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DEPT. OF MINES				
REF. No. 1874/82				

OPEN FILE

EXPLORATION LICENCE 32/79
 HUSKISSON RIVER AREA, TASMANIA

Progress Report on Exploration
 to 15th January, 1982
 Including
 Report for the Six Months
 Period Ended 15th January, 1982

MICROFILMED

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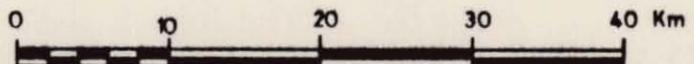
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5 cm

Scale 1:500,000



Centre
Melbourne

Date
1-3-82

THE BROKEN HILL PROPRIETARY CO. LTD.
E.E. 32/79, HUSKISSON RIVER, TAS.
LOCATION MAP

Project No:
T 660-2

Drawing No:
A4-2299

1. GENERAL:

Exploration Licence 32/79 of 17 square kilometres was initially granted to The Broken Hill Proprietary Company Limited on 16th July 1980. An application for renewal from 16th January 1982 has been submitted.

2. EXPLORATION PHILOSOPHY:

The principal target within the licence area is a massive sulphide or skarn hosted tin-tungsten deposit. EL 32/79 covers prospective ground adjacent to the Meredith Granite and includes part of a belt of dolomite bearing sediments which form hosts to mineralization at Mt Lindsay and Renison Bell.

3. SUMMARY OF WORK COMPLETED:

- a) Literature study and evaluation of available data;
- b) Stream sampling and 1:10,000 geological mapping programme (under contract);
- c) Preliminary petrological study;
- d) Airborne EM-magnetics programme (Dighem II);
- e) Preliminary follow-up of stream sample anomalies;
- f) Interpretation of Landsat image.

4. SUMMARY OF WORK IN PROGRESS:

- a) Line cutting, soil sampling and ground magnetic surveying by way of follow-up on stream geochemical and magnetic anomalies;
- b) Rock chip sampling and petrological studies.

5. RESULTS:5.1 Geology

The area covers a portion of the eastern limb of the NNW trending Huskisson Syncline. The sediments present range in age from Siluro-Devonian to Precambrian(?) and young to the west.

Siluro-Devonian quartz sandstone and Ordovician limestone (Gordon Limestone equivalent (?)) and conglomerate are present in the lower reaches of Webbs Creek in the south-western part of the licence area. To the north, the limestone is covered by recent gravels.

A 1½km wide belt of Cambrian sediments, that are probable Crimson Creek Formation equivalents, occupies the central portion of the licence area. These

sediments include lithicwacke, tuffaceous siltstone, chert and carbonate bearing sandstones and breccias.

The eastern segment of the area is occupied by a sequence of grey-black slates and micaceous quartzites of probable Lower Cambrian to Precambrian age. These rocks have been extensively sheared and are tightly folded. They form the western limb of a major northward trending anticline which runs along the eastern boundary of the licence area.

Gabbro, dolerite and altered basalt are the only igneous rocks so far located in the licence area, although altered felsic dyke rocks have been reported from exposures on the Huskisson Road to the north-east. The mafic rocks are presumably related to Cambrian ultramafics which are known to occur both to the south and north of the licence area.

5.2 Geochemistry

a) Stream Sampling:

Fifty-nine stream samples were collected from the area for an overall density of 3.5 samples/square kilometre. Virtually all the significant drainage in the area was sampled. Samples were sieved to -80 mesh and analysed for Sn, W, Cu, Pb, Zn, Ag, Au, As, Sb, Ba, Ni, Co, Cr, Mo and Mn.

Tin values ranged from less than 5 ppm to 750 ppm. Several streams draining the eastern part of the area were considered to be anomalous with respect to Sn and other elements (viz: Cu, Zn, Ba). Follow-up of these anomalies is now in progress.

Results are tabulated in Appendix I and plotted on Figures 4 to 7.

b) Rock Sampling:

One sample of porous ironstone (HUS63) collected during the stream sampling programme, was anomalous with respect to Pb, Zn, As, Sb and Au (25 ppb). Two samples of limestone conglomerate (HUS 60, 61) and one altered mafic clast (HUS 63) from the conglomerate were not anomalous with respect to Sn, W, base or precious metals.

5.3 Geophysics

A helicopter borne E.M. survey (Dighem II) was completed between January and March 1981. The survey consisted of 23 east-west lines for approximately 100 line kilometres at a mean line spacing of 200 metres. No E.M. anomalies of consequence were detected. Several linear magnetic anomalies were defined and follow-up is in progress to establish the nature of the source rocks.

6. SUMMARY OF WORK PROPOSED:

- a) Continue evaluation of geochemical and geophysical anomalies;
- b) Drill selected target zones if warranted.

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APPENDIX 1

Geochemical Results

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Batch No.: L032-1 Client: BHP COMPANY LIMITED, Area Contact: DR. RICK HINE.
 Address: P.O. BOX 559 Address: G.P.O. BOX 1140 L,
 Date Received 04/11/80 CAMBERWELL HOBART, TAS. 7001.
 Date Completed 24/12/80 VIC
 Order No.: T660 - 000626 Sample Type: STREAM SEDIMENTS No. of Samples: 59

SAMPLE NO.	Au	Sn	W	Sb	Ba
	b	M	M	M	M
	120-A	XRF 1A	XRF 1A	XRF 1A	XRF 1A
HUS 31	5	145	<10	<10	60
HUS 32	3	5	<10	<10	40
HUS 33	5	40	<10	20	130
HUS 34	3	<5	<10	<10	10
HUS 35	5	80	<10	<10	40
HUS 36	5	<5	<10	<10	60
HUS 37	5	50	<10	15	90
HUS 38	5	<5	<10	15	130
HUS 39	5	60	<10	10	40
HUS 40	15	15	<10	<10	50
HUS 41	20	115	<10	10	60
HUS 42	10	40	<10	10	30
HUS 43	20	190	<10	<10	<10
HUS 44	15	40	<10	<10	60
HUS 45	30	50	<10	15	140
HUS 46	5	5	<10	<10	130
HUS 47	20	45	<10	<10	90
HUS 48	15	20	<10	<10	80
HUS 49	20	50	<10	<10	120
HUS 50	15	45	<10	<10	30
HUS 51	35	145	<10	<10	10
HUS 52	20	15	<10	10	70
HUS 53	25	80	<10	55	100
HUS 54	15	45	20	<10	<10
HUS 55	20	90	<10	<10	<10
HUS 56	30	35	<10	10	30
HUS 57	30	175	<10	<10	<10
HUS 58	10	20	<10	<10	50
HUS 59	20	120	<10	<10	50

826010

UNITS LEGEND ----- m - Parts per million b - Parts per billion % - percent
 g - Grams a - Absorbance

011

REGION: NW TAS

PROJECT NO.: T660

PROSPECT: Huskisson R.

GRID CO-ORDS:

LOCAL A.M.G.

Project No:

Drawing No:

A4-

DESCRIPTION

Sample Type: Rock

Rock Type: Seds

Soil/Sediment Size Fraction:

HUS 60 Limestone conglomerate with dolomite, chert, mafic?/mafic clasts - fresh

.. 61

.. 62 Altered basic clast in conglomerate.

HUS 63 Porous to massive ironstone consisting mainly of transported limonite

THE BRICKER HILL PROPRIETARY CO. LTD.

GENERAL SAMPLE DESCRIPTION

ANALYSIS

Laboratory A.L.S.

Batch No L245

Date Analysed 5/1/81

Element	Cu	Pb	Zn	Ag	Ni	Co	Cr	Sn	W	Au	Sb	As	Mo	Ba	Sr		
Method								XRF	XRF	120							
HUS 60	20	45	60	2	75	135	40	<5	<10	<0.1							
61	50	50	45	2	70	105	35	..	..	..				
62	<2	30	55	1	40	70	35	..	..	..				
63	30	105	610	2	100	55	60	..	..	25 ppb	60	25	<2	185	10		

MARKS: HUS 60, 61 from Huskisson Dve Road NE of E2 32/79.

HUS 63 EL at 371570 E 5389650 N

Logged or Sampled by: R.H.

Date: 5/1/81

Centre:

Date:

826019

APPENDIX 2

Petrological Reports

HP - 1 : lowgrade metamorphosed, weakly lithic and felspathic,
MRL 12,682 laminated, very fine grained sericitic quartz
 53 86230N sandstone.
 3 71100E

This is a homogeneous sediment, composed largely of a compact bedded, laminated aggregate of very fine (0.08 mm), angular grains of quartz, minor to subordinate grains of extremely fine siliceous, clay/sericite composition which may be altered lithic detritus or altered feldspars. Minor weakly schistose sericite-rich, and possibly graphitic laminae are intercalated.

A minor ill-defined intergranular matrix is also essentially clay/sericite stained with limonite. Accessory extremely fine titaniferous granules, lesser tourmaline, trace detrital muscovite and zircon are scattered.

Ill-defined, small ? sand dykes are seen macroscopically to cut across the laminations.

- positive reaction with acid ?

HP - 2 : micro-dolerite (or coarse basalt) extensively brecciated,
MRL 12,683 granulated and partly altered to saussurite/uralite.

89030N

73000E

This rock has a heterogeneous, poorly defined, fairly fine scale fragmental texture. Patches (presumably fragments) of basic igneous rock consist of an aggregate of randomly interlocking plagioclase laths, studded with small euhedral crystals of clinopyroxene, disseminated Fe and/or Ti oxides (variably leucoxenised), rarer ? orthopyroxene altered to uralite. The texture is subophitic.

These crystalline fragments, are randomly disposed through an incoherent mass of extremely fine granulated pyroxene and lesser plagioclase, in a matrix of turbid saussuritic and uralitic alteration products. Wavy shears of ultrafine uralite/serpentine, sericite and/or talc cut the rock.

Almost certainly this is a tectonic (dislocation metamorphic) breccia, (rather than a pyroclastic).

HP - 3 : altered glassy basalt, crowded with microphenocrysts
MRL 12,684 of plagioclase, pyroxene, rarer altered olivine.

88470N
T2530E

A fairly homogeneous, fine crystalline basaltic rock, about 60% of which consists of feathery microlites of plagioclase randomly disposed through a turbid groundmass of altered (quenched) basic glass.

The remaining 40% consists of scattered relatively more discrete laths (and small phenocrysts) of plagioclase which are partly chloritised, also abundant, very small (0.15 mm), crystals, and some larger phenocrysts of clinopyroxene, and minor totally serpentinised small olivine crystals.

Stringers of chlorite/uralite, carbonate/quartz cut the rock.

HP - 4 : fine, laminated siltstone composed of altered basaltic
MRL 12,685 detritus, probably a derived sediment, possibly a
 87180N fine tuff;
 72850 E accessory disseminated fine pyrrhotite.

This is a laminated, very fine (0.15 mm) sediment of gross 'basaltic' composition. It is largely composed of an accumulation of fine detrital plagioclase, carbonate, and completely uralitised or albitised fragments of original mafic silicate minerals, also minor titaniferous granules.

These components occur in an extremely fine matrix of uralitic alteration products, turbid with leucoxenic dust.

Accessory extremely fine pyrrhotite (3-5%) is disseminated.

HP - 5 : altered leuco-dolerite (gradational to microdiorite);
MRL 12,685 disseminated Fe/Ti oxides.

85450N
72100E

This rock consists of a fine to medium grained crystalline aggregate, dominated by randomly interlocking plagioclase laths (50-60%), which are extensively sericitised.

A primary mafic-silicate phase, and/or clinopyroxene, (30%) is intricately intergrown with the plagioclase with sub-ophitic relationship. This mineral is uraltically altered to actinolitic-hornblende and/or chlorite.

Accessory skeletal grains of quartz (3%) are primarily interstitial. Accessory lath form to skeletal grains of Fe and/or Ti oxides, variably leucoxenised, are randomly scattered. (These oxides are rather more typical of a dolerite than diorite).

018

HP - 6 : sedimentary breccia of fine to medium grained quartz
MRL 12,686 sandstone, with ubiquitous ferruginous-carbonate
87100N (? siderite), and carbonaceous material as an
73350E intergranular matrix.

A random aggregate of subangular fragments of fine sandstone about 10 mm across, occur within a matrix of essentially the same sandy composition. The breccia is thus interpreted as sedimentary.

The fragments consist of a massive compact aggregate of angular to subangular grains of quartz, with a ubiquitous intergranular cement/matrix of ferruginous carbonate (? siderite), with minor sericite and extremely finely divided carbonaceous material. Minor detrital muscovite, tourmaline and cherty fragments form part of the aggregate.

As noted above the whole rock matrix has the same composition although sinuous lenses of sericite (meta pelite) tend to sweep around the fragments.

019

HP - 7 : fine grained volcanoclastic sandstone, probably
MRL 12,687 derived by breakdown transport and redeposition
85800N of a basaltic (to andesitic) volcanic terrain which
72100E may have included tuffs and lavas.

This rock consists of a homogeneous, bedded mass of fine (0.25 mm) angular grains and lithic fragments of volcanic derivation which in approximate order of decreasing abundance are:-

- . fragments of basaltic or andesitic-basalt groundmass.
- . ill-defined fragments of chloritic/uralitic composition, gradational into a matrix, and apparently altered mafic-silicate phases.
- . more or less single plagioclase grains (+ minor chlorite).
- . small fragments of 'cherty' composition, and of carbonate, (in this context probably deuteric alteration phases in the basaltic source rock).
- . angular grains of quartz (probably exotic to the main basaltic source).
- . ill-defined titaniferous and/or ferruginous granules.

HP - 8 : massive fine to medium quartz sandstone;
MRL 12,688 matrix of sericite chlorite and siderite,
90000N locally of continuous pyrite (authigenic);
73350E minor foliae of carbonaceous material.

This rock consists essentially of a compact aggregate of subangular quartz grains, reasonably well sorted, average size 0.25 mm, with minor sericitic fragments. A minor intergranular matrix consists of variable amounts of chlorite, sericite, and ferruginous carbonate (siderite?).

Minor slivers and foliae of carbonaceous material occur throughout.

Intergranular areas in about one third of the sample are occupied by a continuous network of pyrite of authigenic/diagenetic origin.

This rock must surely be a variation of the facies represented by HP - 6.

APPENDIX 3

Consultants Report

- Duplicate of 80-1483

EL 32/79

HUSKISSON RIVER TASMANIA

REPORT ON RECONNAISSANCE GEOLOGY AND STREAM SAMPLING, FOR
THE BROKEN HILL PROPRIETARY CO LTD, OCTOBER 1980

By R Poltock.

CONTENTS

Introduction

Sampling

Geology

- Appendices* - 1) *Rock sample descriptions and locations.*
- 2) *Botanical species list.*

- Plans* - *Contour plan 1:10,000.*
- *Geology and Stream Sample Locations 1:10,000.*

1. INTRODUCTION

The lease of 17 km² is centred on the Huskisson River a tributary of the Pieman, 15 km north of Renison Bell in Western Tasmania.

Access to the area is via a road system developed by Comstaff from the Boco siding on the Murchison Highway, approximately 12 km to the eastern lease boundary. The last few kms of the road are passable only to 4WD vehicles. In addition, an all weather logging road provides access to the northern end of the lease in the vicinity of Ross Creek, from the Hatfield River on the Murchison Highway.

The area has been previously prospected. Flagging tape was frequently seen in streams, with the exception of the Webbs Creek system. No sign of gridding or other follow up work to this stream sampling was evident.

The area is covered by dense temperate rainforest dominated by myrtles, sassafras and mature Eucalypts. Generally the understory is limited to ferns, and foot access is relatively easy.

Two principal geological units were recognized: 1) the Cambrian to Precambrian? (a possible correlate of the Crimson Creek Group); 2) Ordovician to Silurian sediments (including limestones) of the Huskisson Syncline. The Devonian Meredith granite outcrops approximately 2 - 3 km to the north of the northern lease boundary.

2. SAMPLING

A total of 59 stream sediment samples were taken, giving an overall sampling density of 3.5 per km². The optimum of 5 per km² was not attained due to the extent of recent gravel cover in the Webb's Creek Valley.

Samples Hus 1-32 were sieved to -20 mesh, and Hus 33-59 to -40 mesh. The latter to reduce weight for easier kyak transport. Sieves and collecting dishes were nylon and plastic.

Sample locations were marked with:

- orange flagging tape labelled e.g. BHP 02
- permatags labelled e.g. 02 Oct. '80
B.H.P.

Sample bags marked e.g. EL 32/79
02

Rock sample bags were marked with the lease number, the closest stream sample and grid co-ordinates of the Australian Map Grid (see appendices).

3. GEOLOGY

A) Cambrian - Precambrian

The oldest stratigraphic unit in the area is composed of black - grey siltstones and micaceous quartzites which are most likely lower Cambrian to upper Precambrian in age. The sediments dip steeply, are frequently sheared, and the quartzites are intensely quartz veined in places.

These sediments form the western limb of a north trending anticline which runs the full extent of the eastern lease boundary.

To the west the sediments are probably conformably overlain by pink to grey, poorly bedded tuffaceous greywackes and siltstones, a correlate of the lower Cambrian Crimson Creek Argillite. Occasional outcrops of grey to red cherts occur near the base of this unit. Fine grained, weakly magnetic gabbroic rocks occur as thin sill like bodies less than 5m thick in the greywackes and siltstones. These are the only igneous rocks found in the E.L.

The Crimson Creek rocks may be contained in a northerly trending syncline 1.5 km wide, the western edge of this structure is exposed in the southern central part of the E.L.

There is a marked difference between vegetation types on the siltstones and quartzites, and the siltstone and greywackes. The soils on the latter are deep, red-brown clays, supporting a dense cover of myrtles, sassafras, leatherwoods and Eucalypts with a fern dominated understory. Quartzite derived soils are of poorer quality, the dominant trees are as above with the addition of Celery-Top pines and Cheese Woods. The understory is more diverse and thicker e.g. horizontal, native plum, various epacrids and cutting grass.

B) Ordovician - Silurian

To the west of the Huskisson River a quartz pebble conglomerate and sandstone unconformably overlie Cambrian greywackes. These basal Ordovician sediments are less than 10m thick in observed exposures, but appear to persist as a low strike ridge throughout the lease. Dips are 45-50° to the west.

A correlate of the Gordon Limestone 400-500m thick conformably overlies the basal quartzose sediments. The broad gravel filled valley of Webbs Creek is confined to this unit. Outcrops are poor, except in the lower 2 km where dips are steep to overturned. Typically, the limestone shows marked differential weathering between pure limestone and silty and dolomitic bands. Calcite veining and fossiliferous horizons are common.

The limestone is overlain to the west by steeply dipping sandstones with minor carbonate horizons, these may be Silurian sediments. They are the upper most stratigraphic unit in the lease running sub-parallel to the western boundary.

4. MINERALIZATION

Pyrite and minor quartz veining was the only mineralization observed in the lease. This was confined to the Cambrian and Precambrian rocks particularly the dark siltstones. Some massive pyrite was found in quartzites in Ross Creek just to the north of the licence (see appendices).

At some stream sample locations, abundant black heavy minerals were seen e.g. samples 21 and 22. This was tentatively identified as chromite.

It is possible that higher tin-tungsten assays may occur in Webbs Creek, a large component of the sediment in this system has been derived from a granite source outside the licence area. Samples 42, 43, 51, 54 are in this category. At sample location 51, quartz-tourmaline fragments are present.

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APPENDIX 1ROCK DESCRIPTIONS AND LOCATIONS

<u>Co-ords</u>	<u>Stream Sample No.</u>	<u>Description</u>
5386 000N 373 200E	08 - 09	Quartz vein fragment locally derived, may have been pyritic.
5386 070N 373 030E	09 - 10	Silicified cherty gravels - Tertiary?
5386 830N 372 600E	11	Gabbro? Dark grey-green, fine grained, crystalline basic rock with disseminated pyrite and on joint faces. Weakly magnetic.
5387 200N 372 630N	14 - 15	Tuffaceous greywacke and siltstone pink-brown, alternating layers of silt and greywacke 1 cm thick the latter containing fragments of brown siltstone.
5387 180N 372 850E	15	Tuffaceous greywacke. Fine grained grey-green and laminated dark grey-black siltstone.
5387 100N 373 350E	18	Siltstone black, sheared with slickenside surfaces and minor quartz veining. Quartzite black, micaceous, occurring as thin beds in siltstone. Thread like pyrite and quartz veining.
5385 800N 372 100E	19	Black-dark grey siltstone with minor quartz veining and pyrite. Tuffaceous greywacke. grey-green quartzose with siltstone fragments <1 mm.
5385 450N 372 100E	23	Gabbro fine grained, slightly altered, weakly magnetic.
5387 800N 373 450E	25	Chert white to grey, bedding not apparent, strongly jointed.
5387 900N 373 250E	26 - 27	Siltstone grey-brown.
5388 470N 372 530E	29	Volcanic or greywacke? Fine-medium grained, grey-green with abundant, pale green lathe like crystals. Outcrop massive, irregularly jointed.

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<u>Co-ords</u>	<u>Stream Sample No.</u>	<u>Description</u>
5388 700N 372 550E	30 - 31	Siltstone grey-black laminated with thin pyrite bands. Greywacke fine grained.
5380 000N 373 350E	36	Quartzite pale grey, medium grained poorly sorted, with dark siltstone shreds. Large (10 cm) irregular pyrite inclusions.
5389 650N 371 600E	37 - 38	Conglomerate composed of quartz pebbles <2 cm, subrounded in a coarse pink sandstone matrix. Quartzite medium grained poorly sorted.
5389 650N 371 570E	37 - 38	Geothite? crust on stream gravels.
5389 030N 373 000E	47 - 48	Gabbro slightly magnetic. Siltstone dark, thickly bedded with pyrite cubes.
5385 650N 371 400E		Limestone fine grained, dark grey with possible sandy dolomitic bands.
5386 230N 371 100E	58	Quartzite dark grey, fine, well bedded.

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APPENDIX 2

BOTANICAL SPECIES LIST

<u>Nothofagus cunninghamii</u>	Myrtle
<u>Atherosperma moschatum</u>	Sassafras
<u>Eueryphia lucida</u>	Leatherwood
<u>Phyllocladus asplenifolius</u>	Celery Top Pine
<u>Phebalium squameum</u>	Cheese-wood
<u>Anodopetalum biglandulosum</u>	Horizontal
<u>Cenarrhenes nitida</u>	Native Plum
<u>Gahnia</u>	Cutting Grass

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APPENDIX 4

Dighem Survey Results and Report

826030

REPORT NO. 322

DIGHEM^{II} SURVEY

OF

HUSKISSON [REDACTED] AREAS, TASMANIA

FOR

THE BROKEN HILL PROPRIETARY COMPANY LIMITED

BY

DIGHEM LIMITED

TORONTO, CANADA

D.C. FRASER
PRESIDENT

S. VERGOS
GEOPHYSICIST

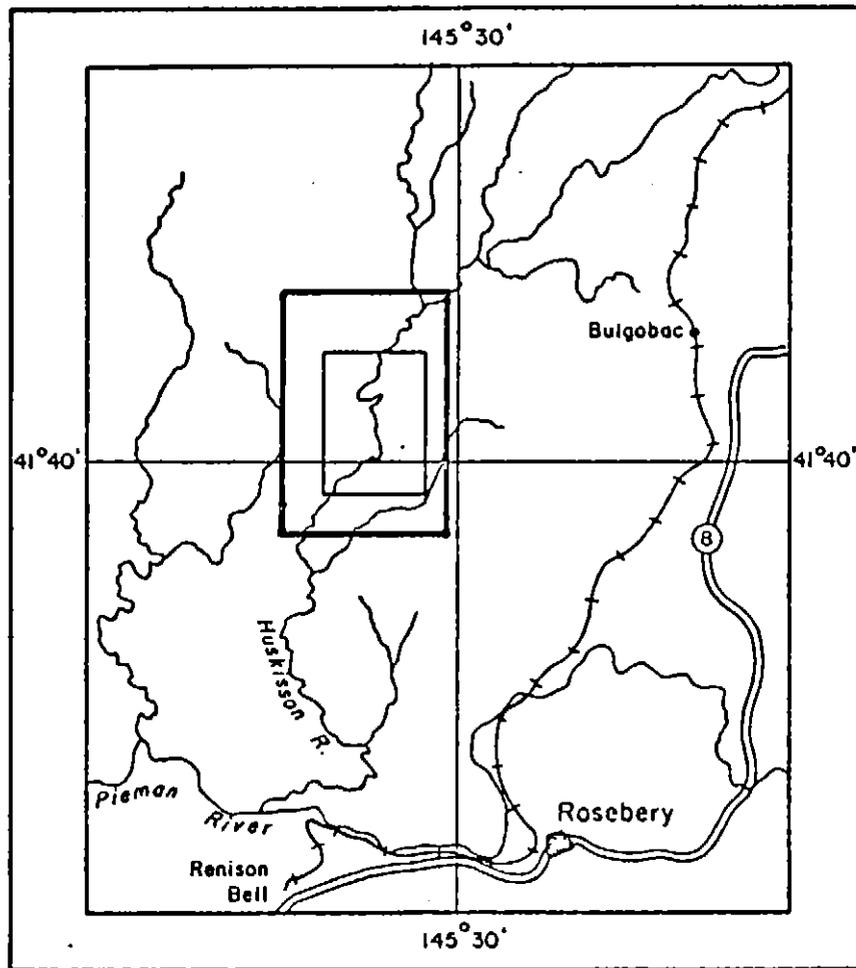
SUMMARY

A DIGHEM^{II} airborne electromagnetic/resistivity/magnetic surveys totalling 210 line-km were flown in Huskisson and Renison areas, Tasmania, for the Broken Hill Proprietary Company Limited in December, 1980.

The Huskisson area is quite resistive with no EM anomalies at all.

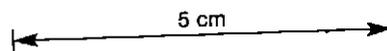
The [REDACTED] has revealed the presence of several targets which appear to warrant ground follow-up work.

LOCATION MAP



Scale 1 : 250,000

Figure 1b. The Huskisson Survey Area



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APPENDIX A: The Flight Record and Path Recovery

APPENDIX B: EM Anomaly List

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INTRODUCTION

DIGHEM^{II} surveys of 210 line-km were flown with a 250 m line-spacing for The Broken Hill Proprietary Company Limited between November 20 and December 26, 1980, over two survey blocks in the [REDACTED] and Huskisson areas, Tasmania (Figures 1a, 1b).

The Lama VH-PDU jet helicopter flew with an average airspeed of 116 km/h and EM bird height of 36 m. Ancillary equipment consisted of a Geometrics 803 magnetometer with its bird at an average height of 51 m, a Sperry radio altimeter, Geocam sequence camera, Barringer 8-channel hot pen analog recorder, and a Geometrics G-714 digital data acquisition system with a Kennedy 9700 9-track 800-bpi magnetic tape recorder. The analog equipment recorded four channels of EM data at approximately 900 Hz, two ambient EM noise channels (for the coaxial and coplanar receivers), and one channel each of magnetics and radio altitude. The digital equipment recorded the EM data with a sensitivity of 0.25 ppm/bit and the magnetic field to one gamma/bit.

The Appendix provides details on the data channels, their respective noise levels, and the data reduction procedure. The quoted noise levels are generally valid for wind speeds up to 35 km/h. Higher winds may cause

- 2 -

the system to be grounded because excessive bird swinging produces difficulties in flying the helicopter. The swinging results from the 5 m² of area which is presented by the bird to broadside gusts. The DIGHEM system nevertheless can be flown under wind conditions that seriously degrade other AEM systems.

ELECTROMAGNETICS

DIGHEM electromagnetic responses fall into two general classes, discrete and broad. The discrete class consists of sharp, well defined anomalies from discrete conductors such as sulfide lenses and steeply dipping sheets of graphite and sulfides. The broad class consists of wide anomalies from conductors having a large horizontal surface such as flatly dipping graphite or sulfide sheets, saline water-saturated sedimentary formations, conductive overburden and rock, and geothermal zones. A vertical conductive slab with a width of 100 m would straddle these two classes.

The vertical sheet (half plane) is the most common model used for the analysis of discrete conductors. All anomalies plotted on the electromagnetic map are interpreted according to this model. The following section entitled

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Discrete conductor analysis describes this model in detail, including the effect of using it on anomalies caused by broad conductors such as conductive overburden.

The conductive earth (half space) model is suitable for broad conductors. Resistivity contour maps result from the use of this model. A later section entitled Resistivity mapping describes the method further, including the effect of using it on anomalies caused by discrete conductors such as sulfide bodies.

Discrete conductor analysis

The EM anomalies appearing on the electromagnetic map are interpreted by computer to give the conductance (i.e., conductivity-thickness product) in mhos of a vertical sheet model. DIGHEM anomalies are divided into six grades of conductance, as shown in Table I. The conductance in mhos is the reciprocal of resistance in ohms.

Table I. EM Anomaly Grades

<u>Anomaly Grade</u>	<u>Mho Range</u>
6	greater than 99
5	50 - 99
4	20 - 49
3	10 - 19
2	5 - 9
1	less than 5

- 4 -

The mho value is a geological parameter because it is a characteristic of the conductor alone; it generally is independent of frequency, and of flying height or depth of burial apart from the averaging over a greater portion of the conductor as height increases.¹ Small anomalies from deeply buried strong conductors are not confused with small anomalies from shallow weak conductors because the former will have larger mho values.

Conductive overburden generally produces broad EM responses which are not plotted on the EM maps. However, patchy conductive overburden in otherwise resistive areas can yield discrete-like anomalies with a conductance grade (cf. Table I) of 1, or even of 2 for conducting clays which have resistivities as low as 50 ohm-m. In areas where ground resistivities can be as low as 1 ohm-m, anomalies caused by weathering variations and similar causes can have conductance grades as high as 4. The anomaly shapes from the multiple coils often allow such surface conductors to be recognized, and these are indicated by the letter S on the map. The remaining anomalies in such areas could be

¹This statement is an approximation. DIGHEM, with its short coil separation, tends to yield larger and more accurate mho values than airborne systems having a larger coil separation.

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bedrock conductors. The higher grades indicate increasingly higher conductances. Examples: DIGHEM's New Inco copper discovery (Noranda, Quebec, Canada) yielded a grade 4 anomaly, as did the neighbouring copper-zinc Magusi River ore body; Mattabi (copper-zinc, Sturgeon Lake, Ontario, Canada) and Whistle (nickel, Sudbury, Ontario, Canada) gave grade 5; and DIGHEM's Montcalm nickel-copper discovery (Timmins, Ontario, Canada) yielded a grade 6 anomaly. Graphite and sulfides can span all grades but, in any particular survey area, field work may show that the different grades indicate different types of conductors.

Strong conductors (i.e., grades 5 and 6) are characteristic of massive sulfides or graphite. Moderate conductors (grades 3 and 4) typically reflect sulfides of a less massive character or graphite, while weak bedrock conductors (grades 1 and 2) can signify poorly connected graphite or heavily disseminated sulfides. Grade 1 conductors may not respond to ground EM equipment using frequencies less than 2000 Hz.

The presence of sphalerite or gangue can result in ore deposits having weak to moderate conductances. As an example, the three million ton lead-zinc deposit of Restigouche Mining Corporation near Bathurst, New Brunswick,

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Canada, yielded a well defined grade 1 conductor. The 10 percent by volume of sphalerite occurs as a coating around the fine grained massive pyrite, thereby inhibiting electrical conduction.

Faults, fractures and shear zones may produce anomalies which typically have low conductances (e.g., grade 1 and 2). Conductive rock formations can yield anomalies of any conductance grade. The conductive materials in such rock formations can be salt water, weathered products such as clays, original depositional clays, and carbonaceous material.

On the electromagnetic map, the actual mho value and a letter are plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal rows of dots, beside each anomaly symbol, indicate the anomaly amplitude on the flight record. The vertical column of dots gives the estimated depth. In areas where anomalies are crowded, the identifiers, dots and mho values may be obliterated. The EM grade symbols, however, will always be discernible, and the obliterated information can be obtained from the anomaly listing appended to this report.

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The purpose of indicating the anomaly amplitude by dots is to provide an estimate of the reliability of the conductance calculation. Thus, a conductance value obtained from a large ppm anomaly (3 or 4 dots) will be accurate whereas one obtained from a small ppm anomaly (no dots) could be inaccurate. The absence of amplitude dots indicates that the anomaly from the coaxial coil-pair is 5 ppm or less on both the inphase and quadrature channels. Such small anomalies could reflect a weak conductor at the surface or a stronger conductor at depth. The mho value and depth estimate will illustrate which of these possibilities fits the recorded data best.

Flight line deviations occasionally yield cases where two anomalies, having similar mho values but dramatically different depth estimates, occur close together on the same conductor. Such examples illustrate the reliability of the conductance measurement while showing that the depth estimate can be unreliable. There are a number of factors which can produce an error in the depth estimate, including the averaging of topographic variations by the altimeter, overlying conductive overburden, and the location and attitude of the conductor relative to the flight line. Conductor location and attitude can provide an erroneous depth estimate because the stronger part of the conductor may be

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deeper or to one side of the flight line, or because it has a shallow dip. A heavy tree cover can also produce errors in depth estimates. This is because the depth estimate is computed as the distance of bird from conductor, minus the altimeter reading. The altimeter can lock on the top of a dense forest canopy. This situation yields an erroneously large depth estimate but does not affect the conductance estimate.

Dip symbols are used to indicate the direction of dip of conductors. These symbols are used only when the anomaly shapes are unambiguous, which usually requires a fairly resistive environment.

A further interpretation is presented on the EM map by means of the line-to-line correlation of anomalies, which is based on a comparison of anomaly shapes on adjacent lines. This provides conductor axes which may define the geological structure over portions of the survey area. The absence of conductor axes in an area implies that anomalies could not be correlated from line to line with reasonable confidence.

DIGHEM electromagnetic 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 conductors in terms of length, strike direction, conductance, depth, thickness (see below), and dip. The accuracy is comparable to an interpretation from a ground EM survey having the same line spacing.

An EM anomaly list attached to each survey report provides a tabulation of anomalies in ppm, and in mhos and estimated depth for the vertical sheet model. The EM anomaly list also shows the conductance in mhos and the depth for a thin horizontal sheet (whole plane) model, but only the vertical sheet parameters appear on the EM map. The horizontal sheet model is suitable for a flatly dipping thin bedrock conductor such as a sulfide sheet having a thickness less than 15 m. The list also shows the resistivity and depth for a conductive earth (half space) model, which is suitable for thicker slabs such as thick conductive overburden. In the EM anomaly list, a depth value of zero for the conductive earth model, in an area of thick cover, warns that the anomaly may be caused by conductive overburden.

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Since discrete bodies normally are the targets of EM surveys, local base (or zero) levels are used to compute local anomaly amplitudes. This contrasts with the use of true zero levels which are used to compute true EM amplitudes. Local anomaly amplitudes are shown in the EM anomaly list and these are used to compute the vertical sheet parameters of conductance and depth. Not shown in the EM anomaly list are the true amplitudes which are used to compute the horizontal sheet and conductive earth parameters.

X-type electromagnetic responses

DIGHEM^{II} maps contain x-type EM responses in addition to EM anomalies. An x-type response is below the noise threshold of 2 ppm, and reflects one of the following: a weak conductor near the surface, a strong conductor at depth (e.g., 100 to 120 m below surface) or to one side of a flight line, or aerodynamic noise. Those responses that have the appearance of valid bedrock anomalies on the flight profiles are mentioned in the report. The others should not be followed up unless their locations are of considerable geological interest.

The thickness parameter

DIGHEM^{II} can provide an indication of the thickness of a steeply dipping conductor. The ratio of the anomaly amplitude of channel 24/channel 22 generally increases as the apparent thickness increases, i.e., the thickness in the horizontal plane. This thickness is equal to the conductor width if the conductor dips at 90 degrees and strikes at right angles to the flight line. This report refers to a conductor as thin when the thickness is likely to be less than 3m, and thick when in excess of 10 m. In base metal exploration applications, thick conductors can be high priority targets because most massive sulfide ore bodies are thick, whereas non-economic bedrock conductors are usually thin. An estimate of thickness cannot be obtained when the strike of the conductor is subparallel to the flight line, when the conductor has a shallow dip, when the anomaly amplitudes are small, or when the resistivity of the environment is below 100 ohm-m.

Resistivity mapping

Areas of widespread conductivity are commonly encountered during surveys. In such areas, anomalies can be generated by decreases of only 5 m in survey altitude as

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well as by increases in conductivity. The typical flight record in conductive areas is characterized by inphase and quadrature channels which are continuously active; local peaks reflect either increases in conductivity of the earth or decreases in survey altitude. For such conductive areas, apparent resistivity profiles and contour maps are necessary for the interpretation of the airborne data. The advantage of the resistivity parameter is that anomalies caused by altitude changes are virtually eliminated, so the resistivity data reflect only those anomalies caused by conductivity changes. This helps the interpreter to differentiate between conductive trends in the bedrock and those patterns typical of conductive overburden. Discrete conductors will generally appear as narrow lows on the contour map and broad conductors will appear as wide lows.

Channel 40 (see Appendix) and the resistivity contour map present the apparent resistivity using the so-called pseudo-layer (or buried) half space model defined in Fraser (1978)². This model consists of a resistive layer overlying a conductive half space. Channel 41 gives the apparent depth below surface of the conductive material.

²Resistivity mapping with an airborne multicoil electromagnetic system: Geophysics, v 43, p. 144-172.

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The apparent depth therefore is simply the apparent thickness of the overlying resistive layer. The apparent depth (or thickness) parameter will be positive when the upper layer is more resistive than the underlying material, in which case the apparent depth may be quite close to the true depth.

The apparent depth will be negative when the upper layer is more conductive than the underlying material, and will be zero when a homogeneous half space exists. The apparent depth parameter must be interpreted cautiously because it will contain any errors which may exist in the measured altitude of the EM bird (e.g., as caused by a dense tree cover). The inputs to the resistivity algorithm are the inphase and quadrature components of the coplanar coil-pair. The outputs are the apparent resistivity of the conductive half space (the source) and the sensor-source distance. The flying height is not an input variable, and the output resistivity and sensor-source distance are independent of the flying height. The apparent depth, discussed above, is simply the sensor-source distance minus the measured altitude or flying height. Consequently, errors in the measured altitude will affect the apparent depth parameter but not the apparent resistivity parameter.

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The apparent depth parameter is a useful indicator of simple layering in areas lacking a heavy tree cover. The DIGHEM^{II} system has been flown for the purpose of permafrost mapping, where positive apparent depths were used as a measure of permafrost thickness. However, little quantitative use has been made of negative apparent depths because the absolute value of the negative depth is not a measure of the thickness of the conductive upper layer and, therefore, is not meaningful physically. Qualitatively, a negative apparent depth estimate usually shows that the EM anomaly is caused by conductive overburden. Consequently, the apparent depth channel 41 can be of significant help in distinguishing between overburden and bedrock conductors.

Interpretation in conductive environments

Environments having background resistivities below 30 ohm-m cause all airborne EM systems to yield very large responses from the conductive ground. This usually prohibits the recognition of bedrock conductors. The processing of DIGHEM^{II} data, however, produces four channels which contribute significantly to the recognition of bedrock conductors. These are the inphase and quadrature difference channels (number 33 and 34), and the resistivity and depth channels (40 and 41). The EM difference channels

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eliminate up to 99% of the response of conductive ground, leaving responses from bedrock conductors, cultural features (e.g., telephone lines, fences, etc.) and edge effects. An edge effect arises when the conductivity of the ground suddenly changes, and this is a source of geologic noise. While edge effects yield anomalies on the EM difference channels, they do not produce resistivity anomalies. Consequently, the resistivity channel aids in eliminating anomalies due to edge effects. On the other hand, resistivity anomalies will coincide with the most highly conductive sections of conductive ground, and this is another source of geologic noise. The recognition of a bedrock conductor in a highly conductive environment therefore is based on the anomalous responses of the two difference channels (33 and 34) and the resistivity channel (40). The most favourable situation is where anomalies coincide on all three channels.

Channel 41, which is the apparent depth to the conductive material, also helps determine whether a conductive response arises from surficial material or from a conductive zone in the bedrock. When this channel rides above the zero level on the orange profile paper (i.e., it is negative), it implies that the EM and resistivity profiles are responding primarily to a conductive upper layer, i.e., conductive

overburden. If channel 41 is below the zero level, it indicates that a resistive upper layer exists, and this usually implies the existence of a bedrock conductor.

Channels 35 and 36 are the anomaly recognition functions. They are used to trigger the conductance channel 37 which identifies discrete conductors. In highly conducting environments, channel 36 may not be generated because it is subject to some corruption by highly conductive earth signals. Some of the automatically selected anomalies (channel 37) are discarded by the human interpreter. The automatic selection algorithm is intentionally oversensitive to assure that no meaningful responses are missed. The interpreter then classifies the anomalies according to their source and eliminates those that are not substantiated by the data, such as those rising from geologic or aerodynamic noise.

The resistivity map often yields more useful information on conductivity distributions than the EM map. In comparing the EM and resistivity maps, keep in mind the following:

- (a) The resistivity map portrays the absolute value of the earth's resistivity.

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(b) The EM map portrays anomalies in the earth's resistivity. An anomaly by definition is a change from the norm and so the EM map displays anomalies, (i) over narrow, conductive bodies and (ii) over the boundary zone between two wide formations of differing conductivity.

The resistivity map might be likened to a total field map and the EM map to a horizontal gradient in the direction of flight³. Because gradient maps are usually more sensitive than total field maps, the EM map therefore is to be preferred in resistive areas. However, in conductive areas, the absolute character of the resistivity map usually causes it to be more useful than the EM map.

Reduction of geologic noise

Geologic noise refers to unwanted geophysical responses. For purposes of airborne EM surveying, geologic noise refers to EM responses caused by conductive overburden

³The gradient analogy is only valid with regard to the identification of anomalous locations. The calculation of conductance is based on EM amplitudes relative to a local base level, rather than to an absolute zero level as for the resistivity calculation.

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and magnetic polarization. It was mentioned above that the EM difference channels (i.e., channel 33 for inphase and 34 for quadrature) tend to eliminate the response of conductive overburden. This marked a unique development in airborne EM technology, as DIGHEM^{II} is the only EM system which yields channels having an exceptionally high degree of immunity to conductive overburden.

Magnetite produces a form of geological noise on the inphase channels of all EM systems. Rocks containing less than 1% magnetite can yield negative inphase anomalies caused by magnetic polarization. When magnetite is widely distributed throughout a survey area, the inphase EM channels may continuously rise and fall reflecting variations in the magnetite percentage, flying height, and overburden thickness. This can lead to difficulties in recognizing deeply buried bedrock conductors, particularly if conductive overburden also exists. However, the response of broadly distributed magnetite generally vanishes on the inphase difference channel 33. This feature can be a significant aid in the recognition of conductors which occur in rocks containing accessory magnetite.

MAGNETICS

The existence of a magnetic correlation with an EM anomaly is indicated directly on the EM map. An EM anomaly with magnetic correlation has a greater likelihood of being produced by sulfides than one that is non-magnetic. However, sulfide ore bodies may be non-magnetic (e.g., the Kidd Creek deposit near Timmins, Ontario, Canada) as well as magnetic (e.g., the Mattabi deposit near Sturgeon Lake, Ontario).

The magnetometer data are digitally recorded in the aircraft to an accuracy of one gamma. The digital tape is processed by computer to yield a standard total field magnetic map which is usually contoured at 25 gamma intervals. The magnetic data also are treated mathematically to enhance the magnetic response of the near-surface geology, and an enhanced magnetic map is produced with a 100 gamma contour interval. The response of the enhancement operator in the frequency domain is shown in Figure 2. The 100 gamma contour interval is equivalent to a 5 gamma interval for the passband components of the airborne data. This is because these components are amplified 20 times by the operator of Figure 2.

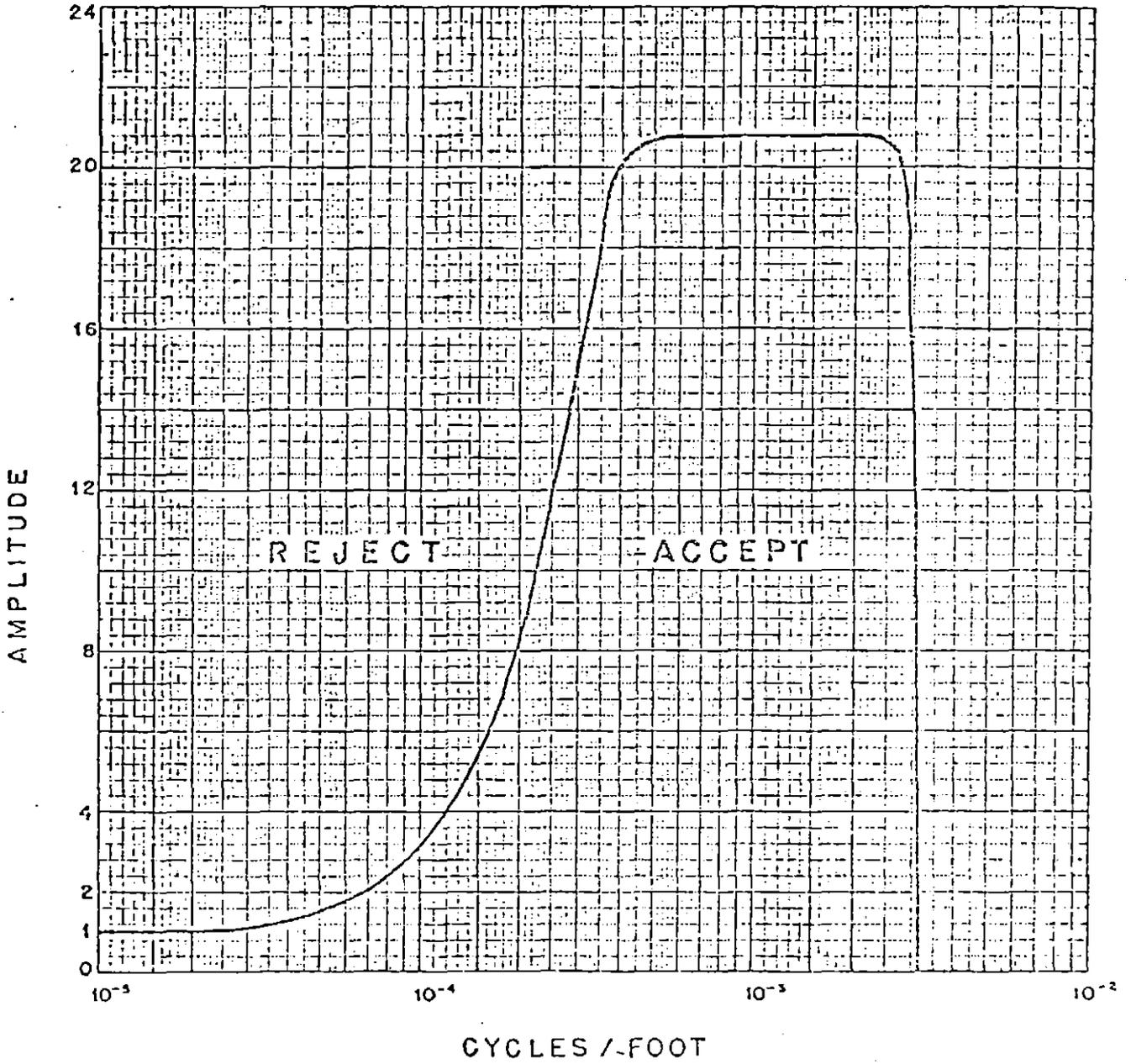


Figure 2 Frequency response of magnetic operator

- 21 -

The enhanced map, which bears a resemblance to a downward continuation map, is produced by digital bandpass filtering the total field data. The enhancement is equivalent to continuing the field downward to a level (above the source) which is 1/20th of the actual sensor-source distance.

Because the enhanced magnetic map bears a resemblance to a ground magnetic map, it simplifies the recognition of trends in the rock strata and the interpretation of geological structure. The contour interval of 100 gammas is suitable for defining the near-surface local geology while de-emphasizing deep-seated regional features.

CONDUCTORS IN THE SURVEY AREA

The electromagnetic maps show the location of conductors and their interpreted conductance (i.e., conductivity-thickness product) and depth. Their strike direction and length are also shown when anomalies can be correlated from line-to-line. When studying the maps for follow-up planning, consult the anomaly listings appended to this report to ensure that none of the conductors are overlooked.

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Huskisson Area

The survey area does not have any EM anomalies; it is highly resistive and moderately active magnetically. The few resistivity contours appear to outline surface conductivity with the possible exception described below.

Three encircled-x symbols are shown on the EM map. These indicate anomalies in channel 44 which focus on a possible, weak bedrock conductor. The resistivity low strikes parallel to the magnetic trend and gives EM anomaly shapes which do not contradict a bedrock conductor interpretation.

Respectfully submitted,
DIGHEM LIMITED



D.C. Fraser
President



S. Vergos
Geophysicist

Eight map sheets accompany this report.

Electromagnetics	2 map sheets
Resistivity	2 map sheets
Magnetics	2 map sheets
Enhanced magnetics	2 map sheets

A P P E N D I X A

THE FLIGHT RECORD AND PATH RECOVERY

Both analog and digital flight records are produced. The analog profiles are recorded on green chart paper in the aircraft during the survey. The digital profiles are generated later by computer and plotted on orange chart paper at a scale identical to the geophysical maps. The digital profiles, which may be displayed, are as follows:

<u>Channel</u> <u>Number/ Label</u>	<u>Parameter</u>	<u>Scale</u> <u>units/mm</u>	<u>Noise</u>
20 MAG	magnetometer	10 gamma	2 gamma
21 ALT	bird height	10 feet	5 feet
22 CXI	coaxial coil-pair inphase	1 ppm	1-2 ppm
23 CXQ	coaxial coil-pair quadrature	1 ppm	1-2 ppm
24 CPI	coplanar coil-pair inphase	1 ppm	1-2 ppm
25 CPQ	coplanar coil-pair quadrature	1 ppm	1-2 ppm
26 VLFT	VLF-EM total field	1 %	1-2 %
27 VLFQ	VLF-EM vertical quadrature	1 %	1-2 %
28 CXS	ambient noise monitor (coaxial coil)	1 ppm	1 ppm
29 CPS	ambient noise monitor (coplanar coil)	1 ppm	1 ppm
33 DIFI	difference function inphase	1 ppm	1-2 ppm
34 DIFQ	difference function quadrature	1 ppm	1-2 ppm
35 REC1	first anomaly recognition function	1 ppm	1-2 ppm
36 REC2	second anomaly recognition function	1 ppm	1-2 ppm
37 SIGT	conductance	1 mho	
40 RES	log resistivity at main frequency	.03 decade	
41 DP	apparent depth at main frequency	3 m	
45 RES2	log resistivity at secondary frequency	.03 decade	
46 DP2	apparent depth at secondary frequency	3 m	

Note: Channels 42 to 44 are experimental.

(ii)

The log resistivity scale of 0.03 decade/mm means that the resistivity changes by an order of magnitude in 33 mm. The resistivities at 0, 33, 67 and 100 mm up from the bottom of the chart are respectively 1, 10, 100 and 1000 ohm-m.

The fiducial marks on the flight records represent points on the ground which were recognized by the aircraft navigator. Continuous photographic coverage allowed accurate photo-path recovery locations for the fiducials, which were then plotted on the geophysical maps to provide the track of the aircraft.

The fiducial locations on both the flight records and flight path maps were examined by a computer for unusual helicopter speed changes. Such changes may denote an error in flight path recovery. The resulting flight path locations therefore reflect a more stringent checking than is provided by standard flight path recovery techniques.

The following brief description of DIGHEM^{II} illustrates the information content of the various profiles*.

*For a detailed description, see D.C. Fraser, Geophysics, v.44, p.1367-1394.

(iii)

Single-frequency surveying

The DIGHEM^{II} system has two transmitter coils which are mounted at right angles to each other. Both coils transmit at approximately the same frequency. (This frequency is given in the Introduction.) Thus, the system provides two completely independent surveys at one pass. In addition, the digital flight chart profiles (generated by computer) include an inphase channel and a quadrature channel which essentially are free of the response of conductive overburden. Also, the EM channels may indicate whether the conductor is thin (e.g., less than 3 m), or has a substantial width (e.g., greater than 10 m). Further, the EM channels include channels of resistivity, apparent depth and conductance. A minimum of 11 EM channels are provided. The DIGHEM^{II} system therefore gives information in one pass which cannot be obtained by any other airborne or ground EM technique.

Figure A1 shows a DIGHEM^{II} flight profile over the massive pyrrhotite ore body in Montcalm Township, Ontario. It will serve to identify the majority of the available channels.

(iv)

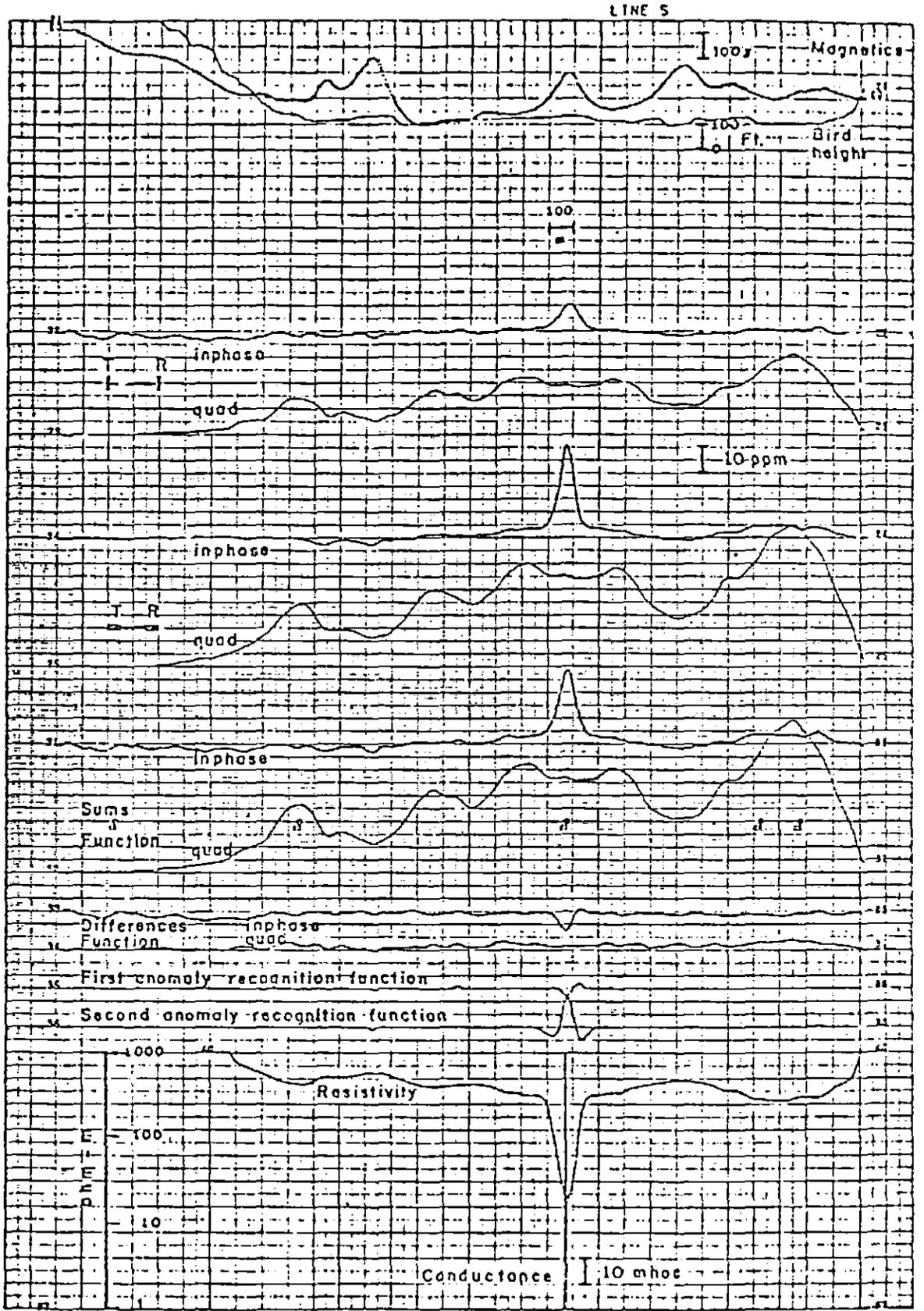


Fig. A1. Flight over Montcalm deposit, with line parallel to strike

(v)

The two upper channels (numbered 20 and 21) are respectively the magnetics and the radio altitude. Channels 22 and 23 are respectively the inphase and quadrature of the coaxial coil-pair, which is termed the standard coil-pair. This coil-pair is equivalent to the standard coil-pair of all inphase-quadrature airborne EM systems. Channels 24 and 25 are the inphase and quadrature of the additional coplanar coil-pair which is termed the whaletail coil-pair.

Channels 31 and 32 are inphase and quadrature sum functions of the standard and whaletail channels; they provide a condensed view of the four basic channels 22 to 25. The sum channels normally are not plotted.

Channels 33 and 34 are inphase and quadrature difference functions of the standard and whaletail channels. The difference channels are almost free from the response of conductive overburden. Channel 37 is the conductance. The conductance channel essentially is an automatic anomaly picker calibrated in conductance units of mhos; it is triggered by the anomaly recognition functions shown as channels 35 and 36.

(vi)

Channel 40 is the resistivity, which is derived from the whaletail channels 24 and 25. The resistivity channel 40 yields data which can be contoured, and so the DIGHEM^{II} system yields a resistivity contour map in addition to an electromagnetic map, a magnetic contour map, and an enhanced magnetic contour map. The enhanced magnetic contour map is similar to the filtered magnetic map discussed by Fraser.*

Figure A2 presents the DIGHEM^{II} results for a line flown perpendicularly to the Montcalm ore body. Channel 20 shows the 175 gamma magnetic anomaly caused by the massive pyrrhotite deposit. For the EM channels, the following points are of interest:

1. On channels 22-25 and 31-34, the ore body essentially yields only an inphase response. The quadrature response is almost completely caused by conductive overburden (which also gives a small inphase response). The hachures show the EM response from the overburden. The overburden response vanishes on the

*Cdn. Inst. Mng., Bull., April 1974.

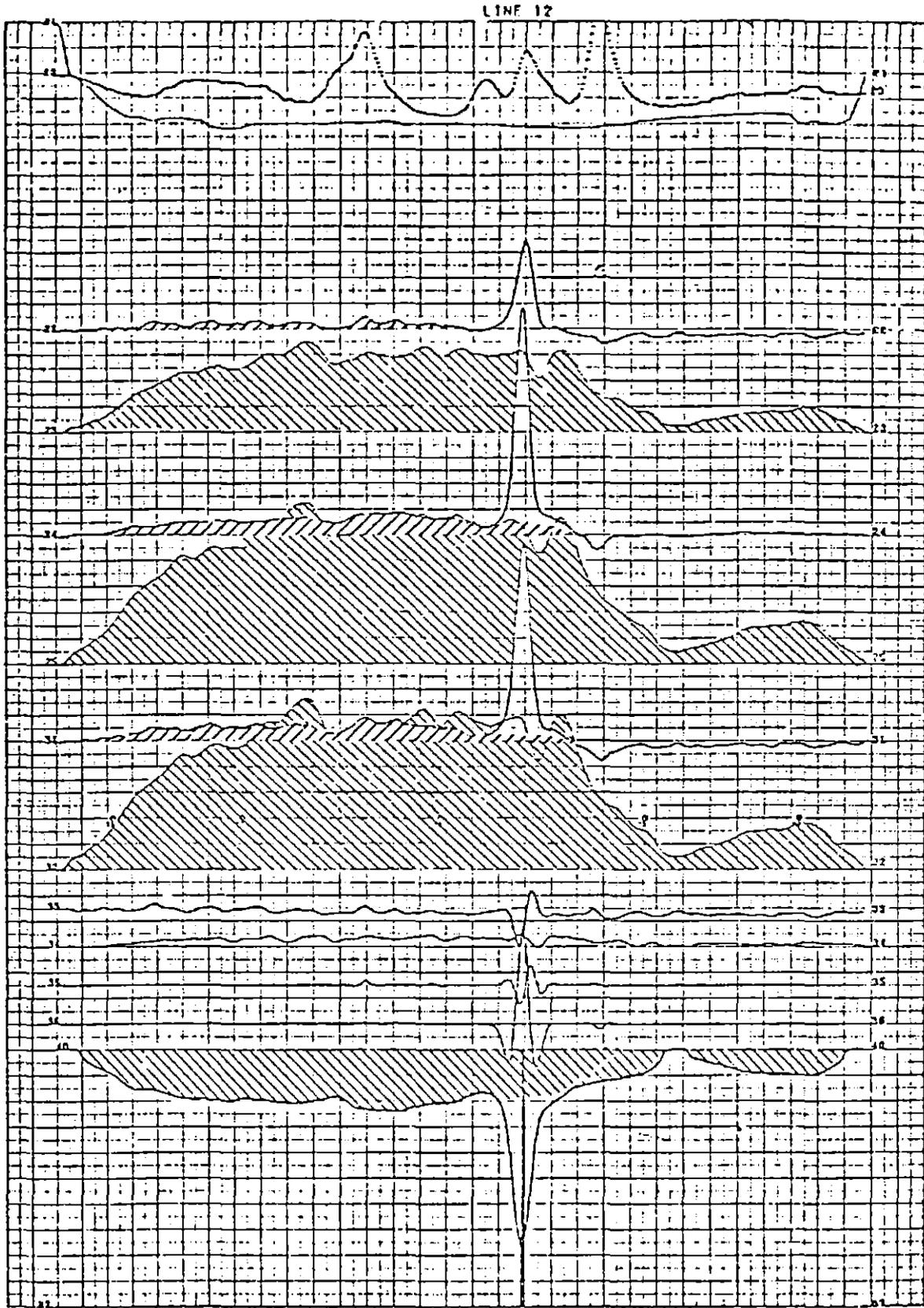


Fig. A2. Flight over Montcalm deposit, with line perpendicular to strike.

(viii)

difference EM channels, as can be seen by comparing the quadrature channels 25 and 34. This is an important point to note because DIGHEM^{II} is the only EM system which provides an inphase channel and a quadrature channel which are essentially free of conductive overburden response.

- 2. The whaletail anomaly of channel 24 has a single peak. This shows that the conductor has a substantial width. If the width had been under 3 m, the conductor would have produced a weak m-shaped anomaly on channel 24.
- 3. The ore body yields a resistivity of 5 ohm-m in a background of about 200 ohm-m (cf. channel 40). A dipole-dipole ground resistivity survey with an a-spacing of 50 m showed a similar background, but the ore body gave a low of only 53 ohm-m because of the averaging effect inherent in the ground technique.
- 4. The ore body has a conductance of 330 mhos according to its EM response on this particular flight line. The conductance channel 37 saturates at 100 mhos, and so the deposit is indicated by a 100-mho spike.

(ix)

Figure A1 illustrates the DIGHEM^{II} results for a line flown subparallel to the ore body. The ore body anomaly is small on the standard coil-pair (channel 22) but shows up strongly on the whaletail coil-pair (channel 24).

Dual-frequency surveying

For surveys flown primarily for resistivity mapping, as opposed to EM surveying, the two transmitter coils may be energized at two well-separated frequencies (e.g., 900 and 3600 Hz). Apparent resistivity and apparent depth maps can be made independently for each frequency. The interpretation procedure involves comparing the apparent resistivities and apparent depths at the two frequencies.

The use of two different coil-pair orientations (i.e., standard and whaletail) for dual-frequency resistivity mapping is an unorthodox procedure. However, as long as the current flow patterns are primarily horizontal, the different coil orientations do not influence the results, according to superposed dipole theory. Wire fences and other cultural features will produce local deviations,

(x)

because they usually respond preferentially to one or the other of the coil-pairs.

The difference channels 33 and 34 are not produced because the divergent frequencies of the two coil-pairs renders them meaningless. In addition, channels 35 to 37 also are not produced.

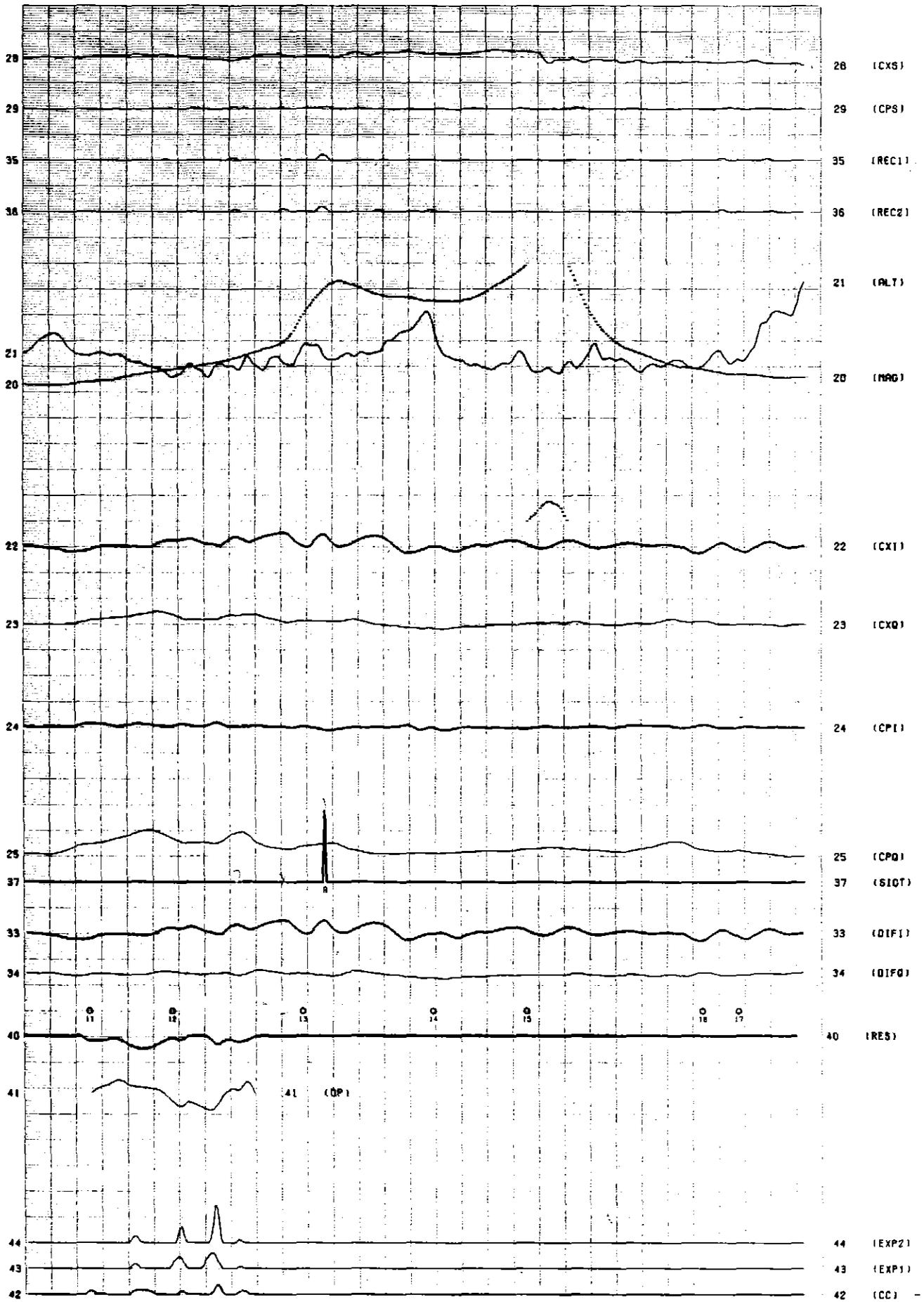
APPENDIX B

EM ANOMALY LIST

[The computer has selected those anomalies indicated by the symbol " + " on the following list as the most likely ones to be caused by bedrock conductors. In areas where the resistivity of the environment is less than 100 ohm-m and where EM anomalies are numerous, attention should be primarily directed to those anomalies indicated by this symbol. In areas of higher resistivity, most anomalies (regardless of the lack of the symbol " + ") will indicate bedrock conductors with the exception of those which are flagged on the EM map by the letters L, L?, S, S?; see EM map legend.]

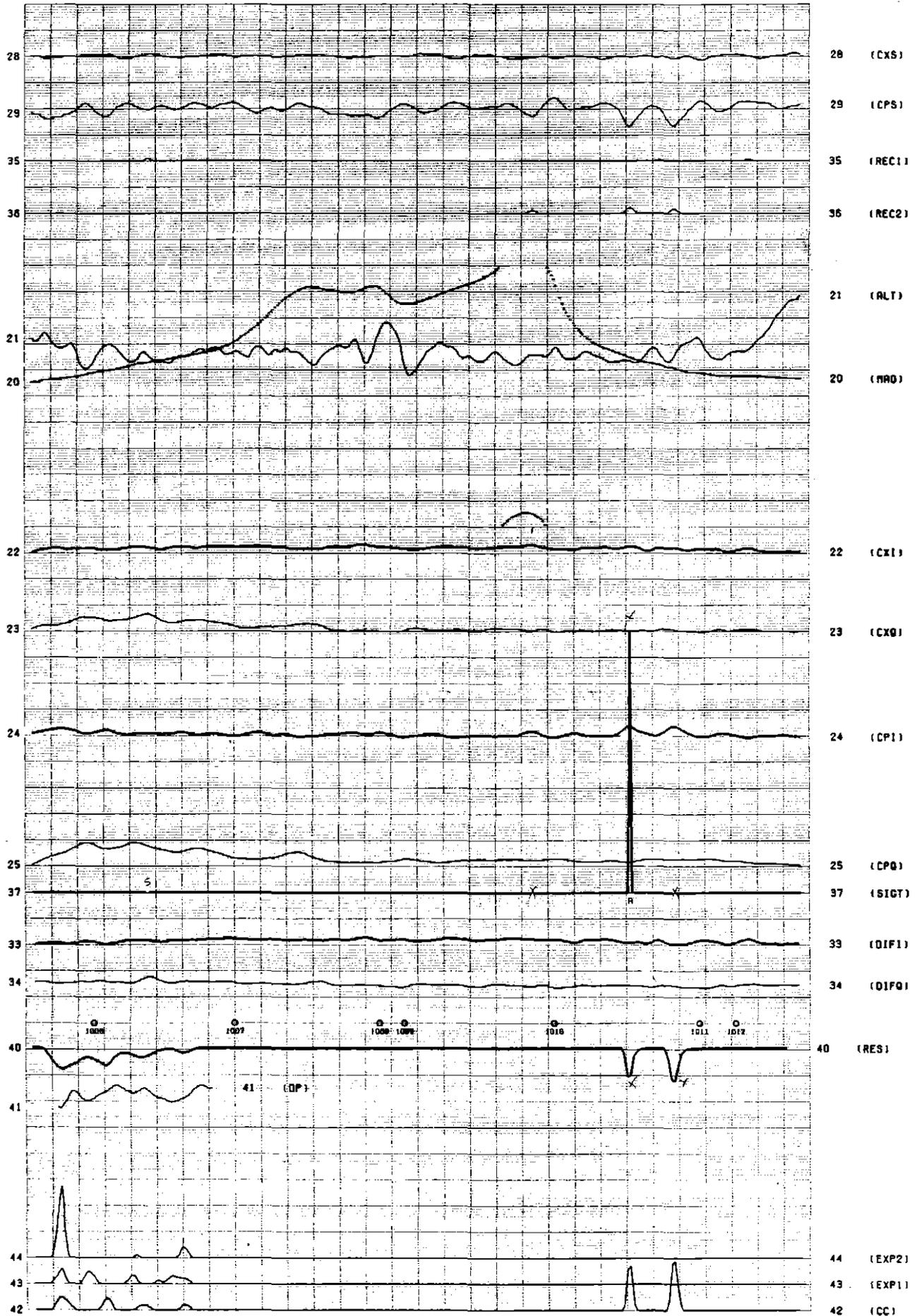
067

826068



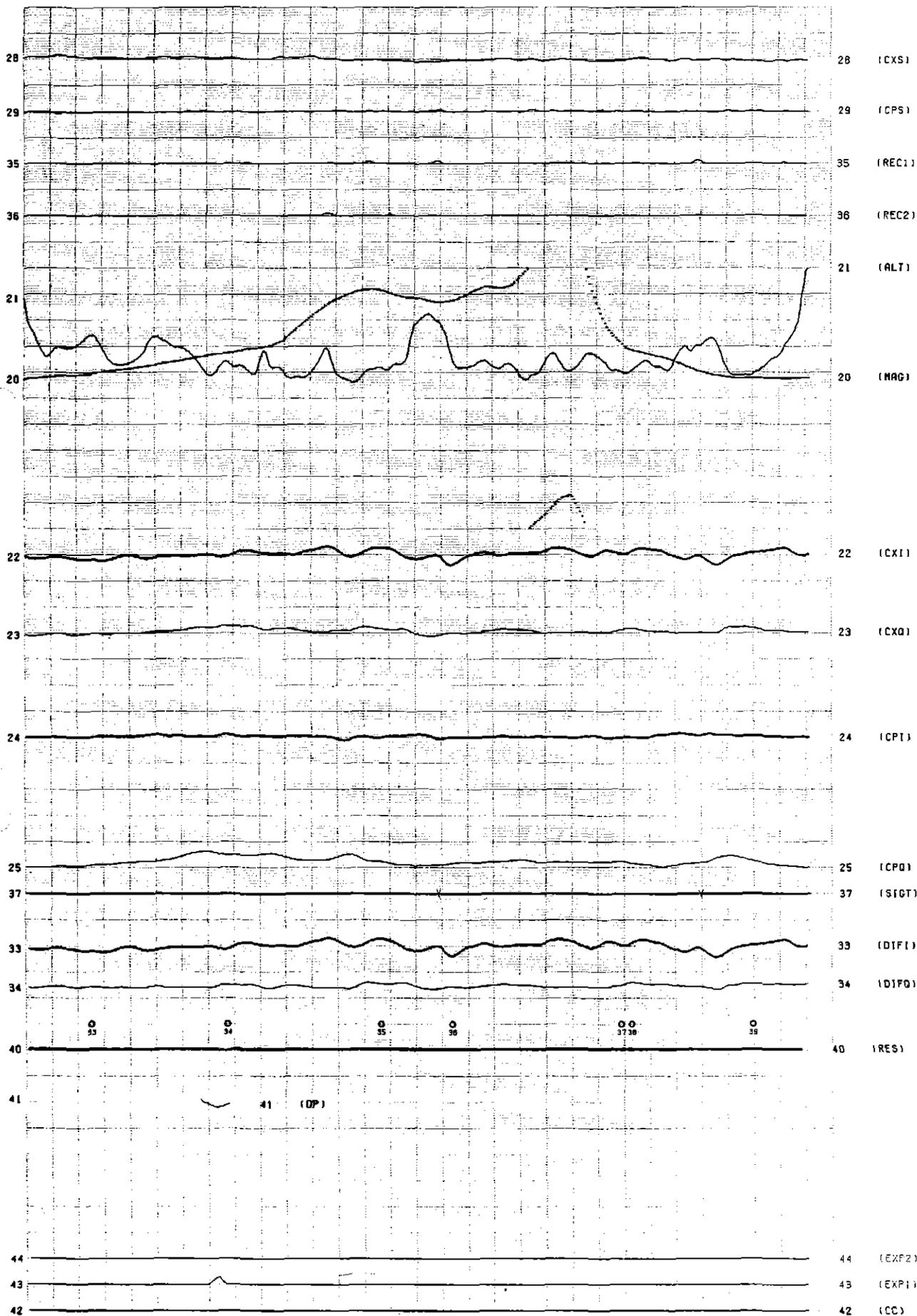
LINE 1 JOB: 322 001 1: 15000

5 cm



069

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LINE 3 JOB: 322 001 1: 15000

5 cm

070

820071



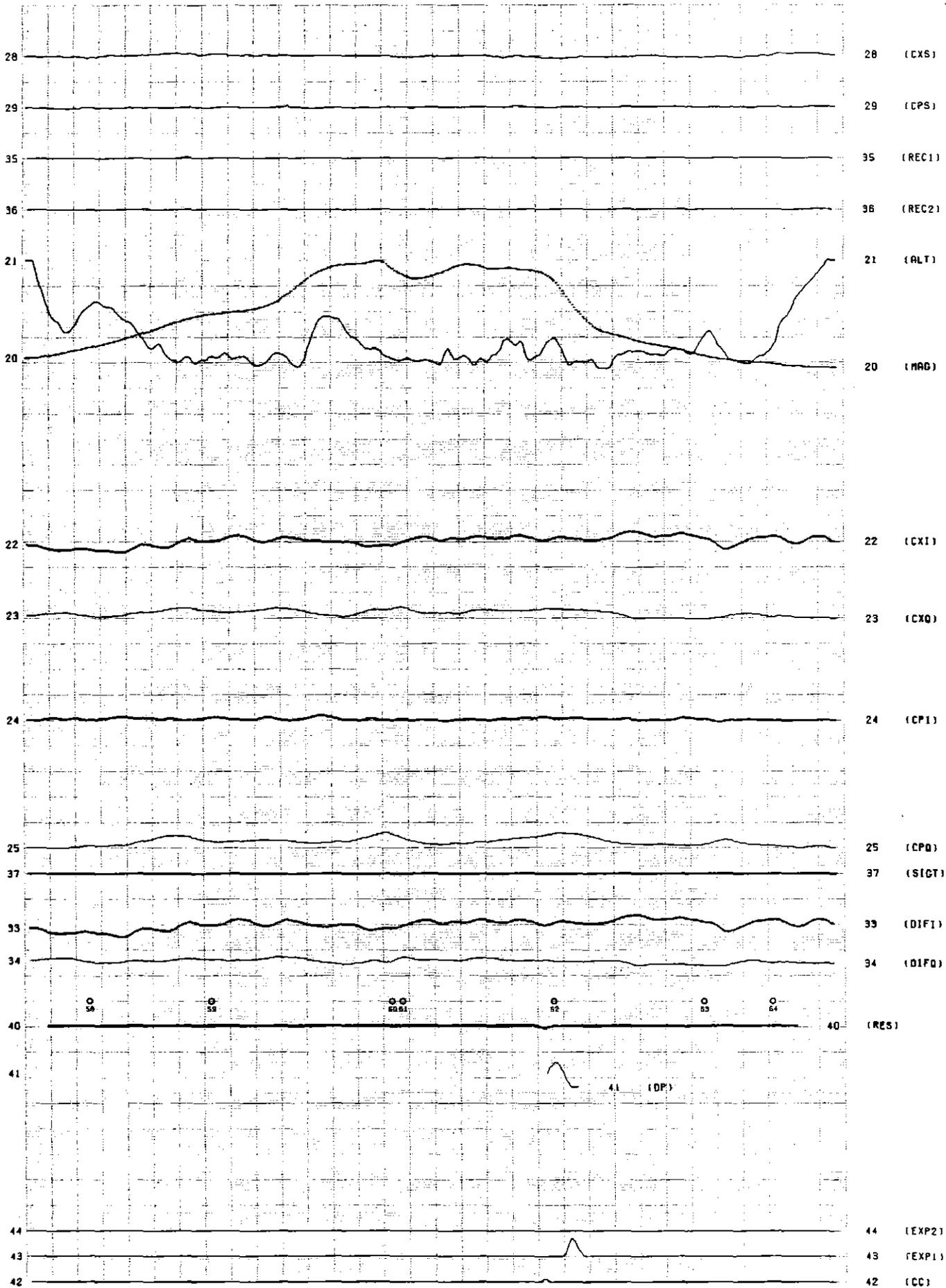
LINE -4 JOB: 322 001 1: 15000

LINE -4

5 cm

071

826072



LINE 5

JOB: 322 001

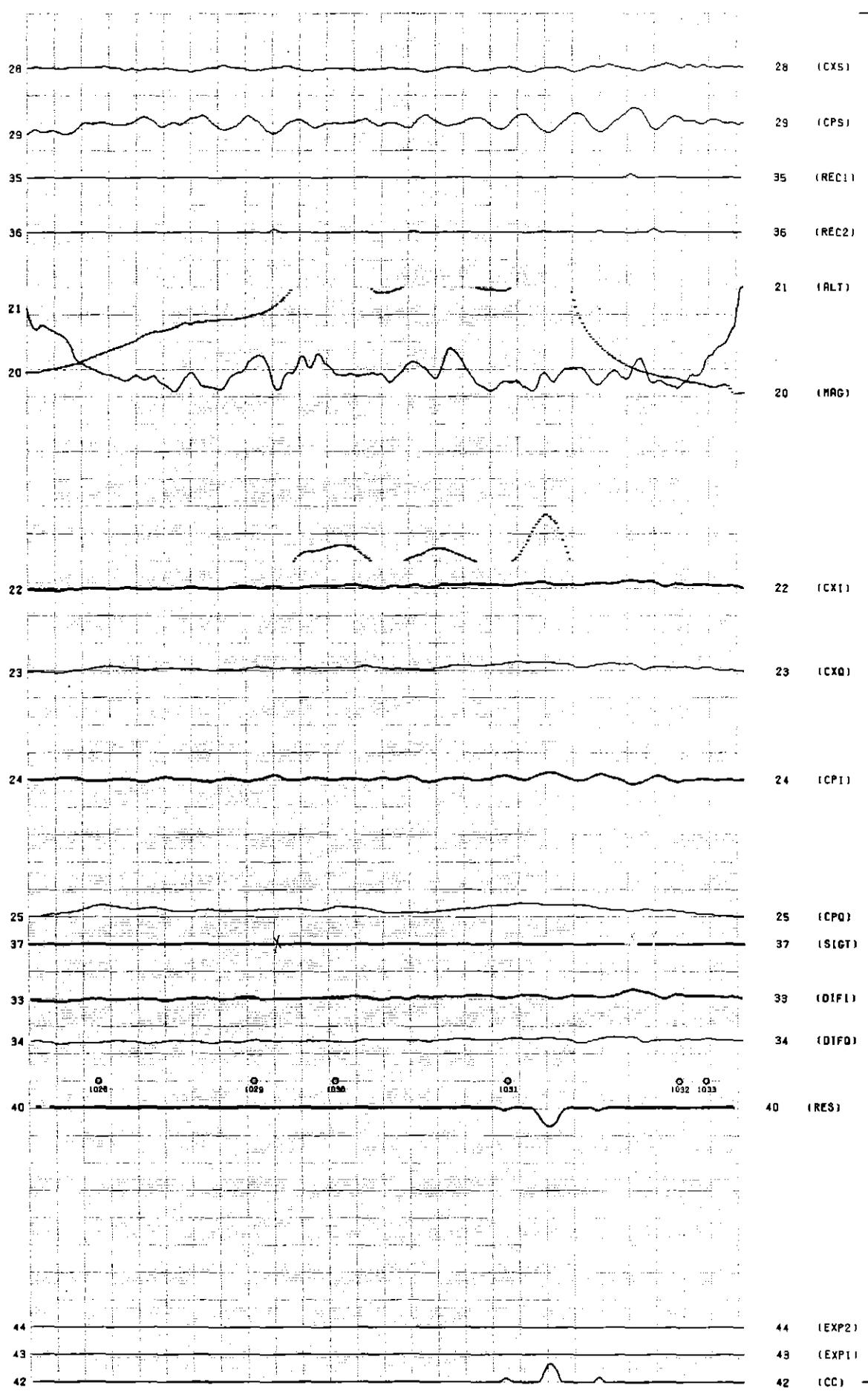
1: 15000

LINE 5

5 cm

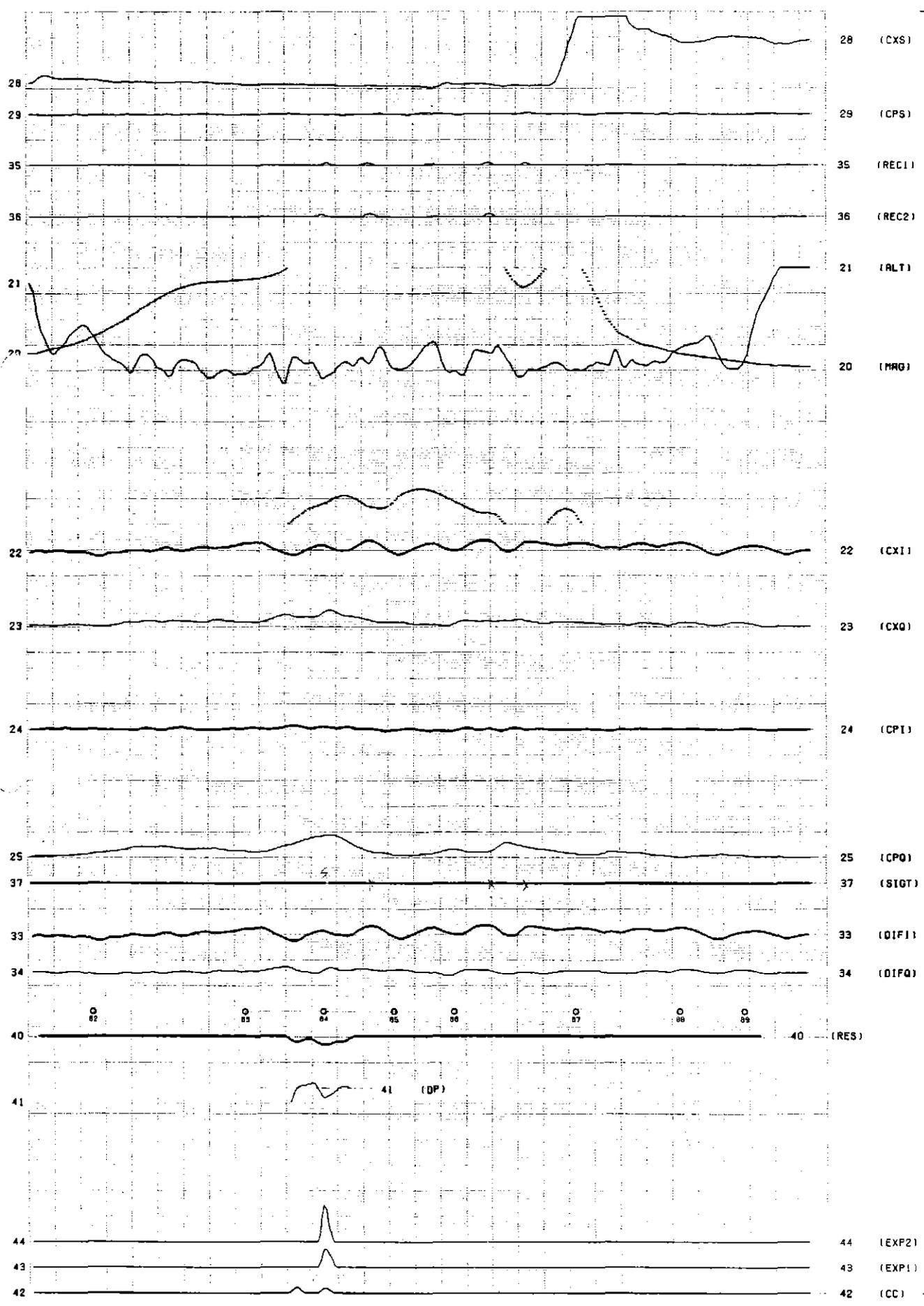
072

826073



LINE 6 JOB: 322 001 1: 15000

5 cm

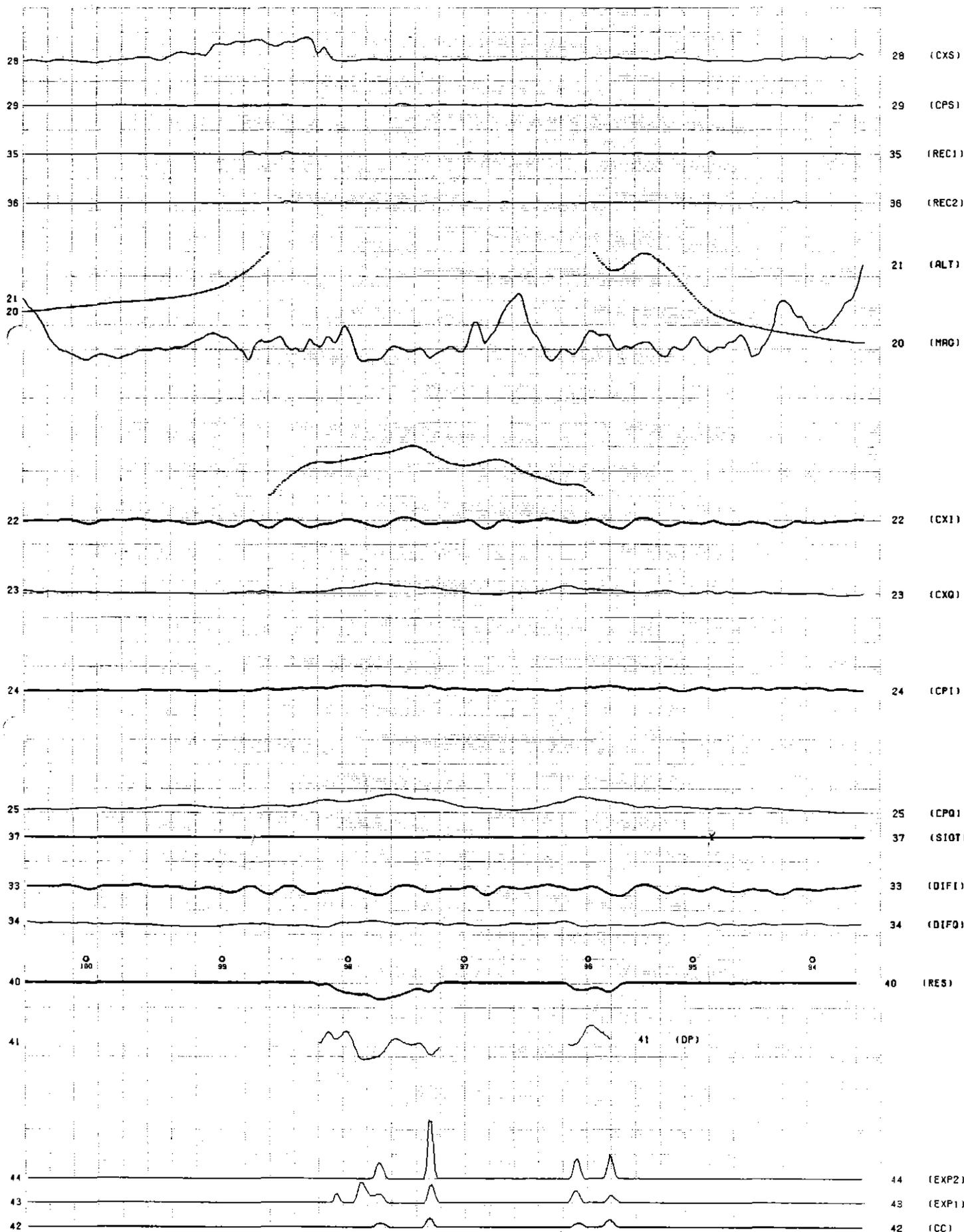


LINE 7 JOB: 322 001 I: 15000

5 cm

074

826075



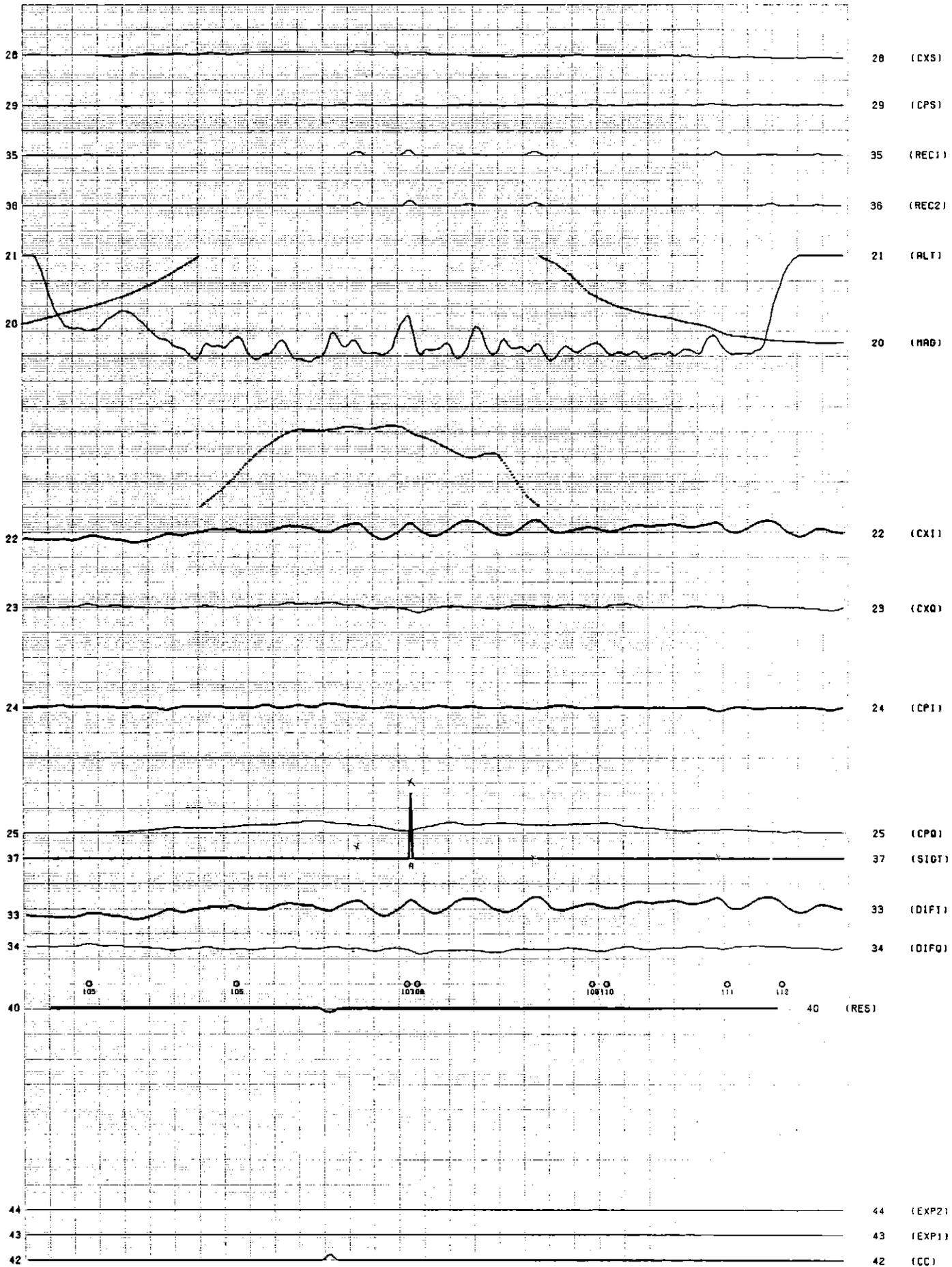
LINE -8 JOB: 322 001 1: 15000

5 cm

LINE -8

075

826076



LINE 9

JOB: 322 001

1: 15000

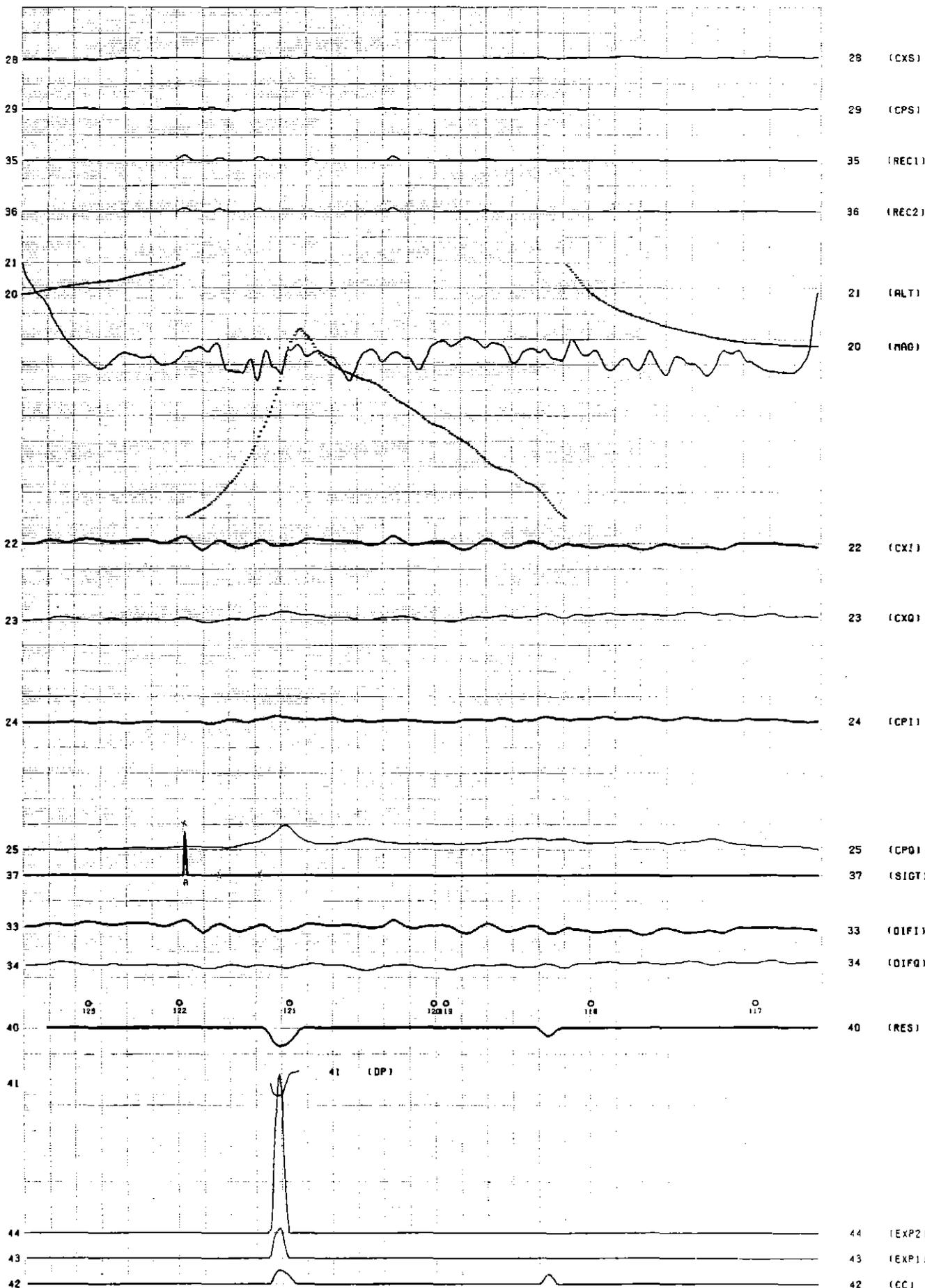
LINE 9

5 cm

28 (CXS)
 29 (CPS)
 35 (REC1)
 36 (REC2)
 21 (ALT)
 20 (MRB)
 22 (CX1)
 23 (CX0)
 24 (CPI)
 25 (CP0)
 37 (SIG)
 33 (DIF1)
 34 (DIF0)
 40 (RES)
 44 (EXP2)
 43 (EXP1)
 42 (CC)

076

826077



LINE -10

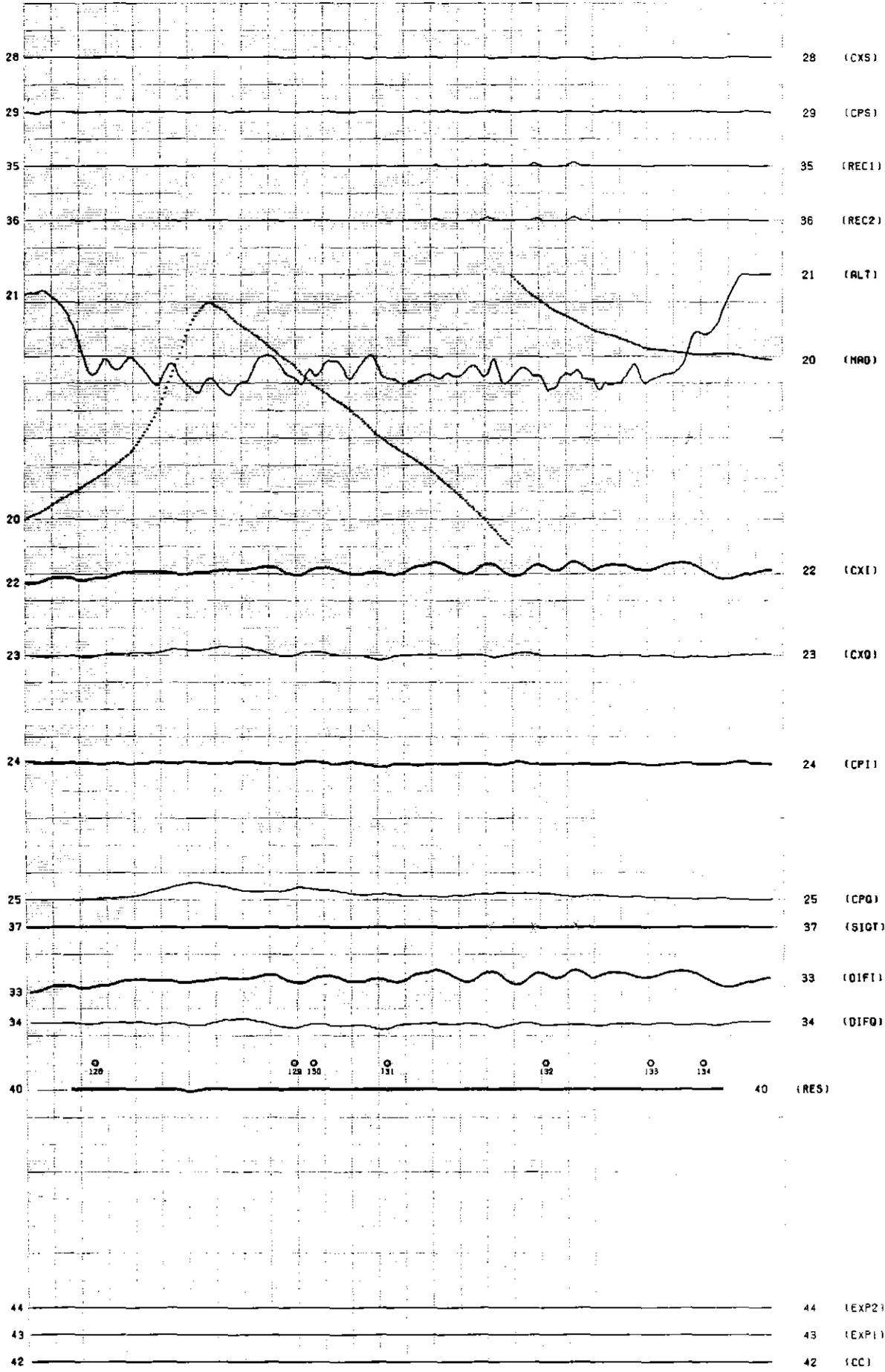
JOB: 322 001 1: 15000

LINE -10

5 cm

077

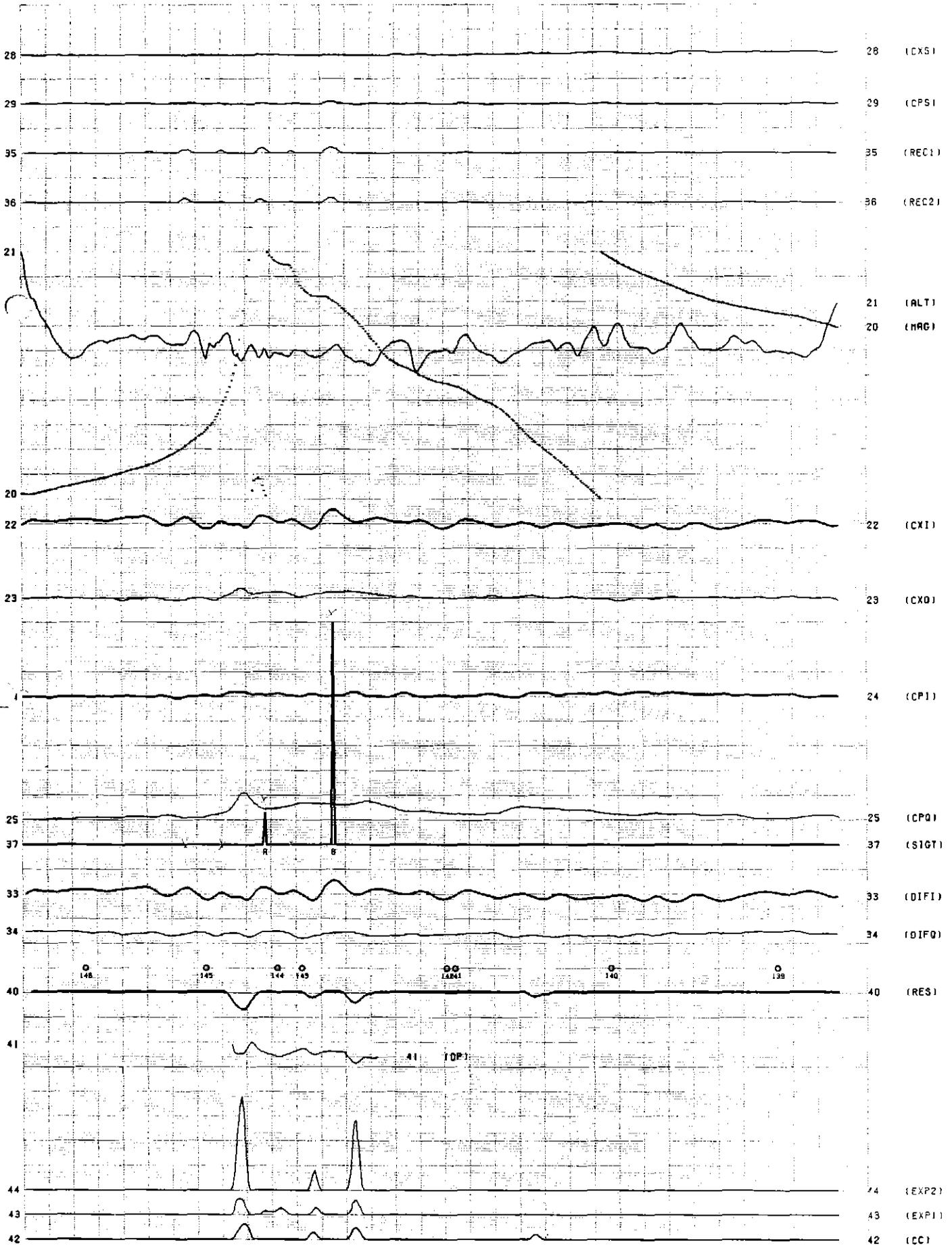
826078



LINE 11 JOB: 322 001 1: 15000

5 cm

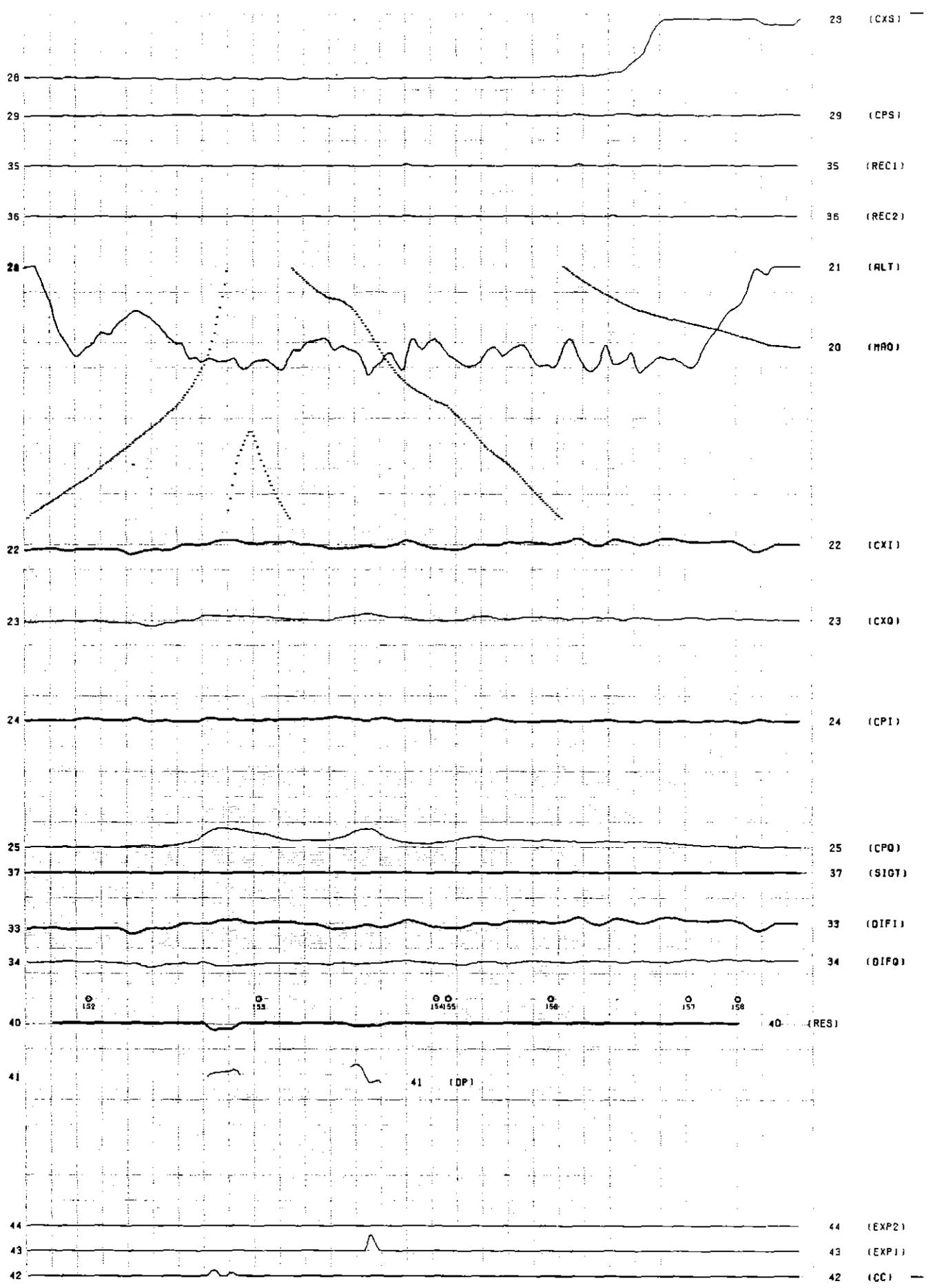
5 cm



079

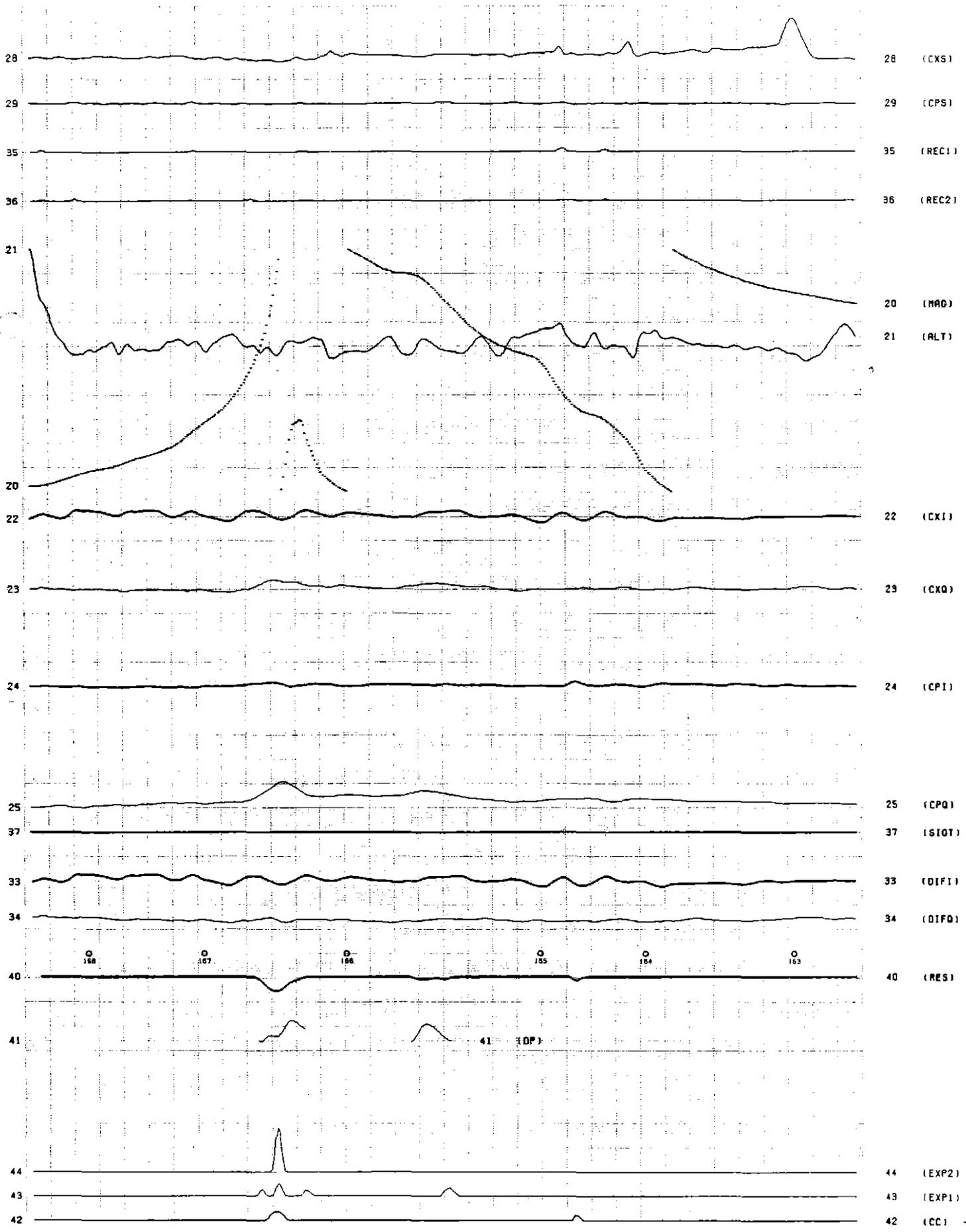
826030

5 cm



080

826081



LINE -14

JOB: 322 001

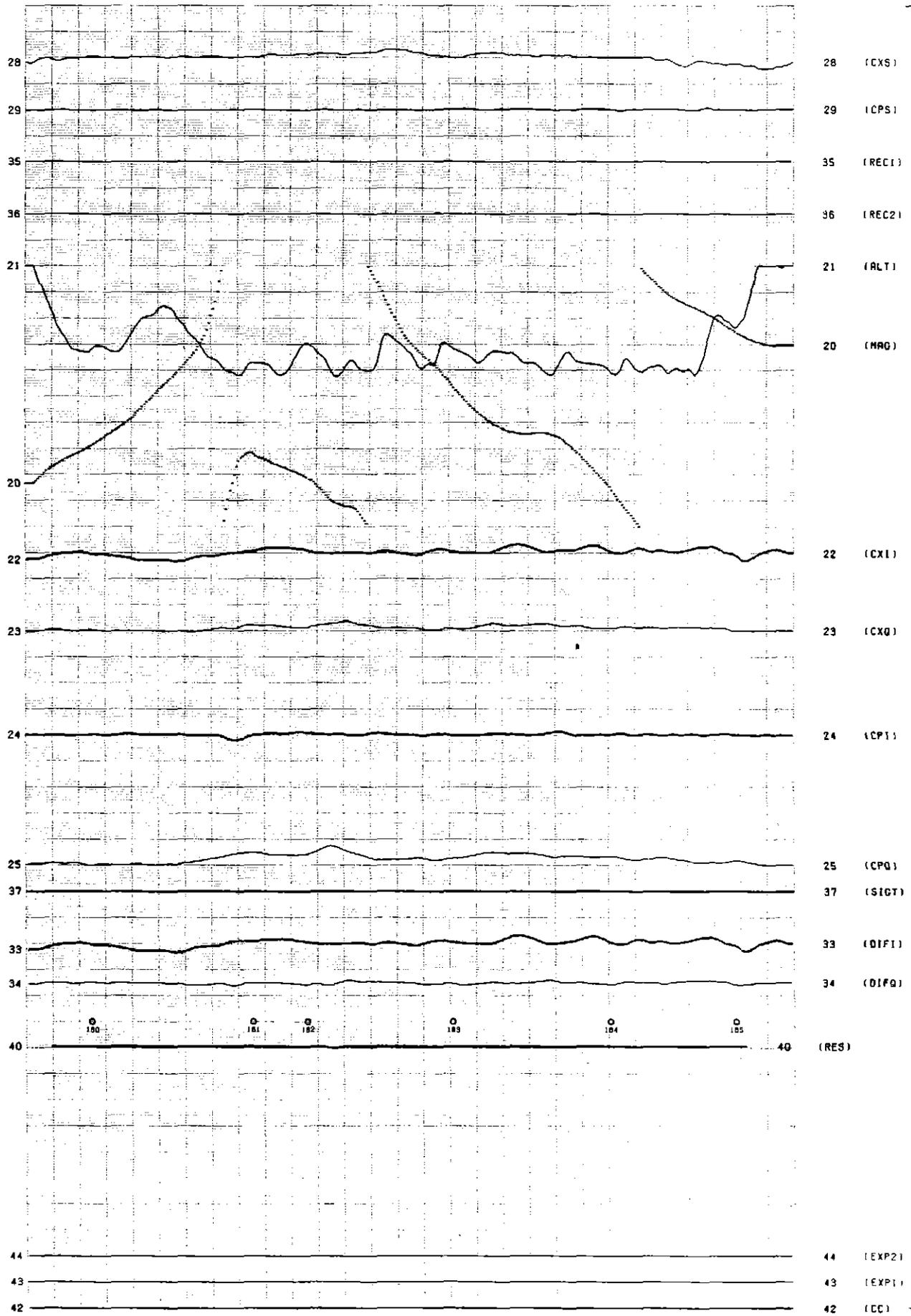
I: 15000

LINE -14

5 cm

081

826082

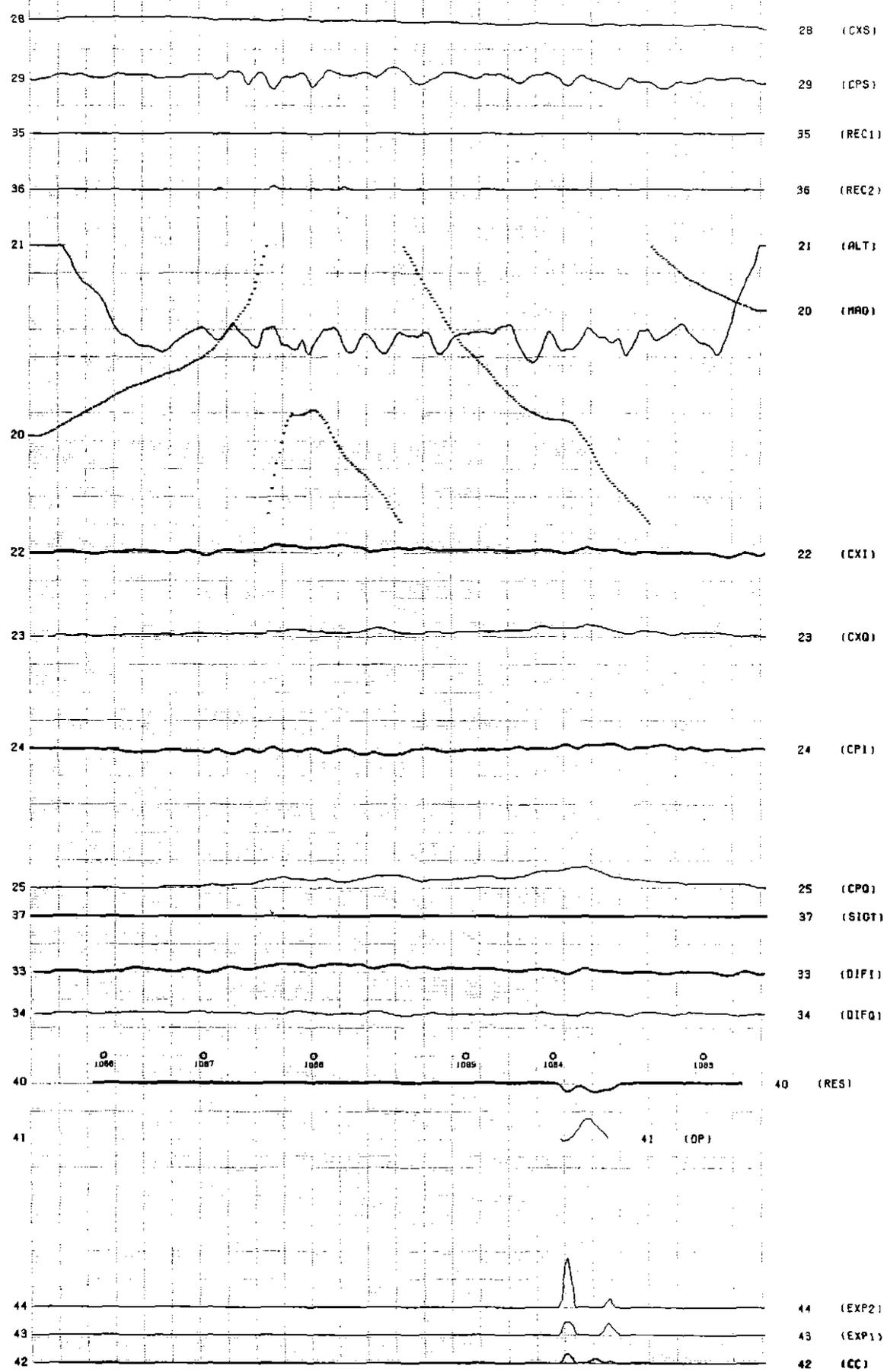


LINE 15 JOB: 322 001 1: 15000

5 cm

082

826083

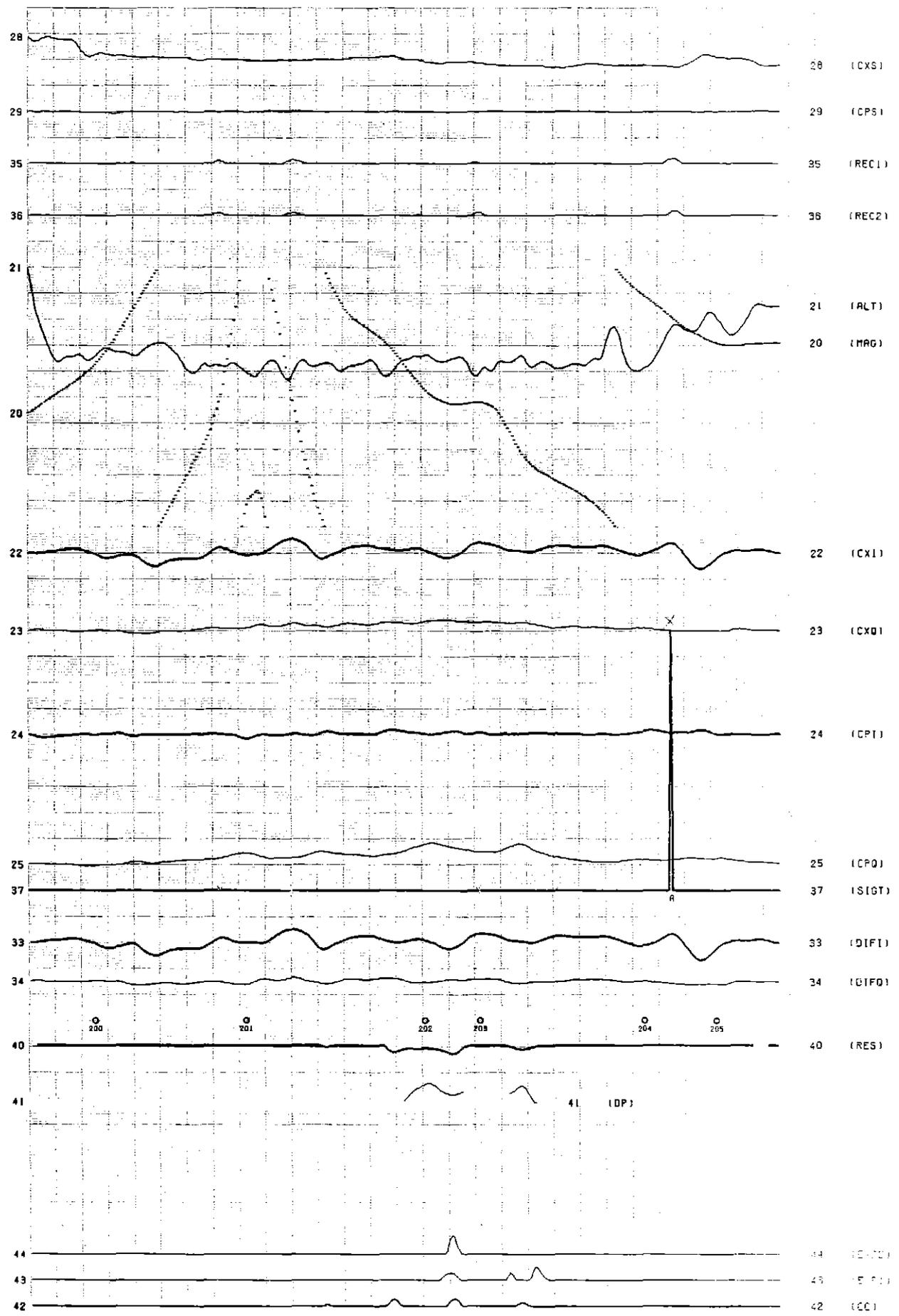


LINE -16 JOB: 322 001 1: 15000

5 cm

083

826084



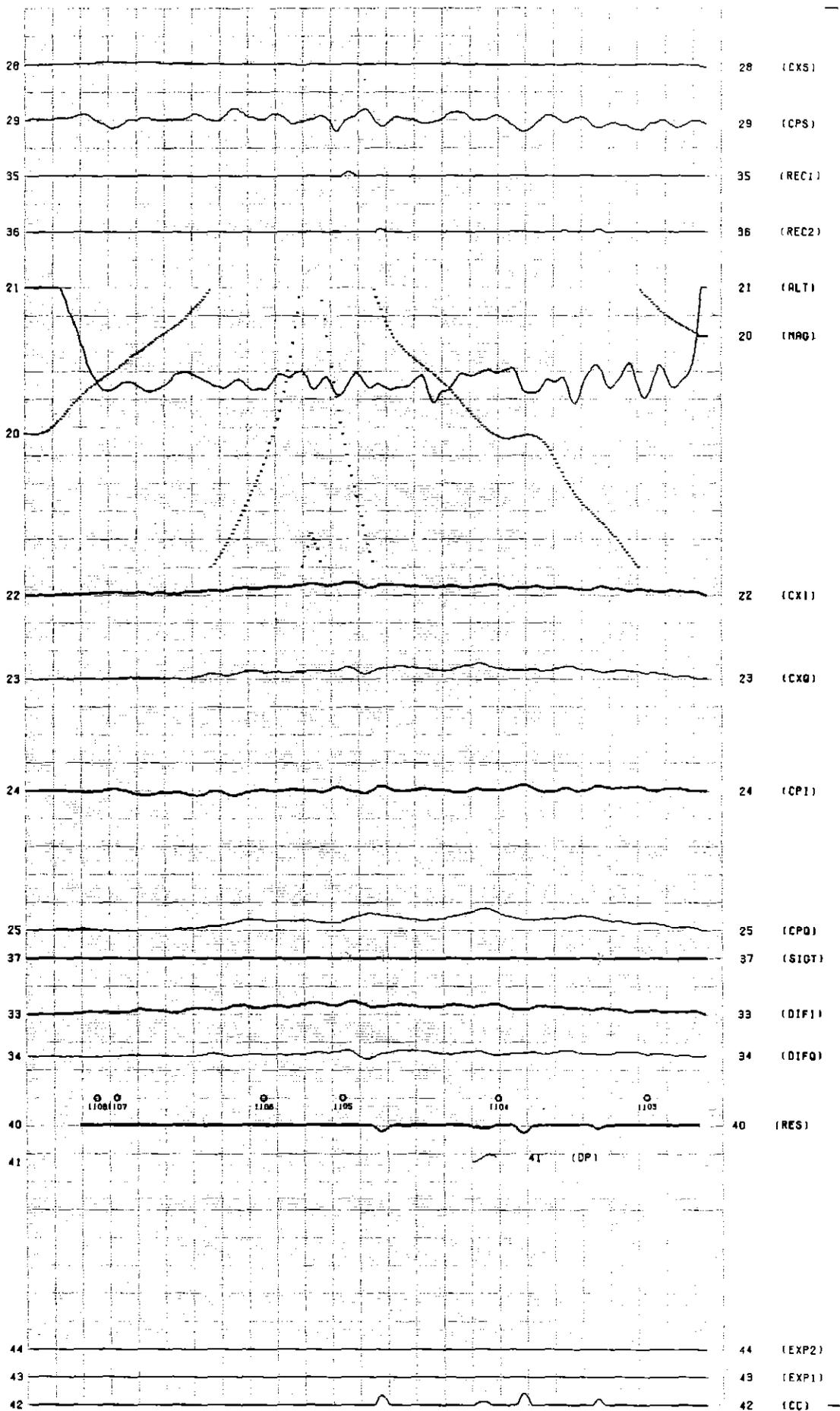
LINE 17 JOB: 322 001 1: 15000

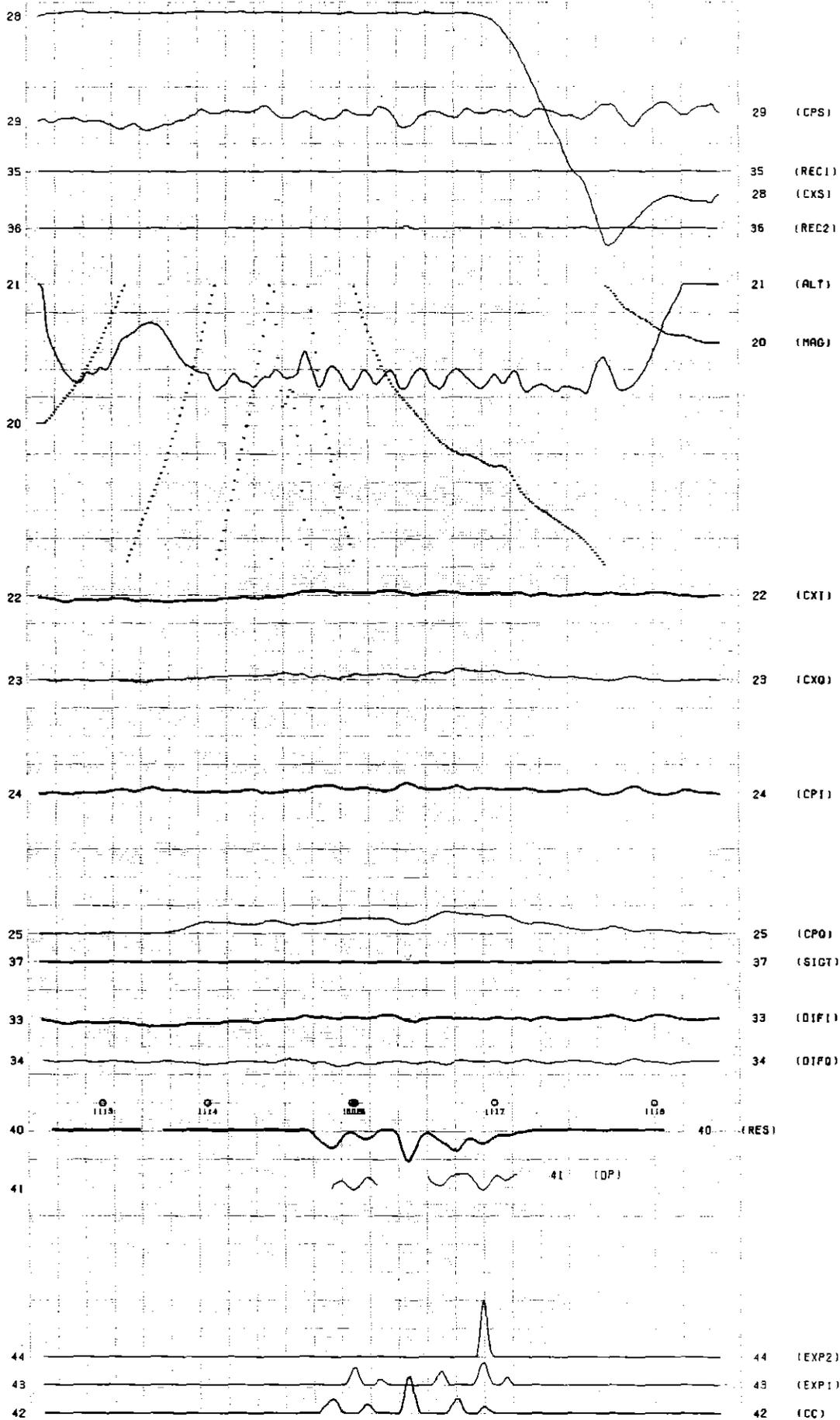
5 cm

084

620095

5 cm





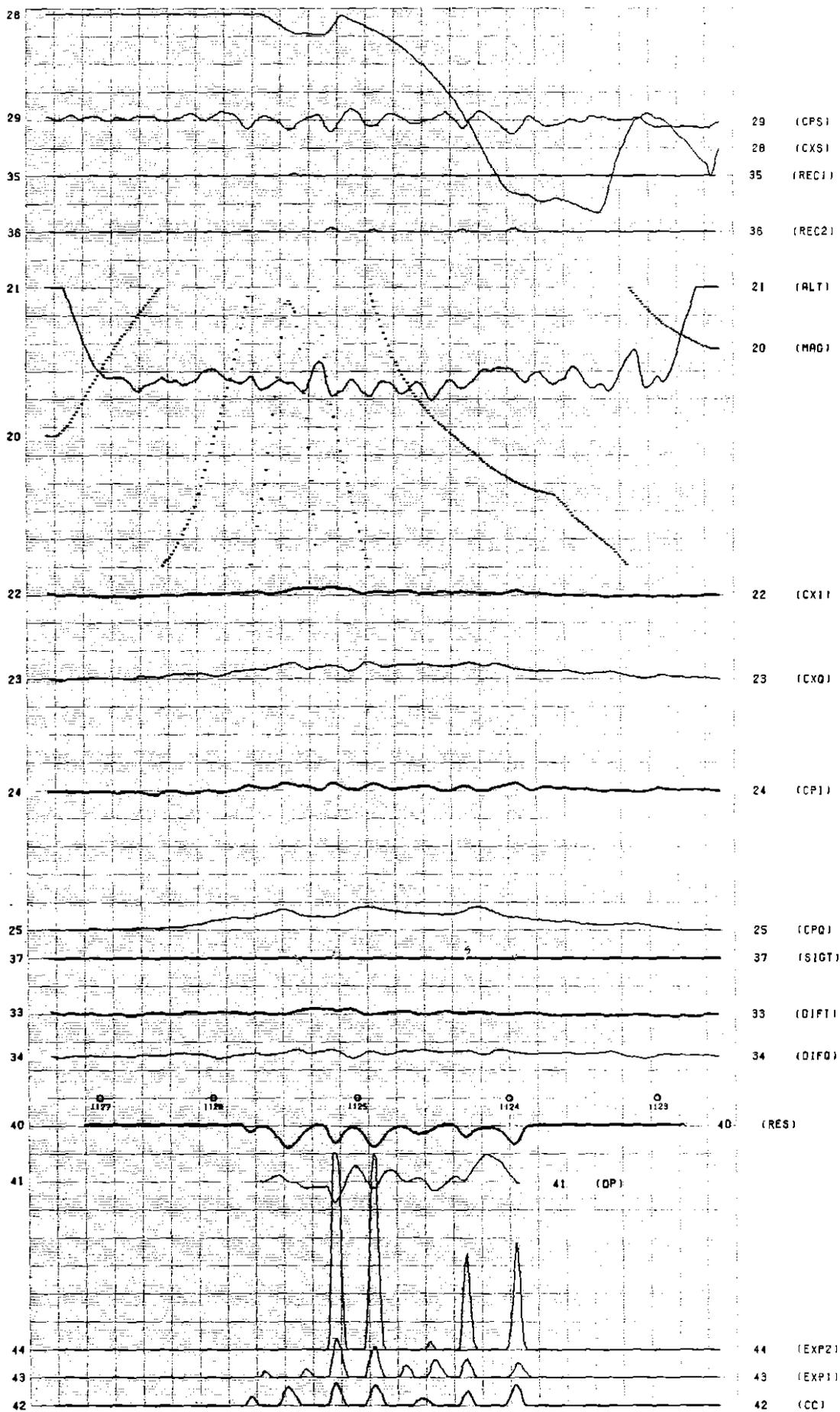
LINE 19 JOB: 322 001 1: 15000

5 cm

086

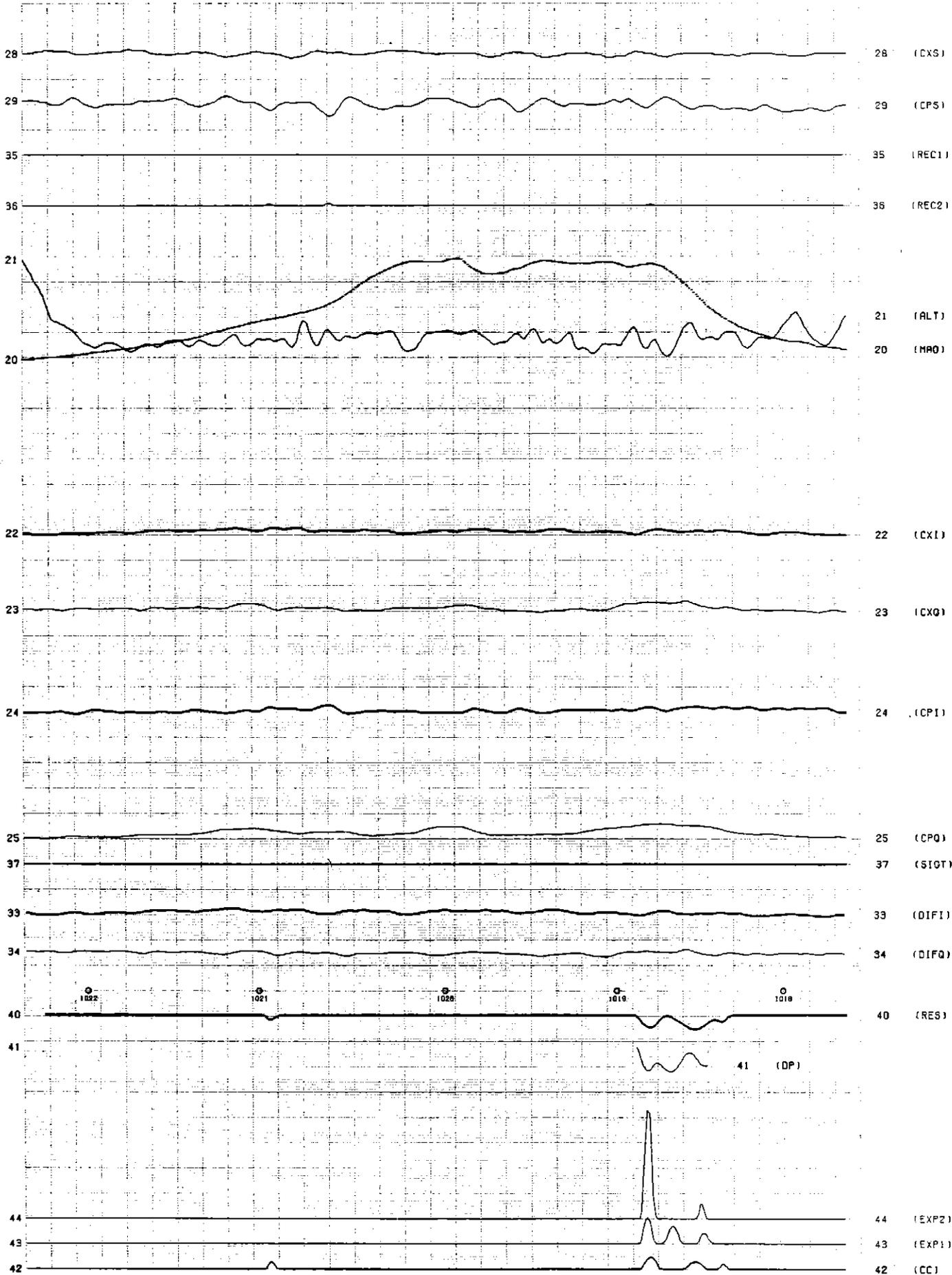
826087

5 cm



087

826088



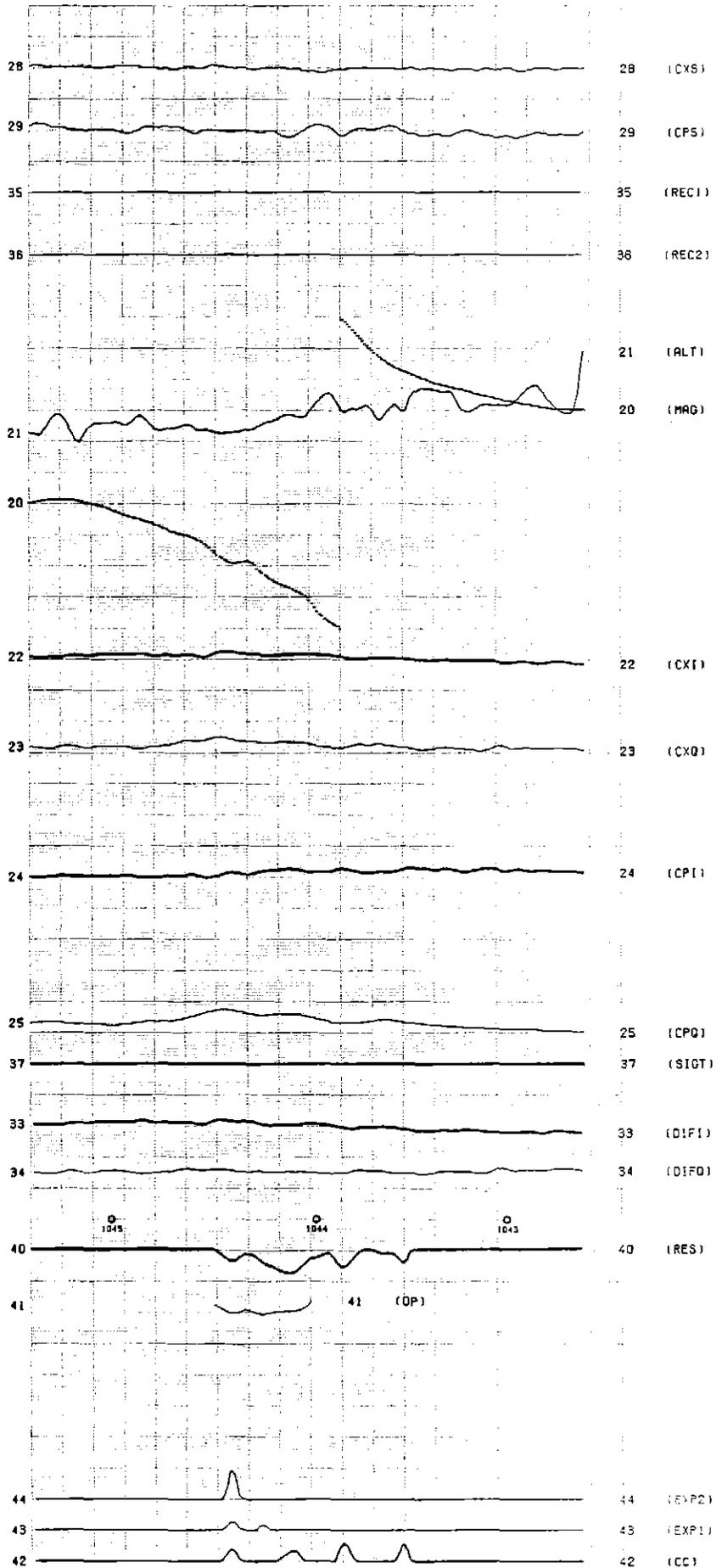
LINE -40

JOB: 322 001

1: 15000

LINE -40

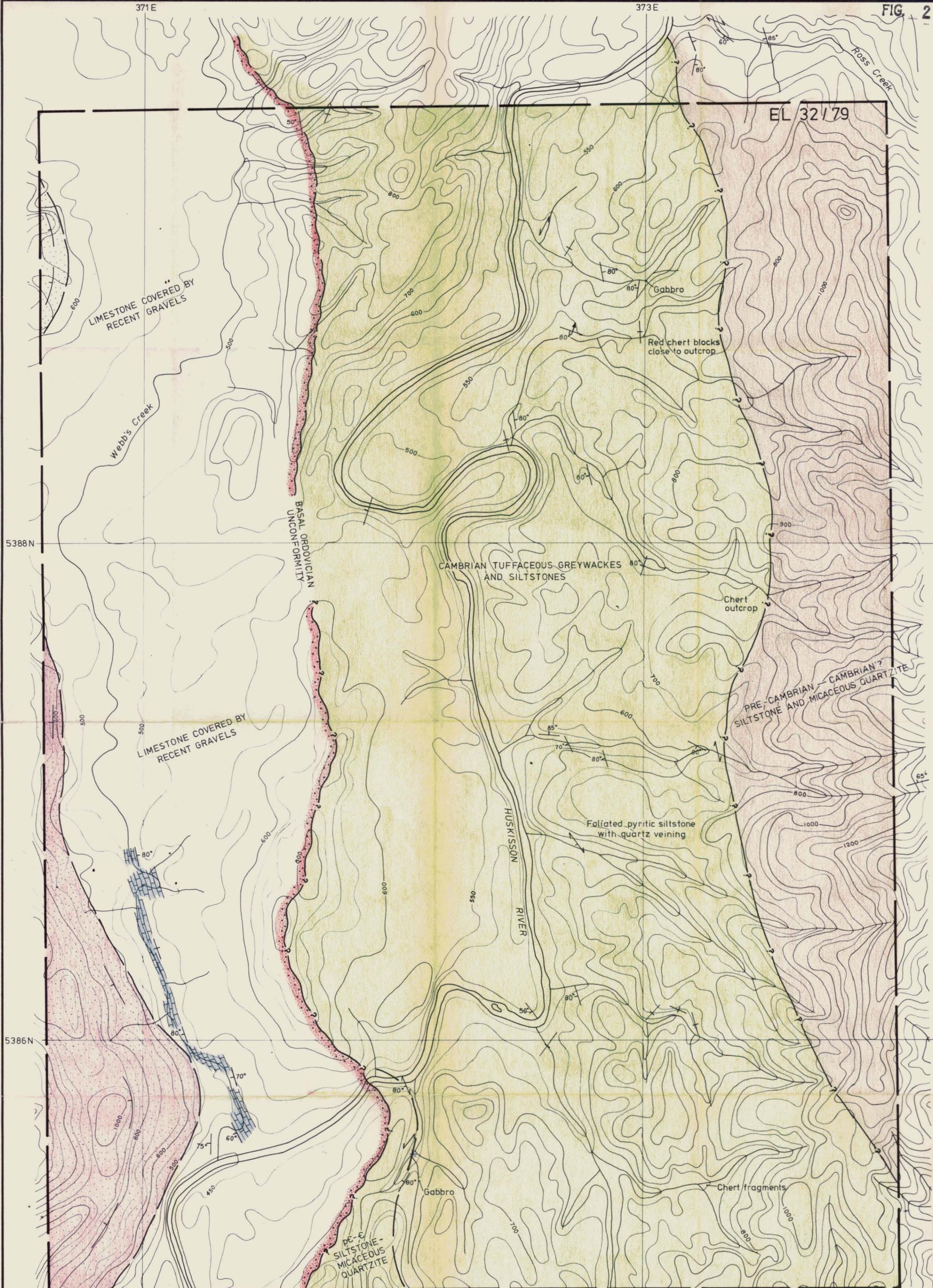
5 cm



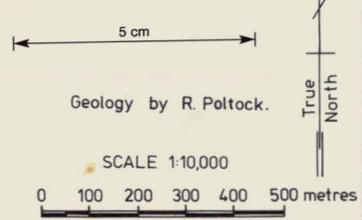
28
29
35
36
21
20
22
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24
25
37
33
34
40
41
44
43
42

(CXS)
(CPS)
(REC1)
(REC2)
(ALT)
(MAG)
(CX1)
(CX0)
(CP1)
(CP0)
(SIGT)
(DIF1)
(DIF0)
(RES)
(OP)
(EXP2)
(EXP1)
(CC)

5 cm



- | | | |
|---|--------------------------------------|---|
| RECENT | PRE-CAMBRIAN | CAMBRIAN |
| Gravels | Siltstone - micaceous quartzite | Tuffaceous greywackes, siltstones
minor cherts and gabbros |
| ORDOVICIAN SILURIAN | Sandstone - minor carbonate horizons | Limestone |
| Sandstone conglomerate | Bedding | Foliation |
| CAMBRIAN | Unconformity | Geological boundary |
| Tuffaceous greywackes, siltstones
minor cherts and gabbros | | |



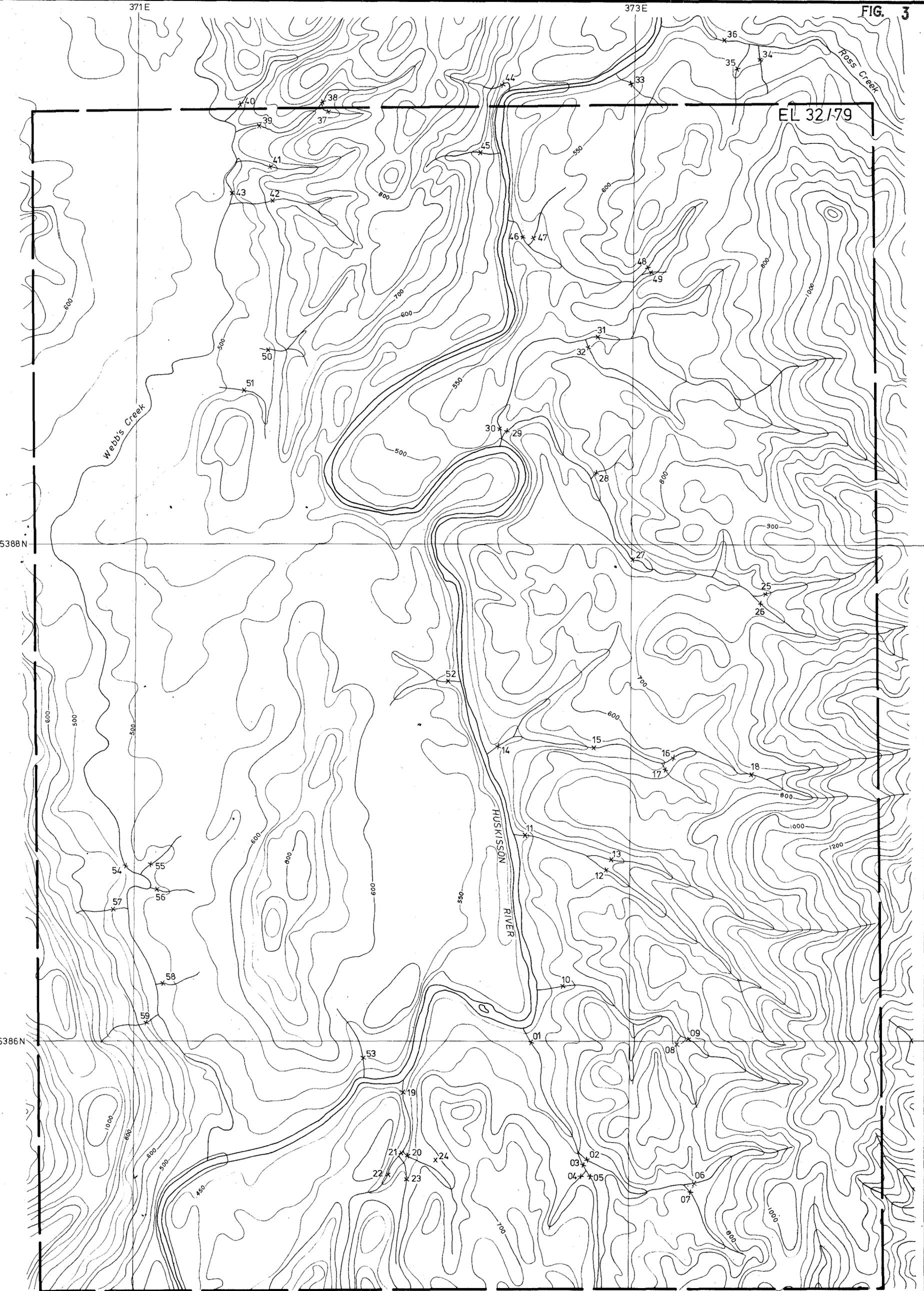
82090 82-1704

THE BROKEN HILL PROPRIETARY CO. LTD.
EXPLORATION DEPARTMENT

EL 32/79 HUSKISSON RIVER AREA

GEOLOGY 006

Revisions:	Drawn: POLTOCK BROS.	Date: 20-11-80	Centre: HOBART
	Traced: J.E.H.	Project No: T660	Drawing No: A2-32/79-1
	Checked:		



50
 Stream sample site
 (samples prefixed "HUS")

5 cm

SCALE 1:10,000
 0 100 200 300 400 500 metres



820091 82-1704

THE BROKEN HILL PROPRIETARY CO. LTD.
 EXPLORATION DEPARTMENT

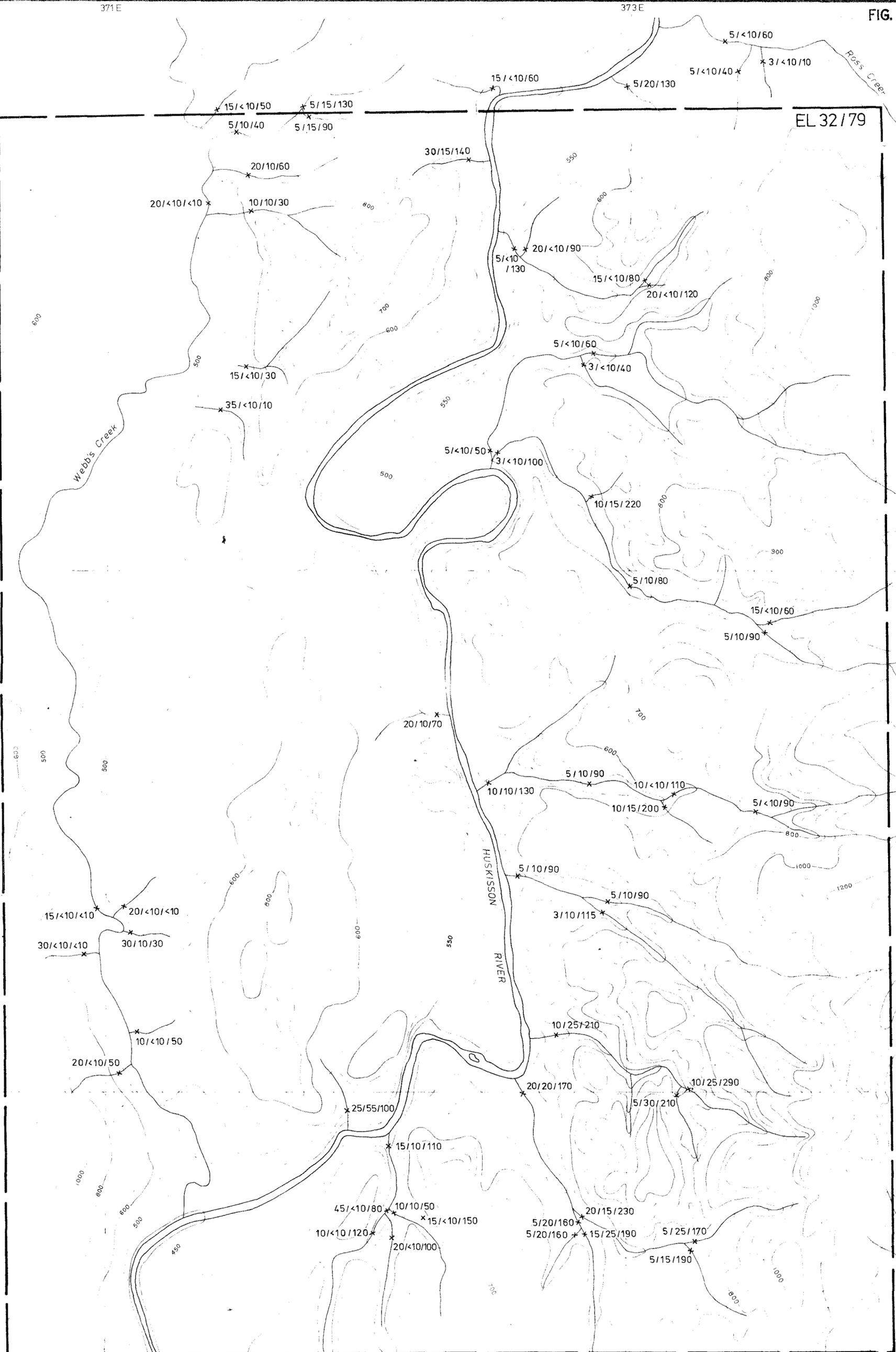
EL 32/79 HUSKISSON RIVER AREA
STREAM SAMPLE LOCATIONS
 2718

Drawn: POLTOCK BROS.	Date: 20-11-80	Centre: HOBART
Traced: J.E.H.	Project No:	Drawing No:
Checked:	T660	A2-32/79-2

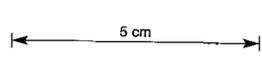
371E

373E

EL 32/79



* 5/30/210 Au / Sb / Ba (ppm, Au in ppb)

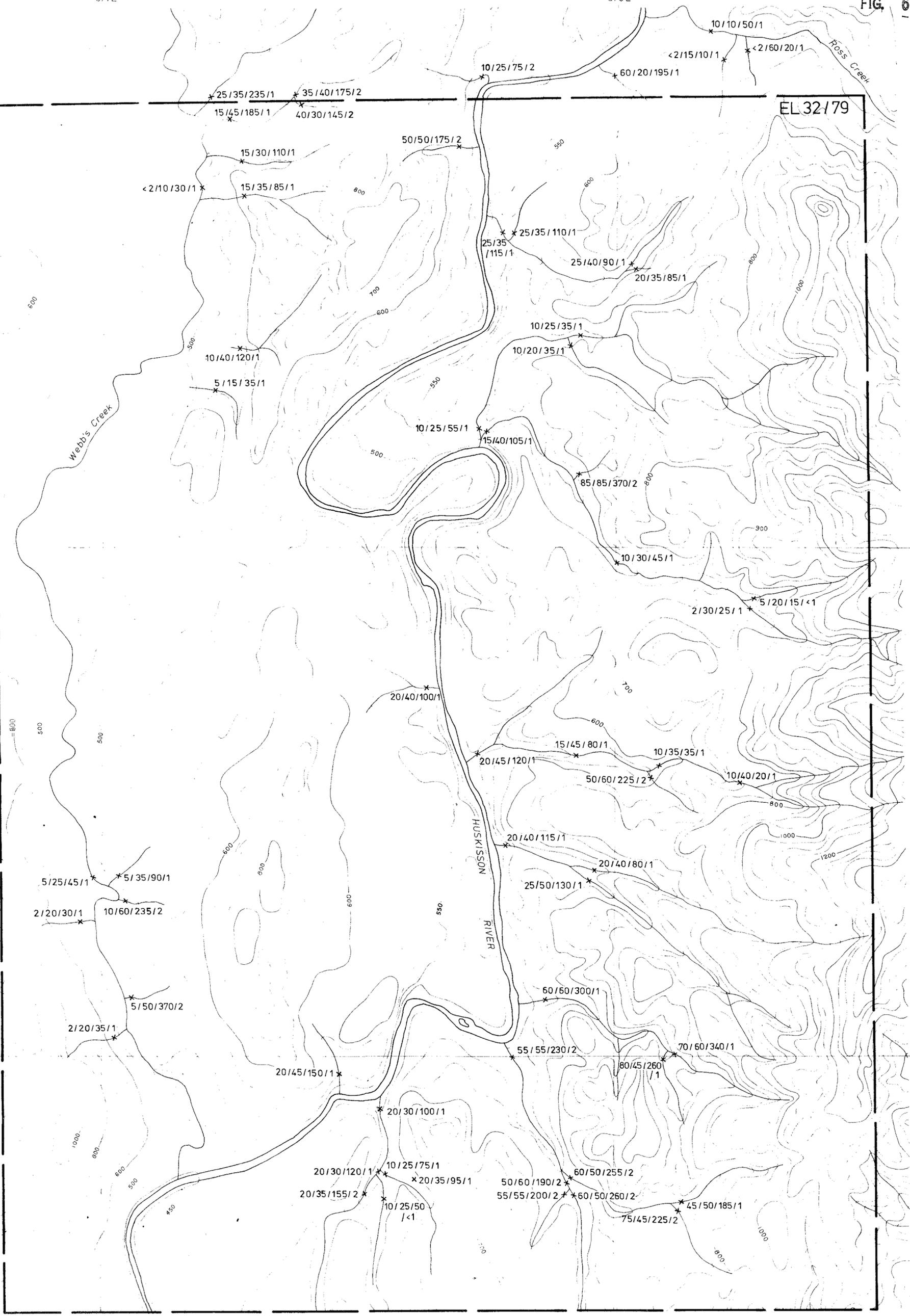


True North

826093 82-1704

THE BROKEN HILL PROPRIETARY CO LTD EXPLORATION DEPARTMENT		
EL 32/79 HUSKISSON RIVER AREA		
GEOCHEMICAL SAMPLE RESULTS 2720		
Au / Sb / Ba (ppm, Au in ppb)		
Drawn	Date 7-1-81	Centre HOBART
Traced J.E.H.	Project N°	Drawing N°
Checked:	T660	A2-32/79-4

EL 32/79



* 20/35/155/2 Cu, Pb, Zn, Ag (ppm)

5 cm

SCALE 1:10,000
0 100 200 300 400 500 metres

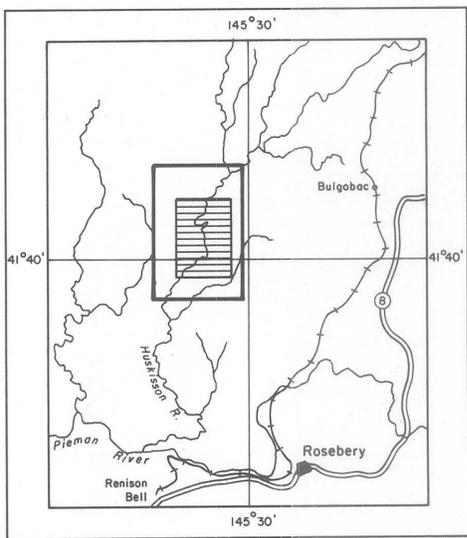
True North

826094 82-1704

THE BROKEN HILL PROPRIETARY CO. LTD. EXPLORATION DEPARTMENT		
EL 32/79 HUSKISSON RIVER AREA GEOCHEMICAL SAMPLE RESULTS		
Cu, Pb, Zn, Ag (ppm) 2721		
Drawn:	Date: 8-1-81	Centre: HOBART
Traced: J.E.H.	Project No:	Drawing No:
Checked:	T660	A2-32/79-5



LOCATION MAP



Scale 1: 250,000



Flight line

Fiducials and numbers

DIGHEM^{II} SURVEY

HUSKISSON RIVER AREA, TASMANIA

MAGNETICS

FOR

THE BROKEN HILL PROPRIETARY COMPANY LIMITED

ISOMAGNETIC LINES

(total field)

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

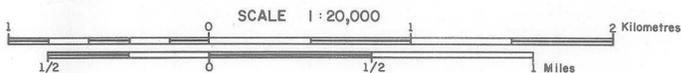
Magnetic Inclination within the survey area: 72°



826096

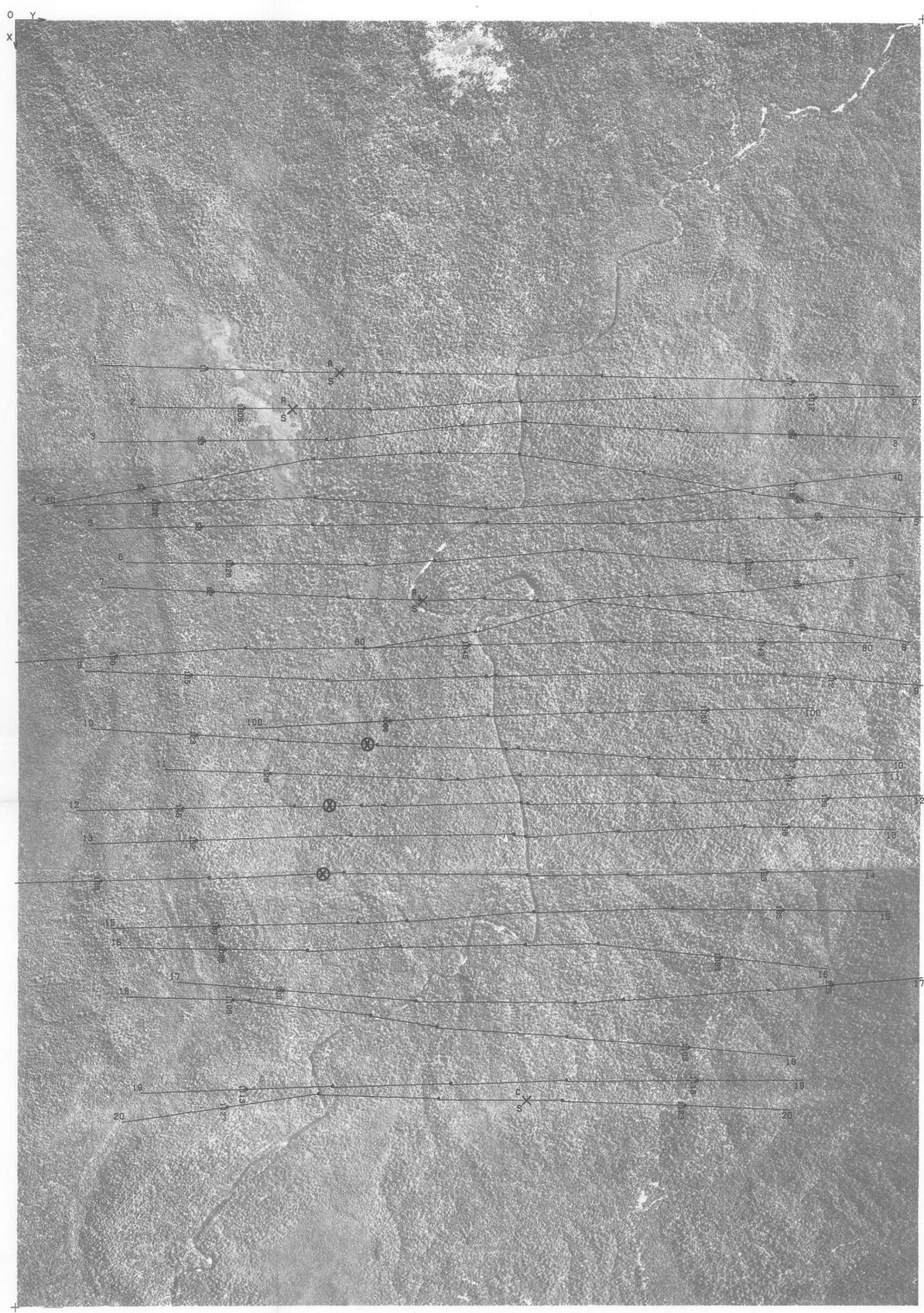
5 cm

5 cm

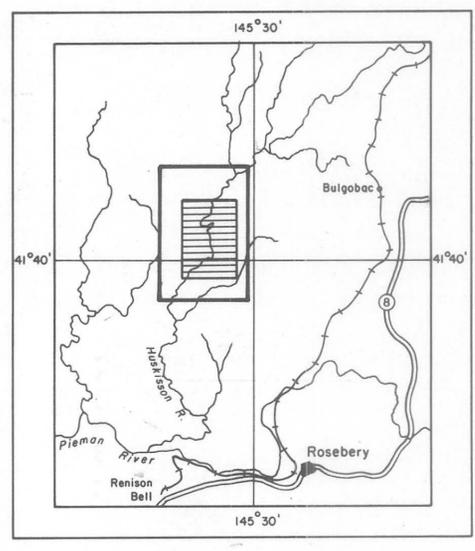


2723.

82-1704



LOCATION MAP



Scale 1: 250,000



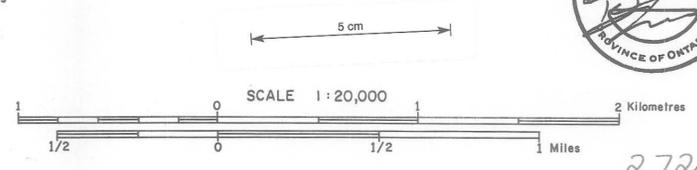
DIGHEM^{II} SURVEY

HUSKISSON RIVER AREA, TASMANIA

ELECTROMAGNETICS

FOR

THE BROKEN HILL PROPRIETARY COMPANY LIMITED



ANOMALY GRADE	EM GRADE SYMBOL	MHO RANGE
6	●	> 100
5	●	50-99
4	●	20-49
3	●	10-19
2	○	5-9
1	○	≤ 4
	X	Possible conductor
	⊗	Ch. 44 anomaly (see report)

Identifier	mho value
—	30
—	10
—	5
—	2
—	1

Depth is greater than	Intensity and Quadrature of Standard Cell is greater than
50 feet	5 ppm
100 feet	10 ppm
150 feet	15 ppm
200 feet	20 ppm

Refer to list of anomalies in survey report for the actual ppm values for all cells, and for conductor depths.

—	Conductor axis
S	Probable surface response
SP	Possible surface response
L	Probable line (power, telephone, pipe, or fence)
L?	Possible line
?	Questionable anomaly
○	Apparent thickness > 10m
∠	Dip
100±	Direct magnetic correction of 100 gamma

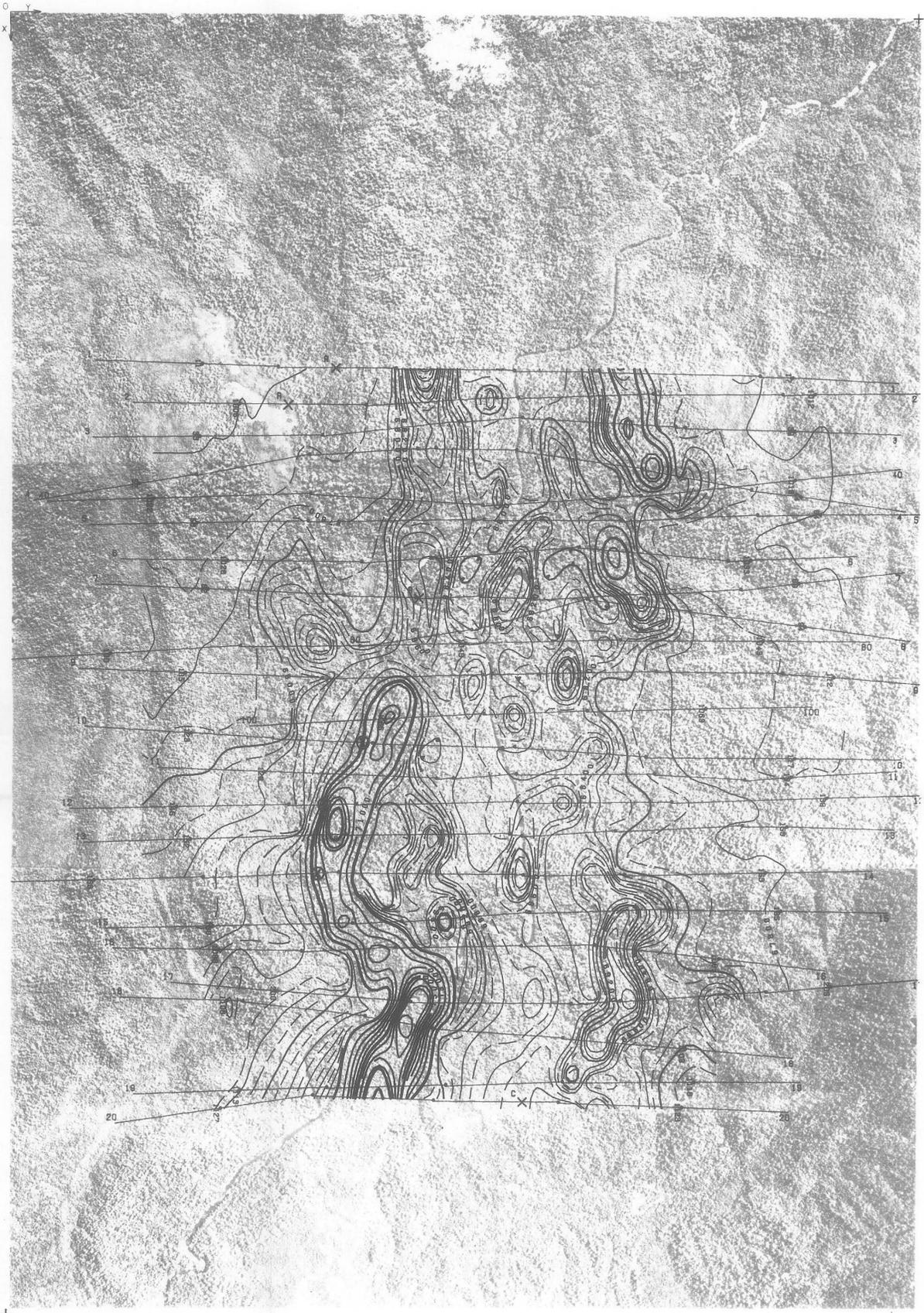
DIGHEM anomalies are divided into six grades of conductivity - thickness product. This product in mhos is the reciprocal of resistance in ohms. The mho is a measure of conductance, and is a geologic parameter. Most swamps yield Grade 1 anomalies but highly conducting clays can give Grade 2 anomalies. 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 Magu River camp yield Grade 4 anomalies, while Malabi 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.

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.

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 oil 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.

826097
82-1704

2724



DIGHEM^{II} SURVEY

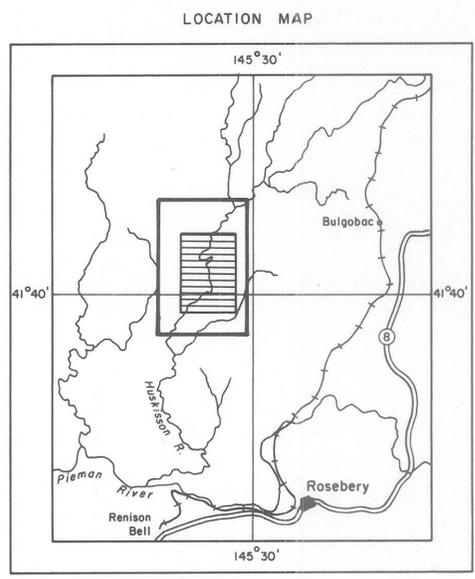
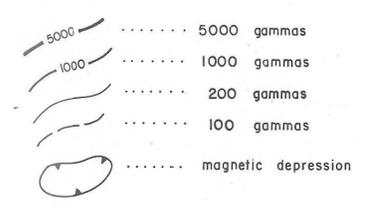
HUSKISSON RIVER AREA, TASMANIA

ENHANCED MAGNETICS

FOR

THE BROKEN HILL PROPRIETARY COMPANY LIMITED

ISOMAGNETIC LINES (enhanced field)

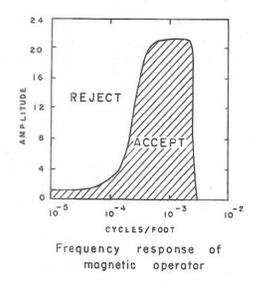
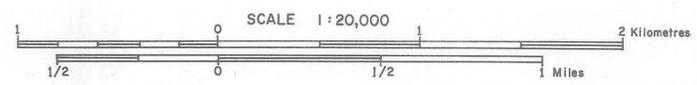


Scale 1:250,000



Flight line
1888
Fiducials and numbers
1888

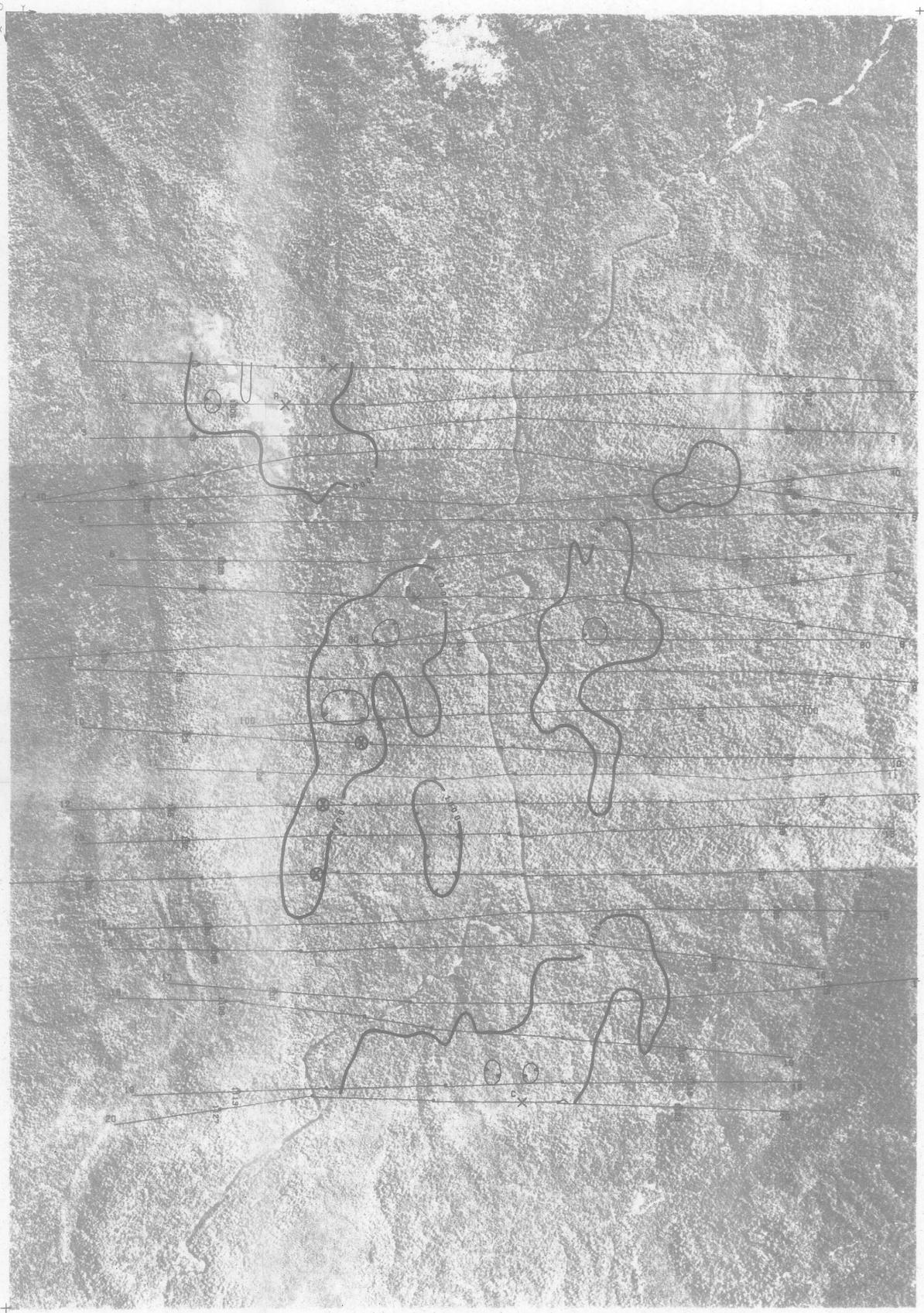
5 cm



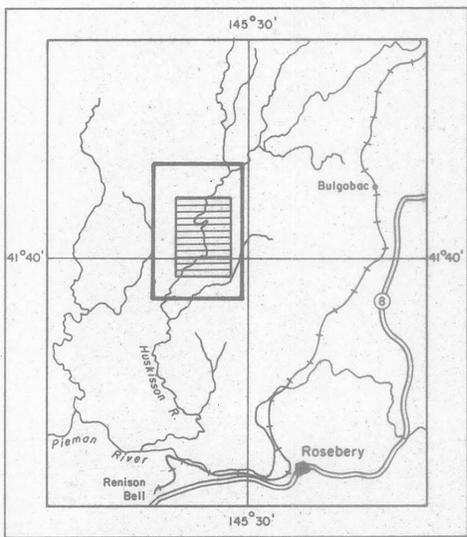
826098

2725

82-1704



LOCATION MAP



Scale 1: 250,000

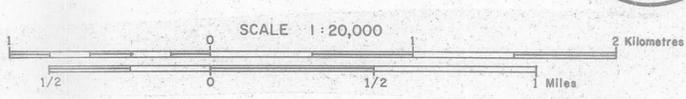
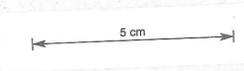
DIGHEM^{II} SURVEY

HUSKISSON RIVER AREA, TASMANIA

RESISTIVITY

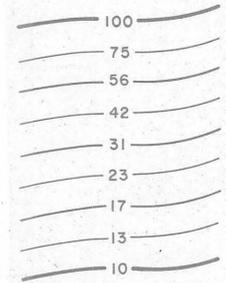
FOR

THE BROKEN HILL PROPRIETARY
COMPANY LIMITED



LEGEND

Contours in ohm-m
at eight intervals per decade



Note
The numbers face in the
direction of increasing value.

826099

2726

82-1704