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ASSESSMENT REPORT ON A RECONNAISSANCE GROUND MAGNETIC AND VLF-EM SURVEY ON THE MAX PROPERTY OMINECA MINING DIVISION

NTS 93/K 16E
Latitude 54°56'N, Longitude 124°03'W

Prepared for:

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By:

Part 1 of 2

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1.0 SUMMARY AND CONCLUSIONS

A combined VLF-EM and ground magnetic survey was carried out on the Max Claims, a property under option to United Pacific Gold Limited, in January and February, 1989. This property, consisting of 24 contiguous mineral claims is located 57 km north of Fort St. James, in the Omineca Mining Division. The property is in the area of Noranda's Tas, Placer Dome's Windy, and Lincoln Resources Mount Milligan prospects, and is in an area which has experienced an increasing amount of interest over the last 25 years. The Max property, staked on the basis of several aeromagnetic highs and placer gold occurrences, was initially explored in 1987 by prospecting, reconnaissance soil and silt sampling and geological mapping.

The 1989 program consisted of placing three grids on or near areas of interest. The area of greatest interest (see Figure 1), located in the eastern portion of the property, could not be examined due to its inaccessibility during winter conditions.

The geophysical survey encountered electromagnetic conductors and contrasting magnetic signatures on all three grids; the Rainbow, the Cripple, and the Lynx. The presence of strong conductors on the Lynx Grid and fairly good conductors on the Rainbow prove the usefulness of the VLF-EM as an exploration tool on this property. The ground magnetic surveys have identified contrasting magnetic signatures, probably the result of various underlying rock types; the extreme highs probably correlate with an ophiolite unit.

2.0 RECOMMENDATIONS

Based on the results of this survey and the previous exploration program, further work is recommended on the Max Claims as outlined below.

1. The eastern portion of the claims group identified during the 1987 program should be surveyed using geophysical and geochemical methods. A 4.5 km baseline with crosslines cut on 200 m spacing and stations every 50 m should be cut and flagged. The IGS-2 system should be run over the grid and soil samples should also be collected from these stations. Concurrently, outcrop exposures should be mapped and sampled on the grid. In areas of strong crossovers, fill-in lines should be cut on 100 m spacings and they should be sampled, surveyed and mapped as described above.

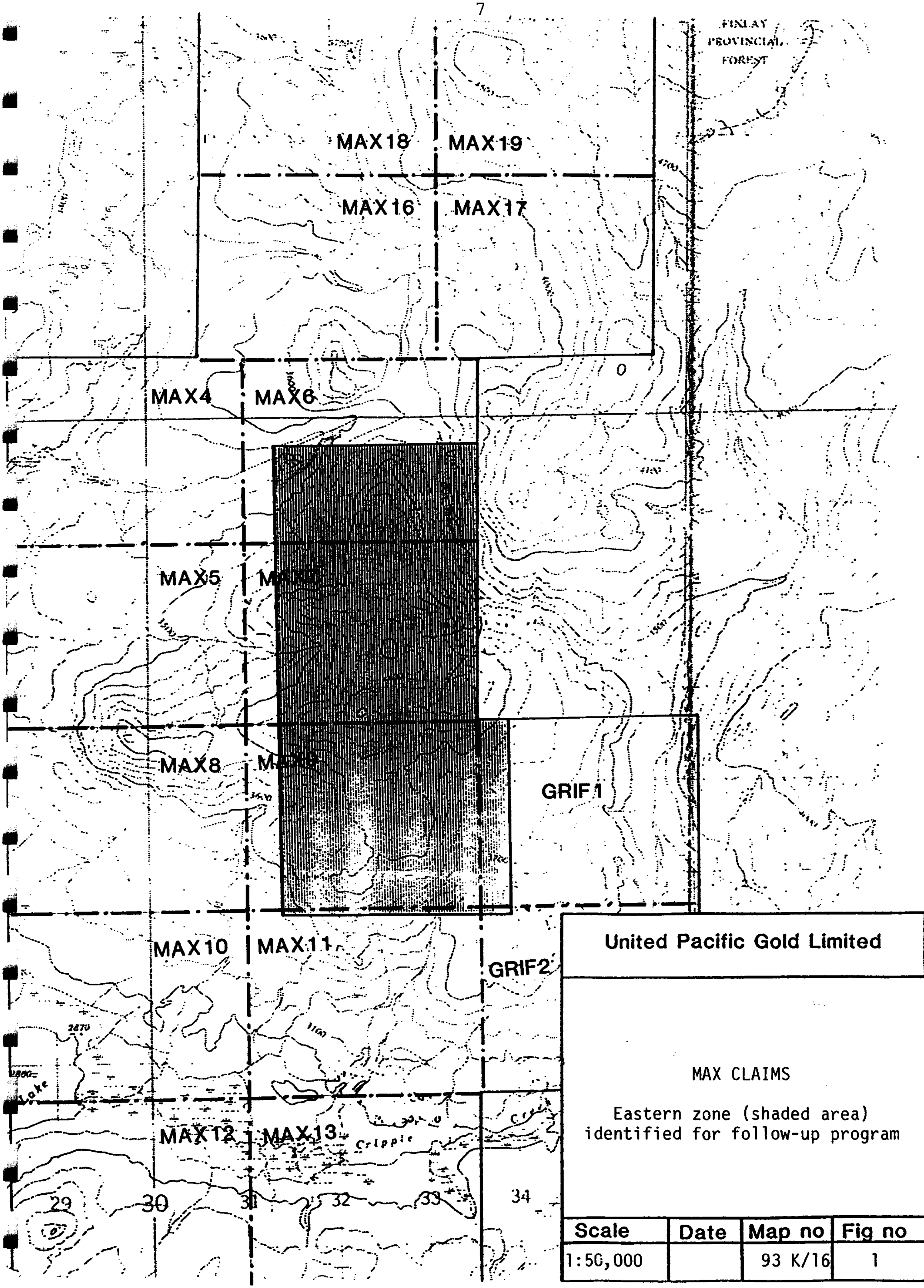
   Areas with coincidentally strong geophysical conductors, geochemical anomalies and or surface showings should be surveyed using the GENIE-EM system. The GENIE is an add-on to the IGS-2 system, and employs multi-frequency EM signals. It can penetrate much deeper than VLF-EM and also provides depth data on the conductor, which the VLF-EM is unable to do adequately.

2. Based on the results of the current survey, the Lynx Grid should be expanded approximately 500 m to the west and 700 m to the east. Grid lines should be on 100 m spacings and the present grid should have 100 m spaced infill lines cut. This grid should then be mapped, sampled, geophysically and geochemically surveyed as in (1) above.

3. Results from the Rainbow Grid area are felt to be unencouraging due to heavy overburden. However, if time and funds permit, the GENIE system should be run over the best conductors, as indicated on the 1989 survey, to better determine overburden depth.

4. Due to unencouraging results, no further work is recommended on the Cripple Grid.

This program is estimated to take approximately two months to complete, utilizing four linecutters/samplers and two geologists and would cost approximately $112,600 as outlined in Appendix 3. Additional funds and time may be required due to a lack of direct access to the main target area in the eastern portion of the claim group.


FINLAY PROVINCIAL FOREST
MAX18
MAX19
MAX16
MAX17
MAX4
MAX6
MAX5
MAX8
GRIF1
MAX10
MAX11
GRIF2
MAX12
MAX13
Lake
Cripple
Creek
29
30
31
32
33
34
United Pacific Gold Limited
MAX CLAIMS
Eastern zone (shaded area)
identified for follow-up program
Scale
Date
Map no
Fig no
1:50,000
93 K/16
1

3.0 INTRODUCTION

A geophysical exploration program consisting of VLF-EM and ground magnetics was performed during the latter part of January and most of February 1989. Throughout the program winter conditions prevailed. For six days an arctic front, bringing with it extreme temperatures, high winds and snow, prevented any field work from being carried out. The average snow accumulation was 1.5 m with drifts exceeding 2 m. All access roads to the property had to be ploughed using a D-8 Caterpillar or broken in by a snowcat, then travelled over by snowmobile. All grid lines were traversed on snowshoes.

A total of 39.8 km of grid lines were established and surveyed on three grids. The placement of the grids was determined in part by a limited budget and also by the winter weather conditions. The area felt to have most potential, located in the eastern part of the property, on top of a plateau covered by the Max 7, 9 and 11 Claims was completely inaccessible during this program.

The IGS-2 geophysical system, comprising a magnetic base station and two field mag and VLF-EM units was employed. D. Cukor, Geologist and M. P. Twyman, Geologist, performed the survey. Initially operations were based out of Fort St. James and later out of a private residence, about 10 km north of the Max property.

3.1 Property Description

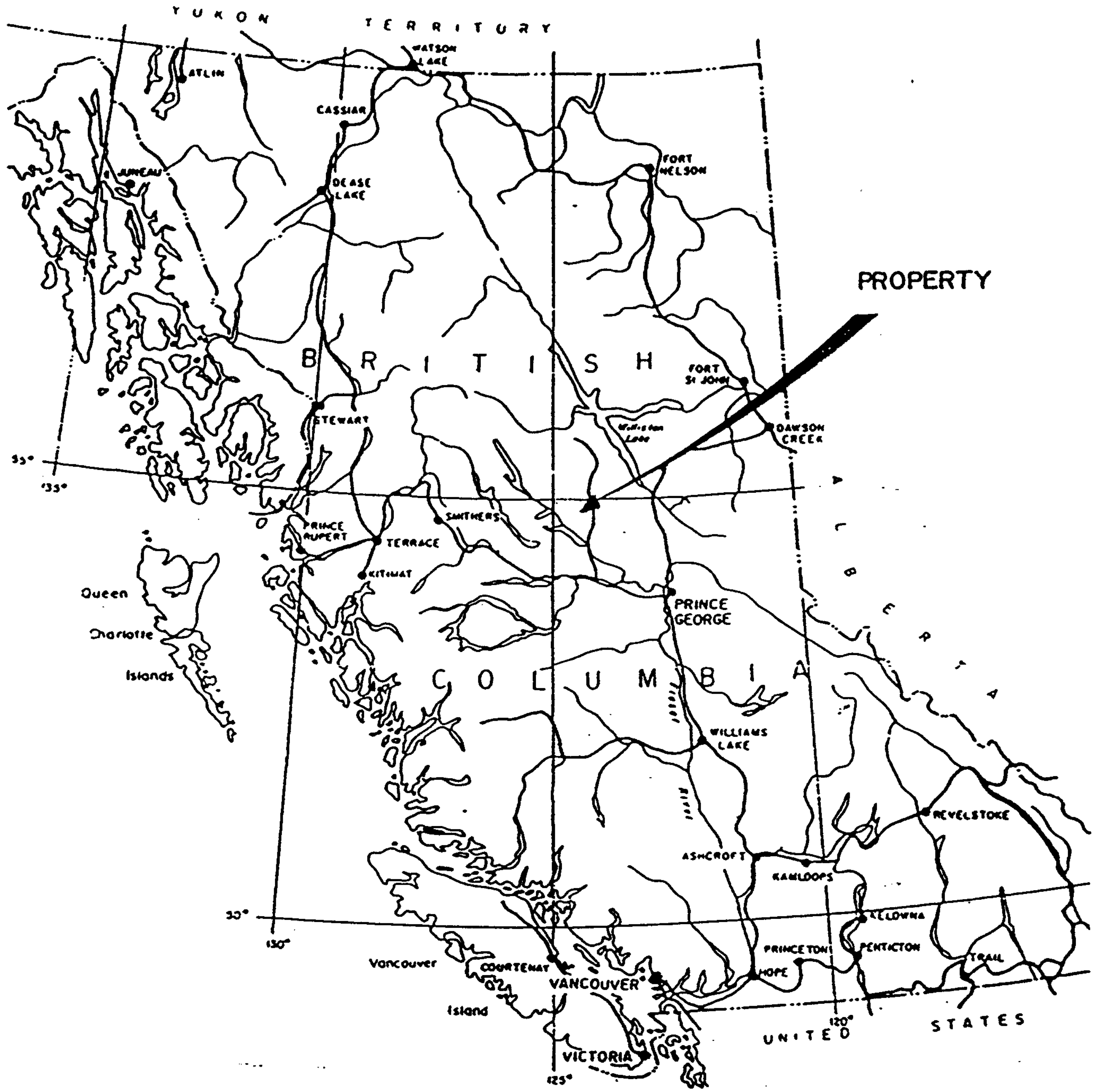
The Max property consists of 24 contiguous mineral claims totalling 466 units, covering an area of approximately 11,650 ha, as listed below, located 57 km north of Fort St. James, British Columbia in the Ominica Mining Division. The claims are registered in the name of A. D. Halleran of Fort St. James, B. C.

and United Pacific Gold Limited has an option to acquire a 100% interest in the property.

CLAIM NAME	UNITS	RECORD NO.	RECORD DATE
Max 1	20	7765	August 13, 1986
Max 2	20	7766	August 13, 1986
Max 3	20	7767	August 13, 1986
Max 4	20	7768	August 13, 1986
Max 5	20	7769	August 13, 1986
Max 6	20	7770	August 13, 1986
Max 7	20	7771	August 13, 1986
Max 8	20	7772	August 13, 1986
Max 9	20	7773	August 13, 1986
Max 10	20	7774	August 13, 1986
Max 11	20	7775	August 13, 1986
Max 12	20	7776	August 13, 1986
Max 13	20	7777	August 13, 1986
Max 14	20	7778	August 13, 1986
Max 15	20	7779	August 13, 1986
Grif 1	20	7904	September 15, 1986
Grif 2	20	7905	September 15, 1986
Fire 1	6	7962	October 6, 1986
Max 16	20	8680	August 13, 1987
Max 17	20	8681	August 13, 1987
Max 18	20	8682	August 13, 1987
Max 19	20	8683	August 13, 1987
Max 20	20	8684	August 13, 1987
Max 21	20	8685	August 13, 1987
Total	466		

3.2 Property Location and Access

The property is located in central British Columbia about 140 km northwest of Prince George and approximately 57 km north of Fort St. James (Figure 2). The claims are approximately centered on the geographical coordinates 54°56' north and 124°03' west.



United Pacific Gold Limited			
MAX CLAIMS			
Scale	Date	Map no	Fig no
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The property is accessible by travelling north on the gravel surface Germanson Highway from Fort St. James for approximately 57 km. In this area, there are three logging roads which provide reasonable access to the southern and northern parts of the claim group (see Figure 4).

Winter access to the property is by snowshoe and snowmobile along unplowed portions of the logging roads.

3.3 Topography and Climate

The topography over much of the property area is moderate, with the total relief being approximately 460 m. Steeper slopes are developed flanking the ridge in the northern portion of the claims (see Figure 4). Streams tend to form steep sided gullies in some areas.

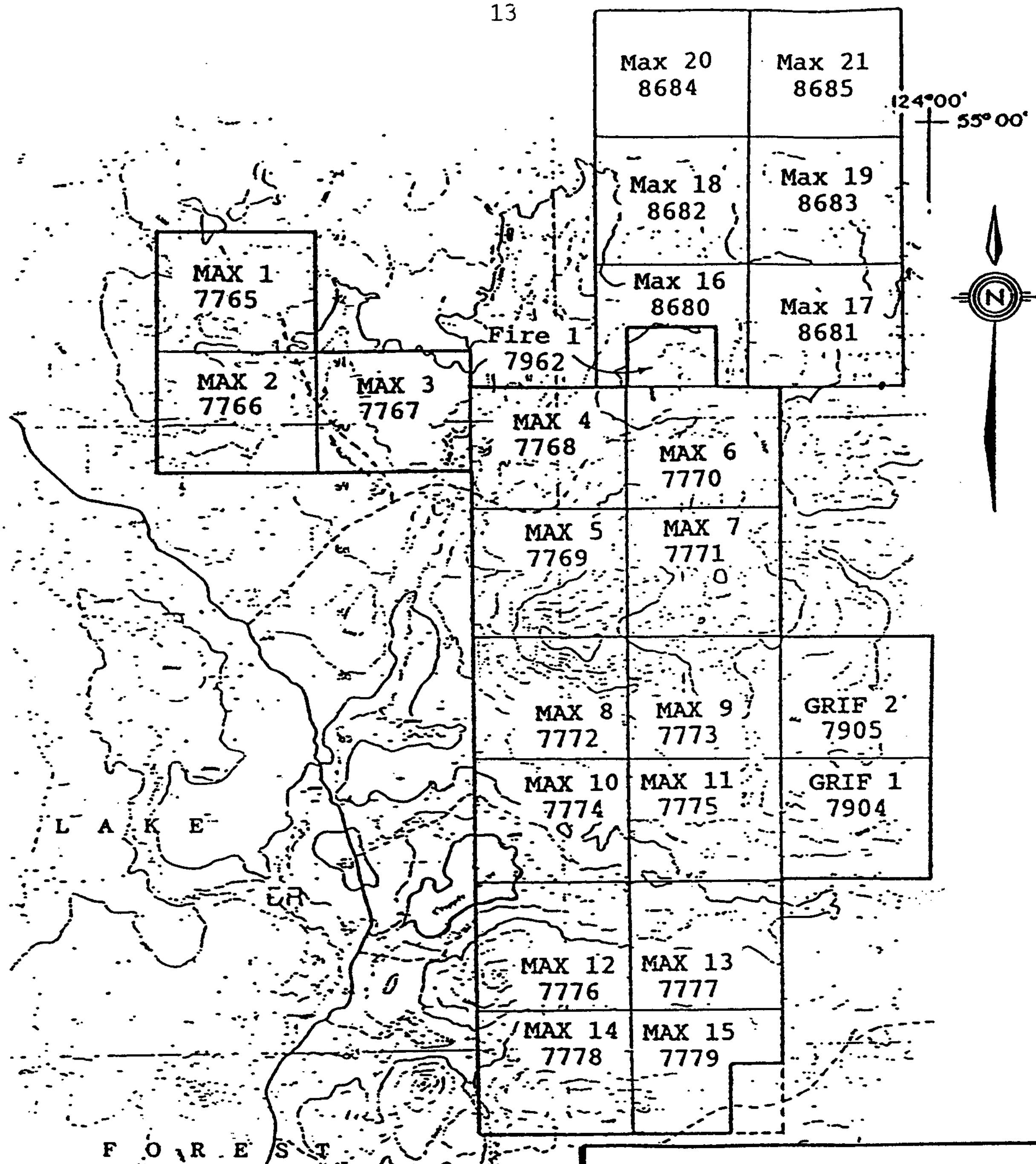
The region is characterised by a northern interior type of climate with long, cold winters, accompanied by snow accumulations of typically between one to two meters. The summers are generally warm, but fairly short. The best time of the year to work in the region is in September and first half of October, when temperatures are cool, and most of the insects are gone.

The forest vegetation consists of fir, hemlock and pine, with various amounts of underbrush. Thickets of alders occur in low lying swampy areas in the forest and in clearings. Many of the clearcut areas have been replanted, and the regenerating forest is from one to four meters in height, and variably passable. Some areas are overgrown with devilsclub exceeding two meters in height.

3.4 Field Methods

Three grids were placed over or near areas of interest in the southern, central and northern portions of the claims block (Figures 3 and 4). They are referred to as the Lynx, Cripple and Rainbow Grids, respectively. The Lynx Grid is located on the Max 14 & 15 Claims, the Cripple Grid is located on Max 10 Claim and the Rainbow Grid is located on the Max 3 Claim.

In each case a baseline and cross lines were surveyed in using hip chain and compass methods. Cross lines were spaced at 200 m with stations flagged on 50 m intervals on the lines. Magnetometer and VLF readings were taken every 50 m along the cross lines.



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MAX CLAIMS

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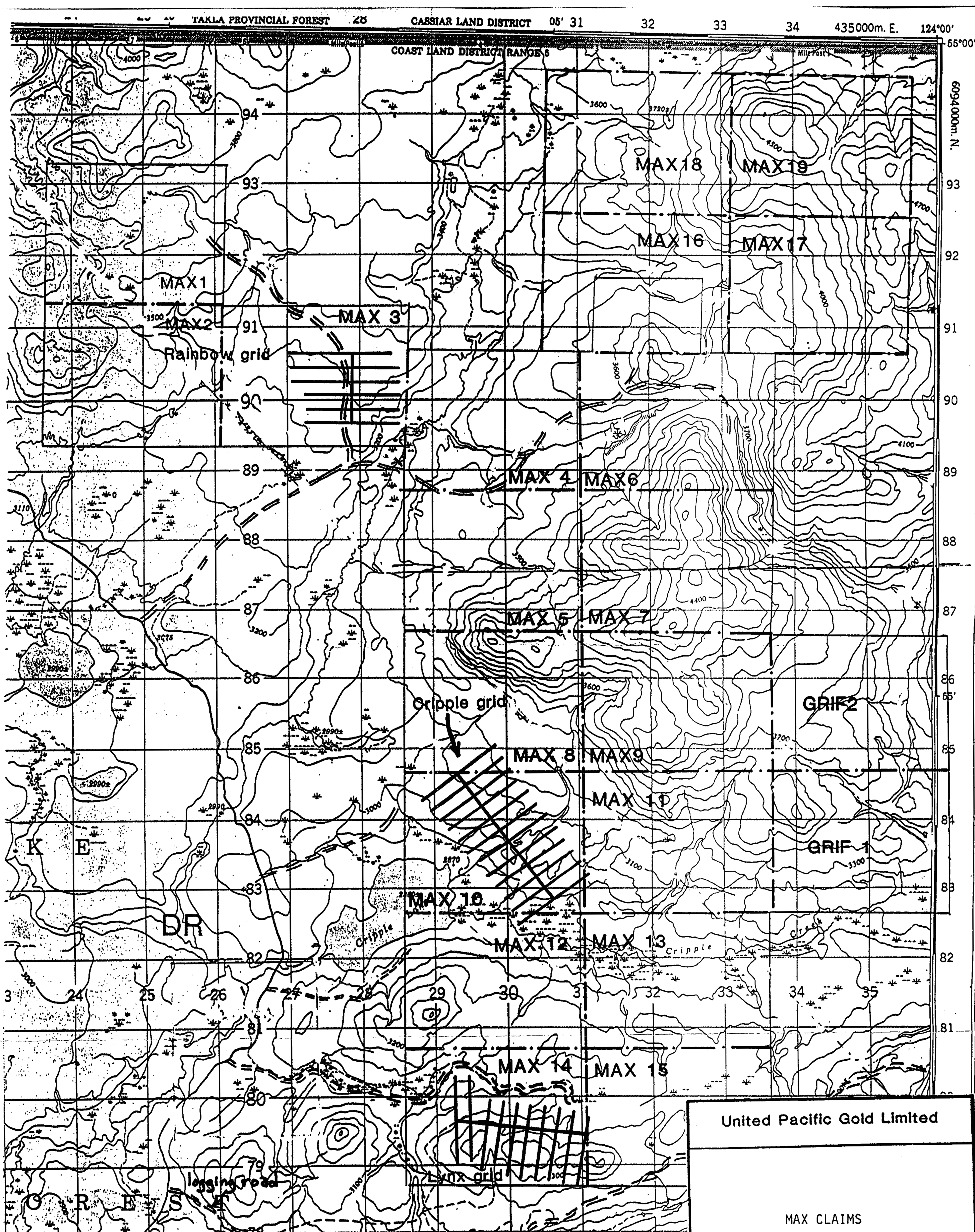

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MAX CLAIMS

Showing grid locations,
and road access.

Scale	Date	Map no	Fig no
1:50,000		NTS 93 K/16	4

3.5 History

The Inzana Lake area was prospected during the 1960's and 1970's on a number of regional exploration programs. Until Noranda's gold discovery on the Tas property, there had been very little work in the area of the Max Claims.

Significant gold mineralization was discovered on the Tas Claims in 1984 and 1985 and the identification of gold in similar settings on Placer Dome's Windy property to the east and Lincoln Resources Mount Milligan prospect to the north of the Max Claims lead to increased interest in the area.

The majority of the claims in the Max Claim group were staked during late 1986 by a prospecting syndicate. The claims encompass a series of magnetic highs and have known placer gold occurrences.

The property was optioned to United Pacific Gold Limited in 1987 and a preliminary work program of geological mapping, prospecting and geochemical sampling was carried out.

4.0 GEOLOGY

4.1 Regional Geology

The property is underlain by Upper Triassic to lower Jurassic metasedimentary and volcanic rocks of the Takla Group (Armstrong 1948). These lithologies lie within the Quesnel Trough, a subdivision of the Intermontane tectonic belt.

The base of the Quesnel Trough is an Upper Triassic black argillite unit. In the eastern margin of the trough this unit commonly overlies Slide Mountain Group ophiolitic sequences. The basal black argillite is in turn overlain by a series of augite porphyry flows, breccias and subordinate argillites. These rocks are overlain by a second sequence of argillites and volcaniclastic rocks of Upper Triassic to Lower Jurassic Age.

Block faulting and tilting are the dominant structural styles within this belt of rocks. Faults generally have trends in northwest and northeasterly directions and are commonly steeply dipping.

Two significant episodes of granitic intrusions have been identified along a northwest trending belt, somewhat oblique to the Quesnel Trough (Armstrong, 1948). The intrusive events cluster around 200 and 100 million year ages.

4.2 Property Geology

The property and surrounding area are underlain by the Upper Triassic and later Takla Group. The Takla Group consists of metasedimentary and volcanic rocks which are intruded by Upper Jurassic or Lower Cretaceous granodiorites, diorite, granite, syenite, gabbro and pyroxenite. For greater detail, the reader is referred to Assessment Report #18020, (U. Schmidt, 1988).

During the course of the geophysical survey, the writers observed that overburden in the Rainbow Grid area and in low lying areas east and north of Cripple Lake appears to be a thick glacial ground moraine.

5.0 GEOPHYSICAL SURVEYS

General Description

The geophysical surveys on the Max property consisted of Ground Magnetics and VLF-EM. The Magnetic and VLF surveys were run simultaneously on each of the three grids. The line spacing on each of the grids was 200 m with readings taken every 50 m. The ideal situation for interpretation purposes is for line spacing and station separation to be equal, however, budgeting restraints, together with directives from the Company, necessitated that the survey be run on a reconnaissance basis, with widely spaced lines.

The geophysical instrument used for the survey was the Scintrex IGS-2 system, which simultaneously takes both magnetic and VLF-EM measurements.

The part of the system dedicated to magnetics utilized three console units, one set up as the base station, the other two as the portable units, and three similar proton precession sensors measuring total magnetic field. The base station and field unit were time synchronized so that the background fields, diurnal variations and micro-pulsations were filtered from the data. The base station was programed to measure the field and record the readings at two second intervals for the Rainbow Grid and at three second intervals for the Cripple and the Lynx Grids.

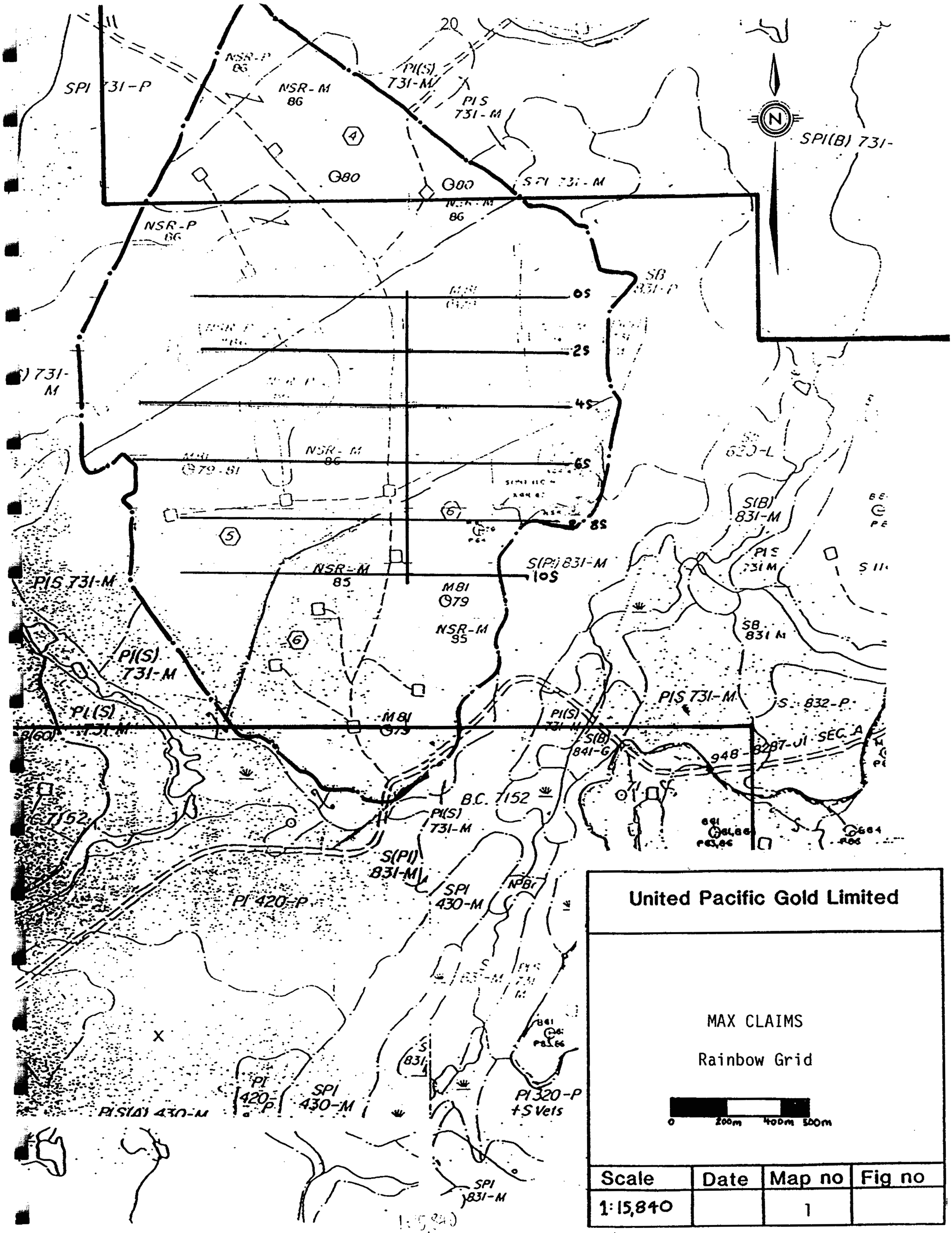
The VLF units were set up to receive signals from NKL, Seattle, Washington, 24.8 kHz on the Rainbow and the Cripple Grids and NPM, Lualualei, Hawaii, 23.4 kHz on the Lynx Grid. Measurements were taken of the horizontal field strength and the in-phase and quadrature (out-of-phase) components of the vertical field. The instrument uses a three coil system, one horizontal and two vertical coils, all at 90° angles to each other. The system is set to automatically adjust the vertical data for topographical shadowing of signals. See Appendix 1 and 2 for a more in-depth discussion of the instrument specifications and theory of VLF-EM and ground magnetics.

6.0 DISCUSSION OF RESULTS

6.1 Rainbow Grid

Figure #5 (Pocket) Ground Magnetic Contour Plan for the Rainbow Grid (Map 1) shows a total relief of 1589 gammas, a low of -1010 gammas and a high of 479 gammas. The data displays two distinctive signatures, east and west of the interpreted fault "A". The east half of the map is fairly flat while the west half shows high relief. The high to the west of fault "A" is probably an intrusive plug.

The overall trend displayed by the VLF on both the Fraser filter, Figure #6 (Pocket) and the Stacked Profile Plan, Figure #7 (Pocket) is NNW-SSE. Conductors 1 and 2 exhibit good response on the inphase and quadrature and significant length. Conductor 3 is weaker than 1 and 2. Conductor 4 exhibits very good response but runs off the edge of the surveyed area and towards a steep ravine to the southeast of the grid. The rest of the conductors are fairly weak and probably reflect water filled fractures.



United Pacific Gold Limited

MAX CLAIMS

Rainbow Grid

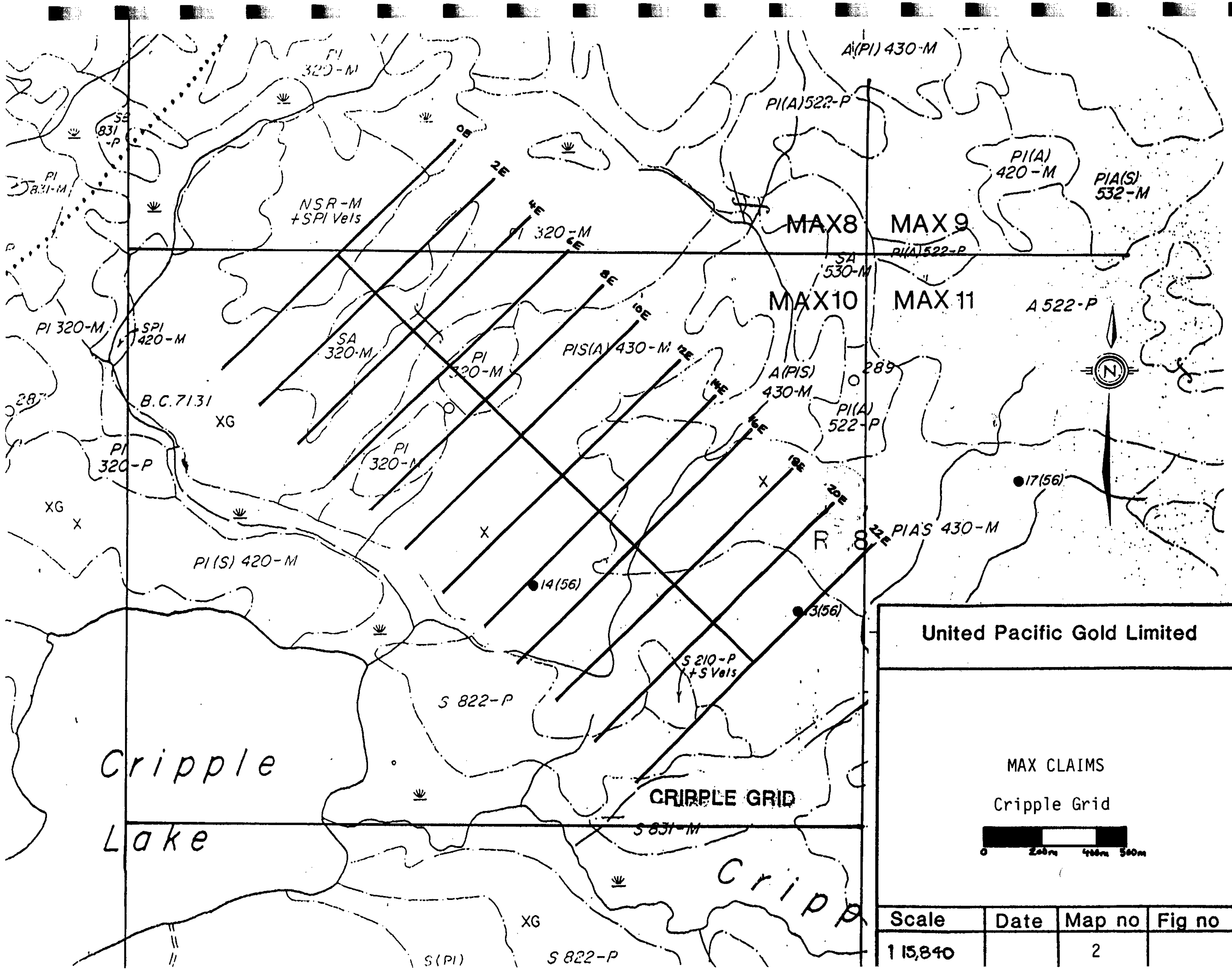
0 200m 400m 500m

Scale	Date	Map no	Fig no
1:15,840		1	

6.2 Cripple Grid

The Ground Magnetic Survey Plan, for the Cripple Grid (Map 2), Figure #8 (Pocket) displays high magnetic relief, with a low value of 406 gammas and a high of 3204 gammas, for a total relief of 2798 gammas. Three distinct regions are apparent on this plan. The most prominent is the high in the south central map area with readings of 1500 gammas and above; steep magnetic gradients are another characteristic of this area. This high is most likely the physical representation of an opholite complex which is found in the region. To the northeast of the high is an area of intermediate magnetic values generally between 1000 and 1500 gammas and a low gradient, and to the northwest an area with values from 400 to 1000 gammas and an even lower gradient. These are thought to be two other separate geological units. Follow-up geological mapping, would be required to identify these rock units.

The VLF-EM displays several weak conductors on the Stacked Profile Plan, Figure #9 (Pocket). However, the in-phase and quadrature response are divergent, suggesting that these conductors are due to ground water in fractures. The interesting feature is that the conductors in the south central map area end coincidentally with the edge of the ground magnetic high and that the trend of the conductors in the northeast side of the map area is NW-SE and in the northwest side it is NE-SW, giving more



MAX8
MAX 9
MAX10
MAX 11
A(PI) 430-M
PI(A)522-P
PI(A) 420-M
PIA(S) 532-M
NSR-M +SPI Veis
PI 320-M
SA 530-M
A 522-P
PI 320-M
SPI 420-M
SA 320-M
PI 320-M
PIS(A) 430-M
A(PIS) 430-M
289
PI(A) 522-P
B.C.7131
XG
PI 320-P
PI 320-M
17(56)
PIAS 430-M
R 8
XG
PI(S) 420-M
14(56)
3(56)
S 210-P +S Veis
S 822-P
Cripple
Lake
CRIPPLE GRID
S 831-M
Cripp
XG
S(PI)
S 822-P
0E
2E
4E
6E
8E
10E
12E
14E
16E
18E
20E
22E
United Pacific Gold Limited
MAX CLAIMS
Cripple Grid
Scale
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Date
Map no
2
Fig no

support to the idea of three geological units, as suggested above.

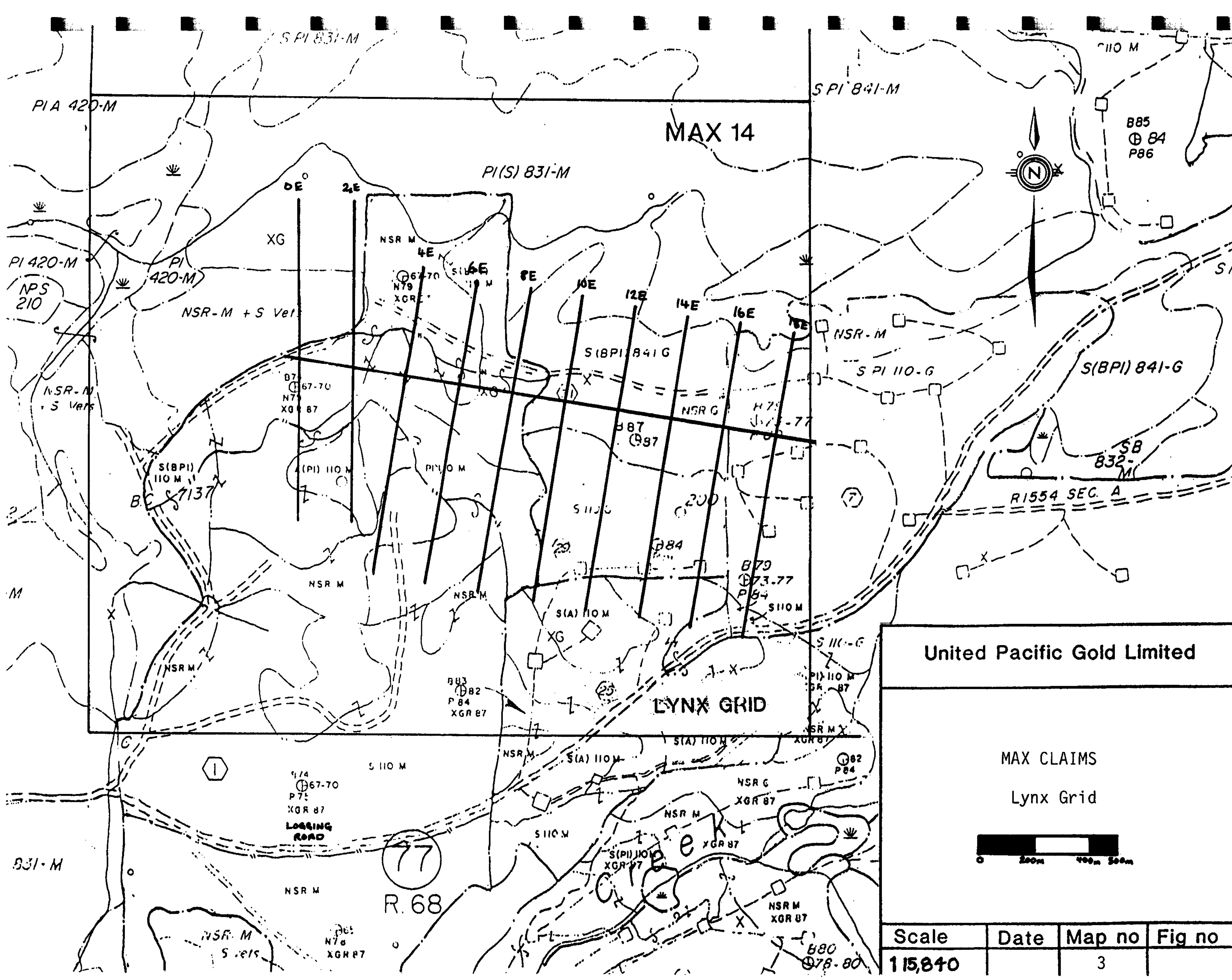
The Fraser Filter data is displayed on Figure #10 (Pocket) which also shows these various conductive features.

6.3 Lynx Grid

Total magnetic relief on the Ground Magnetic Contour Plan Figure #11 (Pocket) is 1019 Gammas. The general pattern on the Lynx Grid (Map 3) is low magnetic values in the southwest area of the map, with highs to the east and the north. It is believed that the two regimes; values below 500 gammas and values above 500 gammas represent two rock types or possibly different volcanic flows. The banded appearance of the magnetic map offers support to the multiple volcanic flow theory.

The VLF-EM outlined six interesting conductors which are probably metalliferous, labelled A through F on the Stacked Profile Plan, Figure #12 (Pocket). Three areas of high conductivity are apparent as well on the Fraser Filtered data, Figure #13 (Pocket).

Conductors B,C,D,E follow the areas of high conductivity and have good response in both the in phase and quadrature.



MAX 14
PI(S) 831-M
S PI 841-M
PI A 420-M
PI 420-M
NPS 210
NSR-M + S Vei
XG
NSR M
0E
2E
4E
6E
8E
10E
12E
14E
16E
18E
S(BPI) 841 G
S(BPI) 841-G
NSR-M
S PI 110-G
NSR G
B87
S(A) 110 M
S 110 M
NSR M
LYNX GRID
LOGGING ROAD
R. 68
77
R1554 SEC. A
SB 832-M
B85
P86
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MAX CLAIMS
Lynx Grid
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Conductor A also has good response, however it does not follow any areas of high conductivity.

In conclusion, results from the Lynx Grid and to a lesser extent the Rainbow Grid, indicate that the Scintrex IGS-2 system is a useful exploration tool on the Max property. Conductors identified on the Lynx Grid during this survey, combined with exploration results from a previous reconnaissance geochemical exploration program, indicate that further work is warranted in the area.

The northern portion of the claims group that was identified as the prime target during the previous exploration program is recommended for follow up utilizing the Scintrex IGS-2 system, in conjunction with geochemical and mapping surveys. (See recommendations for details.)

M.P. Twyman, B.Sc., F.G.A.C.

D. Cukor, B.Sc.

BIBLIOGRAPHY

1. Schmidt, U. <u>Report on the Geology and Geochemistry of the Max Property.</u> Assessment Report #18020, 1988.

2. Armstrong, J.E. <u>Map 907A, Fort St. James, 1":6 miles GSC,</u> 1948.

STATEMENT OF QUALIFICATIONS

I, MICHAEL P. TWYMAN, residing at 4687 Tourney Road, North Vancouver do hereby testify that:

1. I am a practicing Geologist and have been since 1984 after completing a Bachelor of Science in Geology at the University of British Columbia.

2. I am a Fellow of the Geological Association of Canada.

3. The conclusions and statements in this report are the result of my observations made in the field.

Michael P. Twyman, B.Sc., F.G.A.C.
Consulting Geologist
Vancouver, British Columbia

April, 1989

STATEMENT OF QUALIFICATIONS

I, DAMIR CUKOR, of 6108 McKee Street, Burnaby, British Columbia, DO HEREBY CERTIFY that:

1. I graduated from the University of British Columbia in 1984 as a Bachelor of Science in Geology;

2. Since 1983, I have been employed as a geologist with NVC ENGINEERING LTD.;

3. I have worked in the field of exploration geology and geophysics for 13 seasons and have held positions of responsibility since 1982;

4. I performed and/or supervised work as documented in this Report;

5. I have no interest, direct or indirect, in the properties of United Pacific Gold Limited.

D. Cukor, B.Sc.
Consulting Geologist
NVC ENGINEERING LTD.

April, 1989

APPENDIX I

THE IGS-2 SYSTEM

1.0 INTRODUCTION

1.1 General Information

The IGS-2 Integrated Geophysical System is a portable microprocessor-based instrument which allows more than one type of survey measurement to be performed by a single operator during a survey.

The IGS-2 is a modular system which can easily be configured to suit different and changing survey requirements. Reconfiguring the system is easy and offers both operational flexibility and minimal redundancy with a minimum number of spare consoles and/or modules.

When configured with any of the available sensor options, the IGS-2 System Control Console becomes a method-specific instrument according to the sensor option(s) utilized. In addition, the IGS-2 Console is an electronic notebook into which geophysical, geological or other data may be manually entered and digitally stored.

Data is stored in the IGS-2 in an expandable, solid state memory and can be output in the field by connecting the instrument to a printer, tape recorder, modem or microcomputer.

The 32 character digital display uses full words in most cases, ensuring clear communication. Both present and previous data are displayed simultaneously, allowing comparisons to be made at a glance during a survey.

The IGS-2 records header information, data values, station number, line number, grid number and the time of each observation in its internal memory. Data are first sorted by grid number, then in order of increasing line number and, within each line, by increasing station number. In this way, the data are organized logically regardless of the sequence in which they were taken. Ancillary data can also be manually entered and recorded at a given station, along with the survey parameters.

The IGS-2 may appear complex because of the new microprocessor-based technology employed in its design. However, it does not perform any operation that is, in principle, unfamiliar to an experienced operator. Only the procedures have changed. For instance, data can now be recorded in the memory of the IGS-2 by a

Figure IGS:1
The IGS-2 as Worn by an Operator

series of simple keystrokes, rather than recording measurements by hand in a notebook. Likewise, an error spotted in the records, which would be corrected or erased by hand, is now corrected by means of the Edit function which allows the error to be removed from memory, corrected, and then refiled, or erased altogether.

1.2 Product Updates

At Scintrex we are continually working in improve our line of products. You may be notified as important changes occur to either the software or hardware of our products. We would appreciate hearing from you if you are interested in our latest developments. We would also value hearing from you about any successes, or problems you may have encountered so that we may advise you.

THE MP-3/4 MAGNETOMETER

1.0 INTRODUCTION

1.1 General Outline

This section of the manual describes in detail the proton magnetometer method.

A theoretical explanation of the magnetic method is given first. Then the table MAG SETUP MENUS is presented for reference. After this, the following topics are dealt with in detail:

1) method enabling procedures,
2) measuring procedures,
3) warning messages,
4) equipment setup procedures,
5) troubleshooting information,
6) specifications and
7) parts list.

1.2 The Magnetic Method

The magnetic method consists of measuring the magnetic field of the earth as influenced by rock formations having different magnetic properties and configurations. The measured field is the vector sum of induced and remanent magnetic effects. Thus, there are three factors, excluding geometrical factors, which determine the magnetic field. These are the strength of the earth's magnetic field, the magnetic susceptibilities of the rocks present and their remanent magnetism.

The earth's magnetic field is similar in form to that of a bar magnet's. The flux lines of the geomagnetic field are vertical at the north and south magnetic poles where the strength is approximately 60,000 nT. In the equatorial region, the field is horizontal and its strength is approximately 30,000 nT.

The primary geomagnetic field is, for the purposes of normal mineral exploration surveys, constant in space and time. Magnetic field measurements may, however, vary considerably due to short term external magnetic influences. The magnitude of these variations is unpredictable. In the case of sudden magnetic storms, it may reach several hundred gammas over a few minutes. It may be necessary, therefore, to take continuous readings of the geomagnetic field with a base station magnetometer while the magnetic survey is being done. An alternative field procedure is to make periodic repeat measurements at convenient traverse points, although this is a very unreliable method during active magnetic storms when it is important to have proper reference data.

The intensity of magnetization induced in rocks by the geomagnetic field F is given by:

$$I = kF$$

where I is the induced magnetization
k is the volume magnetic susceptibility
F is the strength of the geomagnetic field

For most materials, k is very much less than 1. If k is negative, the body is said to be diamagnetic. Examples are quartz, marble, graphite and rock salt. If k is a small positive value, the body is said to be paramagnetic, examples of which are gneiss (k = 0.002), pegmatite, dolomite and syenite. If k is a large positive value, the body is strongly magnetic and it is said to be ferromagnetic, for example, magnetite (k = 0.3), ilmenite and pyrrhotite.

The susceptibilities of rocks are determined primarily by their magnetite content since this mineral is so strongly magnetic and so widely distributed in the various rock types. (Of considerable importance, as well, is the pyrrhotite content.)

The remanent magnetization of rocks depends both on their composition and their previous history. Whereas the induced magnetization is nearly always parallel to the direction of the geomagnetic field, the natural remanent magnetization may bear no relation to the present direction and intensity of the earth's field. The remanent magnetization is related to the direction of the earth's field at the time the rocks were last magnetized. Movement of the body through folding, etc., and the chemical history since the previous magnetization are additional factors which affect the magnitude and direction of the remanent magnetic vector.

Thus, the resultant magnetization M of a rock is given by:

$$M = M_n + kF$$

where M_n is the natural remanent magnetization, and F is a vector which can be completely specified by its horizontal (H) and vertical (Z) components and by the declination (D) from true north. Similarly, M_n is specified when its magnitude and direction are known. Thus, considerable simplification results if $M_n = 0$, whereupon M merely reduces to kF. In the early days of magnetic prospecting, it was usually assumed that there was no remanent magnetization. However, it has now been established that both igneous and sedimentary rocks possess remanent magnetization, and that the phenomenon is a widespread one.

1.2 Theory of Operation

The Very Low Frequency (VLF) Electromagnetic Method measures variations in the components of the electromagnetic fields, set up by communication stations operating in the 15 to 30 kHz frequency range. These stations, located around the world, generate signals for the purposes of navigation and communication with submarines.

In far field, above uniform earth, the groundwave of the vertically polarized VLF radiowave has three field components:

1) a radial, horizontal electrical field,
2) a vertical electrical field, and
3) a tangential, horizontal magnetic field.

When these three fields meet conductive bodies in the ground, eddy currents are induced causing secondary fields to radiate outwards from these conductors. In the Magnetic Field mode, the IGS-2/VLF-4 measures the horizontal field and two components of the

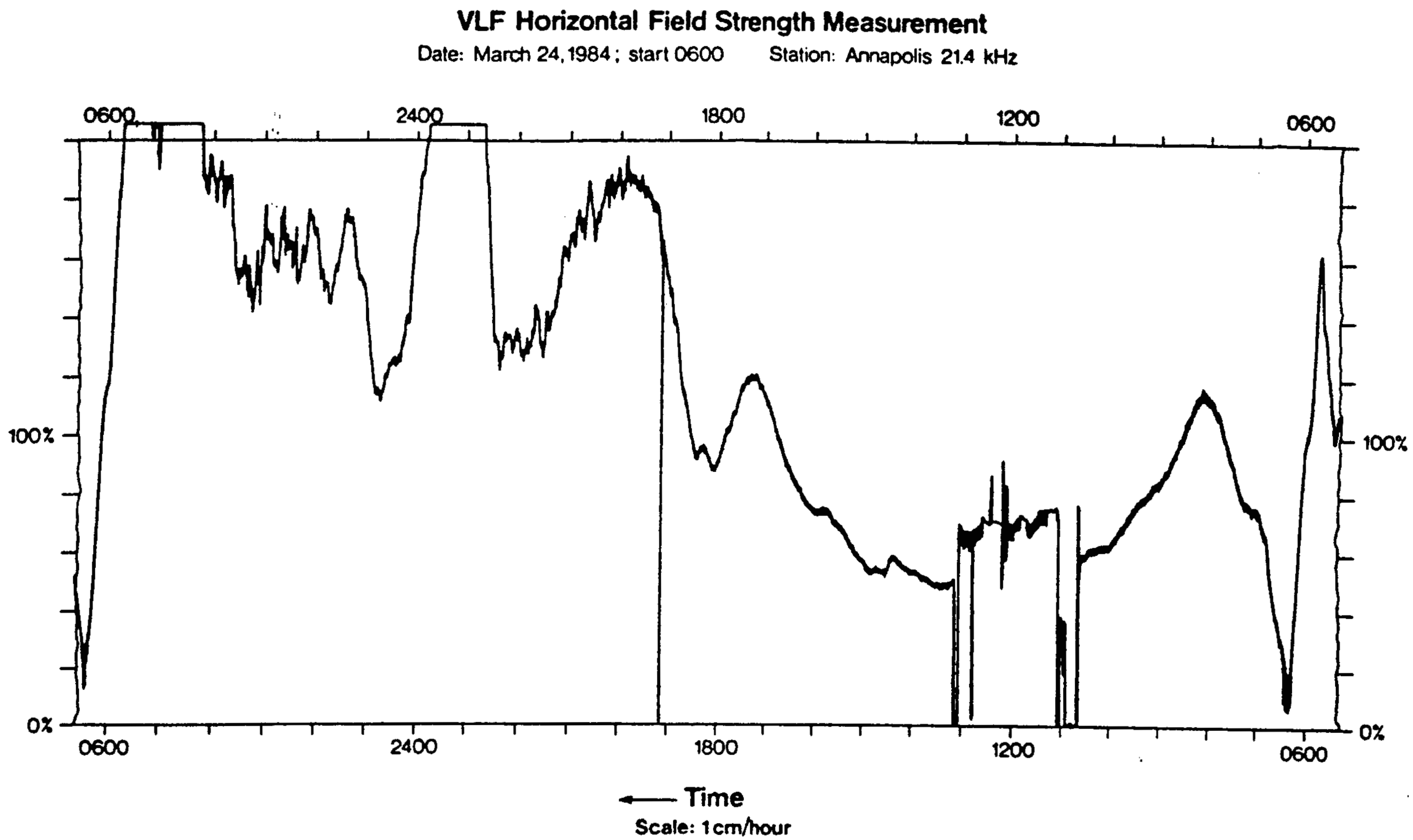


Figure VLF:1
Chart Recording of Primary Field Changing with Time

vertical field, normalized by the horizontal field measurement. In the Electrical Field mode, it measures the horizontal magnetic and electrical fields.

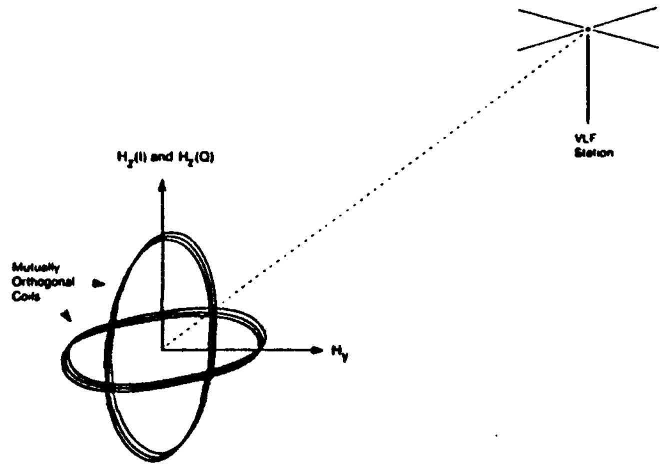
1.3 What the IGS-2/VLF-4 Measures

As its primary measurement, the IGS-2/VLF-4 employs two mutually orthogonal receive coils to determine three parameters of the VLF-magnetic field. These are: 1) the horizontal amplitude vector in a direction perpendicular to a line joining the operator to the station; 2) the amplitude of the component of the vertical field vector which is in phase with the horizontal vector; and 3) the amplitude of the component of the vertical field vector which is 90° out of phase with the horizontal vector. These three parameters, for the given VLF transmitter, are recorded simultaneously. Since the vertical components are expressed as a percentage of the horizontal vector, they are automatically normalized for any changes in the amplitude of the transmitted primary field.

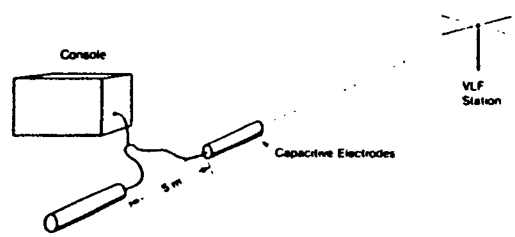
The primary field from a VLF station can in fact, vary considerably. Figure VLF:1 is a recording of the horizontal field strength from the Annapolis VLF station made in Toronto, Canada. For the most part, the field fluctuates moderately during the course of the day due to changes in atmospheric conditions. There are, however, more dramatic changes indicated on the recording. Towards evening there is a large upwards swing in the field strength, and at several points during the day, both partial and total drops in the field amplitude can be observed. In the light of these irregularities, the horizontal field data should always be considered with reservation as it is difficult to know whether changes are caused by conductors or by variations in the station's signal.

If the primary field strength is constant, changes in the amplitude of the horizontal magnetic field mainly reflect variations in the conductivity of the earth. Normally there will be no vertical magnetic field. However, near a conductor, a vertical field will be observed. The relative amplitudes of the in-phase and quadrature components may be used to interpret the conductivity-size characteristics of the conductor.

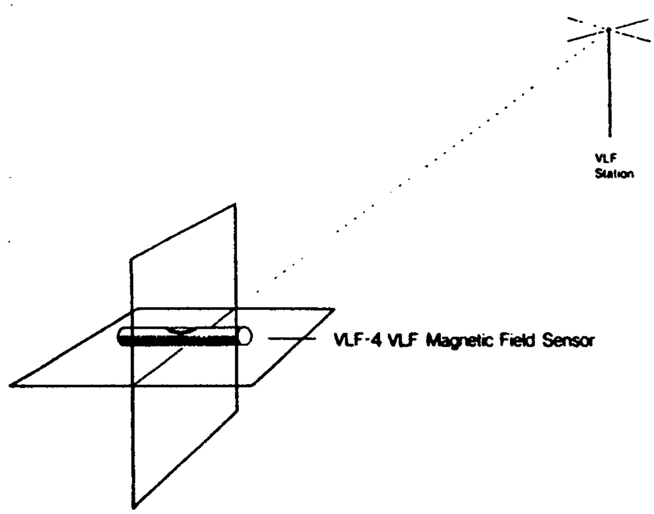
To permit measurement of the VLF-electric field, a dipole consisting of two cylindrical electrodes and 5 meters of wire is used. When this dipole is correctly laid out, the IGS-2/VLF-4 measures the in-phase and quadrature components of the horizontal electric field in the direction of the line joining the operator and the transmitter station. The phase reference is the horizontal magnetic field.



The VLF-magnetic field measurement comprises: 1) horizontal amplitude H_y, 2) the amplitude of $H_z(I)$ (the vertical field component which is in-phase with H_y) and 3) the amplitude of $H_z(Q)$ (the vertical field component which is 90° out-of-phase with H_y.



The VLF-4 is used to measure the in-phase $E_x(I)$, and quadrature $E_x(Q)$, components of the horizontal electric field, E_x, in the line joining the operator and the transmitter station. The phase is referenced to that of the horizontal magnetic field H_y. These components are not recorded but are used in the calculations of resistivity and phase made by the VLF-4.



An electronic level sensor on the axis of the horizontal vector receiver coil provides automatic side-to-side tilt compensation. The error in the vertical in-phase component is less than 1% for tilts up to 15° provided that the operator is facing the VLF station directly. Tilts in any other direction of up to 10° produce no significant error (1%) in the other components and, therefore, require no compensation.

Figure VLF:2
What the VLF-4 Measures

The IGS-2/VLF-4 uses the magnetic and electric field measurements to automatically calculate the apparent resistivity of the earth as well as the phase angle between the magnetic and electric field components. If the earth is uniform (not layered) within the depth of the VLF measurement, the phase angle between the horizontal magnetic and electric VLF fields will be 45 degrees. A non-uniform earth will give rise to other phase angles.

The following formulae are used for resistivity and phase calculations:

Apparent Resistivity Calculation:

$$\rho = \frac{1}{2\pi f \mu_o} \left| \frac{E_x}{H_y} \right|^2$$

where:

ρ = apparent resistivity in ohm-meters
E_x = horizontal electric amplitude, calculated
$E_x = (E_x(I)^2 + E_x(Q)^2)^{\frac{1}{2}}$
H_y = horizontal magnetic amplitude, measured
f = VLF station frequency in Hertz
μ_o = permeability of the ground in Henries/meter, a constant

The resistivity calculation has a range of 1 to 100,000 ohm-meters with a resolution of 1 ohm-meter.

Phase Angle Calculation

The phase angle ϕ is expressed as:

$$\phi = \text{arc tan} \frac{E_x(Q)}{E_x(I)}$$

where:

$E_x(Q)$ = horizontal quadrature VLF electric field.
$E_x(I)$ = horizontal in-phase VLF electric field, phase rferenced to the horizontal magnetic field, Hy.

The phase angle calculation has a range of -180° to +180° with a resolution of 1°. By definition the angle is positive when the electrical field leads the magnetic field.

9.0 SPECIFICATIONS

9.1 Standard Console Specifications

Digital Display	32 character, 2 line LCD display
Keyboard Input	14 keys for entering all commands, coordinates, header and ancillary information.
Languages	English plus French is standard.
Standard Memory	16K RAM. More than sufficient for a day's data in most applications.
Clock	Real time clock with day, month, year, hour, minute and second. One second resolution, ±1 second stability over 12 hours. Needs keyboard initialization only after battery replacement.
Digital Data Output	RS-232C serial interface for digital printer, modem, microcomputer or cassette tape recorder. Data outputs in 7 bit ASCII, no parity format. Baud rate is keyboard selectable at 110, 300, 600 and 1200 baud. Carriage return delay is keyboard selectable in increments of one from 0 through 999. Handshaking is done through X-ON/X-OFF protocol. Allows IGS-2 to act as a master for other instrumentation.
Analog Output	For a strip chart recorder. 0 to 999 mV full scale with keyboard selectable sensitivities of 10, 100 or 1000 units full scale.

Console Dimensions	240 x 90 x 240 mm includes mounted battery pack.
Weights	Console: 2.2 kg Console with Non-rechargeable Battery Pack; 3.2 kg. Console with Rechargeable Battery Pack: 3.6 kg.
Operating Temperature Range	-40°C to +50°C provided optional Display Heater is used below -20°C.
Power Requirements	Can be powered by external 12 V DC or one of the Battery Pack Options listed below.

9.2 Battery Pack Options

Battery Pack lifetime depends on which Battery Pack is selected, sensor(s) used, reading time and ambient temperature. Life expectancy would be 1 to 10, eight hour survey days.

Non-Rechargeable Battery Pack	Includes battery holder and 10 disposable 'C' cell batteries for installation on console. Used in low sensitivity total field magnetometry or VLF in temperatures above 0°C. Weight is 0.9 kg.
Rechargeable Battery Pack and Charger	Includes battery holder, 6 rechargeable, non-magnetic, sealed lead-acid batteries and charger for installation on console. Best for high sensitivity total field measurements, all gradient measurements and operation below 0°C. Pack weighs 1.3 kg. Charger specifications are: 140 x 95 x 65 mm, 115/230 V AC, 50/60 Hz, 20 VA, overload protected.

8.0 SPECIFICATIONS

8.1 Magnetometry Specifications

Total Field Operating Range	20,000 to 100,000 nT (1 nT = 1 gamma).
Gradient Tolerance For Total Field:	±5000 nT/m.
Total Field Absolute Accuracy	±1 nT at 50,000 nT ±2 nT over total field operating and temperature range.
Resolution	0.1 nT.
Tuning	Fully solid-state. Manual or automatic mode is keyboard selectable.
Reading Time	2 seconds. For portable readings this is the time taken from the push of a button to the display of the measured value.
Continuous Cycle Times	Keyboard selectable in 1 second increments upwards from 2 seconds to 999 seconds.

9.0 SPECIFICATIONS

Frequency Tuning	Automatic digital tuning. Can be tuned to any frequency in the range 15.0 to 29.0 kHz with a bandwidth of 150 Hz. Up to three frequencies can be chosen by keyboard entry for sequential measurements.
Field Strength Range	Fields as low as 100 mA/m can be received. In practice, background noise may require fields up to 5-10 times this level. Maximum received field is 2 mA/metre. These values are specified for 20 kHz. For any other frequency, calculate the above limits by multiplying by the station frequency in kHz and dividing by 20.
Signal Filtering	Narrow bandpass, low pass and sharp cut-off high pass filters.
Measuring Time	0.5 seconds sample interval. As many as 2^{16} samples can be stacked to improve measurement accuracy.
VLF-Magnetic Field Components Measured	1) Horizontal amplitude, 2) vertical in-phase component, and 3) vertical quadrature components. Vertical components are displayed as a percentage of horizontal component and are related in phase to the horizontal component. Their range is ±120%; reading resolution 1%.
VLF-Magnetic Field Sensor	Two air-cored coils in a backpack mounted housing with an electronic level for automatic tilt compensation. The error in the vertical in-phase component is less than 1% for tilts up to ±15°.

APPENDIX II

APPENDIX 2

VLF THEORY

The signal transmitted by the VLF station is recorded by the vertical coils as:

$$Hp = A \sin wt; \quad Hs = B \cos (wt - \phi) \qquad (1.0)$$

where:
- Hp = primary signal
- Hs = secondary (phase laged) signal
- w = frequency
- t = time
- ϕ = phase lag
- A = amplitude of primary signal
- B = amplitude of secondary signal

These two received signals combine giving an ellipse, which has two axis corresponding to the maximum length and minimum width of the ellipse.

i.e.

$$\frac{Hp^2}{A^2} + \frac{Hs^2}{B^2} - \frac{2\, HpHs \sin \phi}{AB} = \cos^2 \phi \quad (2.0)$$

By measuring the angle from horizontal of the long axis of the ellipse, a conductor is located when this tilt angle is zero.

The Scintrex IGS VLF measures the primary vertical (in phase) Hp and the secondary (quadrature) Hs to obtain a conductor's location (from Hp) and the conductor's quality using both Hp and Hs.

i.e.

$$o = \tfrac{1}{2} \tan^{-1} (2\, Hp/100\, (1 - e^2))$$

where
- o = tilt angle (degrees)
- Hp = vertical in phase, expressed as a o/o
- $\phi = \tan^{-1} \left(\frac{Hp}{Hs}\right)$

VLF THEORY (Continued)

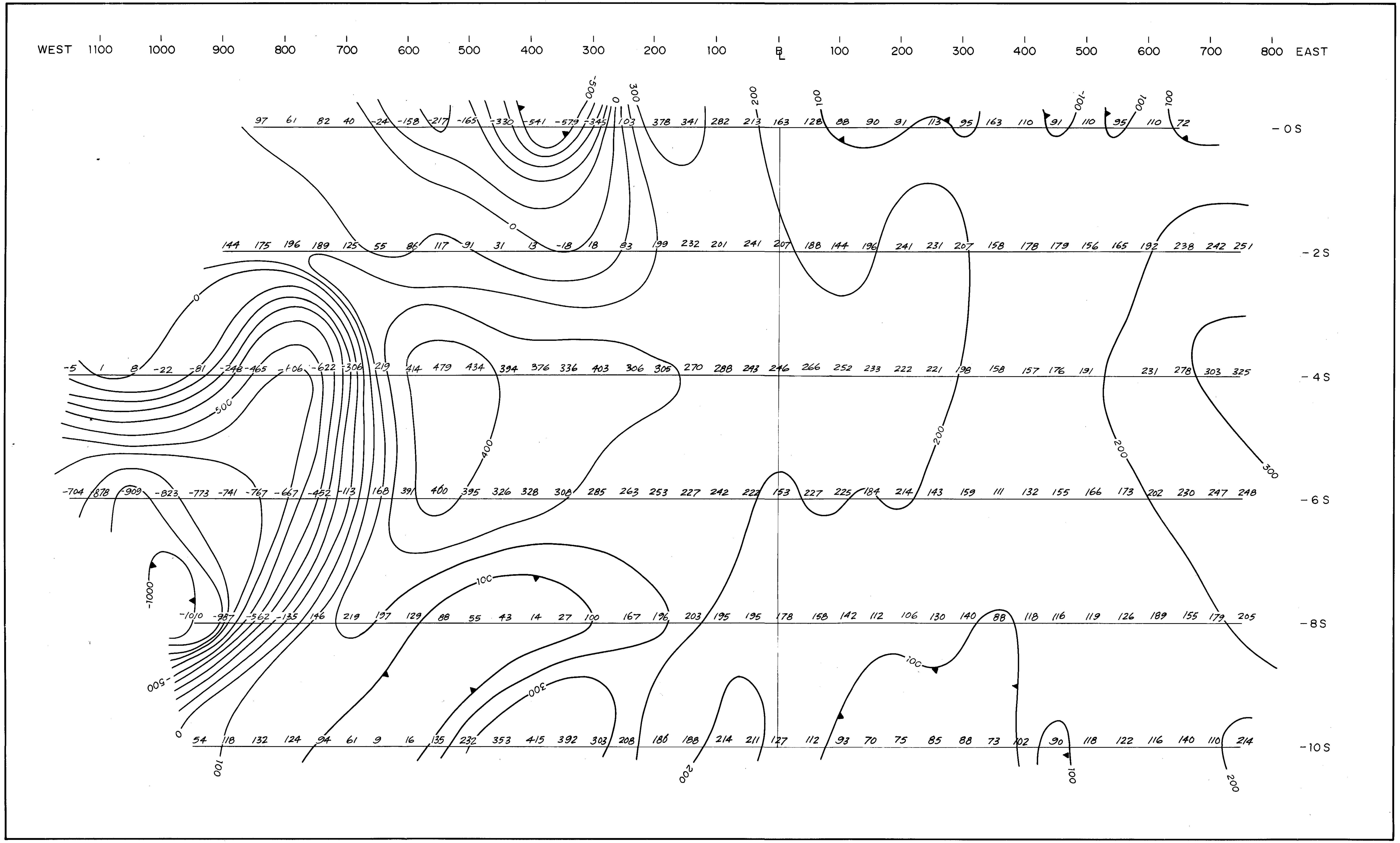
where ϕ = phase lag (degrees)
Hp = vertical in phase (any units)
Hs = vertical quadrature (same units as Hp)

Since the quadrature readings require a magnetic field phase reference, using unpublished means, the phase lag value is untested and should be considered qualatative only, but it is likely reasonably precise (the readings are repeatable), but may or may not be accurate (the correct value).

APPENDIX III

Proposed Budget for a Combined Geophysics, Geochemical, and Mapping Exploration Program on the Lynx Grid and Eastern Zones of the Max Claims.

Room and Board			$120/day	$ 5,160
Travel		4 @	300/day	1,200
Geologists		2 @	250/day each	21,500
Field Assistants		4 @	100/each	17,200
Cook		1 @	150/day	6,450
Truck		2 @	50/day	4,300
Fuel				2,688
Supplies/Field				2,350
Supplies/Camp				500
ASSAY	soils	500 x	25	12,500
	rocks	100 x	25	2,500
Shipping Costs				500
Instrument Rental	IGS	$300 x	43 days	12,900
	Genie	$300 x	10 days	3,000
Communication				200
Report/Office Expenses				5,000
Subtotal				$ 97,948
Contingency			15%	14,690
TOTAL				**$112,638**
			Rounded	**$112,640**



100 0 100 200 300
metres

Contour interval: 250 gammas

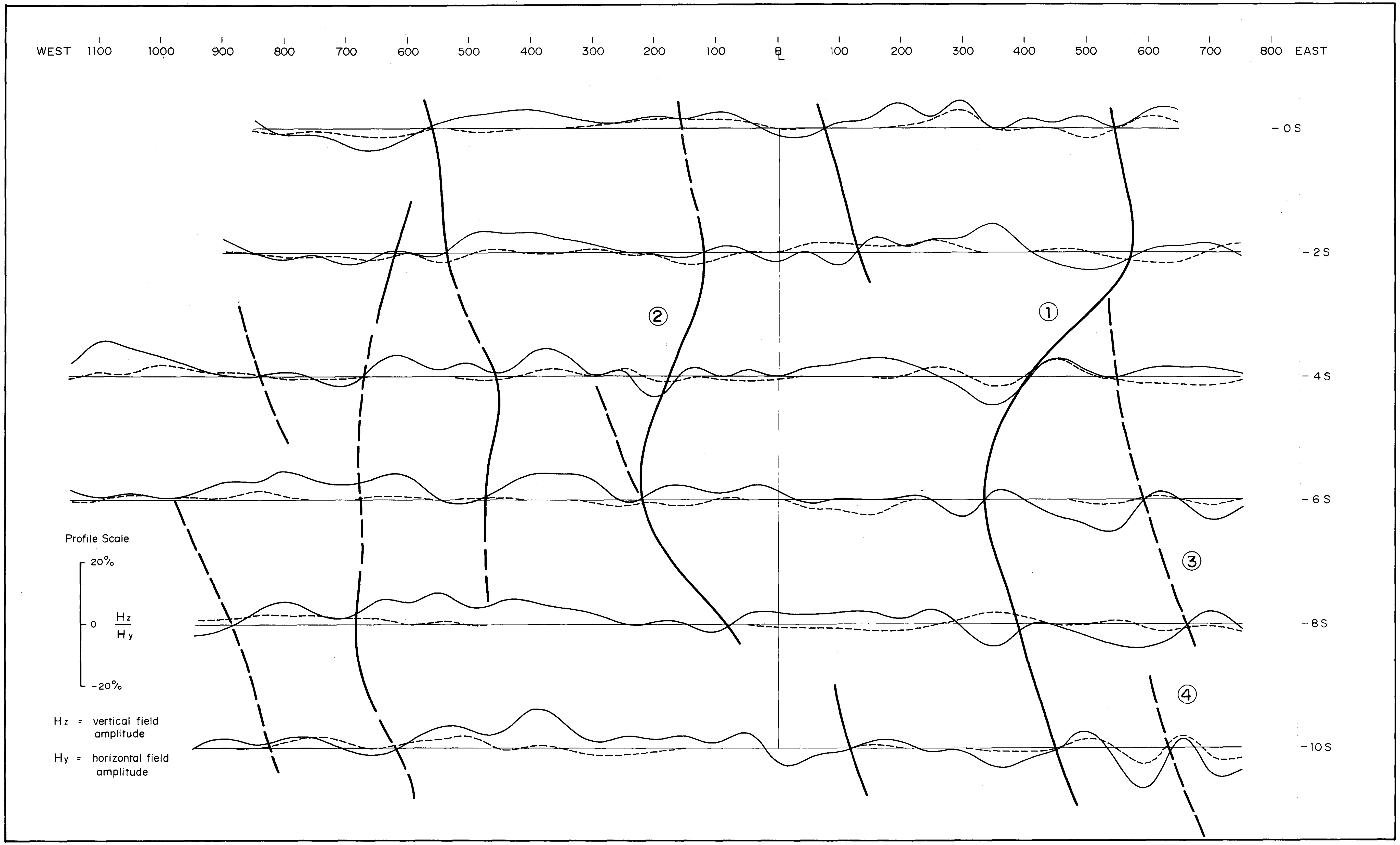
Instrument: Scintrex IGS-2

Part 1 of 2

GEOLOGICAL BRANCH
ASSESSMENT REPORT

18,988

CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS		OMINECA M.D., B.C.	
RAINBOW GRID GROUND MAGNETIC CONTOUR PLAN			
SCALE	DATE	NTS	FIG. Nº
1:5000	Feb.'89	93K/16E	5



Part 1 of 2

100 0 100 200 300
metres

GEOLOGICAL BRANCH
ASSESSMENT REPORT

18,988

Station: 24.8 kHz , Seattle, Wa.

Instrument: Scintrex IGS-2

—— in phase

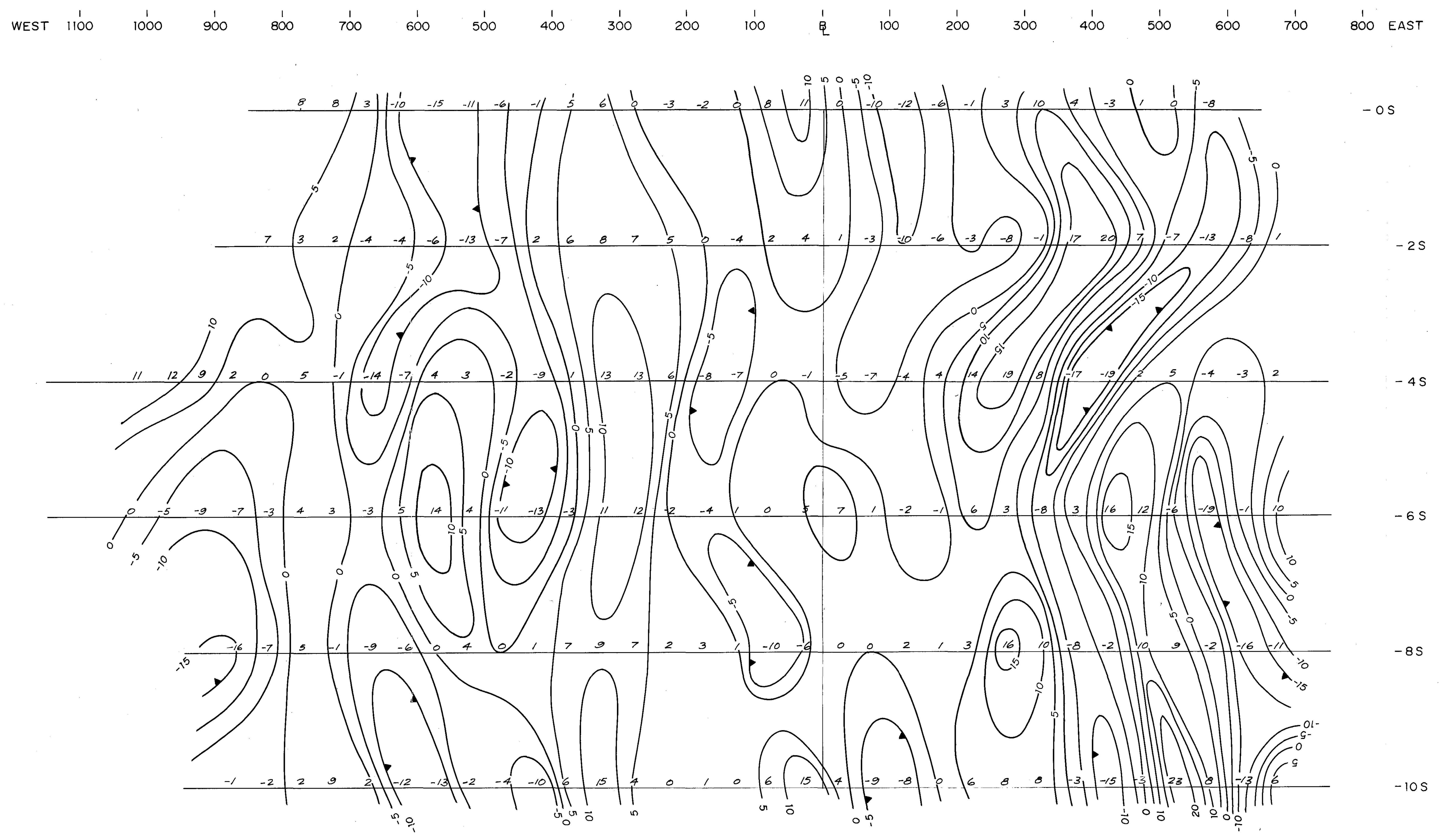
----- quadrature

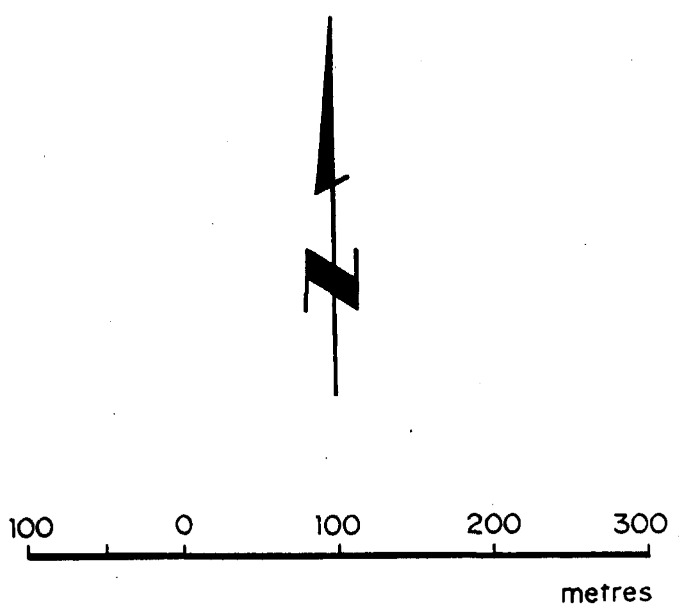
Conductors

—— interpreted

— — inferred

CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS		OMINECA M.D., B.C.	
RAINBOW GRID			
VLF-EM STACKED PROFILE PLAN			
SCALE	DATE	NTS	FIG. Nº
1:5000	Feb.'89	93K/16E	6





Station: 24.8 kHz, Seattle, Wa.

Instrument: Scintrex IGS-2

Contour interval 5%

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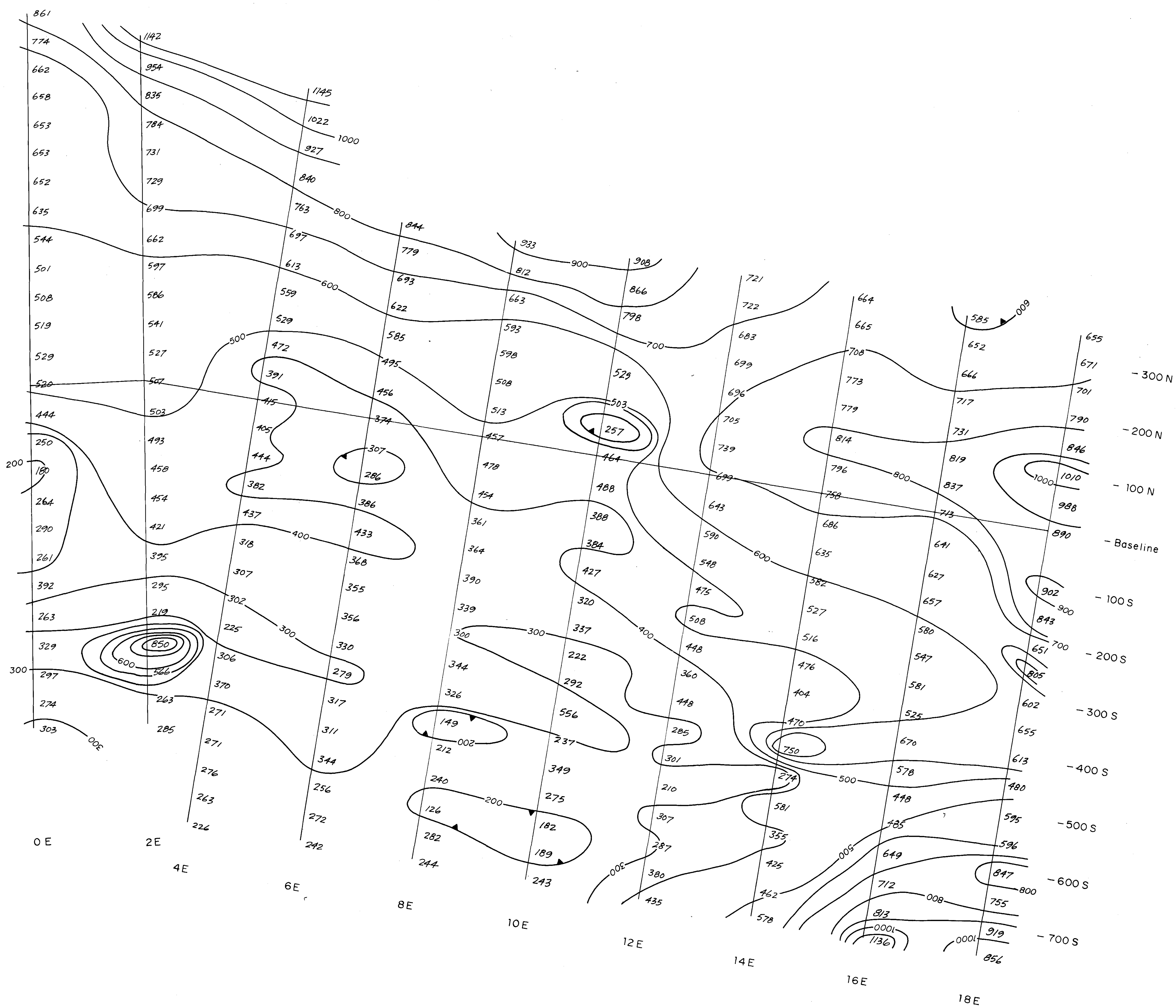
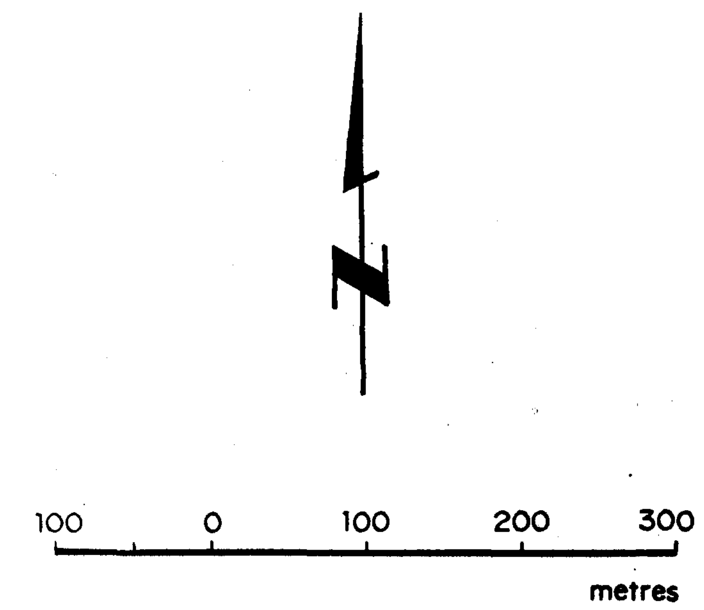
GEOLOGICAL BRANCH
ASSESSMENT REPORT

18,988

CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS OMINECA M.D., B.C.			
RAINBOW GRID			
VLF-EM			
FRASER-FILTER			
SCALE	DATE	NTS	FIG. Nº
1:5000	Feb. '89	93K/16E	7





Contour interval: 100 gammas

Instrument: Scintrex IGS-2

Part 1 of 2

GEOLOGICAL BRANCH ASSESSMENT REPORT

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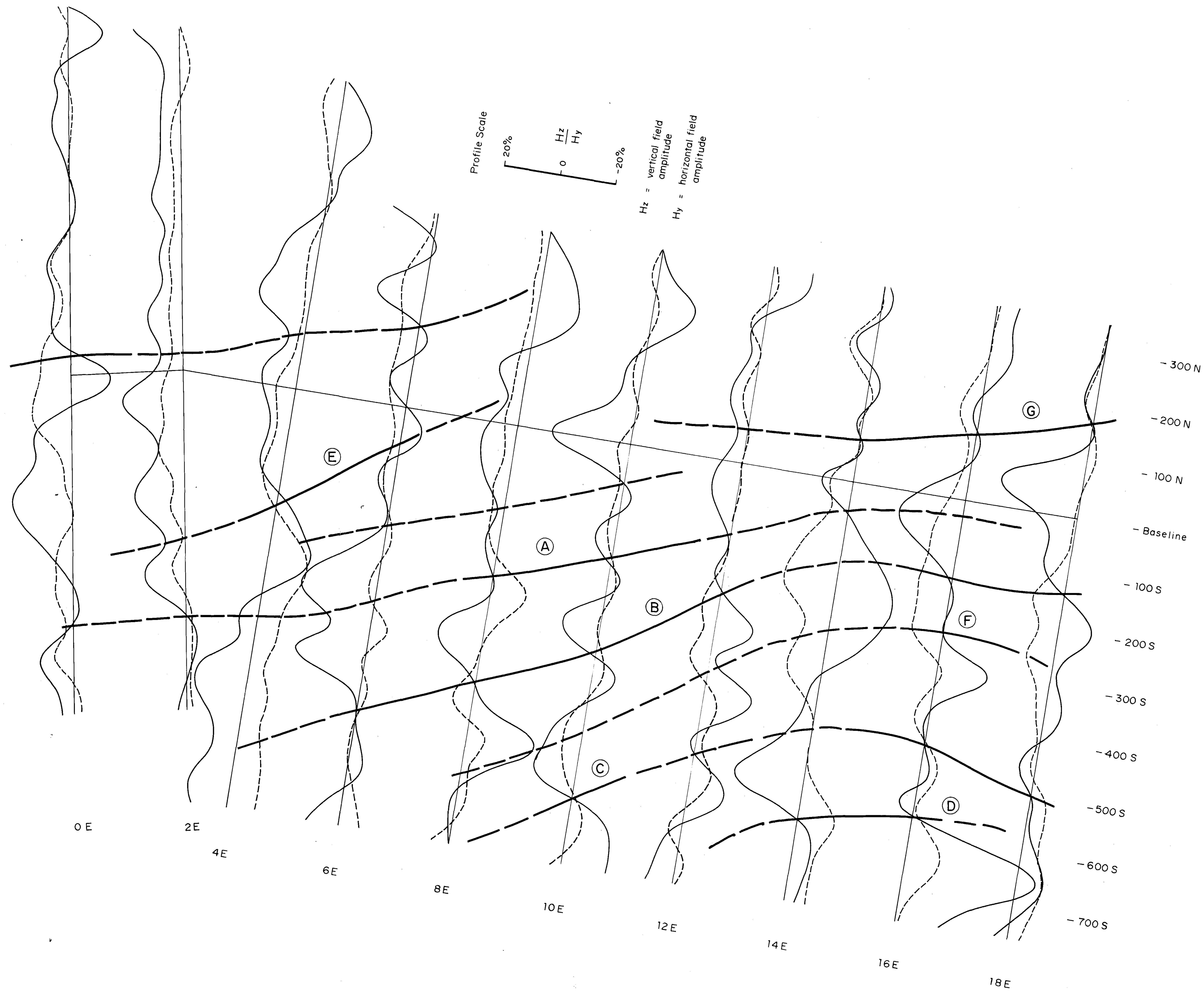
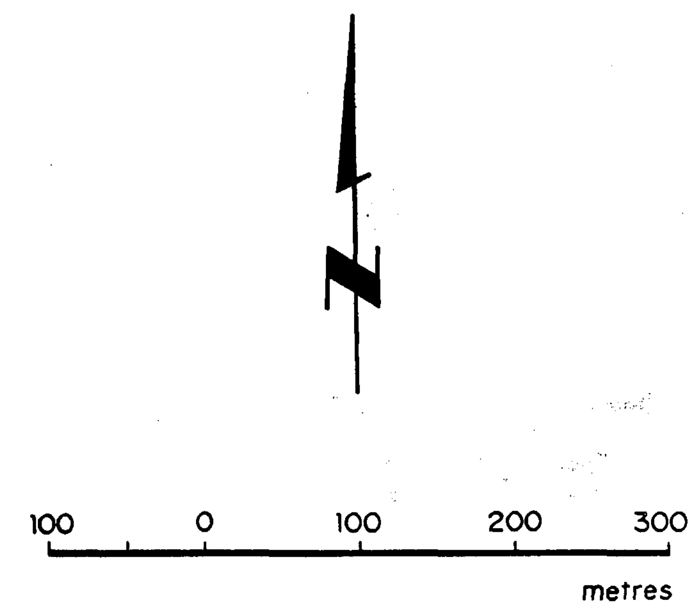
CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS		OMINECA M.D., B.C.	
LYNX GRID GROUND MAGNETIC CONTOUR PLAN			
SCALE	DATE	NTS	FIG. Nº
1:5000	Feb.'89	93K/16E	8





Station: 23.4 kHz , Lualualei, Hawaii

Instrument: Scintrex IGS-2

——— in phase

– – – – – quadrature

Conductors

——— interpreted

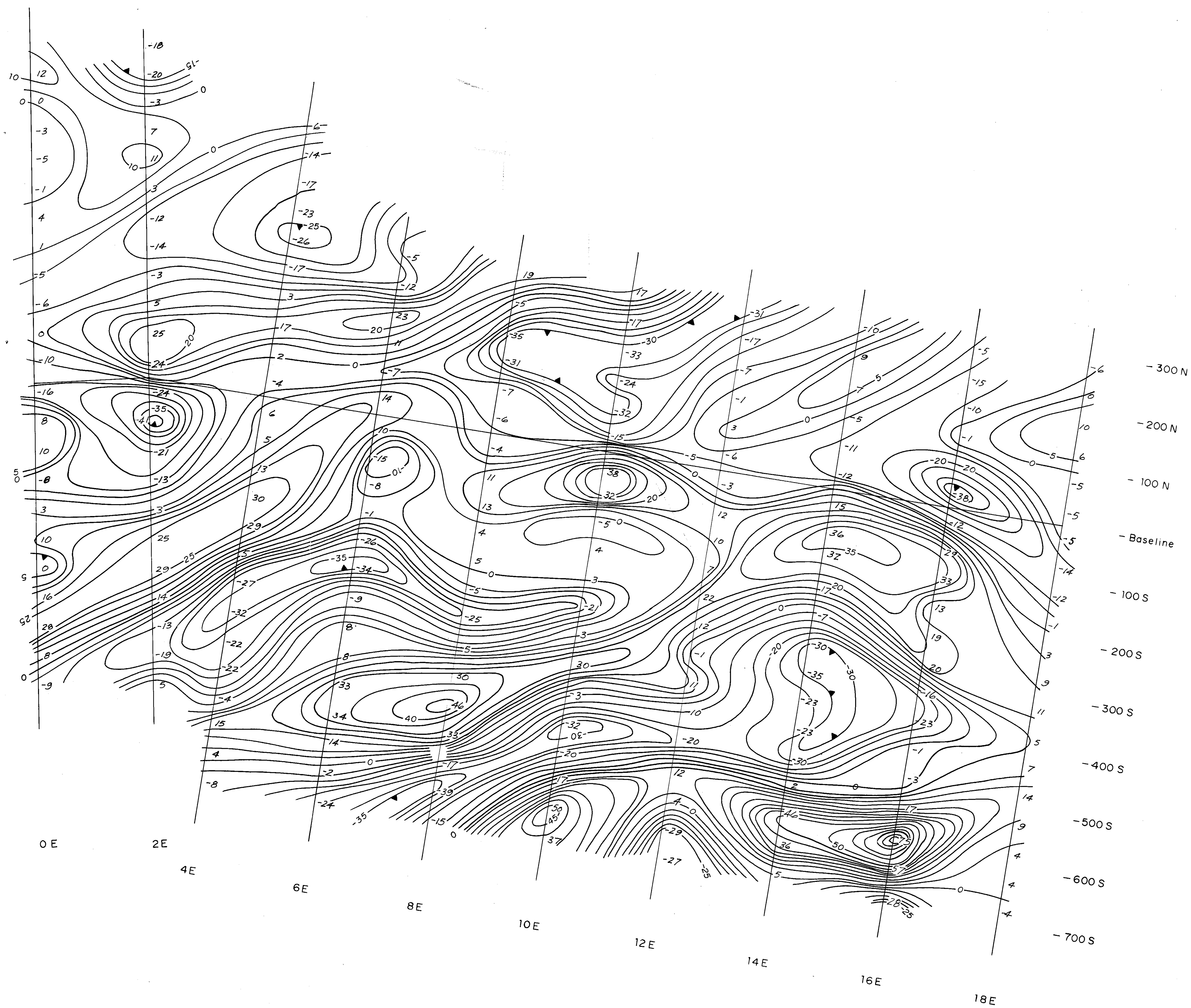
— — inferred

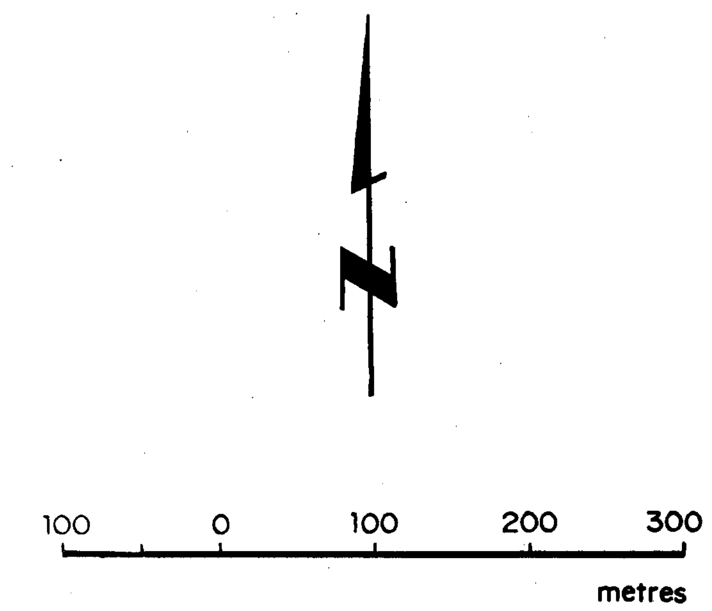
Part 1 of 2

GEOLOGICAL BRANCH
ASSESSMENT REPORT

18,988

CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS	OMINECA M.D., B.C.		
LYNX GRID			
VLF-EM STACKED PROFILE PLAN			
SCALE	DATE	NTS	FIG. Nº
1:5000	Feb.'89	93K/16E	9





Station: 23.4 kHz, Lualualei, Hawaii

Instrument: Scintrex IGS-2

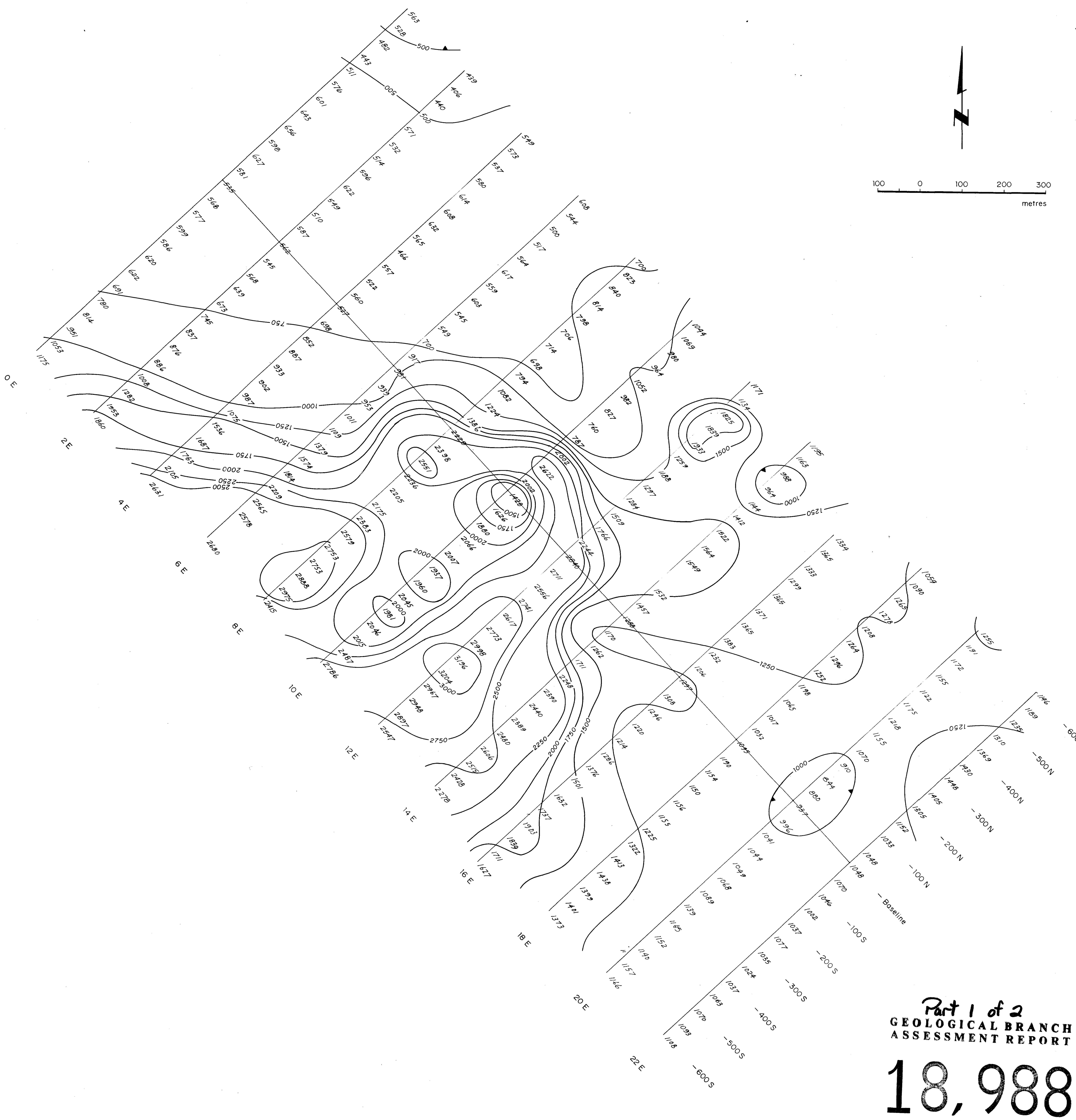
Contour interval 5%

Part 1 of 2

GEOLOGICAL BRANCH
ASSESSMENT REPORT

18,988

CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS		OMINECA M.D., B.C.	
LYNX GRID VLF-EM FRASER-FILTER			
SCALE	DATE	NTS	FIG. Nº
1:5000	Feb. '89	93K/16E	10



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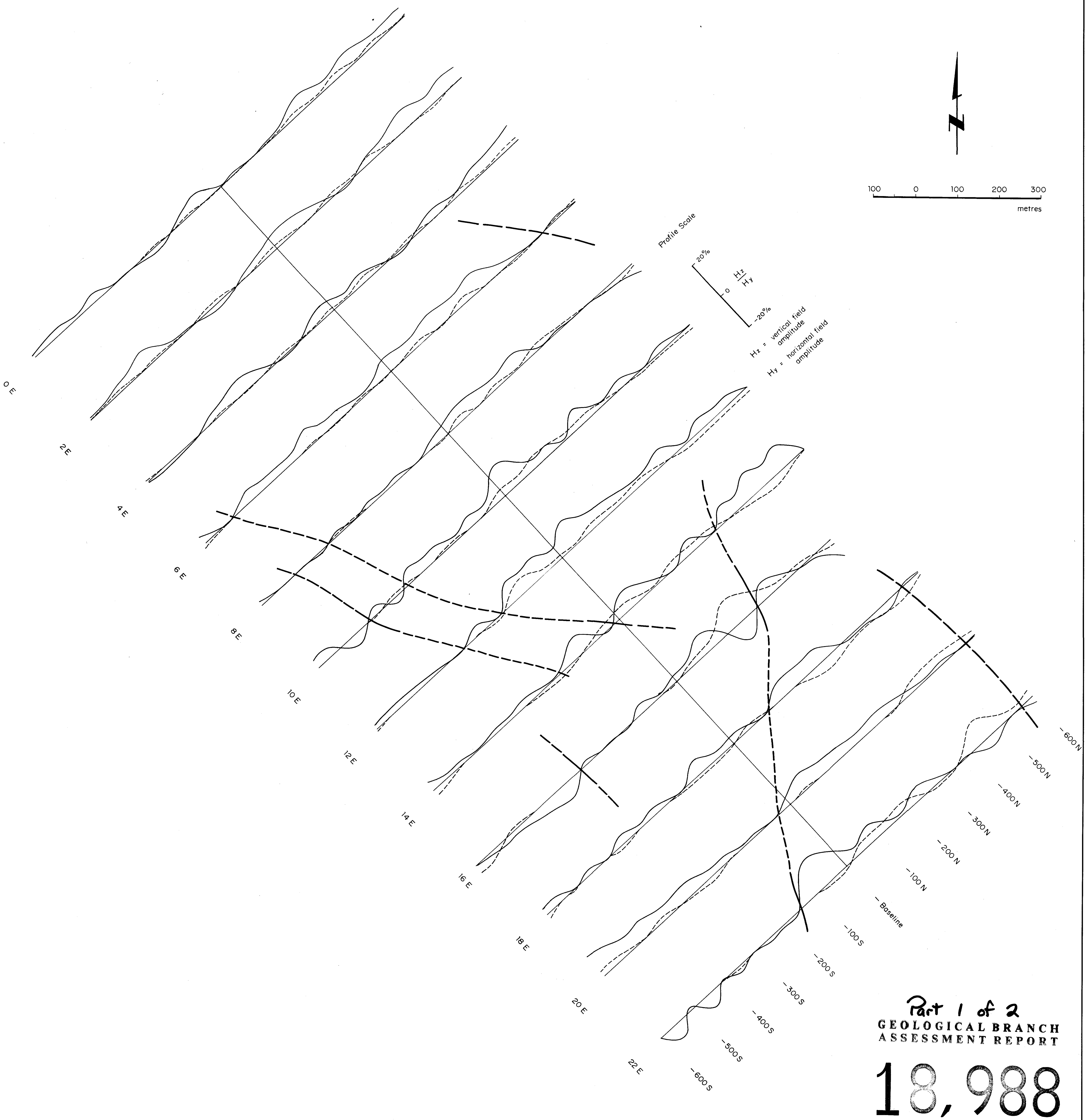
GEOLOGICAL BRANCH ASSESSMENT REPORT

18,988

Contour interval: 250 gammas

Instrument: Scintrex IGS-2

CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS		OMINECA M.D., B.C.	
CRIPPLE GRID GROUND MAGNETIC CONTOUR PLAN			
SCALE	DATE	NTS	FIG. No
1:5000	Feb.'89	93K/16E	11



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GEOLOGICAL BRANCH
ASSESSMENT REPORT

18,988

Station: 24.8 kHz, Seattle, Wa.
Instrument: Scintrex IGS-2

——— in phase
- - - - quadrature

Conductors
——— interpreted
— — inferred

CITY RESOURCES (CANADA) LTD.			
MAX CLAIMS		OMINECA M.D., B.C.	
CRIPPLE GRID VLF-EM STACKED PROFILE PLAN			
SCALE	DATE	NTS	FIG. Nº
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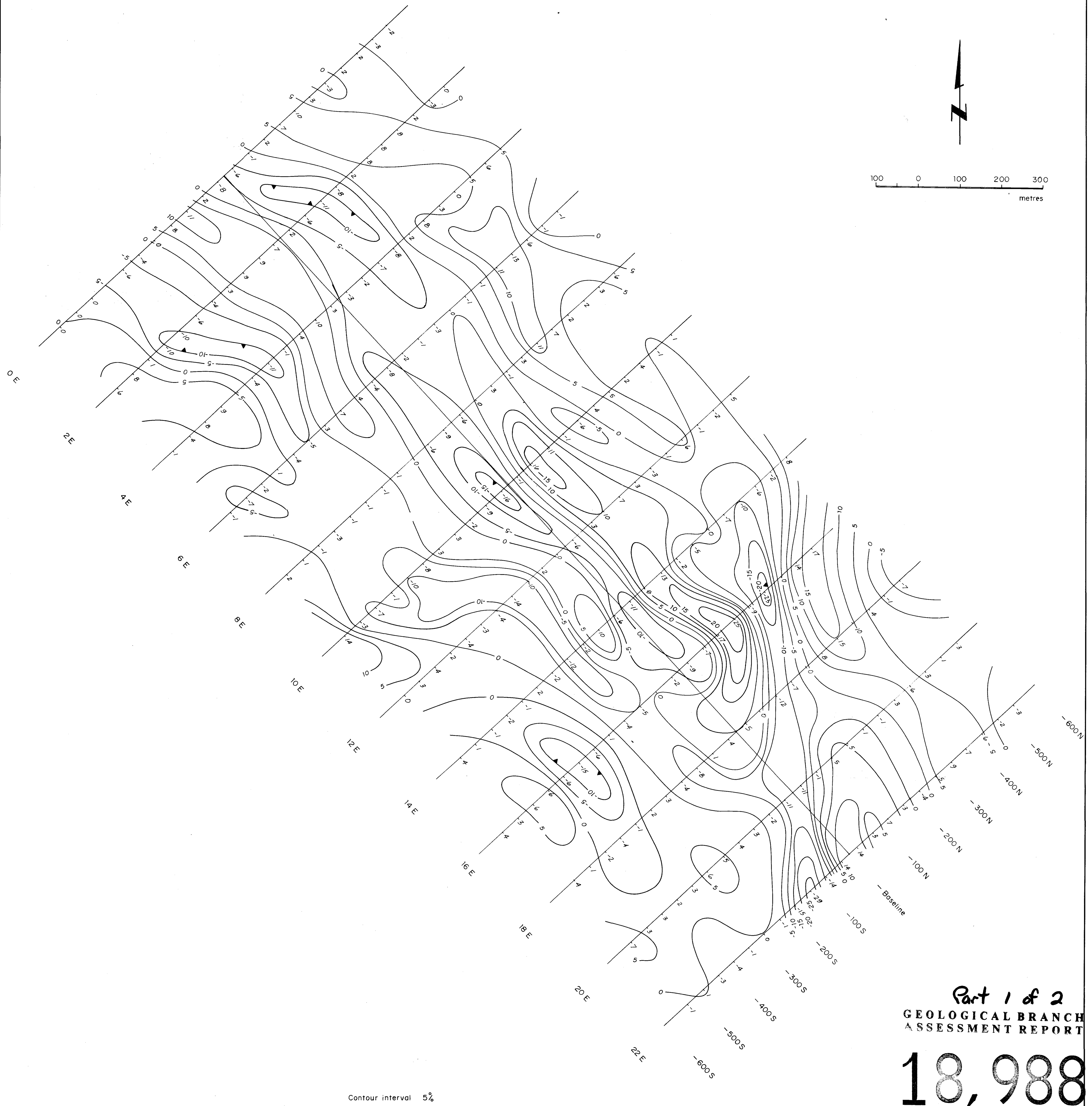

Contour interval 5%

Station: 24.8 kHz, Seattle, Wa.

Instrument: Scintrex IGS-2

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ASSESSMENT REPORT

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MAX CLAIMS		OMINECA M.D., B.C.	
CRIPPLE GRID VLF-EM FRASER-FILTER			
SCALE	DATE	NTS	FIG. Nº
1:5000	Feb.'89	93K/16E	13