85-900-14069

9/86

GEOLOGICAL AND GEOPHSYICAL REPORT

ON THE

WRICH 1, 2 and 3 CLAIMS

TOODOGGONE RIVER AREA

OMINECA MINING DIVISION, B.C.

94E-2E,W

($57^{\circ}08'$ N. LAT., $126^{\circ}45'$ W. LONG.)

FOR

SEREM INC.

21ST FLOOR - 1055 W. GEORGIA ST.

VANCOUVER, B.C.

(OWNER AND OPERATOR)

BY

MOHAN VULIMIRI, B.Sc., M.Sc.

AND

GRANT CROOKER, B.Sc., F.G.A.C.

NOVEMBER, 1985

GEOLOGICAL BRANCH
ASSESSMENT REPORT

14,069

TABLE OF CONTENTS

ILLUSTRATIONS

INTRODUCTION

General

Field work was carried out on the property by Grant Crooker, Mohan Vulimiri, and Sheila Keilbach, geologists, from July 12th through July 18th, 1985.

Geological mapping, prospecting, and VLF-EM and VLF-EMR surveying were carried out on the claims.

Location and Access

The Wrich claim group is located between 57°07' and 57°09' N. latitude and between 126°43' and 126°47' W. longitude in the Sturdee River - Finlay River area, Toodoggone River Map Sheet, 94E-2E,W, Omineca Mining Division (Figures 1 and2).

Access to the property is by airplane from Smithers to Sturdee Airstrip, a distance of 280 kilometers, and from Sturdee Airstrip to the property by helicopter, a distance of 20 kilometers.

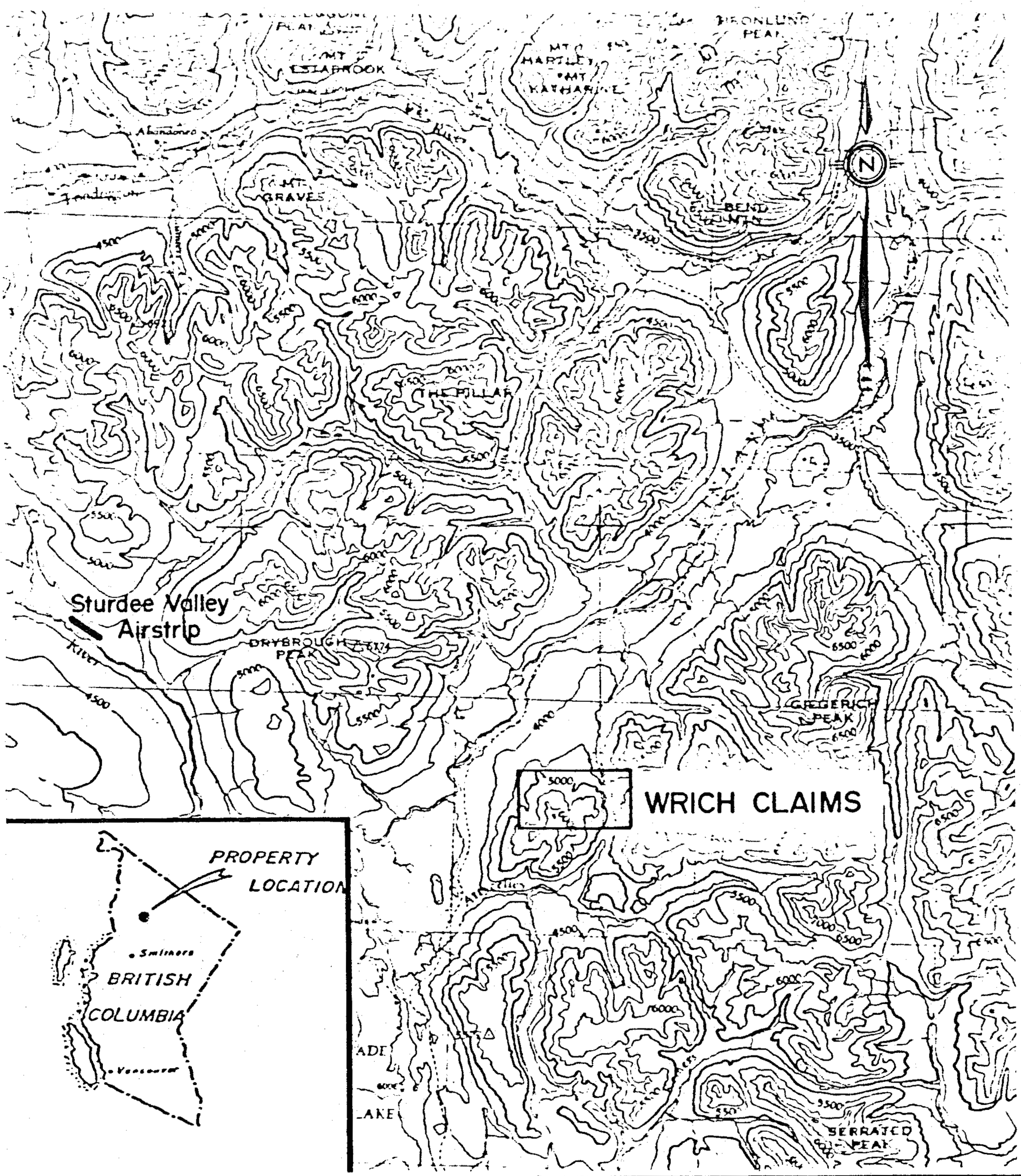
Physiography

Topography is moderate to steep; elevation ranges from 1220 to 2020 meters above sea level. Outcrop exposure is poor over the grid area.

Higher elevations are above tree line, while lower elevations are covered with thick spruce and fir.

Property and Claim Status

The claims (Figure 2) are owned and operated by Serem Inc., Box 11175, Royal Centre, 1055 West Georgia St., Vancouver, B.C. Upon acceptance of this report, all claims will be in good standing until 1987.



VANCOUVER, B.C.

SEREM INC.

WRICH GROUP

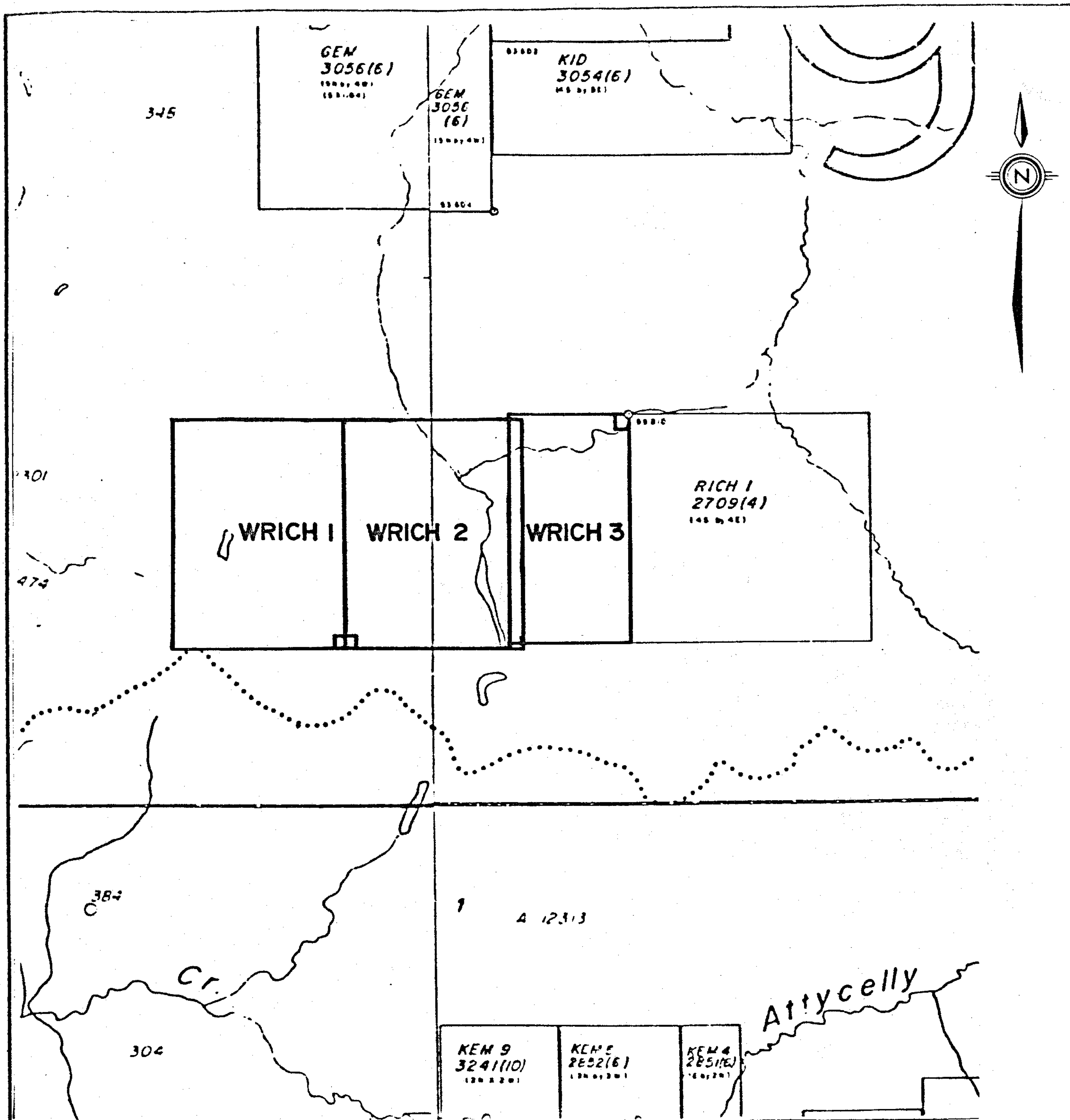
LOCATION MAP

0 5 10 15

KMS.

scale

DRAWN BY : G. CROOKER	N.T.S. : 94E/2EW
DATE : Nov. 1985	FIGURE Nº. 1



0 1 2 3 KMS.

scale

VANCOUVER, B.C.

SEREM INC.

WRICH GROUP

CLAIM MAP

DRAWN BY : G. CROOKER	N.T.S. : 94E/ 2EW
DATE : NOV. 1985	FIGURE Nº. 2

The claims consist of the following:

Claim	Units	Record No.	Record Date
Wrich 1	12	4249	Sept. 9, 1981
Wrich 2	12	4250	Sept. 9, 1981
Wrich 3	8	4327	Oct. 15, 1981

Propery History

Serem first carried out silt sampling in the area during 1980. Anomalous gold values were obtained and the ground was staked the following year.

Work during 1982 included geological mapping, rock sampling and soil geochemical sampling. This program indicated the claims are underlain by Toodoggone and Takla volcanic rocks. A zone of fumerolic-type, clay-pyrophyllite alteration occurs within the Toodoggone rocks in the grid area. Chalcedony occurs as matrixin breccias and veinlets. In addition, anomalous gold values of up to 790 ppb and anomalous silver values of up to 9.0 ppm indicated geochemical anomalies. The geochemical anomalies and altered zones are co-incidental. Rock sampling did not give significant results, with the exception of one sample which returned 20.40 oz/ton silver and 0.192 oz/ton gold. For detailed results, the 1982 Assessment Report can be referred to.

EXPLORATION PROCEDURE

Work in 1985 consisted of detailed geological mapping, prospecting and VLF electro-magnetic and electro-magnetic resistivity surveys. The purpose of the work was to deliniate the source of the gold and silver geochemical anomalies discovered by previous work.

The pickited baseline from the old grid was located, and a new grid was established as closely as possible to the original. The baseline was ran at 130°-310° for 600 meters and crosslines were ran at right angles to the baseline every 50 meters. A total of 7800 meters of crosslines were established with stations every 20 meters.

Seventy-eight hundred meters of VLF-EM Surveying were carried out, with readings taken every 20 meters along the lines. A Geonics EM-16 was used as a receiver, with NLK, Seattle, Washington, at 24.8 KHz the transmitter. This transmitter was used due to its good signal strength and orientation to the geological structures.

The EM-16 measures In-phase and Quadrature components of vertical magnetic field as a percentage of horizontal primary field. (That is tangent of the tiltangle and ellipticity). Both values are given in percentages. Field procedure requires to always face the same direction when taking readings. When approaching a conductor the readings will be positive, and when leaving a conductor the readings will be negative. The EM-16 is rotated in the vertical plane until a minimum signal is obtained. This reading is the "In-phase" and gives the tiltangle in degrees and the tangent of the tiltangle expressed as percent. Once this minimum signal is obtained, the "Quadrature" knob is rotated until the signal minimum is obtained. This reading is approximately the ratio of the quadrature component of the vertical secondary field to the horizontal primary field.

The VLF-EM can pick up conductors caused by electrolyte-filled fault or shear zones and porus horizons, graphite, carbonaceous sediments, lithological boundaries as well as sulphide bodies.

The In-phase and Quadrature data were plotted as percentages on Figure 4 at a scale of 1:1250. The Fraser filter method was then applied to the In-Phase data, and the results plotted as a scale of 1:1250 on Figure 5.

Seventy-eight hundred meters of VLF-EMR (electro-magnetic resistivity) surveying were carried out with readings taken every 20 meters (unless snow or talus conditions prevented a reading). A Geonics EM-16R was used as a receiver, with NLK, Seattle, Washington, at 24.8 KHz the transmitter.

The EM-16R measures the horizontal components of the radial electric field and the tangential magnetic field (apparent resistivity), and the phase differences between the radial electric field and the tangential magnetic field (phase angle).

Field procedures require that the instrument be oriented in the direction of the transmitter selected. Two probes are pushed in to the ground 10 meters apart, in the direction of the transmitter. The resistivity control is then rotated until a signal minimum is located. The phase angle control is then rotated until a further signal minimum is obtained. The apparent resistivity in ohm-meters, and phase angle in degrees are then recorded from the appropriate control.

The apparent resistivity readings give the electrical resistiviy of the ground, while the phase angles give the conductivity of overburden.

The apparent resistivity is high for Silicous, non-conductive rocks, and low for altered, kaolinized rocks.

The apparent resistivity and phase angles were plotted at a scale of 1:1250 of Figure 6.

The geology was mapped at a scale of 1:1250 (Figure 3). Four rock samples of quartz-chalcedony material were taken and fire assayed for gold and silver. The results are shown on figure 3.

GEOLOGY

The Wrich claim group is underlain by Toodoggone and Takla volcanic rocks.

The Toodoggone volcanic rocks consist of crystal, crystal lapilli and welded tuffs, they occur on Wrich #2 and Wrich #3 claims, and on the eastern portion of Wrich #1 claim. On Wrich

#3 the rocks were deposited as thick ash falls. Welded tuff outcrop in southeast portion of Wrich #2 and in southeast portion of Wrich #1. It is characterized by strong flattening of lapilli, darker colour and higher density.

Rocks which have not been subjected to hydrothermal alteration have purple to medium to dark grey groundmass. The purple colour is due to the presence of hematite and the grey is due to the presence of ferromagnesian minerals in the groundmass.

Takla volcanic rocks are present in the Wrich #1 claim in fault contact with the Toodoggone rocks to the east.

For more detailed general geology description of the area, assessment reports of 1981 and 1982 can be referred to.

The grid geological mapping carried out on the Wrich #1 and #2 claims in 1982 was again remapped with emphasis on structural control of the chalcedony-quartz breccia zones. The mapping showed that the lithological units and chalcedony breccias are affected by several strong 120^{o} trending fault zones (figure 3). The pattern of the associated conjugate shears suggest a right lateral movement on these faults.

MINERALIZATION AND ALTERATION

A zone of intense fumerolic-type clay-pyrophyllite alteration in association with chalcedony-quartz breccia zones occurs in the Toodoggone volcanic rocks in the grid area. Rocks are altered to clay + chalcedony + manganese oxides + iron oxides $\pm$ quartz $\pm$ alunite $\pm$ pyrophyllite. Chalcedony occurs as matrix and fragments in breccias and as narrow veinlets. Quartz is relatively rare and is present in vugs and in narrow fractures. Minor pyrophyllite is associated with quartz and chalcedony. Banded chalcedony was also observed. The banding as well as the chalcedony occurring as both matrix and fragments in breccia zones suggest the multi-stage episodicity of the mineralizing system.

Detailed results with respect to rock assays and geochemical soil sampling can be referred to in the 1982 assessment report. During that programme only one rock sample assayed 20.4 oz/ton silver and .192 oz/ton gold.

Four grab rock samples were assayed for gold and silver. All returned anomalous values in gold and silver. The assays are shown below.

Sample No.	Au oz/ton	Ag oz/ton
WR 851	0.04	0.4
WR 852	0.02	0.1
WR 853	<0.01	0.6
WR 854	0.03	0.5

GEOPHYSICS

VLF-EM Survey

The Fraser Filter Method was applied to all In-phase readings to allow contouring of the data. The results were contoured at 10 percent intervals (Figure 5).

Four VLF electro-magnetic conductors were delineated (Figure 3).

Conductor A is a moderate conductor extending from 3+00W and 0+30S to 1+00E and 2+10S. This conductor appears to delineate the sourthern contact of the clay altered tuffs with chloritized tuffs. It may also be indicating a number of faults observed in the area.

Conductor B. is a moderate conductor extending from 4+00W and 1+10N to 2+00E and 0+50N, and may be indicating the northern contact of the clay altered tuffs and chloritized tuffs.

Conductor C is a moderate conductor extending from 3+50W and 3+50N to 0+50E and 2+50N. No cause is apparent for this conductor.

Conductor D is a very strong conductor extending from 1+00 and 3+90N to 1+50E and 3+10N. This conductor appears to delineate the contact of chloritized tuffs with unaltered tuffs.

VLF-EMR Survey

The VLF-EMR Survey indicated a number of zones of high and low apparent resistivity (Figure 6). Two distinct narrow zones of high resistivity run parallel to the baseline in the zone of clay alteration and quartz chalcedony breccia float. These two zones may by indicating quartz-chalcedony breccia zones within the clay altered zones.

CONCLUSIONS AND RECOMMENDATIONS

Geochemical soil sampling in 1982 showed the soil anomaly with values up to 890 ppb gold and 29.5 ppm silver coincides remarkably with the chalcedony-quartz breccia zones and the intense clay-pyrophyllite alteration zone. Details with respect to 1982 results can be referred to in the 1982 assessment report.

The VLF elector-magnetic survey delineated four conductors. The conductors appear to indicate the boundaries between different hydothermally altered zones and post-mineral faults.

The VLF electro-magnetic resistivity survey delineated two distinct, narrow zones of high resistivity within the clay pyrophyllite alteration zone. These probably represent chalcedony-quartz breccia zones. Significant chalcedony-quartz breccia float and outcrops are present along the trend of the resistivity high.

The above results warrant extensive and systematic drilling of the co-incidental geochemical and geophysical anomalies and chalcedony-quarz breccia zones.

Repectfully submitted,

Mohan R. Vulimiri

Mohan R. Vulimiri, B.Sc.,(Hons) M.Sc.

Grant Crooker

Grant F. Crooker, B.Sc., F.G.A.C.

REFERENCES

CRAWFORD, S.A. AND VULIMIRI, M.R. (1982) - Geological and Geochemical Report on the Wrich 1,2 and 3 claims, Omineca Mining Division.

CERTIFICATE OF QUALIFICATIONS

I, Mohan R. Vulimiri, of 1120 Heywood Street, North Vancouver, in the Province of British Columbia, hereby certify as follows:

1) I am a graduate with a B.Sc. (Hons) degree from the Indian Institute of Technology, Kharagpur.

2) I am a graduate with a M.Sc. (Economic Geology) degree from the University of Washington.

3) I am involved in mineral exploration in British Columbia, and have been since 1970, and I have acted in responsible positions since 1974.

4) I have no direct or indirect interest in the property.

Dated this 28th day of Nov., 1985, at Vancouver, in the Province of British Columbia.

Mohan Vulimiri

Mohan R. Vulimiri, B.Sc., M.Sc.
Geologist

CERTIFICATE OF QUALIFICATIONS

I, Grant F. Crooker, of Upper Bench Road, Keremeos, in the Province of British Columbia, hereby certify as follows:

1) That I graduated from the University of British Columbia in 1972 with a Bachelor of Science Degree in Geology.

2) That I have prospected and actively pursued geology prior to my graduation and have practised my profession since 1972.

3) That I am a member of the Canadian Institute of Mining and Metallurgy.

4) That I am a Fellow of the Geological Association of Canada.

5) That I have no direct or indirect interest in the property.

Dated this 28th day of Nov , 1985, at Vancouver, in the Province of British Columbia.

G. F. Crooker

Grant F. Crooker, B.Sc., F.G.A.C.
Geologist

DETAILED COST STATEMENT

WAGES

1 Geologist, G. Crooker 10 days @ $300.00 per day July 12-18, August 19-21, 1985	$ 3,000.00
1 Geologist, M. Vulimiri 11 days @ $300.00 per day July 12-18, August 19-22, 1985	3,300.00
1 Geologist, S. Keilbach 7 days @ $200.00 per day July 12-18, 1985	1,400.00

CAMP COSTS (includes groceries, camp supplies, camp equipment, radio, expediting etc.)

G. Crooker, 7 days @ $50.00 per day July 12-18, 1985	350.00
M. Vulimiri, 7 days @ $50.00 per day July 12-18, 1985	350.00
S. Keilbach, 7 days @ $50.00 per day July 12-18, 1985	350.00

TRANSPORTATION

Helicopter (Hughes 500D) 2.5 hours charter @ $450.00 per hour	1,125.00
2.5 hours fuel @ $110.00 per hour	275.00
Fixed Wing *(Smithers to Sturdee Strip) 7 days @ $72.50 per day July 12-18, 1985	507.50
Mob. and Demob.* 7 days @ $78.25 July 12-18, 1985	547.75

SUPPLIES (flagging, topofil thread, etc.) — 55.00

INSTRUMENT RENTAL

Geonics EM-16R 7 days @ $25.00 per day July 12-18, 1985	175.00

ASSAYS

4 (Au,Ag) @ $22.00 each	88.00
PREPARATION OF REPORT (secretarial, draughting, reproduction, etc.)	800.00
TOTAL	$12,323.25

* Mobilization and demobilization costs and Fixed Wing costs are pro-rated over 7 projects in the Toodoggone covering 44 days.

MIN-EN LABORATORIES LTD.
705 WEST 15TH STREET
NORTH VANCOUVER, B.C.
Phone: 980-5814

Certificate of Assay

TO: SHEILA KIELBACH

PROJECT No.

DATE JULY 27TH, 1985.

File No. SK-1

SAMPLE No.	Ag	Au		
	oz/ton	oz/ton		
WR 851	0.4	0.04		
WR 852	0.1	0.02		
WR 853	0.6	<0.01		
WR 854	0.5	0.03		

MIN-EN Laboratories Ltd.

CERTIFIED BY Randy Blaskovich

GEONICS LIMITED
1745 Meyerside Drive, Unit 8, Mississauga, Ontario, Canada L5T 1C5 Tel. (416) 676-9580 Cables: Geonics

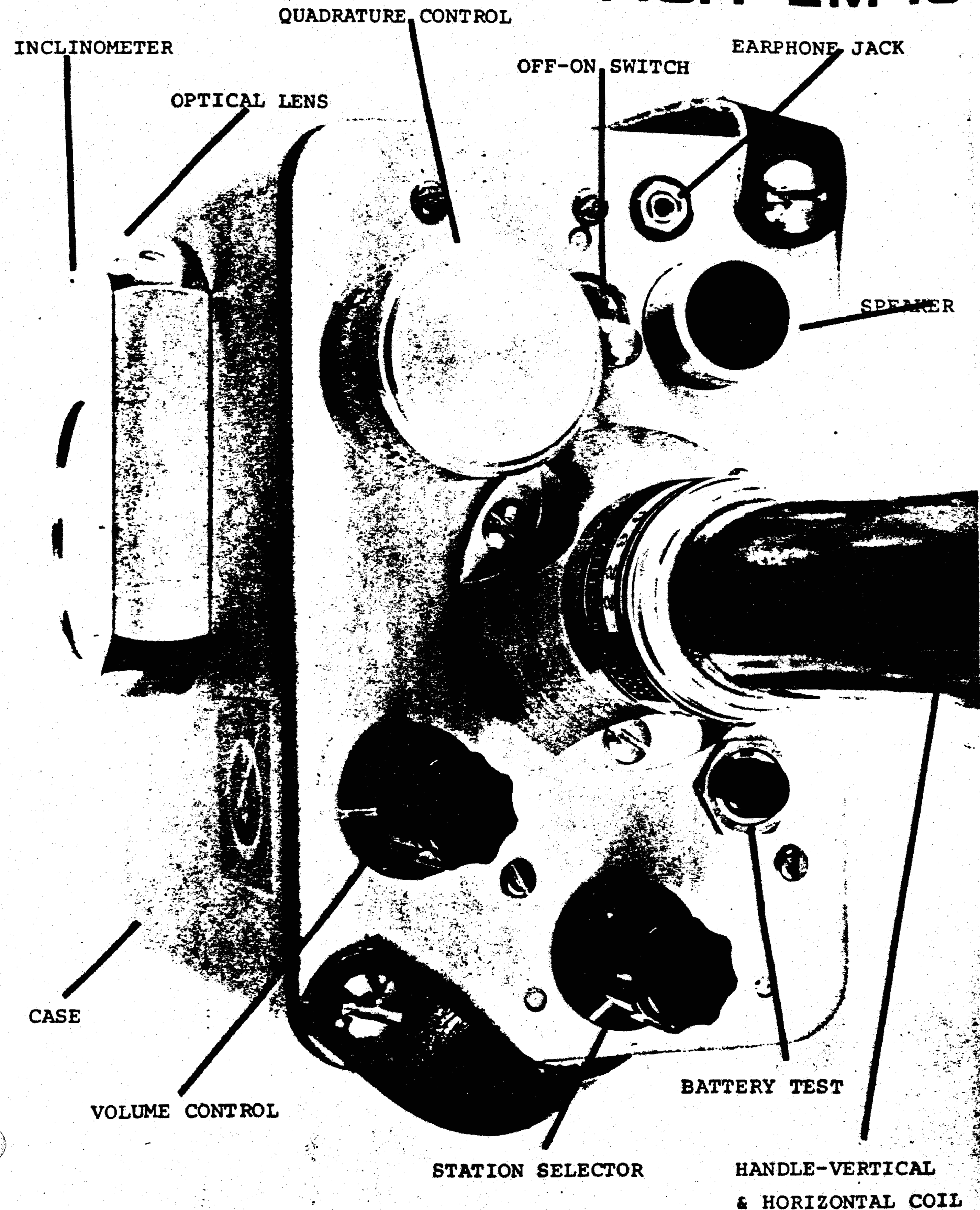
OPERATING MANUAL
for
EM16 VLF-EM

Revised Jan.1979

EM16 SPECIFICATIONS

MEASURED QUANTITY	In-phase and quad-phase components of vertical magnetic field as a percentage of horizontal primary field. (i.e. tangent of the tilt angle and ellipticity).
SENSITIVITY	In-phase :±150% Quad-phase :± 40%
RESOLUTION	±1%
OUTPUT	Nulling by audio tone. In-phase indication from mechanical inclinometer and quad-phase from a graduated dial.
OPERATING FREQUENCY	15-25 kHz VLF Radio Band. Station selection done by means of plug-in units.
OPERATOR CONTROLS	On/Off switch, battery test push button, station selector switch, audio volume control, quadrature dial, inclinometer.
POWER SUPPLY	6 disposable 'AA' cells.
DIMENSIONS	42 x 14 x 9cm
WEIGHT	Instrument: 1.6 kg Shipping : 4.5 kg

FIG. I EM 16


QUADRATURE CONTROL
INCLINOMETER
EARPHONE JACK
OFF-ON SWITCH
OPTICAL LENS
SPEAKER
CASE
BATTERY TEST
VOLUME CONTROL
STATION SELECTOR
HANDLE-VERTICAL
& HORIZONTAL COIL

PRINCIPLES OF OPERATION

The VLF-transmitting stations operating for communications with submarines have a vertical antenna. The Antenna current is thus vertical, creating a concentric horizontal magnetic field around them. When these magnetic fields meet conductive bodies in the ground, there will be secondary fields radiating from these bodies. (See Figures 3 & 4). This equipment measures the vertical components of these secondary fields.

The EM16 is simply a sensitive receiver covering the frequency band of the VLF-transmitting stations with means of measuring the vertical field components.

The receiver has two inputs, with two receiving coils built into the instrument. One coil has normally vertical axis and the other is horizontal.

The signal from one of the coils (vertical axis) is first minimized by tilting the instrument. The tilt-angle is calibrated in percentage. The remaining signal in this coil is finally balanced out by a measured percentage of a signal from the other coil, after being shifted by 90°. This coil is normally parallel to the primary field,(See instrument Block Diagram - Figure 2).

Thus, if the secondary signals are small compared to the primary horizontal field, the mechanical tilt-angle is an accurate measure of the vertical real-component, and the compensation $\pi/2$-signal from the horizontal coil is a measure of the quadrature vertical signal.

Some of the properties of the VLF radio wave in the ground are outlined by Figures 4 thru 9.

ACCOMPANYING NOTES FOR FIGURES 2 - 9

FIGURE 2 is the block diagram of the EM16. The diagram is self-explanatory. Both the coils (reference and signal coil) are housed in the lower part of the handle. The directions of the axis of the coils are as follows: The reference coil axis is basically horizontal and is kept more or less parallel to the primary field during measurement. The signal coil is at right angles to the reference coil and its axis is, of course, vertical.

The signal amplifier has the two inputs, one connected to the signal coil and one to the reference channel. By tilting the coils, the operator minimizes the signal from the signal (vertical axis) coil. Any remaining signal is reduced to zero by the quadrature control in the reference channel. The signal amplifier has zero output

SELECTION OF THE STATION

The magnetic field lines from the station are at right angles to the direction of the station. Always select a station which gives the field approximately at right angles to the main strike of the ore bodies or geological structure of the area you are presently working on. In other words, the strike of geology should point to the transmitter. (See Figure 3). Of course, ±45° variations are tolerable in practice.

Tuning of the EM16 to the proper transmitting station is done by means of plug-in units inside the receiver. The instrument takes two selector-units simultaneously. A switch is provided for quick switching between these two stations.

To change a plug-in unit, open the cover on top of the instrument, and insert the proper plug. (Figure 10) Close the cover and set the selector switch to the desired plug-in.

On the following pages is a variety of information on the most commonly used (i.e. reliable) VLF Transmitters including transmission frequency, geographical location and their scheduled maintenance periods.

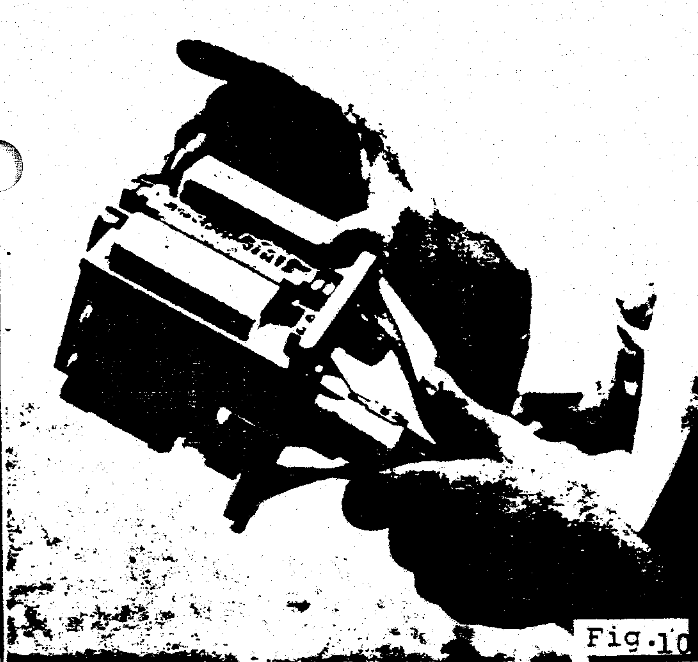


Fig.10

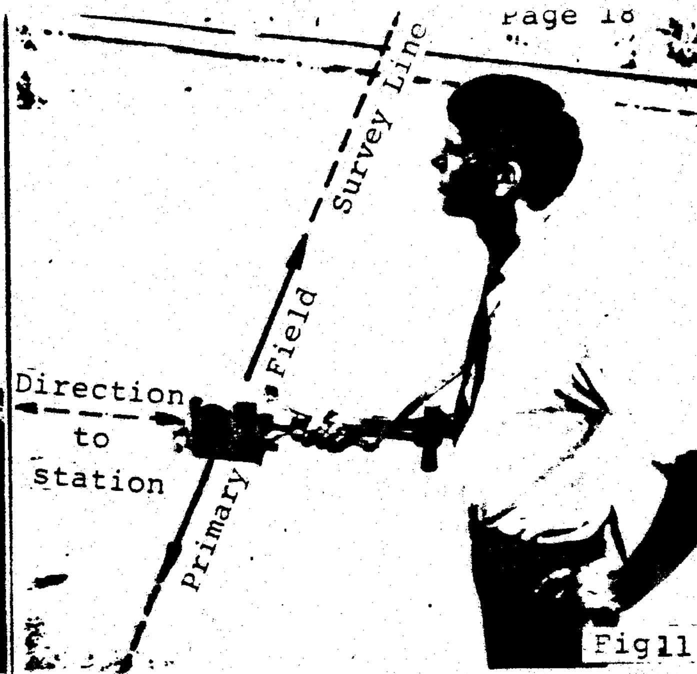


Fig 11

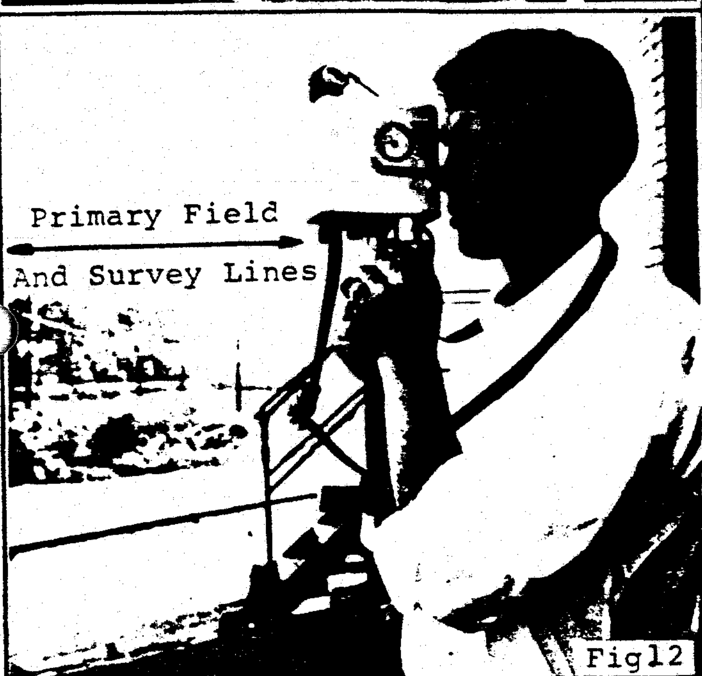
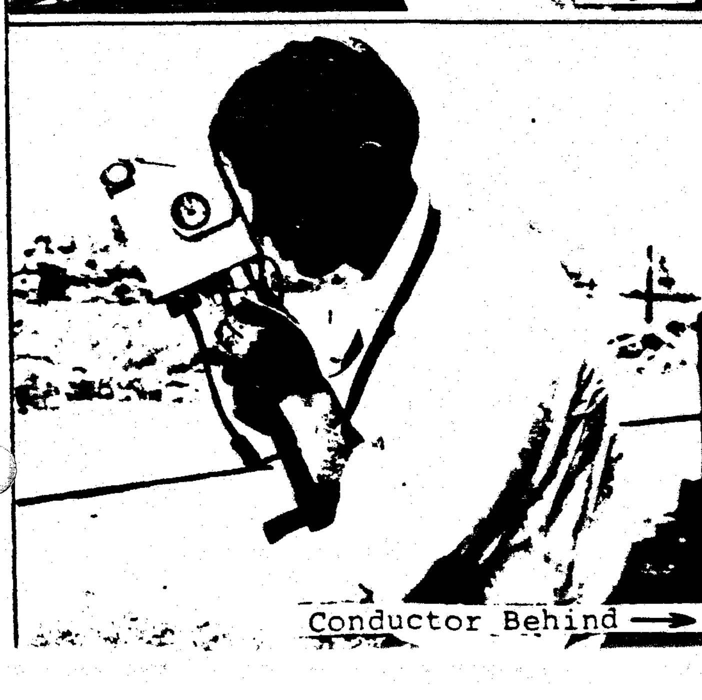
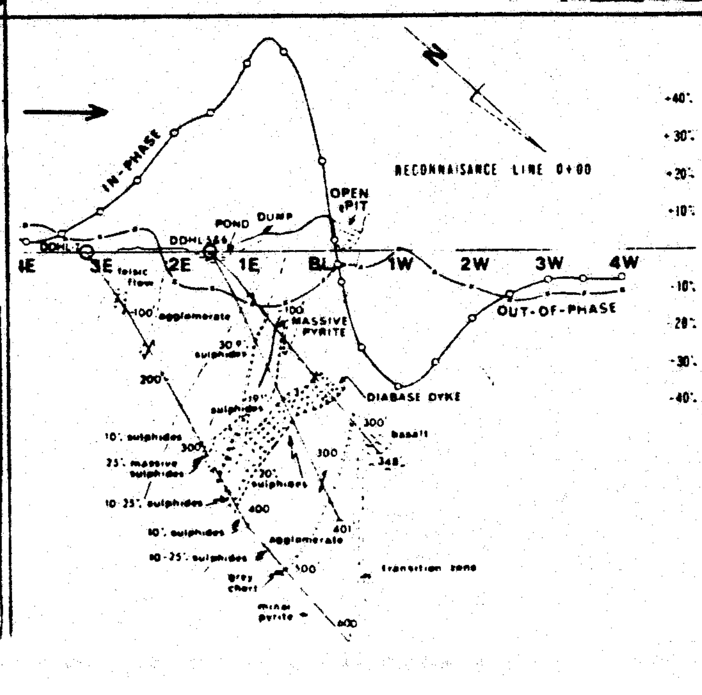


Fig 12

Fig.13





REVISED
April 2, 1982

VLF Transmitter Information

NAVY STATIONS OFF-AIR TIMES:

NAA	Schedule off 1300 to 2300 UT daily 15 Nov. through Nov. 17
NDT	Scheduled off twenty-four hours each day 28 Oct. and 29 Oct. (Local); ten hours each day Mon. through Sat. (Local) Beginning 14 Jan. 1979 at 2300 UT and ending 6 Feb. at 0900 UT; Twenty-four hours each day Mon. 0900 UT; Ten hours each day Mon. through Sat. (Local) Beginning 7 Mar. at 2300 UT and ending 13 Apr. at 0900 UT.
NPM	19 Oct. 1800 to 2158 UT Scheduled off 1800 to 0200 UT Mon. through Fri. (Local) 15 Jan. 1979 to 17 Mar.
NSS	Scheduled off 15 Oct. to 10 Nov. and 1200 to 2400 UT daily 21 Nov. through 24 Nov.
NWC	May be off intermittently untill 24 Nov.

NORMAL MAINTENANCE PERIODS:

Cutler NAA	Every Mon. 1200 to 2000 UT. If Holiday falls on Mon., maintenance will be preformed on preceding Fri.
NDT	First Thur./Fri. of month 2300 to 0900 UT, other Thur./Fri. 2300 to 0700 UT
Seattle NLK	Every Thur. 1600 to 2400 UT. During daylight saving time every Thur. 1500 to 2300 UT.
NPM	Every Wed./Thur. 1700 to 0500 UT.
NSS	Every Tues. 1200 to 2000 UT.
NWC	Every Wed. 0000 to 0800 UT.

For further information the U.S. Naval Observatory, Time Service Division, Washington D.C. may be contacted at (202) 254-4548.

REVISED
Sept. 22, 1982

The frequency of NLK is now 24.8 kHz.

FIELD PROCEDURE

Orientation & Taking a Reading

The direction of the survey lines should be selected approximately along the lines of the primary magnetic field, at right angles to the direction to the station being used. Before starting the survey, the instrument can be used to orient oneself in that respect. By turning the instrument sideways, the signal is minimum when the instrument is pointing towards the station, thus indicating that the magnetic field is at right angles to the receiving coil inside the handle.(Fig.11).

To take a reading, first orient the reference coil (in the lower end of the handle) along the magnetic lines.(Fig.12) Swing the instrument back and forth for minimum sound intensity in the speaker. Use the volume control to set the sound level for comfortable listening. Then use your left hand to adjust the quadrature component dial on the front left corner of the instrument to further minimize the sound. After finding the minimum signal strength on both adjustments, read the inclinometer by looking into the small lens. Also, mark down the quadrature reading.

While travelling to the next location you can, if you wish, keep the instrument in operating position. If fast changes in the readings occur, you might take extra stations to pinpoint accurately the details of anomaly.

The dials inside the inclinometer are calibrated in positive and negative percentages. If the instrument is facing 180° from the original direction of travel, the polarities of the readings will be reversed. Therefore, in the same area take the readings always facing in the same direction even when travelling in opposite way along the lines.

The lower end of the handle, will as a rule, point towards the conductor. (Figs.13 & 14) The instrument is so calibrated that when approaching the conductor, the angles are positive in the in-phase component. Turn always in the same direction for readings and mark all this on your notes, maps, etc.

THE INCLINOMETER DIALS

The right-hand scale is the in-phase percentage(ie.Hs/Hp as a percentage). This percentage is in fact the tangent of the dip angle. To compute the dip angle simply take the arctangent of the percentage reading divided by 100. See the conversion graph on the following page.

The left-hand scale is the secant of the slope of the ground surface. You can use it to "calculate" your distance to the next station along the slope of the terrain.

(1) Open both eyes.

(2) Aim the hairline along the slope to the next station to about your eye level height above ground.

(3) Read on the left scale directly the distance necessary to measure along the slope to advance 100 (ft) horizontally.

We feel that this will make your reconnaissance work easier. The outside scale on the inclinometer is calibrated in degrees just in case you have use for it.

PLOTTING THE RESULTS

For easy interpretation of the results, it is good practice to plot the actual curves directly on the survey line map using suitable scales for the percentage readings. (Fig.15) The horizontal scale should be the same as your other maps on the area for convenience.

A more convenient form of this data is easily achieved by transforming the zero-crossings into peaks by means of a simple numerical filtering technique. This technique is described by D.C. Fraser in his paper "Contouring of VLF-EM Data", Geophysics, Vol. 34, No. 6. (December 1969)pp958-967. A reprint of this paper is included in this manual for the convenience of the user.

This simple data manipulation procedure which can be implemented in the field produces VLF-EM data which can be contoured and as such provides a significant advantage in the evaluation of this data.

GEONICS LIMITED

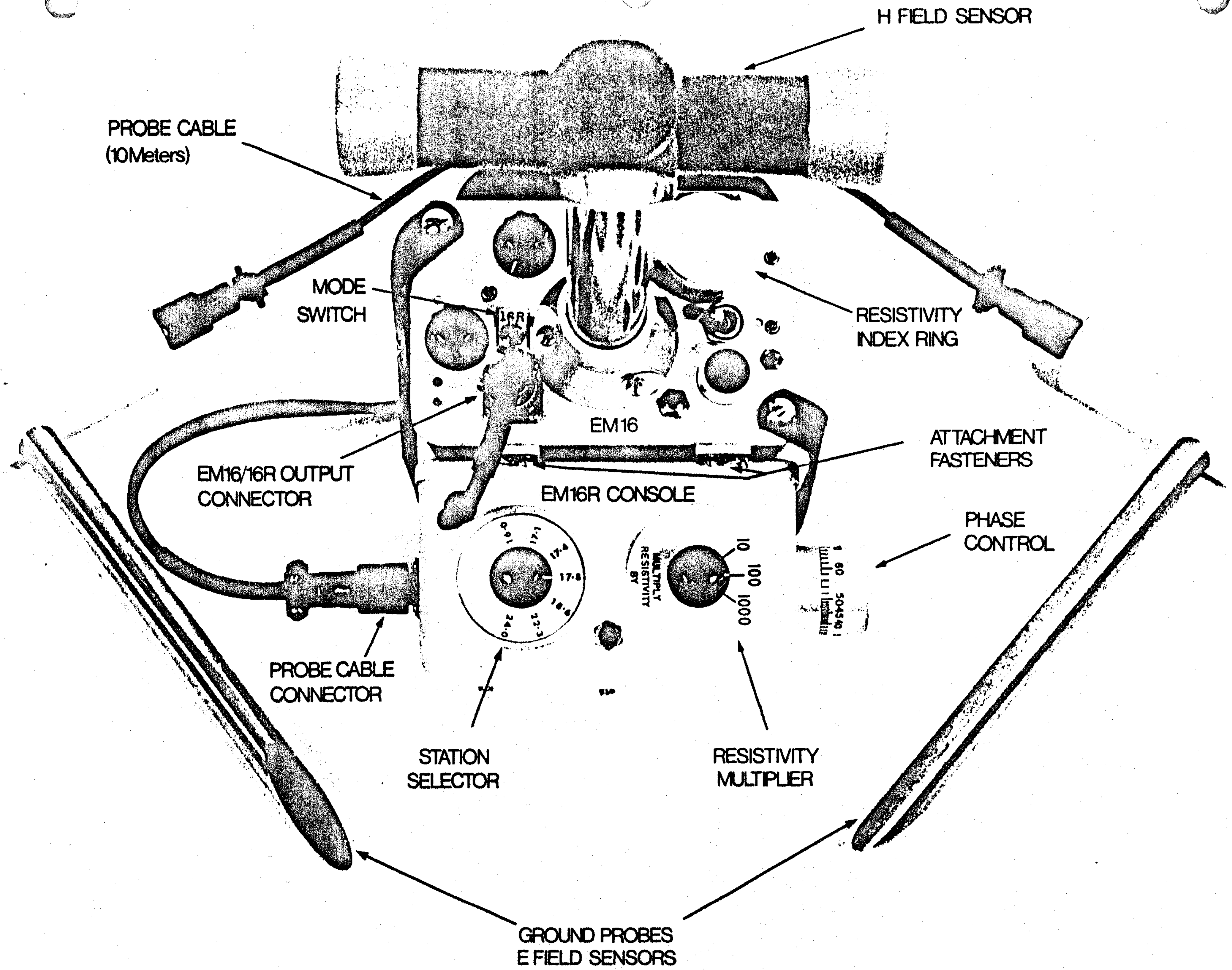
1745 Meyerside Drive, Unit 8, Mississauga, Ontario, Canada L5T 1C5 Tel. (416) 676-9580 Cables: Geonics

OPERATING MANUAL
for
EM16R VLF RESISTIVITY METER
(Attachment to EM16)

Revised Jan. 1979

EM16R SPECIFICATIONS

MEASURED QUANTITY	•Apparent Resistivity of the ground in ohm-meters •Phase angle between E_x and H_y in degrees
RESISTIVITY RANGES	• 10 - 300 ohm-meters • 100 - 3000 ohm-meters •1000 - 30000 ohm-meters
PHASE RANGE	0-90 degrees
RESOLUTION	•Resistivity: ± 2% full scale •Phase : ± 0.5^{o}
OUTPUT	Null by audio tone. Resistivity and phase angle read from graduated dials.
OPERATING FREQUENCY	15-25 kHz VLF Radio Band. Station selection by means of rotary switch.
INTERPROBE SPACING	10 meters
PROBE INPUT IMPEDANCE	100 MΩ in parallel with 0.5 picofarads
DIMENSIONS	19 x 11.5 x 10 cm. (attached to side of EM16)
WEIGHT	1.5 kg (including probes and cable)


H FIELD SENSOR
PROBE CABLE
(10Meters)
MODE
SWITCH
RESISTIVITY
INDEX RING
EM16
ATTACHMENT
FASTENERS
EM16/16R OUTPUT
CONNECTOR
EM16R CONSOLE
PHASE
CONTROL
PROBE CABLE
CONNECTOR
STATION
SELECTOR
RESISTIVITY
MULTIPLIER
GROUND PROBES
E FIELD SENSORS

FIELD PROCEDURE

1. Mounting of The EM16R Console To The EM16 Unit

Align the EM16R console, in respect to the EM16 cover, so that the station selector on the console is close to the EM16R output receptacle on the EM16 control plate. See photograph on facing page.

To mount the console on the EM16 use 4 stud fasteners.

To connect the EM16 console with the EM16 electrically, plug the EM16R console output plug in the corresponding receptacle on the EM16 control panel.

2. Orientation

The instrument measures resistivity along a line in the same direction as the station. After a VLF transmitting station has been selected EM16 is used to determine the direction to the transmitter.

The MODE selector switch is thrown to EM16, and the QUADRATURE/RESISTIVITY dial is turned to zero. With the two receiver coils in the handle of the EM16 in a horizontal plane, with the EM16R unit underneath, turn the whole instrument in a horizontal plane until the station signal goes to null. At this time the long axis of the EM16 handle (signal coil) is pointing towards the station, and the short axis (reference coil) is maximum coupled to the magnetic field. Switch mode to EM16R.

The EM16 QUADRATURE Knob zero line is used as a cursor for the EM16R RESISTIVITY Index ring, and the EM16R RESISTIVITY Index ring zero line is the cursor for the EM16R QUADRATURE Knob.

All EM16 calibrations are in black, all EM16R calibrations are in red.

3. Taking a Reading

To take a reading, orient the unit so that the shorter handle arm is at the right angle to the direction of the station and in the horizontal plane, as described in 2.

For convenience and stability the instrument can be laid on the ground during the reading, with the EM16R console beneath. Connect the probes to the EM16R console receptacle through the 10 meters long probe cable.

Ensure that the station selector switch on the EM16 and EM16R are both turned to the desired station frequency.

Push the probes into the ground 10 metres apart in the direction of the station, that is to say aligned with the long axis of the handle. The cable end with a red marker sleeve goes to the probe nearest the top of the EM16 instrument case, the unmarked cable goes to the probe off in the direction of the EM16 coil handle. Set the resistivity multiplier switch to x1000 position, rotate the EM16R RESISTIVITY CONTROL (same knob as for QUADRATURE when using EM16) for minimum sound intensity in the speaker.

Turn the phase control knob on the EM16R console to further minimize the sound.

Resistivity is read from the position of the red zero line on the quadrature dial against the red numerals on the index ring. Multiply by 1000 in this case to obtain actual resistivity in ohm meters.

If the number on the resistivity index ring is 3 or less, use a lower resistivity multiplier scale and re-do the nulling procedure.

The x10 resistivity multiplier scale should be used in the case of a resistivity reading of 300 ohm meters or less.

Record the phase angle by which the measured electrical field component leads the reference magnetic field component. This is 45° for homogeneous conditions, as when the depth of the layer being measured is more than one or two skin depths. When a lower layer more resistive is present the phase angle will generally decrease, and increases when a more conductive layer is present.

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Paper 75-1 Part A

Report of Activities April - October 1974

64.

VLF RESISTIVITY (RADIOHM) SURVEY, AGRICOLA LAKE AREA, DISTRICT OF MACKENZIE

Project 670041

W.J. Scott
Resource Geophysics and Geochemistry Division

Introduction

During the last week of July 1974, a VLF resistivity survey was carried out over the Agricola Lake massive sulphide prospect. Measurements were made along the soil survey lines (Cameron, this publication, report 55, Fig. 1) using the Radiohm technique (Collett and Becker, 1968). In this technique, the apparent resistivity of the earth is determined by a magnetotelluric measurement of the radiated field from a remote radio transmitter.

The quantities measured are the horizontal components of the radial electric field (E_x) and the tangential magnetic field (H_y), and the phase difference between E_x and H_y. A value for apparent resistivity is derived from the approximate expression:

$$\rho a = \frac{1}{\mu \ \omega} \left| \frac{Ex}{Hy} \right|^2$$

ρa = the apparent resistivity in ohm-metres

where μ = the magnetic permeability of the medium (assumed = $4 \pi \times 10^{-7}$ Henrys per metre)

ω = the angular frequency of the signal $2 \pi f$, where f is the frequency in h_z

The instrument used in this survey was a Geonics EM16R, which obtains H_y by means of an integral coil and E_x by means of two ground probes spaced 10 m apart. The measurement is made by orienting the instrument so that the coil is maximally coupled to H_y (determined from an audio signal) and inserting the two ground probes along the direction indicated by the

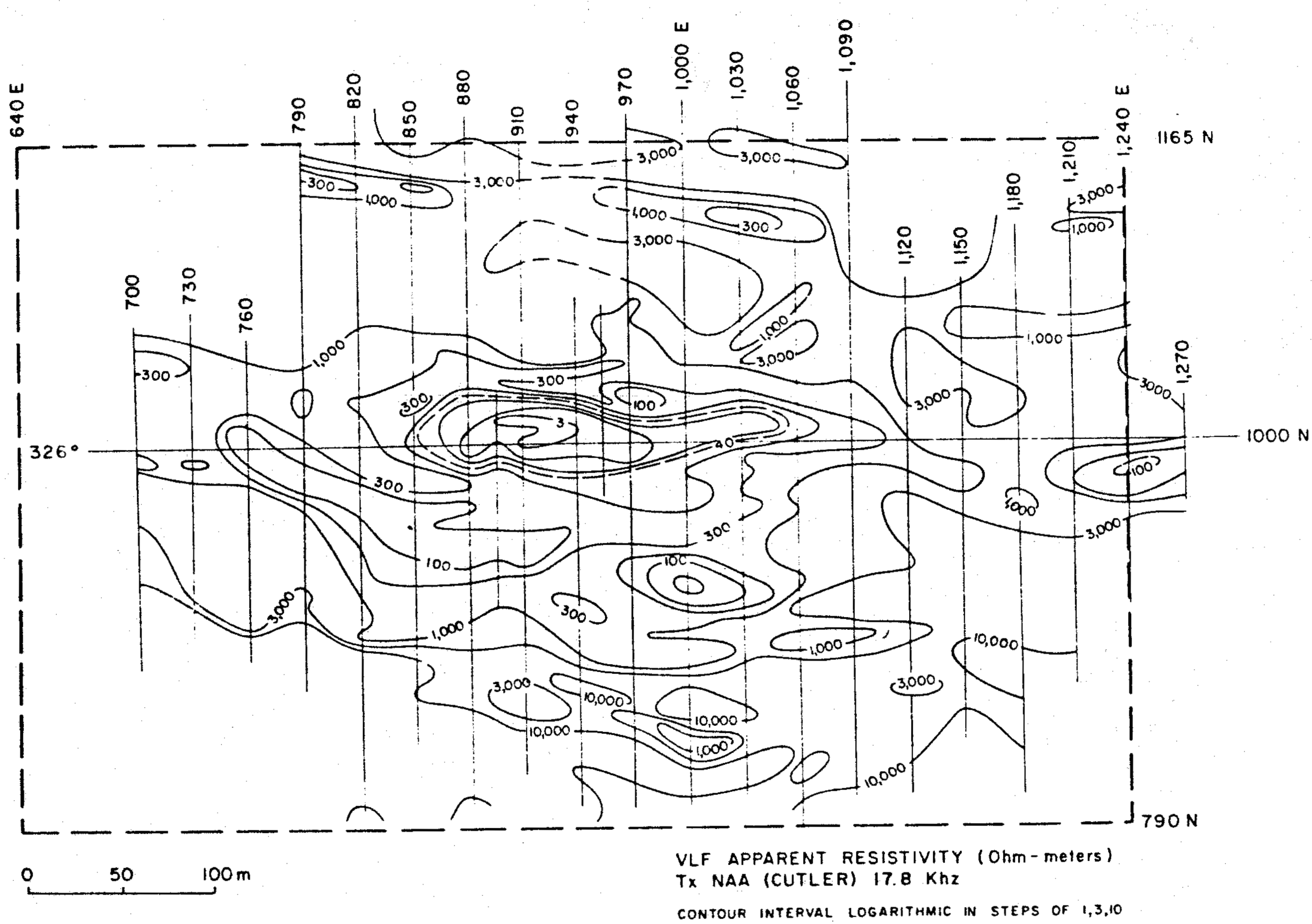

Figure 1. Contour map of VLF apparent resistivity, Agricola Lake massive sulphide prospect, N.W.T.

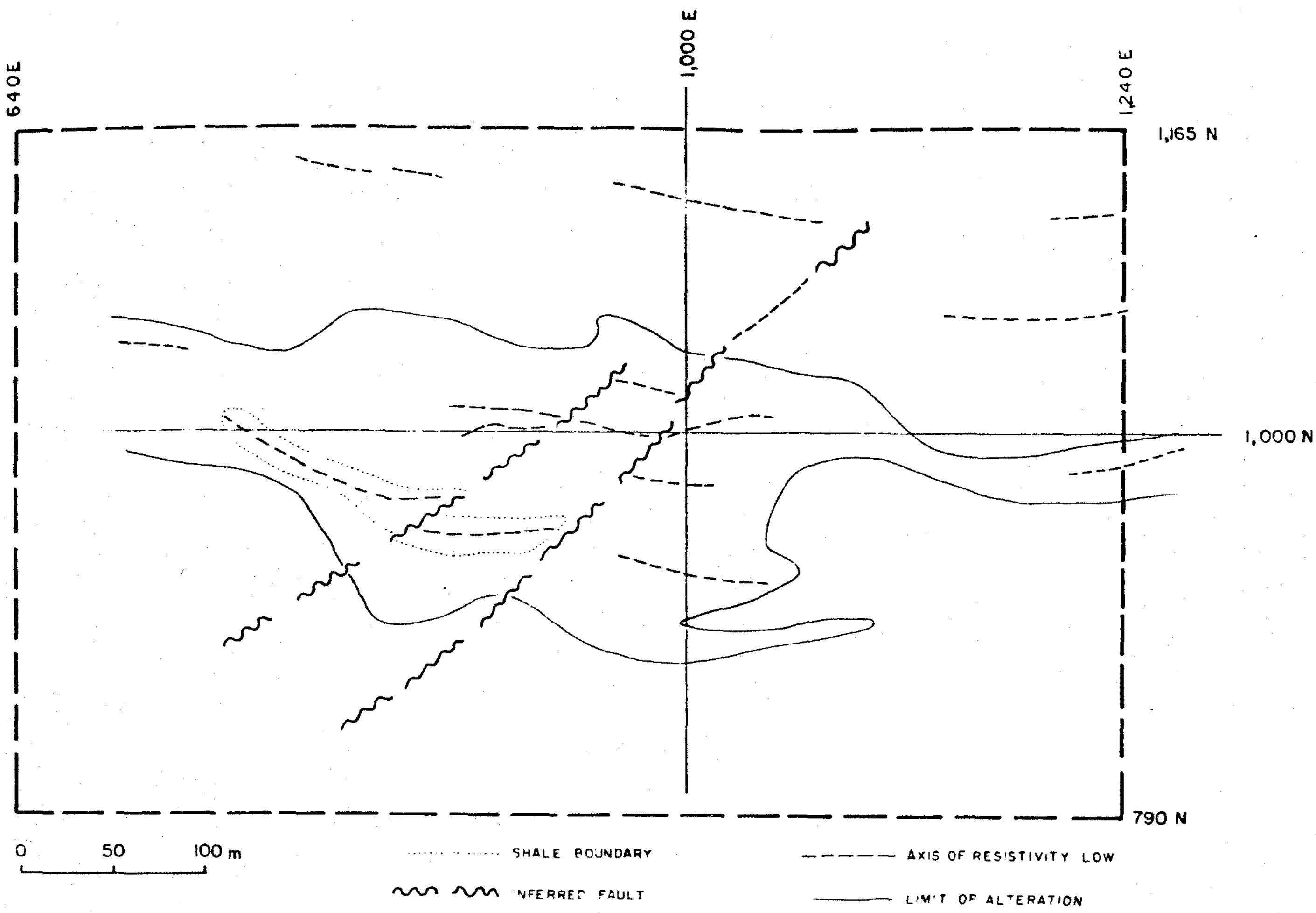

Figure 2. Geological interpretation of VLF apparent resistivity data, Agricola Lake massive sulphide prospect, N. W. T.

instrument orientation. After the audio signal is nulled by means of two controls, the phase angle and apparent resistivity values can be read directly from the instrument. The apparent transmitter azimuth may be determined from the orientation of the instrument.

For the present survey the signal utilized was from NAA, Cutler, Maine, at a frequency of 17.8 Kh_z. The transmitter azimuth was approximately parallel to the base line of the survey grid.

During four and a half field days some 900 measurements of resistivity, phase angle and transmitter azimuth were made by a crew of two, augmented at times by a third man to speed the work on rough ground. The readings were taken at intervals of 15 m on grid lines spaced at 30 m. When adjacent readings varied by a factor of 1.5 or more, intermediate readings were taken.

Results

Figure 1 shows a contour map of apparent resistivities obtained on the grid lines indicated: Figure 2 shows an interpretation based on these data. For purposes of clarity the grid lines are defined to run north-south, and the baseline east-west (true bearings notwithstanding). Directions referred to in this paper are understood to be grid directions.

The observed variation of apparent resistivities agrees in general with the preliminary geological interpretation of (*see* Cameron, op. cit., Fig. 2). In the northern part of the grid, apparent resistivities from 1000 to 4000 ohm-m reflect the presence of acid and intermediate volcanics, whose southern boundary agrees on the whole with the 1000 ohm-m contour.

Rather higher resistivities in the southern part of the grid correlate with a further sequence of acid and intermediate volcanics. In the south-central area, the 1000 ohm-m contour agrees with the northern limit of the volcanics. In the southeast, however, the resistivity data suggest that the unaltered volcanics may extend farther west beneath thin overburden, than indicated by the geological map.

The central area of low resistivity (less than 1000 ohm-m) in general coincides with the area mapped as hydrothermally altered volcanics. Within this zone are several prominent lows. Lying on the baseline from 850 E to 1060 E is a pronounced low, whose outline as shown by the dashed 40-ohm-m contour (Fig. 1) agrees with the part of the boundary of a massive sulphide zone indicated by diamond drilling by the

Yava Syndicate (Northern Miner, August 15, 1974). A small low at 990 N, 1240 E coincides with high metal values in the soil, and may be an extension of the main sulphide body.

The low trending southeast from 760 E on the baseline to 940 N, 940 E crosses a shale unit indicated by the presence of shale fragments in frost boils. In view of the lack of outcrop it is possible that the geology could be re-interpreted to place the shale member under this low as suggested in Figure 2. The results of a magnetic survey on the same grid (Kornik, this publication, report 62) support this interpretation. The low at 925 N, 1000 E appears from the magnetics not to be an extension of this feature, and may indicate a further concentration of sulphides.

The weak east-west low from 960 E to 1080 E at 1120 N coincides with rocks mapped as rusty-weathering intermediate volcanics; it is probable that the westward extension of the feature from 790 E to 870 E indicates the presence of more of this unit. A similar low from 1140 E to 1240 E at about 1060 N may also be associated with such a rock unit.

The traces of two faults trending northeast-southwest (Fig. 2) are picked on the basis of aberrations in the resistivity contours and offsets in the axes of low trends. Further faulting could probably be inferred as well, but would best be done on the basis of a combined interpretation of all the geophysical results. The two faults shown, however, are also indicated by the magnetic data (Kornik, op. cit.).

Discussion and Conclusion

Despite the fact that the area is well within the zone of continuous permafrost (Brown, 1967) there is a wide variation in apparent resistivities. For metallic sulphide mineralization this is to be expected, but it is less obvious that frozen rocks should exhibit such variation. Spot measurements on shale outcrops to the north of the grid give resistivities ranging from 10 to 200 ohm-m, while some measurements on outcrop within the zone of alteration yielded values of a few hundred ohm-m. It is reasonable to suppose that such low resistivities are the result of clay minerals in the rock, with the resultant retention of some pore water in the fluid phase, despite ground temperatures significantly below $0^{o}C$.

In the unaltered volcanics, however, particularly to the south, quite wide variations in resistivity did not appear to be related to known rock types, and subdivision of the volcanics on the basis of resistivity would at the present time appear unreliable. It is possible that further work, including laboratory measurements of resistivities at low temperatures, may clarify this problem.

The phase angle and azimuth data taken in this survey have not been shown, because they contain peculiarities which are difficult to interpret. Phase angles are theoretically limited to the range from 0 to 90 degrees, yet at a number of stations, particularly at the west end of the baseline, values much greater than 90 degrees were recorded. Strong variations were observed in the apparent azimuth of the transmitter, as indicated by the direction of H_y. It is probable that these variations are the result of the presence of a strong linear conductor in a region of generally high resistivity. It is hoped that further study will identify the cause of this variation.

The major disadvantage of VLF Radiohm measurements is the lack of penetration through any thickness of conductive overburden. In this study area, however, overburden was generally thin. There appeared to be no significant correlation of resistivity variation with the presence or absence of overburden.

The concept of Radiohm measurements, as embodied in the Geonics EM16R, is extremely useful, particularly in difficult conditions such as experienced at this site. Even in permafrost regions, there appears to be some utility in resistivity mapping as an aid to geological work.

Acknowledgments

The help of D. Eberle (Geological Survey of Germany), A. Williams (GSC), J. Williams (DOE) and Jim Thomas (GSC) in carrying out the field work is gratefully acknowledged.

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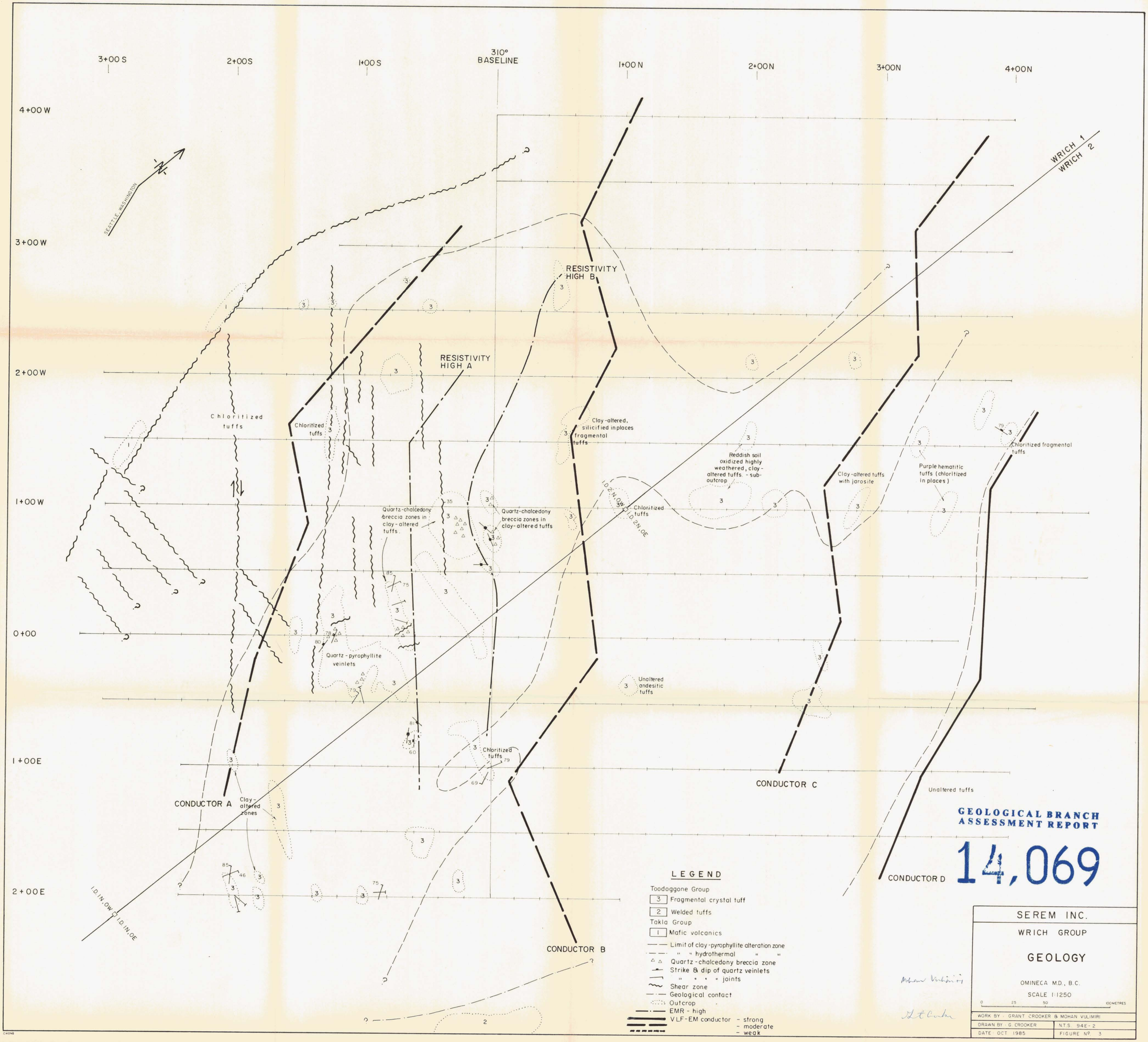

GEOLOGICAL BRANCH
ASSESSMENT REPORT

14,069

SEREM INC.

WRICH GROUP

GEOLOGY

OMINECA M.D., B.C.

SCALE 1:1250

0 25 50 100 METRES

WORK BY : GRANT CROOKER & MOHAN VULIMIRI

DRAWN BY : G. CROOKER | N.T.S. 94E-2

DATE: OCT 1985 | FIGURE No. 3

3+00S
2+00S
1+00S
310°
BASELINE
1+00N
2+00N
3+00N
4+00N
4+00W
3+00W
2+00W
1+00W
0+00
1+00E
2+00E
SEATTLE, WASHINGTON
WRICH 1
WRICH 2
I.D.2N,OW
I.D.2N,OE
I.D.IN,OW
I.D.IN,OE
CONDUCTOR A
CONDUCTOR B
CONDUCTOR C
CONDUCTOR D
INSTRUMENT : GEONICS EM-16R
TRANSMITTER : NLK - 24.8 KHz , SEATTLE, WASHINGTON
STATION
GEOLOGICAL BRANCH
ASSESSMENT REPORT
14,069
SEREM INC.
WRICH GROUP
VLF - EM SURVEY
FRASER FILTER DATA
OMINECA M.D., B.C.
SCALE 1:1250
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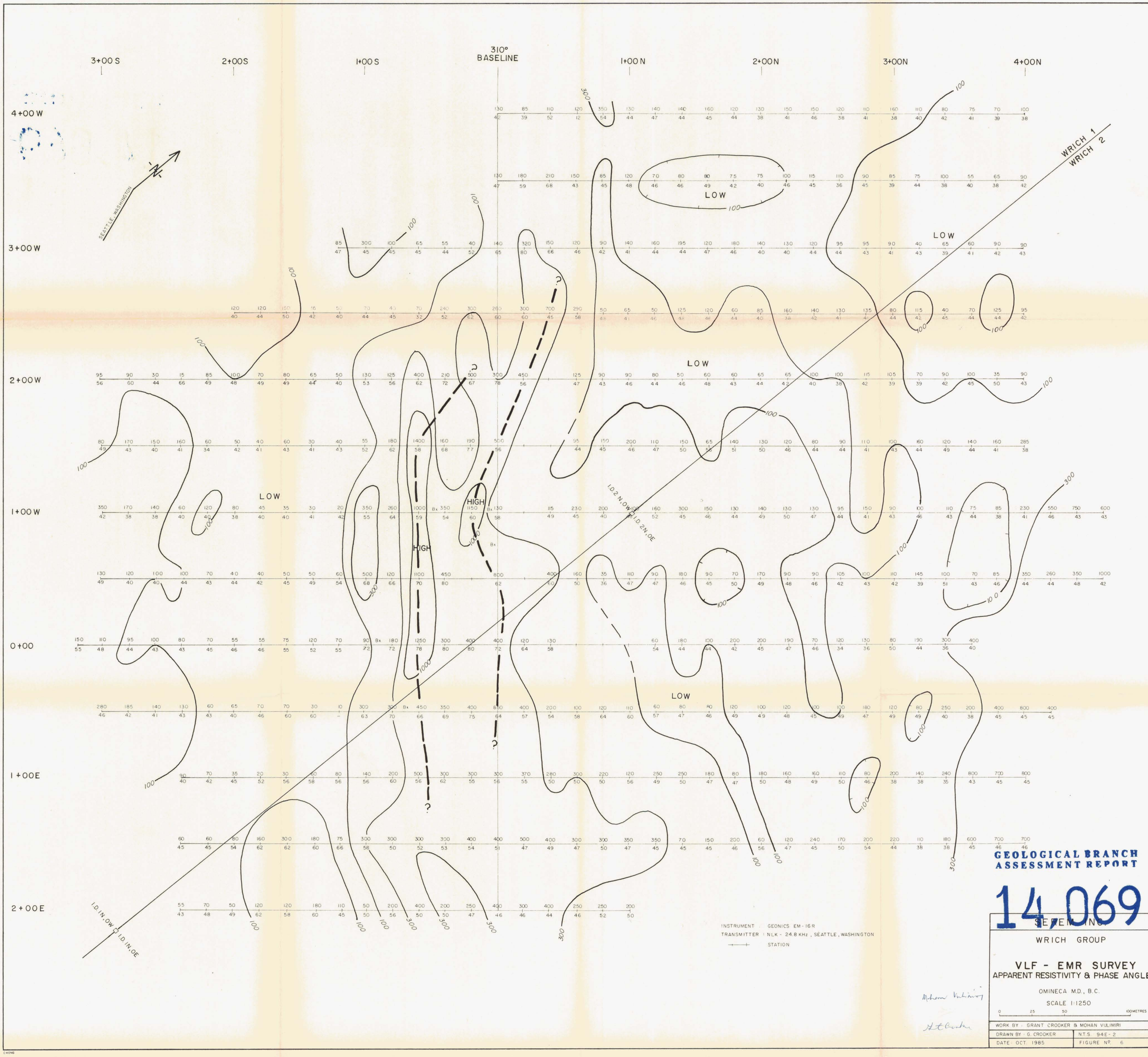
100METRES
WORK BY : GRANT CROOKER & MOHAN VULIMIRI
DRAWN BY : G. CROOKER
N.T.S. 94E-2
DATE : OCT. 1985
FIGURE Nº. 5



3+00 S
2+00S
1+00 S
310°
BASELINE
1+00 N
2+00N
3+00N
4+00N
4+00 W
3+00 W
2+00 W
1+00 W
0+00
1+00E
2+00E
SEATTLE, WASHINGTON
WRICH 1
WRICH 2
LOW
HIGH
I.D.2N.OW
I.D.2N.OE
I.D.IN.OW
I.D.IN.OE
INSTRUMENT : GEONICS EM-16R
TRANSMITTER : NLK - 24.8 KHz , SEATTLE, WASHINGTON
STATION
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ASSESSMENT REPORT
14,069
WRICH GROUP
VLF - EMR SURVEY
APPARENT RESISTIVITY & PHASE ANGLE
OMINECA M.D., B.C.
SCALE 1:1250
0
25
50
100METRES
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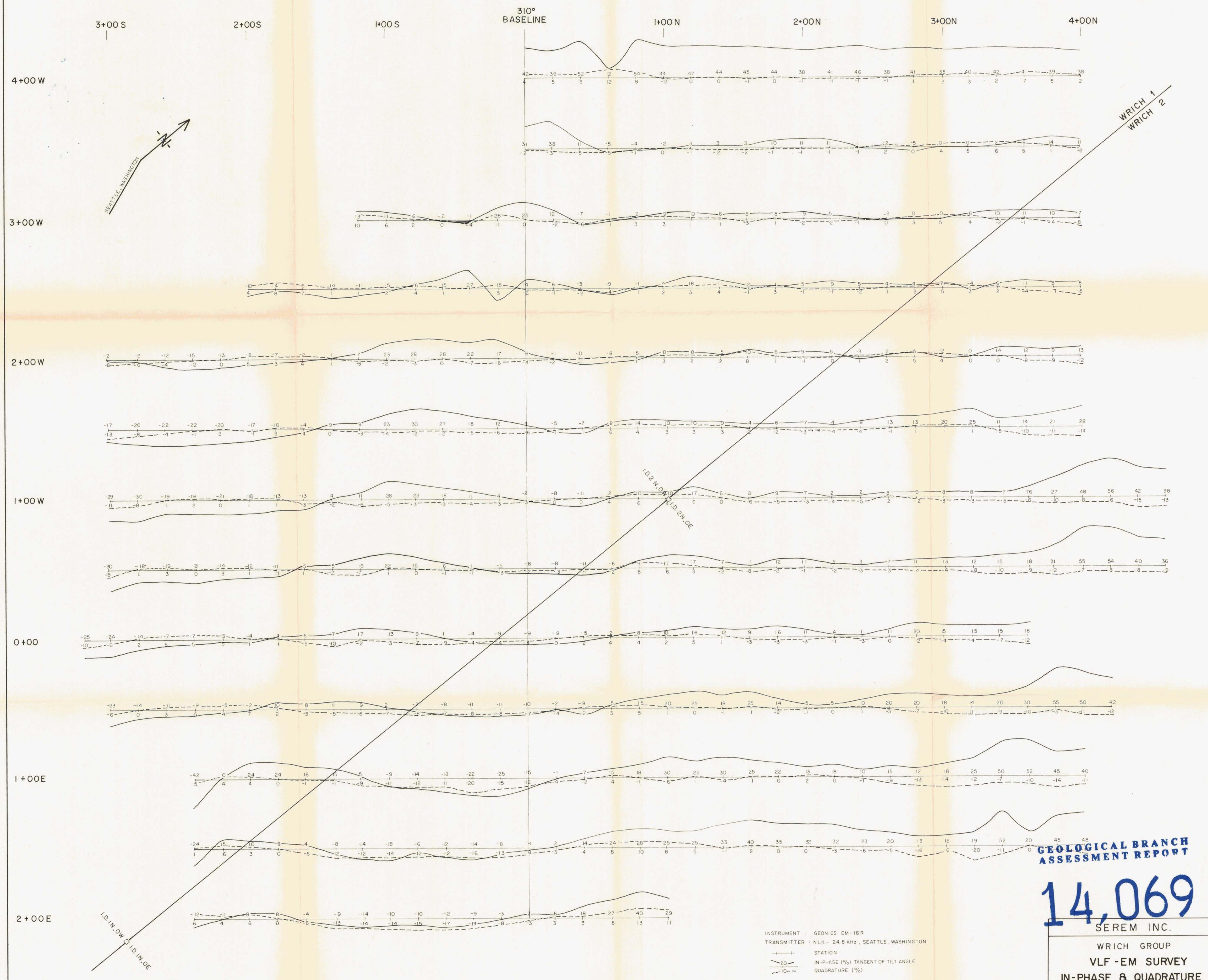
DATE : OCT. 1985
FIGURE Nº. 6



INSTRUMENT : GEONICS EM-16R

TRANSMITTER : NLK - 24.8 KHz , SEATTLE, WASHINGTON

STATION

20 IN-PHASE (%) TANGENT OF TILT ANGLE

-10 QUADRATURE (%)

50%

0 VERTICAL SCALE 1cm = 25%

-50%

GEOLOGICAL BRANCH
ASSESSMENT REPORT

14,069

SEREM INC.

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VLF-EM SURVEY

IN-PHASE & QUADRATURE DATA

OMINECA M.D., B.C.

SCALE 1:1250

0 25 50 100METRES

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DRAWN BY : G. CROOKER	N.T.S. 94E-2
DATE : OCT. 1985	FIGURE Nº. 4