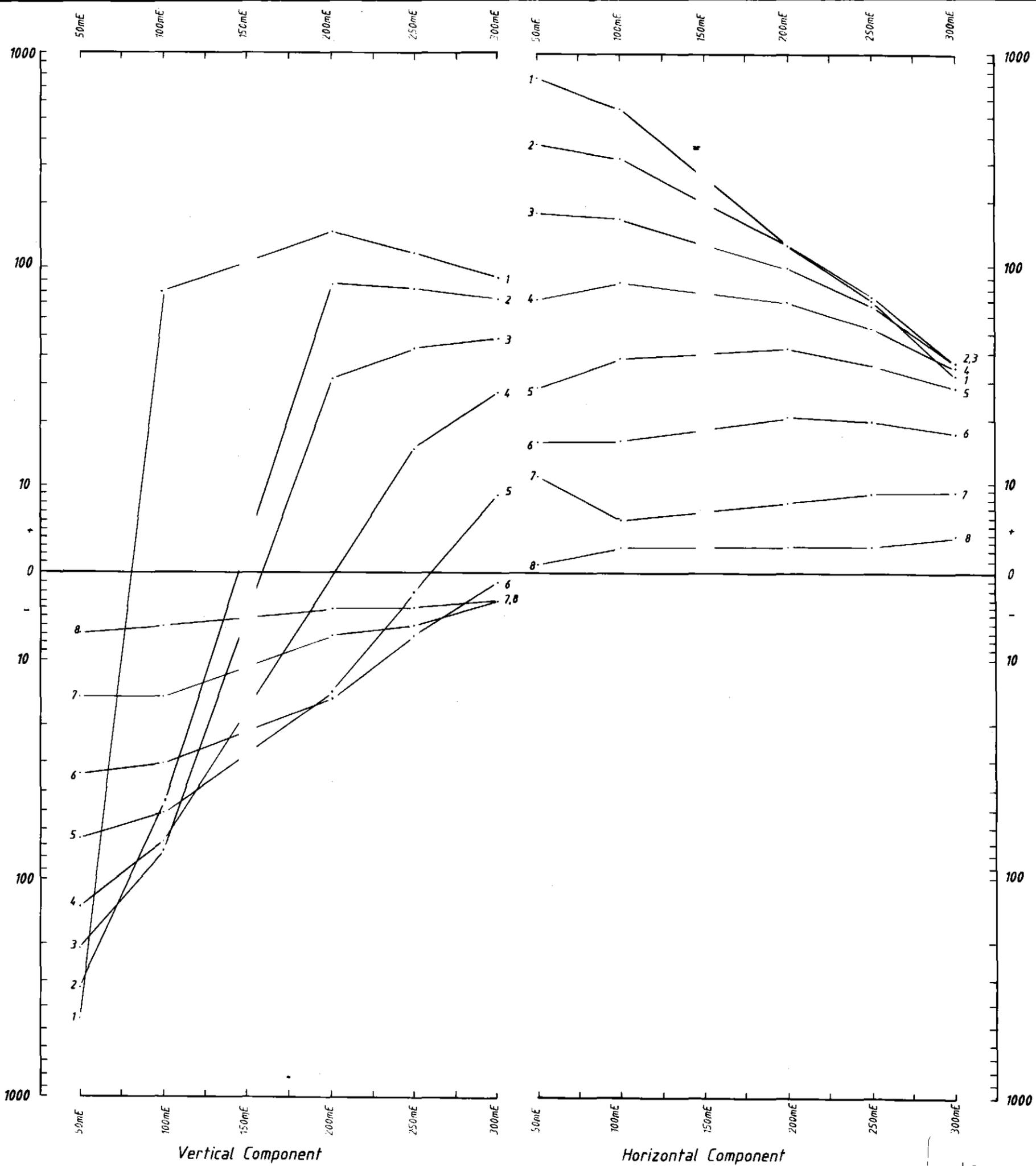
DEEP E.M. MODE
 Tx: 100m x 100m Single turn
 Rx: 55m x 15m roving
 Time Base: 20 msec.
 Gain: 800

- 209B - DIGHEM ANOMALY
- - LOOP POSITION
- SURVEYED LINE



029

830044 82-1700R	
CRA EXPLORATION PTY. LIMITED	
RAZORBACK M.L.	
P.E.M LINE EME - 5	
Ref: SK 55-3	Report N° 11043
Scale: AS SHOWN	Date: OCTOBER 1981
Auth. M.F.F.	Plan N° TASH 510
Drawn: R T	



DEEP E.M. MODE
 Tx: 100m x 100m Single turn
 Rx: 55m x 15m roving
 Time Base: 20 msec.
 Gain: 800

- 209B - DIGHEM ANOMALY
- - LOOP POSITION
- SURVEYED LINE

830045 82-1700R

CRA EXPLORATION PTY. LIMITED

RAZORBACK M.L.

P.E.M LINE EMW - 1

Ref: SK 55-3	Report N ^o . 11043
Scale: AS SHOWN	Date: OCTOBER 1981
Auth. M.F.F.	Plan N ^o TASH 511
Drawn R T	