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**GEOPHYSICAL-GEOCHEMICAL REPORT**

**on**

**INDUCED POLARIZATION, VLF-EM AND SOIL SAMPLE SURVEYS**

**SOPHIA CLAIM**

**SOPHIA LAKE, NICOLA M.D., B.C.**

| | | |
|---|---|---|
| Property | : | 22 kms, N10E of the Town of Merritt and 9 kms S40E of the south end of Mamit Lake. |
| | : | $50^{0}120^{0}$S.W. |
| | : | N.T.S. - 92I/7E |
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GEOTRONICS SURVEYS LTD.
Engineering & Mining Geophysicists
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## SUMMARY

Soil sampling and VLF-EM surveys were carried out over the Sophia Lake property of Lakewood Mining Co. Ltd (NPL) during September 1977, and an induced polarization survey during August, 1978. The property is located on and around Sophia Lake, 22 kms northerly of Merritt, British Columbia. Access to the property is gained by a dirt road leaving the Merritt-Logan Lake gravel road and can be driven by two-wheel drive vehicle. The terrain consists mainly of lightly forested grasslands with slopes that are mainly gentle. The object of the surveys was to locate economic sulphide mineralization as is found on nearby Swakum Mtn. or the Tolman Lake property.

The work to date prior to the staking of the Sophia Claim has consisted of trenching.

The property is underlain by a sequence of limestone, argillite, greywacke, conglomerate and andesite porphyry, of the Nicola Group which is Upper Triassic in age. Possibly a dioritic intrusive also occurs on the property.

Mineralization occurs as pyritization and associated sphalerite, galena and chalcopyrite in the north trench zone. Pyrite was also encountered in drill hole No. 2, and galena and sphalerite within drill hole No. 3.

The government aeromagnetic map shows three lineations, one quite strong that strike through the property and are suggestive of regional faults. There is also a small high that may be reflecting the diorite intrusive(?) which Sookochoff noted.

The VLF-EM readings and soil samples were taken every 100 feet on 400-foot separated lines. The VLF-EM readings were Frazer-filtered, plotted, and contoured. The soil samples were tested for lead, zinc, copper, silver and tungsten and the results plotted, statistically analyzed, and contoured.

The I.P. survey, frequency domain, was done with a dipole length, dipole separation, and readings taken every 50 meters. The resistivity and metal factor values were calculated, and these along with the frequency effect, were statistically analyzed, plotted and contoured.

## CONCLUSIONS

1. The property is favourable to the possibility of it containing a body of economic mineralization for the following reasons:-

   a) Limestone is known to occur on the property. This rock type along with greenstone are hosts to sulphides on the Swakum deposits.

   b) An aeromagnetic high of low intensity occurs on the Sophia Claim and may reflect a diorite intrusive(?) as noted by Sookochoff. This high could be related to the Swakum Mtn. high of much greater intensity which is interpretted to reflect an intrusive associated with the Swakum Mtn. deposits.

   c) Three aeromagnetic lineations interpretted to be faults cross in the area of Sophia Lake.

   d) Copper, lead, zinc, silver, gold and tungsten mineralization occur only two kms to the southwest on Swakum Mtn. Copper, lead, zinc and silver mineralization occur only two kms west around Tolman Lake.

e) Much pyritization and minor galena, sphalerite and chalcopyrite occur on the Sophia Claim.

2. The VLF-EM has revealed several conductors on the property ranging in strength from weak to moderate. The strike is mainly northeasterly, but is also northerly.

   The conductors are likely faults, shear zones and contacts.

3. The soil sample results appear to occur in at least six zones.

4. Of the soil sample results (done on only three lines), there is fairly good correlation between the lead and zinc anomalies which is not unexpected. There is also a good correlation between the silver and copper anomalies suggesting tetrahedrite to be the causitive source. The tungsten anomalies correlate only in a minor way with the copper anomalies.

5. Some of the geochemistry anomalies correlate with the VLF-EM conductors indicating some of the mineralization to be structure (probably shear zones) related.

6. The most interesting I.P. results occur on the northwestern part of the survey area where no soil sample results are available. Anomaly A is composed of two separate anomalies that may be reflecting pyritization surrounding an economic sulphide body. Anomaly B correlates with known pyritization and associated base metal sulphides. Considering the number of I.P. anomalies within the northwest section, and considering the fact that they at least reflect pyrite, this area is quite amenable to the possible location of base metal sulphides.

7. Anomaly C, correlating excellently with a resistivity low (i.e. metal factor high) occurs between the east and west sections of geochemistry anomaly 6 and probably is caused by an associated body of pyrite.

8. Anomaly D and an associated smaller anomaly correlates with lead geochemistry results, and to a lesser extent, with zinc, copper, and silver geochemistry results.

RECOMMENDATIONS

The results to date are very positive and definitely warrant further exploration as follows:

1. Soil Geochemistry - the rest of the survey grid should be soil sampled so that I.P. anomalies A, B, C (northern part), E and F are covered by the soil survey. The sampling interval is probably adequate at 25 meters on the 120-meter separated lines, but, considering the possible low ion mobility, it is preferable to sample every 12.5 meters on 60-meter separated lines. The samples should be assayed for at least copper and zinc, and preferably lead and silver as well. Silver and copper correlate together so well that analysis for silver could be dispensed with. However, considering the small additional cost and that extra information is gained, silver analysis is recommended, in any case.

   Considering the high cost of the tungsten analysis, it is recommended not to analyze for tungsten. It may prove useful at a later date, however, and, therefore, the samples should be kept for at least two years.

2. I.P. Survey - This should be continued in all directions, considering that I.P. anomalies are open on all sides of the grid. Any new areas of I.P. surveying, of course, should also be covered by soil sampling and VLF-EM surveys. The I.P. survey parameters should be kept as is, that is, a dipole length, separation, and reading interval of 50 meters, unless the overburden depth is expected to be greater than 15 meters, then 100 meters.

3. Diamond Drilling - As of now, there are definite drill targets on soil anomalous zones 1, 2, 4, possibly 5, and 6. The IP anomalies not covered by the soil sampling could be drilled as well, especially anomaly A east. However, the location of drill targets could be decided more intelligently after the soil sampling is carried out.

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INDUCED POLARIZATION

VLF-EM AND SOIL SAMPLE SURVEYS

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## INTRODUCTION AND GENERAL REMARKS

This report discusses the survey procedure, compilation of data, and the interpretation of an induced polarization (I.P.) survey, a very low frequency electromagnetic (VLF-EM) survey and a soil sampling survey over the Sophia Claim in the Mamit Lake area of the Nicola Mining District.

The VLF-EM survey was carried out by Quilum Explorations Ltd of Sechelt, B.C. for Lakewood Mining during the first part of September, 1977. A report was written on the results along with magnetic survey results by John B. Davies and subsequently submitted for assessment credits. The writer, however, has re-interpretted the results and, therefore, included them in this report.

The soil sampling was carried out in the latter part of September, 1977 by Quilum Explorations Ltd. for Lakewood Mining on only three lines resulting in a total number of samples of 144. These were subsequently tested for lead, zinc, silver, copper and tungsten.

The induced polarization survey was carried out by personnel of Lakewood Mining during August, 1978.

The purpose of carrying out the various surveys was to locate probable zones of economic sulphide mineralization. The soil sampling, hopefully, should reflect the mineralization directly. The purpose of the VLF-EM survey was to locate the mineralization directly as well as to locate structure associated with sulphide mineralization. That of the I.P. survey was to locate fracture-filling or disseminated (i.e. non-massive) sulphides which could mean locating pyritization associated with the economic sulphide mineralization.

## PROPERTY AND OWNERSHIP

The property is comprised of one 20-unit claim as shown on Figure 1 and as described below:

| Claim Name | Tag No. | No.Units | Record No. | Expiry Date |
|---|---|---|---|---|
| Sophia | 34090 | 20 | 176(9) | Sept 10/78 |

Two years have been applied from the I.P. survey, which, if accepted, will give a new expiry date of September 10, 1980.

The claim is owned by Lakewood Mining Co.Ltd of Vancouver, British Columbia.

## LOCATION AND ACCESS

The claim is located on the north-western flank of Swakum Mountain, 22 air kilometers N10°E of the town of Merritt and four miles S25°E of the south end of Mamit Lake.

The geographical coordinates are 50° 18.5' north latitude and 120° 44'W longitude.

Access is easily gained by two-wheel drive vehicle. One travels northwest for about three miles towards Spences Bridge, along Highway No. 8 out of Merritt to the northerly-running Logan Lake gravel road. One then goes up this road for about 19 kms. to just past Tolman Creek where there is an easterly-running dirt road. The property is about 10 kms.up this road.

## PHYSIOGRAPHY

The Sophia Lake property lies within the physiographic division known as the Thompson Plateau which is part of the Interior Plateau system. The Thompson Plateau is typified by gently rolling upland of low relief, for the most part lying between 1,200 and 1,500 meters, but with prominences of more resistent rock rising above it such as Swakum Mountain at 1,723 meters. The plateau is cut by numerous creeks and rivers producing steep-sided valleys and gorges.

The above description is very typical of the property which has an elevation varying from about 1,460 meters a.s.l. to 1,560 meters a.s.l. to give a relief of 100 meters. The terrain is largely flat to gently rolling.

The vegetation could be considered open-forested grassland with the trees being pine, fir and spruce. In some areas there is a number of deadfalls.

Water is plentiful on the property with there being at least three lakes, (2 small ones in the southwest corner), one of which is Sophia Lake, and connecting streams.

## HISTORY OF PREVIOUS WORK

Prior to the staking of the claim (1976), trenching was done on the property at a time unknown to the writer. Also, three shallow holes were diamond drilled by Lakewood Mining earlier in 1978.

## GEOLOGY

According to the G.S.C. map of the area, the property is underlain only by the Upper Triassic Nicola Group of rocks. These are comprised of greenstone, andesite, basalt, agglomerate, breccia tuff, minor argillite, limestone and conglomerate.

The closest intrusive is the Guichon Creek Batholith which is of Upper Triassic to Middle Jurassic Age and which is less than 7 kms. to the west. It is composed of acidic intrusives, the main ones being quartz monzonite, granodiorite, and quartz diorite.

The geology of the property hasn't been mapped, though L. Sookochoff, geological engineer, has spent about a day on the property. In the area of the trenches just east of the baseline on lines D and E, he noted a contact (northeast striking?) between limestone to the east and argillite to the west as well as some base metal mineralization. In the second set of trenches 200 meters west of the baseline on lines G and H, Sookochoff noted what appeared to be an intrusive diorite with associated pyritization.

There are many occurrences of mineralization throughout the area within the Nicola rocks. The best known and closest are those on Swakum Mountain centering about 2 kms. to the southeast of the legal claim post. The G.S.C. shows six different deposits on its maps. They all occur as veins, disseminations and replacement deposits in limestone and greenstone which are interbedded with each other. The ore minerals generally consist of galena, sphalerite, chalcopyrite, pyrrhotite, pyrite and tetrahedrite in most of the deposits as well as scheelite in one of the deposits. All of the deposits carry significant values in gold and silver.

An exploration program is apparently going to be undertaken shortly on these deposits.

About two kms. to the west of the Sophia claim is the Tolman Lake property held by Ruskin Developments Ltd. Work on this property has consisted of trenching, adit work, drilling, VLF-EM surveying, and soil sampling. Within two occurrences, the mineralization occurs as sphalerite, chalcopyrite, galena, and pyrite, with silver values which is found in a zone of brecciated and bleached andesite, with quartz and calcite forming the matrix. The third occurrence is more of the vein-type but contains the same minerals.

AEROMAGNETIC INTERPRETATION

The aeromagnetic survey was flown by the Lockwood Survey Corporation Ltd from June to September, 1967 for the governments of both British Columbia and Canada. It was flown at a terrain clearance of 1,000 feet on east-west lines at about one-half mile apart.

The magnetic expression for the area on and around the property is rather typical of the Nicola volcanics. It consists of small, low-intensity magnetic highs and lows, varying from 2,480 gammas to 2,850 gammas. A local exception is a 3,700-gamma high found two kms. to the S.W. on Swakum Mountain. This high likely reflects an intrusive associated with the deposits of Swakum Mountain. What could be associated with this high is a small high of 2,770 gammas found on the Sophia Claim.

Of particular interest to this property are three aeromagnetic lineations that cross in the area of Sophia Lake. These strike N30W, N30E, and easterly. These lineations are very likely regional faults.

The lineations are shown on Figure 2.

## VLF-EM SURVEY

### 1. Instrumentation and Theory:

A VLF-EM receiver, Model 27, manufactured by Sabre Electronic Instruments Ltd, of Burnaby, B.C. was used for the survey. This instrument is designed to measure the magnetic component of a very low frequency (VLF) electromagnetic field. The U.S. Navy submarine transmitter located at Seattle, Washington and transmitting at 18.6 KHz, was used.

In all electromagnetic prospecting, a transmitter produces an alternating magnetic field (primary) by a strong alternating current usually through a coil of wire. If a conductive mass such as a sulphide body is within this magnetic field, a secondary alternating current is induced within it which in turn induces a secondary magnetic field that distorts the primary magnetic field. It is this distortion that the EM receiver measures. The VLF-EM uses a frequency range from 16 to 24 KHz., whereas most EM instruments use frequencies ranging from a few hundred to a few thousand KHz. Because of its relatively high frequency, the VLF-EM can pick up bodies of a much lower conductivity and therefore is more susceptible to clay beds, electrolyte-filling fault or shear zones and porous horizons, graphite, carbonaceous sediments, lithological contacts as well as sulphide bodies of too low a conductivity, for other EM methods to pick up.

Consequently, the VLF-EM has additional uses in mapping structure and in picking up sulphide bodies of too low a conductivity for conventional EM methods and too small for induced polarization (in places it can be used instead of I.P.). However, its susceptibility to lower conductive bodies results in a number of anomalies, many of them difficult to explain and, thus, VLF-EM preferably should not be interpreted without a good geological knowledge of the property and/or other geophysical and geochemical surveys.

2. Survey Procedure:

A baseline, running N20E was chained, compassed and marked every 100 feet by flagging tape through the center of the property. The survey lines were run S70E at 400-foot intervals and were chained, compassed and marked every 100 feet by flagging as well. Readings by the VLF-EM receiver were taken every 100 feet with the instrument facing towards the transmitter at Seattle.

A magnetic survey was carried out at the same time but the results were not available to the writer. Apparently the magnetic expression was very flat.

3. Compilation of Data:

The readings were reduced by the writer by applying the Frazer filter. Filtered data, as shown on Figure 4, are plotted between the reading stations. The positive filtered values were contoured at intervals of $4^{\circ}$.

The Frazer filter is essentially a 4-point difference operator which transforms zero crossings into peaks, and a low-pass smoothing operator which reduces the inherent high frequency noise in the data. Therefore, the noisy, non-contourable data are transformed into less noisy, contourable data. Another advantage of this filter is that a conductor that does not show up as a cross-over on the unfiltered data quite often will show up on the filtered data.

## SOIL GEOCHEMISTRY SURVEY

1. Survey Procedure:

The soil samples were taken at each spot where VLF-EM readings were taken, that is, every 100 feet on 400-foot lines but only on lines C, D, and E. The samples were taken with an auger and the horizon sampled was B, the colour of which varied from dark brown to light brown to red. The depth the sample was taken from was about 30 cms. Samples were placed in brown wet-strength paper bags with grid co-ordinates marked thereon.

2. Testing Procedures:

All samples were tested by Vangeochem Lab Ltd. of North Vancouver, B.C. The sample is first thoroughly dried and then sifted through an -80 mesh screen. A measured amount of the sifted material is then put into a test tube with subsequent measured additions of a solution of perchloric and nitric acid. This mixture is next heated for a certain length of time. The parts per million (ppm) copper, lead, zinc, silver or tungsten is then measured by atomic absorption.

3. Treatment of Data:

The values in ppm copper, tungsten and zinc were grouped into logarithmic intervals of 0.10, silver, 0.05, and lead, 0.075. The cumulative frequency for each interval of each element was then calculated and then plotted against the correlating interval to obtain the logarithmic cumulative frequency graphs as shown on Figure 2.

The coefficient of deviation, indicative of the range or spread of values was calculated for silver, lead, zinc and copper to be 0.13, 0.11, 0.16, and 0.18 respectively, all somewhat low figures. Therefore, the range of values is rather narrow. This statistical parameter is indicative of how well the element has been mechanically or chemically dispersed. Considering the lower than average value, one could then say the dispersion rate for each element is rather low. This is unusual for zinc which is generally moderately high but may be limited by organic activity and coprecipitation with limonite.

In contrast, the coefficient of deviation for tungsten is calculated to be 0.31 indicating the dispersion rate to be relatively high.

Other statistical parameters are taken from the graph. The mean background value is taken at the 50% level. The sub-anomalous threshhold value (a term used by the writer to denote the minimum value that is not considered anomalous but still important as an indicator of mineralization) is taken at one standard deviation from the mean background value which is at the 16% level. The anomalous threshold value is two standard deviations away at the 2½% level.

The parameters taken from the graph are as follows: (values are in parts per million)

| | Lead | Zinc | Silver | Tungsten | Copper |
|---|---|---|---|---|---|
| Mean background value | 14 | 54 | 0.7 | 10 | 23 |
| Sub-anomalous thresh-hold value | 18 | 78 | 0.95 | 21 | 35 |
| Anomalous threshhold value | 23 | 110 | 1.3 | 43 | 53 |

The lead, zinc, silver, copper and tungsten values were plotted on Figures 5 to 9 respectively at a scale of 1:3000 (1 cm - 30m). The values were then contoured at an interval of one standard deviation beginning at the sub-anomalous threshhold value. This contour was dashed in whereas the anomalous contours were drawn in solid.

## INDUCED POLARIZATION SURVEY

### 1. Instrumentation and Theory:

The induced polarization equipment used was frequency-domain type manufactured by Sabre Electronic Instruments Ltd. of Burnaby, B.C. A 12-volt lead-acid battery was used for a power source to give a power potential of 500 watts.

The transmitter output voltage is 125, 250, 375, or 500 volts with selection by a switch. The transmitter current varies up to 1,000 milliamperes. The self-potential buckout is operated manually by a 10-turn precision pot with a range of $\pm$ 1 volt.

There are basically two methods of I.P. surveying, frequency-domain and time domain. Both methods are dependent upon a current flowing across an electrolyte-electrode interface or an electrolyte-clay particle interface, the former being called electrode polarization and the latter being called membrane polarization.

In time-domain electrode polarization, a current is caused to flow along electrolyte-filling capillaries within the rock. If the capillaries are blocked by certain mineral particles that transport current by electrons (most sulphides some oxides, graphite), ionic charges build up at the particle-electrolyte interface, positive ones where the current enters the particle, and negative ones where it leaves. This accumulation of charge creates a voltage that tends to oppose the current flow across the interface. When this current is stopped the created voltage slowly decreases as the accumulated ions diffuse back into the electrolyte. Thus is produced the induced polarization effect.

In membrane polarization a similar effect occurs. A charged clay particle attracts opposite charged ions from the electrolyte in the capillary around the particle. If a current is forced through the capillary, the charged ions are displaced.

When the current is stopped, the ions slowly diffuse back to the same equilibrium state as before the current flow. This explains I.P. anomalies where no metallic-type minerals exist.

Frequency-domain I.P. is based on the fact that the resistance produced at the electrolyte-charged particle interface decreases with increasing frequency. Two parameters commonly used for measuring frequency-domain induced polarization are frequency effect and metal factor (as in this survey). The one used for time-domain measurements is chargeability.

In the process of carrying out an I.P. survey, two other geophysical methods are used and measured. These are self-potential (S.P.) and resistivity. The S.P. must be nulled by the I.P. receiver in order to obtain accurate I.P. measurements and is a measure of the 'battery action' of the ground. The resistivity value is calculated from the voltage and current readings obtained while measuring the I.P. effect and therefore can be utilized to determine how resistive (or conductive) the ground is.

2. Survey Procedure:

The dipole-dipole array was used with an electrode spread (or dipole length) of 50 meters at only the first separation (n = 1). The two frequencies used were 0.3 Hz and 10Hz.

Non-polarizing, unglazed porcelain pots with a copper electrode and copper sulphate electrolyte were used for the potential electrodes. Stainless steel stakes were used for the current electrodes.

Readings were taken every 50 meters on 120-meter separated lines trending N70W-S70E. The I.P. grid is somewhat different from the EM-soil sampling grid. The lines are fairly close to being the same but a new baseline was put in add the stations were flagged at 25 meter intervals.

3. Compilation of Data:

The three types of data, described as follows, were plotted on survey plans at a scale of 1:3000.

1. Percent frequency effect (Figure 10) - this is the actual measure of the induced polarization effect in a frequency domain survey. The term is derived from the percentage change in the electrode-electrolyte transfer impedance at the two different frequencies. A disseminated sulphide body would cause a large change. This property is measured directly in the field.

   The frequency effect data were statistically analyzed by grouping it into logarithmic intervals of 0.10 and plotting these on a graph as shown on Figure 3.

   The threshhold values were determined as follows:

| | |
|---|---|
| Mean background value (50%) | 6.2% |
| Possibly anomalous level 1/2 standard deviation below 50% (31%) | 8.2% |
| Probably anomalous level (or sub-anomalous) 1 standard deviation below 50% (16%) | 10.8% |
| Definitely anomalous level 2 standard deviation below 50% (2½%) | 18.5% |

   The data were plotted on Figure 10 and contoured with 8, 10, 18 and 32% contours. The 8% contour was dotted in, the 10%, dashed, and the 18 and 32% contours drawn in solid.

2. Resistivity (Figure 11) - this is a measure of how resistive, or inversely, how conductive the overburden and/or bedrock is. Most often a disseminated sulphide body is expressed by a resistivity low. The resistivity values in ohm-meters

were arrived at by dividing the receiving voltage by the transmitter current and multiplying by 942 (a geometric factor peculiar to the dipole-dipole array with a dipole length of 50 meters and a dipole separation of n = 1).

The resistivity data was also statistically analyzed by grouping it into logarithmic intervals of 0.10 and plotting it on a graph (Figure 3). Unlike the I.P. data, the resistivity lows are primarily of importance. The parameters were determined as follows:

| | | |
|---|---|---|
| Anomalous threshhold low value-2 standard deviations above 50% | (97½%) | 40 ohm meters |
| Sub-anomalous threshhold low value-1 standard deviation above 50% | (84%) | 90 ohm meters |
| Mean background value | (50%) | 220 ohm meters |
| Sub-anomalous thresh-hold high value-1 standard deviation below 50% | (16%) | 510 ohm meters |
| Anomalous threshhold high value-2 standard deviations below 50% | (2½%) | 1200 ohm meters |

The resistivity data were plotted on Figure 11 and contoured with the 60 and 100 ohm-meter contours drawn in solid 500, 1200, 2800 and 6600 ohm meter contours dashed in. This gives a contour interval of 1 standard deviation. The background contour was not drawn in.

3. Metal factor (Figure 12) - this commonly used parameter was devised to show the correlation between I.P. results and resistivity results since often the causitive sources of I.P. anomalies such as disseminated or fracture-filling sulphide bodies have a low resistivity. This is caused by the sulphides themselves or electrolyte-filled fractures so often associated with a sulphide body.

It is arrived at by dividing the I.P. value by the resistivity value and multiplying by 1000. As a result, it is not a measure of any one physical property but a combination of two.

The metal factor data were statistically analyzed the same way as the metal factor data to give the statistical parameters as follows:

| | |
|---|---|
| Mean background value | 25 |
| Sub-anomalous threshhold value | 60 |
| Anomalous threshhold value | 140 |

The data were plotted on Figure 12 and contoured at an interval of one standard deviation. The sub-anomalous contour of 60 was dashed in whereas the anomalous contours were drawn in solid.

4. Compilation Map (Figure 13)
This map was drawn to show the correlation of the different surveys. The VLF-EM anomalies are shown drawn as a solid line which reflects the center of the anomalies. All the other results, lead, zinc, silver, copper, tungsten, I.P. and resistivity, are shown by the sub-anomalous contours.

## DISCUSSION OF RESULTS

1. VLF-EM
Largely because the writer chose to contour down to $0^{o}$ there are numerous anomalies as shown on the VLF-EM survey map (Figure 4). The main strike of these anomalies is primarily northeasterly and, secondly, northerly. The causitive source, in all probability is structure such as fault, shear, fracture or contact zones including the weak anomalies outlined only by the 0-degree contour. This was found to be the case on the VLF-EM survey done over the Tolman Lake property to the west.

For ease in identification, especially in correlating with the soil geochemistry and I.P. results, the anomalies (which could be called conductive zones) have been labelled by the small letters, a to p.

The long, linear anomalies, such as g, j, m, n, and possibly p, are quite likely due to fault zones. These are sometimes related to mineralization as was found on the Tolman Lake property where long linear anomalies correlated directly with the zones of mineralization.

Anomaly l correlates directly with a zone of pyritization, which, as is shown, has been trenched.

Anomaly n could well be caused by the contact between limestone and argillite. The writer is unsure of where the contact occurs but it probably runs northerly through the trenches. If this is the case, then anomaly n is offset to the east of the contact and then may be caused by an associated fault or shear zone.

Some of the VLF-EM anomalies correlate quite well with the soil geochemistry results as well as the I.P. results. These will be discussed below.

2. Soil Geochemistry:

The soil sampling was done only on lines C, D, and E, and not east of about 450E. This, therefore, limits the correlation with the geophysical results to these three lines.

It appears, looking at the compilation map (Figure 13), that all of lines C, D, and E are anomalous in at least one metal. However, it must be remembered that the metal ions will spread out from their causitive source and therefore reflect a larger area of mineralization than is actually the case, even though on this property the ion mobility of copper, lead, zinc and silver is fairly low. There are also many one-value anomalies that are anomalous in only one or two metals and these have a tendency of ''cluttering up'' the compilation map.

Therefore, looking carefully at the soil geochemistry anomalies, they can be divided into at least six anomalous zones on the basis of strength, size, and correlation. These are labelled by the numbers 1 to 6. All of the zones are open in at least one direction and, therefore, giving the size of the zone is usually of no value.

Zone 1 is primarily a lead anomaly and as such can be divided into two main zones, east and west. It is also anomalous, in mainly sub-anomalous values, in zinc, silver, and copper. Zone 1 west reaches a high of 72 ppm lead and is open to the north, south and west.

Zone 1 east reaches a high of 81 ppm lead, 137 ppm zinc, and 87 ppm copper and is open to the north and south.

The lead, zinc and copper anomalies trend in a very definite northerly direction and are very linear in shape. (To see this in the lead anomalies, see the lead survey plan). This, coupled with the fact that the anomalies correlate with VLF-EM anomalies, c, d, e, and f, which also strike mainly in a northerly direction, suggest that the causitive sources are shear zone related.

Zone 1 east correlates with an I.P. anomaly open to the west. Zone 1 west was not covered by the I.P. survey.

Zone 2 is a correlation of all five metals that were tested as well as VLF-EM anomaly h, a 1-value I.P. anomaly, and a resistivity high. The 5 metals, in order of importance and with the highest value in brackets are copper (87 ppm), silver (1.7 ppm) tungsten (170 ppm), zinc (127 ppm) and lead (20 ppm). The strike is very definitely N20E and it is open to both the north and south. The lineal shape as well as its correlation with VLF-EM anomaly h suggest, like Zone 1, the causitive source is shear-zone related. The resistivity high (1- value) occurs on the western side of the VLF-EM anomaly. The resistivity high may be reflecting a different rock-type,or, simply bedrock occurring close to the surface.

Zone 3 is considered a minor anomaly since it is a correlation of four metals with I-value highs. It contains the highest lead value of 265 ppm which occurs on line D. The other three metals are copper (57 ppm), silver (1.2 ppm), and zinc (92 ppm) and these occur only on line C. There is also a correlation with VLF-EM anomaly i.

Zone 4 is primarily anomalous in copper (105 ppm) and silver (1.8 ppm) followed by lead (20 ppm). There is no correlation with VLF-EM or I.P. anomalies though VLF-EM anomalies k and j flank the northeastern and southwestern sides. The strike of Zone 4 averages N20E with it being open mainly to the north.

Zone 5 is primarily a large tungsten anomaly containing several anomalous values, two of which are 100 ppm. It is open mainly to the south and appears to strike N20E as well. VLF-EM anomaly j occurs on the western side and, m, on the eastern side. Zone 5 correlates with a 1-value I.P. anomaly as well as being open towards a major resistivity low to the south.

Zone 6 is quite possibly the most interesting zone. It, like Zone 1, is composed of an eastern section and a western section. These two sections are separated by an I.P. high/resistivity low trending in a northeasterly direction. Zone 6 probably occurs within limestone.

Zone 6 west is composed of five metals in order of importance, tungsten (150 ppm), zinc (115 ppm), silver (1.4 ppm) copper (50 ppm) and lead (20 ppm). This zone was partially drilled by D.D.H. #2 (about 200 feet at $-45^{o}$) which encountered much pyritization, and which according to Sookochoff, didn't go deep enough. The strike appears to be N20E and it is open to the north.

Zone 6 is a correlation of all the metals except tungsten. In order of importance, they are zinc (184 ppm), lead (32 ppm), silver (1.2 ppm) and copper (42 ppm). The strike is probably about N10E with the anomaly being open to the north.

VLF-EM anomalies n and p occur on the western and eastern edges respectively, showing that the causitive source, like all the others, is structure related.

Additional comments on the soil geochemistry survey are as follows:
The copper and silver anomalies correlate together the best suggesting quite strongly that the causitive source is tetrahedrite.

Zinc and lead, in general, correlate fairly well together, which is usually the case.

The tungsten anomalies occur primarily by themselves, but its best correlation appears to be copper. Interestingly, almost all the tungsten anomalies, no matter what size, appear to correlate with a VLF-EM anomaly.

3. <u>I.P.-Resistivity</u>
From the point of view of the IP results, the most interesting area is the northwestern section of the survey grid because of the numerous I.P. values. Sookochoff noted what could be a dioritic intrusive in this area and associated sulphides may be what is causing the higher number of anomalous values.

Anomaly A is the strongest I.P. anomaly of the survey. It is composed of two sections that come together to the south in a V. The western section strikes N20W, is 450 meters long by 70 meters wide, and reaches a high of 15%. The eastern section strikes northerly, is 80 meters wide by at least 360 meters long being open to the north, and has a high of 40%, the highest on the property.

Zone A east correlates excellently with a resistivity low resulting in a very high metal factor anomaly (Figure 11) making it the most interesting I.P. anomaly of the survey. The causitive source is in all likelihood sulphides which is probably pyrite and possibly other sulphides. Considering the shape and strength of the anomaly, the causitive source is probably close to the surface with overburden depth in the area of ten meters.

Zone A west has partial correlation with the resistivity results resulting in a metal factor anomaly of sub-anomalous values only on line H.

Both sections of anomaly A may be reflecting the outer edges of a mineralized zone resulting in a mineral body with a diameter in the order of at least 200 meters (it is open to the north). This quite often occurs, especially in the case of porphyry copper ore bodies, where the I.P. highs reflect pyritization on the perimeter of the main body of ore. This could also be said of zone A east outlining a body of economic mineralization with anomaly B or any of the 1-value I.P. highs within this area.

Anomaly B has a diameter of about 200 meters and reaches a high of 21%. The metal factor contours suggest it strikes N20E and is connected to the I.P. high on Line D to the south.

This anomaly correlates with a well-known zone of pyritization that has been trenched.

Zone C consists of two I.P. highs which the metal factor values suggest are of the same zone. The zone strikes northeasterly and has a length of over 600 meters. The I.P. anomalies reach a high of 12.5% but the metal factor anomaly reaches a high of 1250, which is the highest on the property, largely because of the correlating very low resistivity value of 10 ohm-meters.

As mentioned previously, zone C occurs between the east and west sections of soil geochemistry anomaly 6. Very possibly the I.P. high is reflecting a heavy zone of pyritization associated with the economic sulphides.

Anomaly D occurs on the western edge of the survey grid and therefore is open to the west. It reaches a high of only 11.5% but correlates very well with soil geochemistry Zone 1, especially the lead results. No metal factor anomaly occurs here since the anomaly D correlates with a resisitivity high, which possibly may reflect an intrusive. The intrusive could also possibly be an explanation for the soil geochemistry highs (i.e. the anomalous soil values are a result of an increase in background). However, the lead values are too high to be explained as such.

Anomalies E and F occur on the eastern edge of the survey grid, strike northeasterly and are open to the east. Like Zone A, anomaly E coupled with Zone C could be reflecting the perimter of a body of mineralization. This may appear to be an outside possibility, but it is a possibility that should be kept in mind.

Considering it is quite likely that the I.P. anomalies reflect pyritization, it is quite possible that there is associated gold values.

The resistivity results of an I.P. survey are primarily of interest where the resistivity lows correlate with I.P. highs. Here the resistivity low is caused by the sulphide mineralization and/or electrolyte-filled fractures associated with the sulphide zone.

Resistivity lows can also be caused by swamps. This may be the case with the survey's largest resistivity low at the southern edge of the grid since it occurs next to Sophia Lake.

Quite often resistivity results are simply a reflection of the overburden thickness with the resistivity highs reflecting thin overburden and resistivity lows reflecting thick overburden.

As mentioned earlier, resistivity highs can also reflect intrusives, especially in a sedimentary bedrock environment.

Respectfully submitted,
GEOTRONICS SURVEYS LTD.,

David G. Mark
Geophysicist

October 18, 1978

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# GEOPHYSICIST'S CERTIFICATE

I, DAVID G. MARK, of the City of Vancouver, in the Province of British Columbia, do hereby certify:

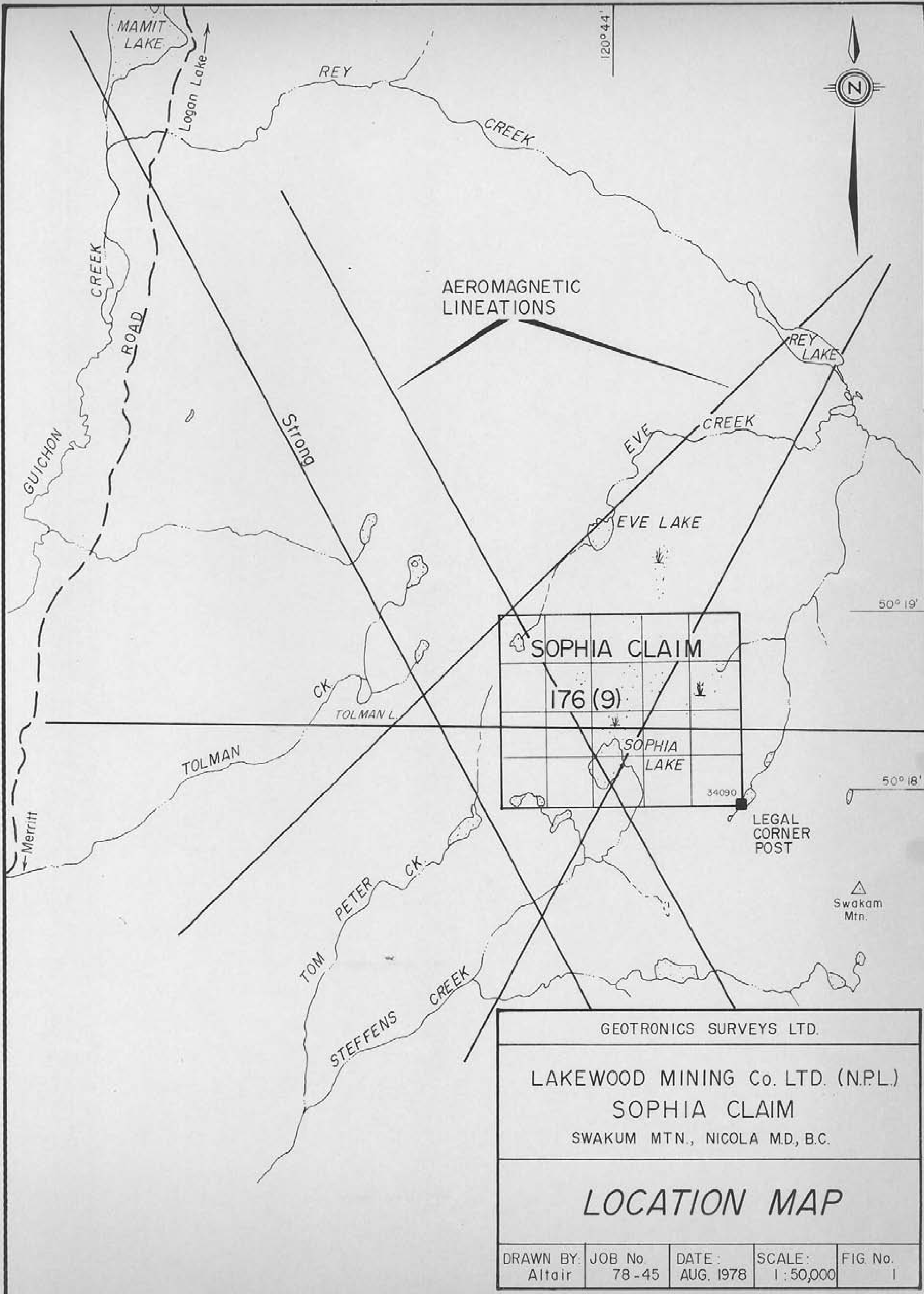
That I am a Consulting Geophysicist of Geotronics Surveys Ltd., with offices at 420-890 West Pender Street, Vancouver, British Columbia.

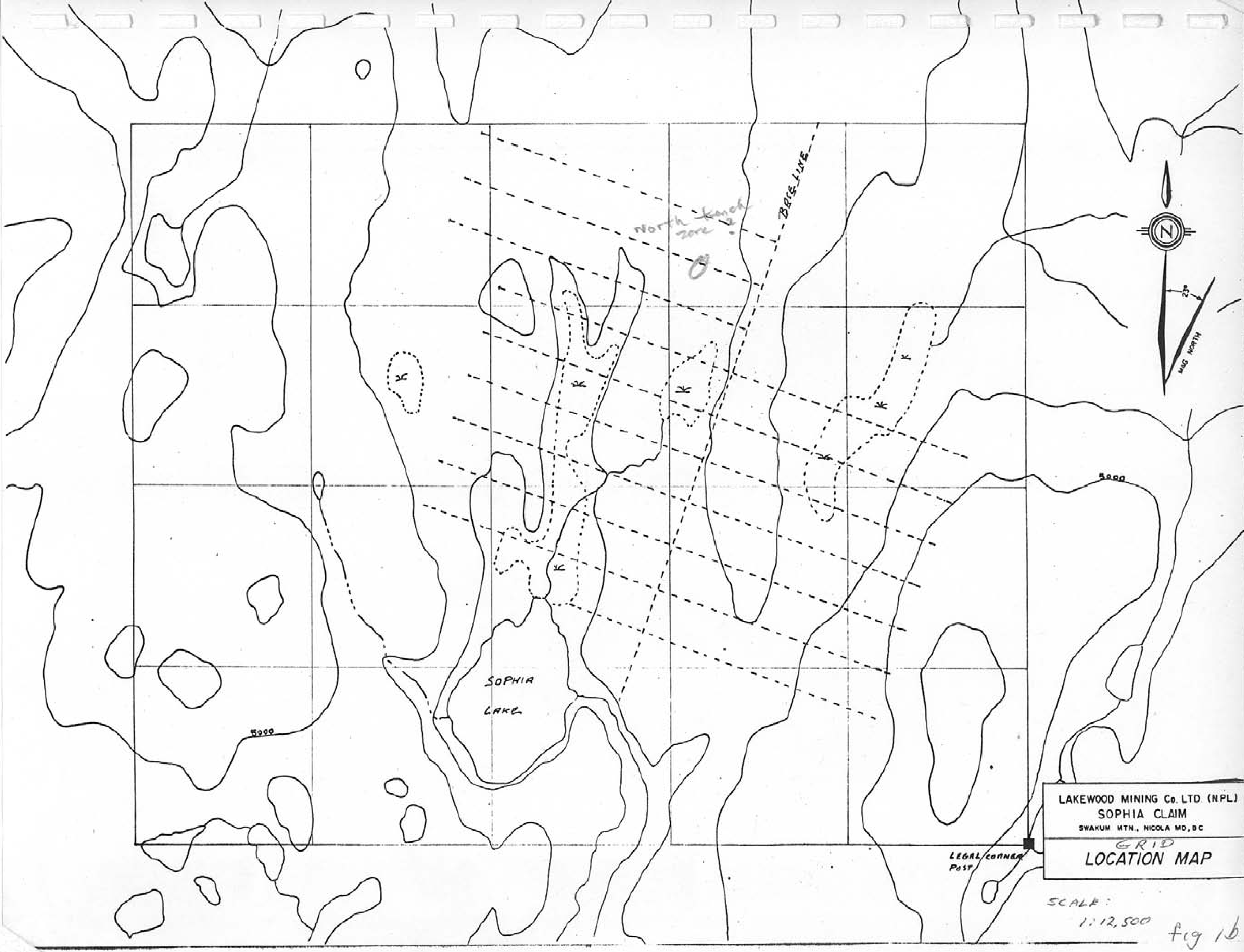
I further certify:

1. I am a graduate of the University of British Columbia (1968) and hold a B.Sc., degree in Geophysics.
2. I have been practising in my profession for the past ten years and have been active in the mining industry for the past thirteen years.
3. I am an active member of the Society of Exploration Geophysicists and a member of the European Association of Exploration Geophysicists.
4. This report is compiled from data obtained from soil sampling and VLF-EM surveys carried out during September 1977 and from an induced polarization survey carried out during August, 1978. None of the surveys were under my supervision.
5. I have no direct or indirect interest in the properties or securities of Lakewood Mining Company Ltd (NPL) Vancouver, B.C. nor do I expect to receive any interest therein.

David G. Mark
Geophysicist

October 18, 1978


MAMIT LAKE
Logan Lake
120°44'
REY CREEK
CREEK
GUICHON
ROAD
AEROMAGNETIC LINEATIONS
Strong
REY LAKE
EVE CREEK
EVE LAKE
50° 19'
SOPHIA CLAIM
176 (9)
CK
TOLMAN L.
TOLMAN
SOPHIA LAKE
34090
50° 18'
LEGAL CORNER POST
Merritt
TOM PETER CK.
Swakam Mtn.
STEFFENS CREEK
GEOTRONICS SURVEYS LTD.
LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.
LOCATION MAP
DRAWN BY: Altair
JOB No. 78-45
DATE: AUG. 1978
SCALE: 1:50,000
FIG. No. 1



LAKEWOOD MINING Co. LTD (NPL)
SOPHIA CLAIM
SWAKUM MTN., NICOLA MD, BC
GRID
LOCATION MAP
SCALE: 1:12,500
LEGAL CORNER POST
BASE LINE
North Ranch zone ?
SOPHIA LAKE
5000
5000
N
23°
MAG NORTH
fig 1b

**LAKEWOOD**

**MINING CO. LTD. N.P.L.**

2245 W. 13th AVE.,
VANCOUVER, B.C.
V6K 2S4
TELEPHONE: 733-2408

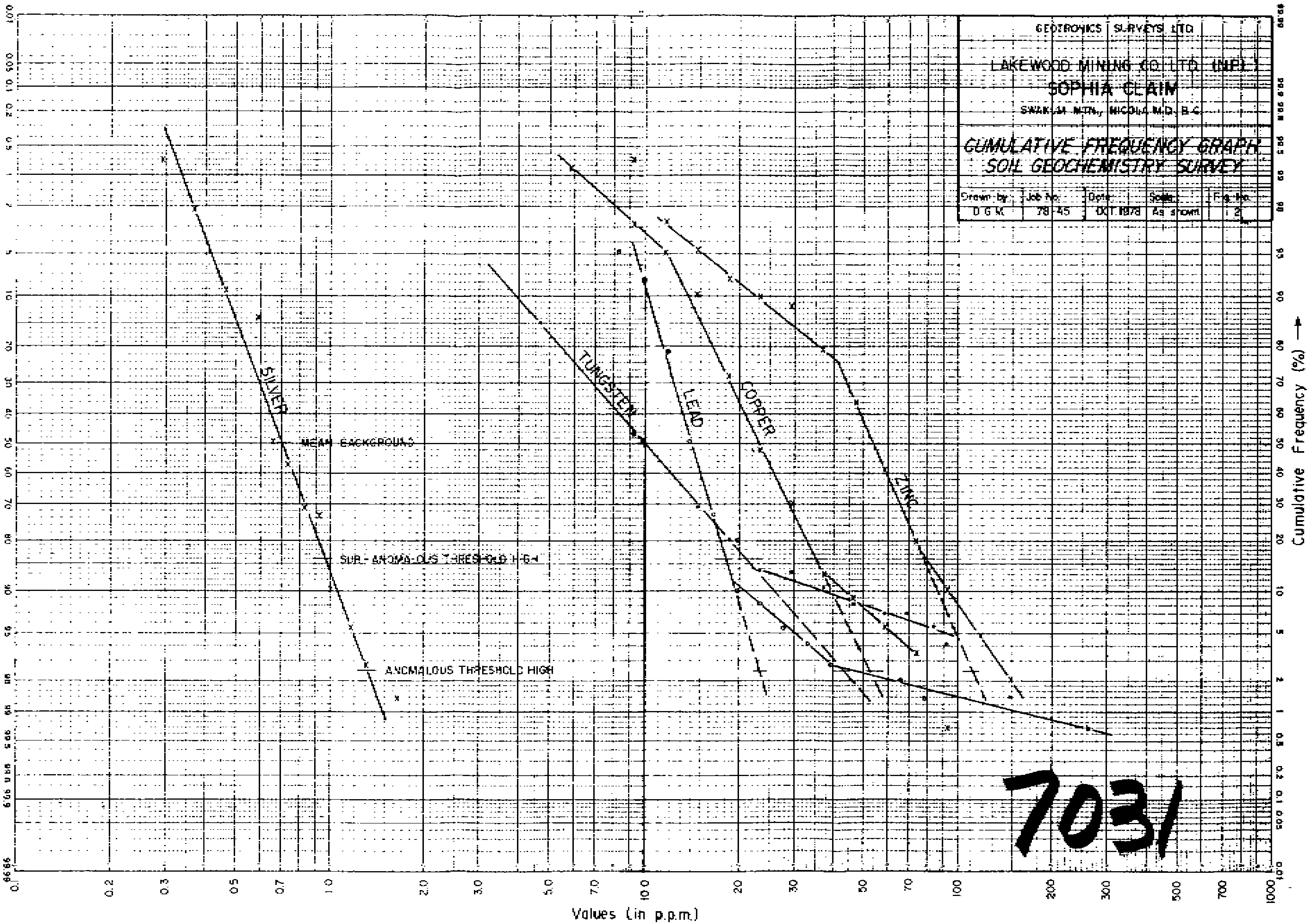
Expenses

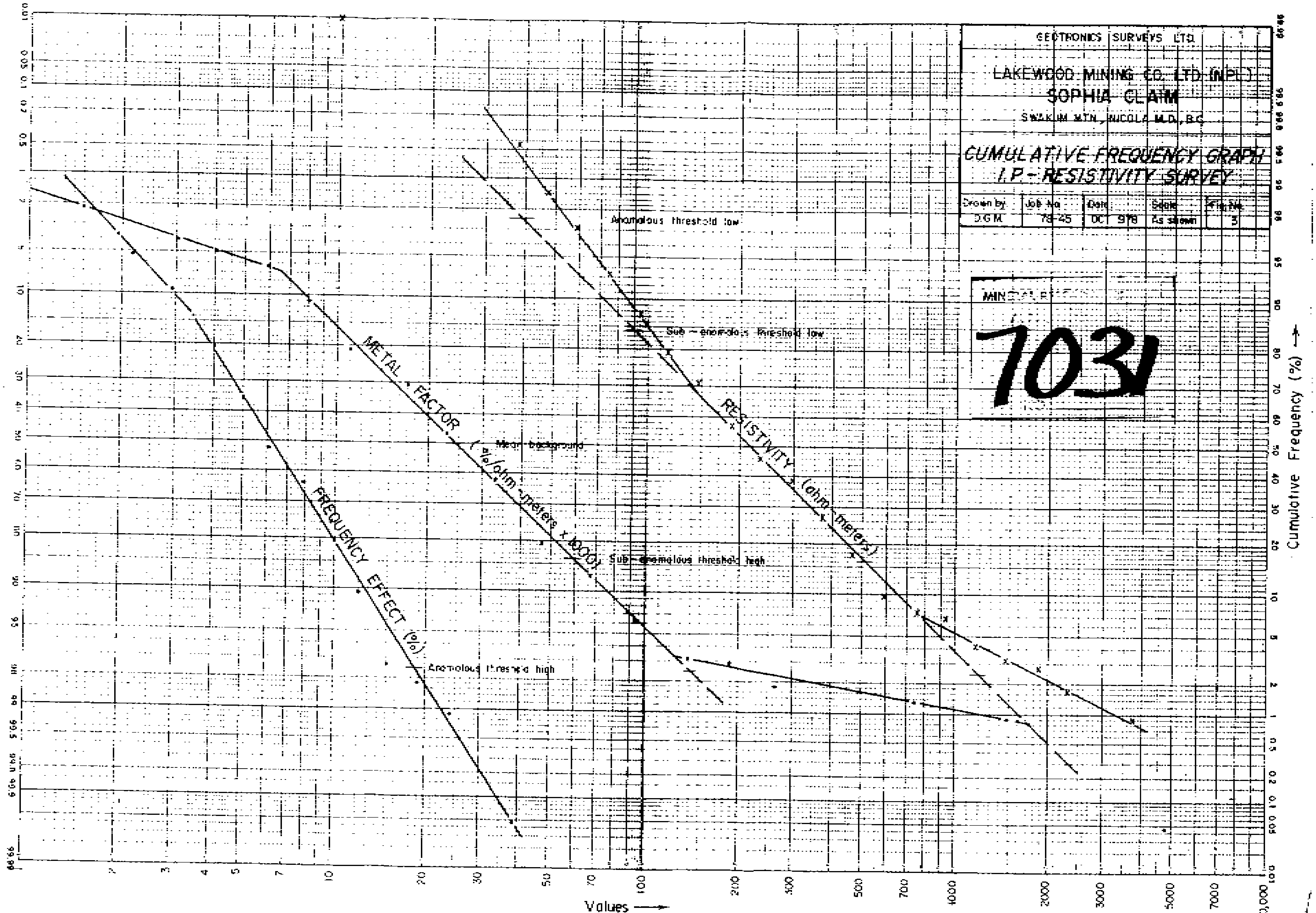
I.P. survey carried out on the SOPHIA Claim. Record # 176 (9), Nicola M.D., B.C. to the value of the following:

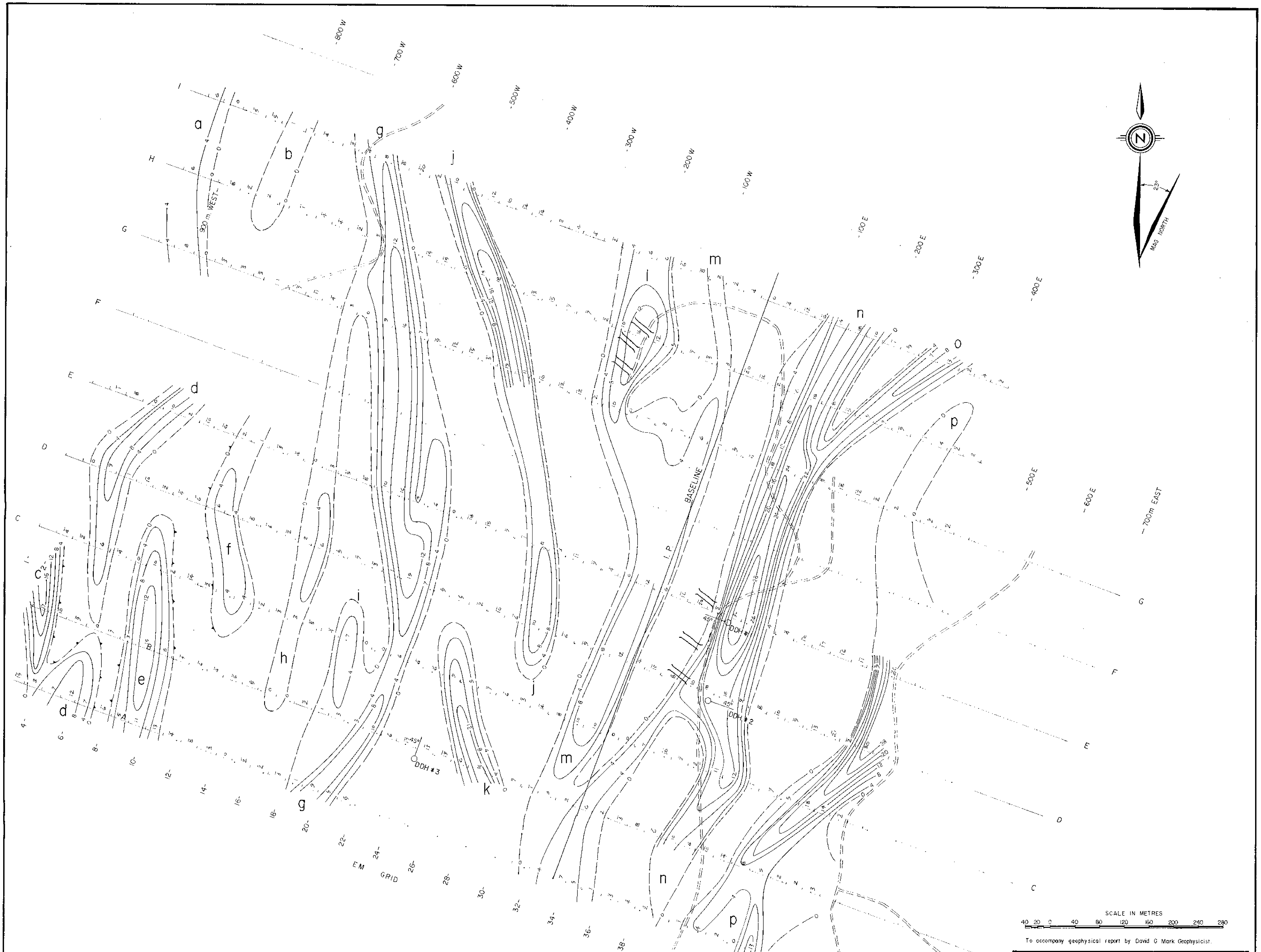
| | | |
|---|---|---|
| Field | | |
| Blazing and flagging I.P. line. | | |
| I.P. survey, 4 men at $80 per day (9 days) | | $2,880.00 |
| Rental | | |
| 4 wheel drive vehicle | | 450.00 |
| Survey supplies | | |
| I.P. unit and generator | | 500.00 |
| Room and board | | |
| 4 men, at $25 per day (9 days) | | 900.00 |
| | | $4,730.00 |
| Report | | |
| Geophysicist, 30 hours at $30 per hour | $900.00 | |
| Clerical, 12 hours at $14 per hour | 168.00 | |
| Drafting and printing | 760.00 | |
| Typing and xeroxing | 220.00 | |
| | $2,048.00 | $2,048.00 |
| Total | | $6,778.00 |

Respectfully submitted by
Lakewood Mining Co. Ltd. N.P.L.

Charles Boitard, President


GEOTRONICS SURVEYS LTD.
LAKEWOOD MINING CO. LTD. (NPL)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.
CUMULATIVE FREQUENCY GRAPH
SOIL GEOCHEMISTRY SURVEY
Drawn by: D.G.M.
Job No: 78-45
Date: OCT. 1978
Scale: As shown
Fig. No. 2
SILVER
TUNGSTEN
LEAD
COPPER
ZINC
MEAN BACKGROUND
SUB-ANOMALOUS THRESHOLD HIGH
ANOMALOUS THRESHOLD HIGH
Values (in p.p.m.)
Cumulative Frequency (%)
7031


GEOTRONICS SURVEYS LTD.
LAKEWOOD MINING CO. LTD. (NPL)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.
CUMULATIVE FREQUENCY GRAPH
I.P. - RESISTIVITY SURVEY
Drawn by: D.G.M.
Job No.: 78-45
Date: OCT. 978
Scale: As shown
Fig. No.: 3
703
Anomalous threshold low
Sub - anomalous threshold low
Mean background
Sub - anomalous threshold high
Anomalous threshold high
METAL FACTOR (%/ohm-meters x 1000)
RESISTIVITY (ohm-meters)
FREQUENCY EFFECT (%)
Values
Cumulative Frequency (%)

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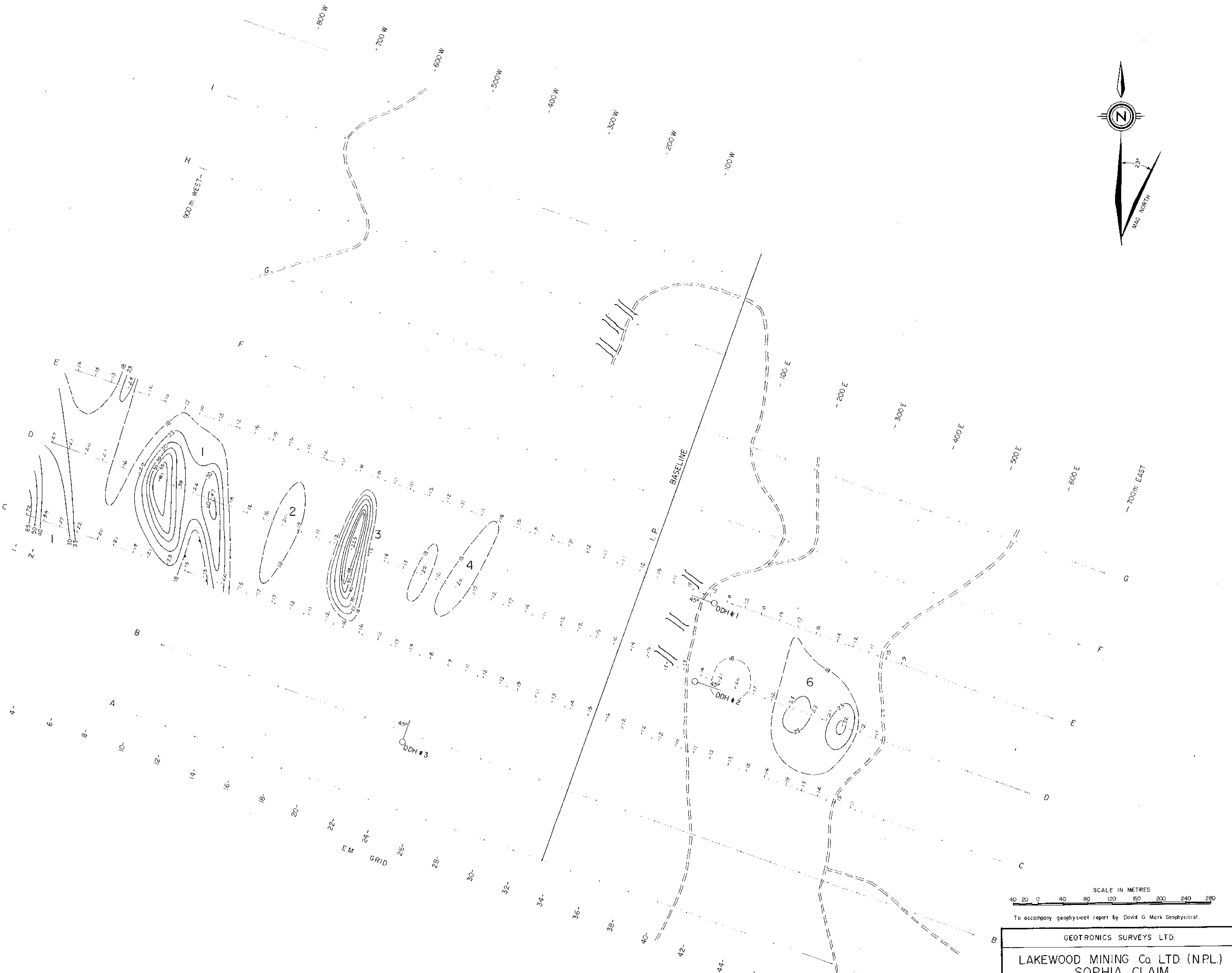
LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.

VLF-EM SURVEY
FRASER-FILTERED
DATA + CONTOURS

| DRAWN BY | JOB No | DATE | SCALE | FIG No |
|---|---|---|---|---|
| CB ALTAIR | 78-45 | AUG 1978 | 1:3000 (1cm.=30m) | 4 |




SCALE IN METRES

40 20 0 40 80 120 160 200 240 280

To accompany geophysical report by David G Mark Geophysicist.

GEOTRONICS SURVEYS LTD.

LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C

*SOIL GEOCHEMISTRY SURVEY*
*LEAD*
*DATA + CONTOURS*

| DRAWN BY. | JOB No | DATE | SCALE | FIG No |
|---|---|---|---|---|
| CB ALTAIR | 78-45 | AUG. 1978 | 1: 3000 (1cm = 30m) | 5 |

CONTOURS

Contour interval - 1 Standard deviation

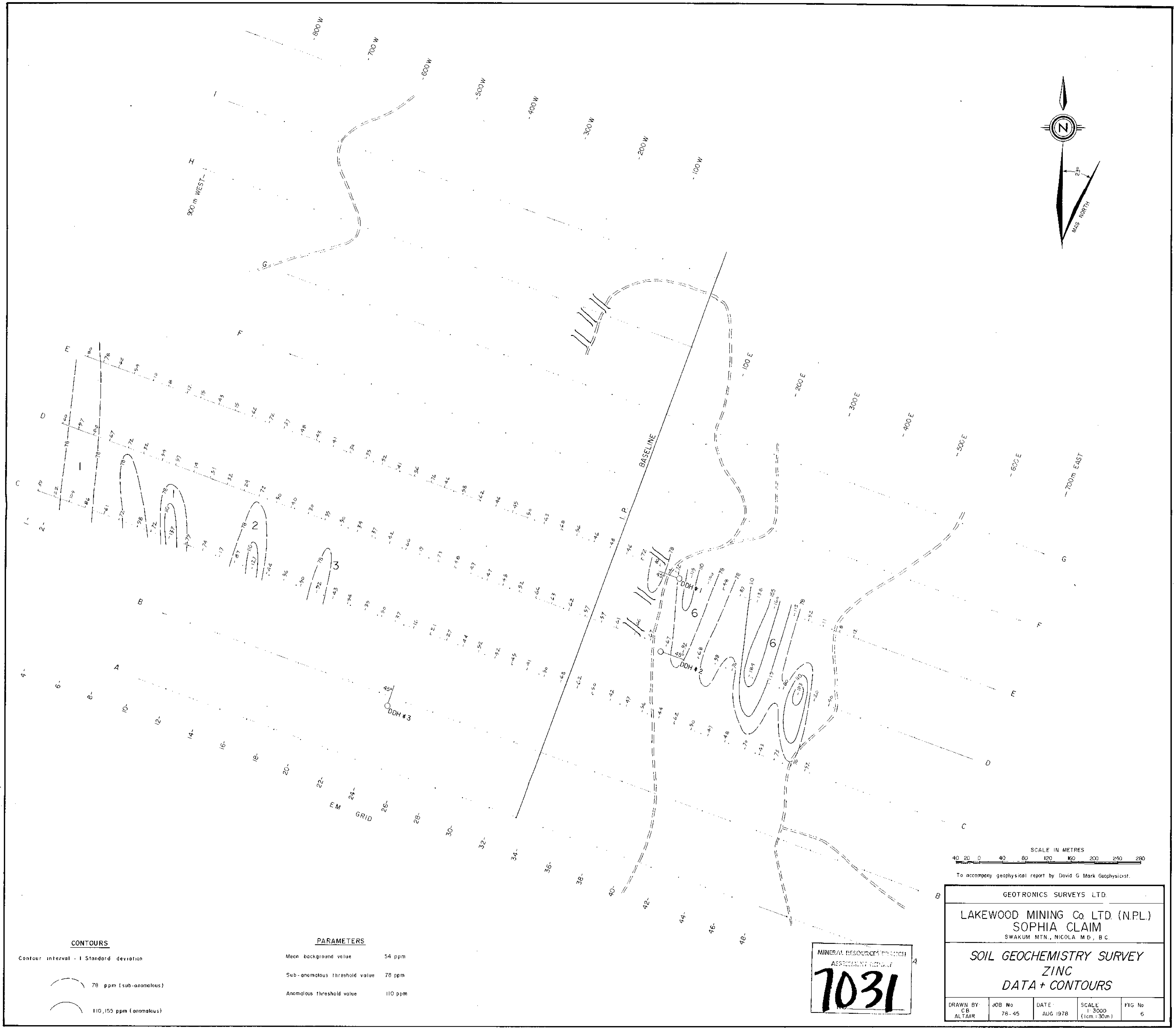
18 ppm (sub-anomalous)

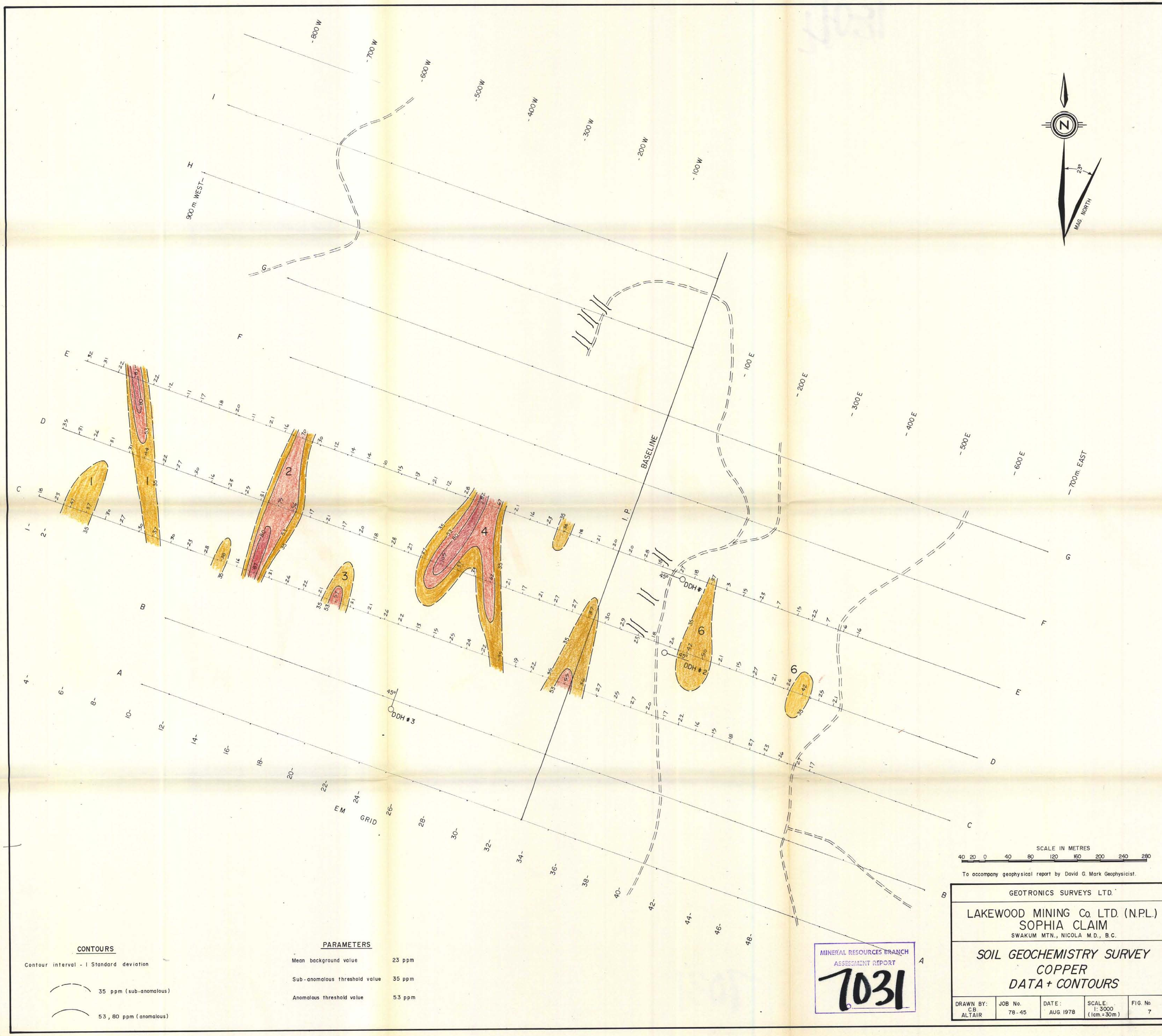
23, 30, 40, 50, 65 ppm (anomalous)

PARAMETERS

| | |
|---|---|
| Mean background value | 14 ppm |
| Sub-anomalous threshold value | 18 ppm |
| Anomalous threshold value | 23 ppm |

7031


900 m WEST
800 W
700 W
600 W
500 W
400 W
300 W
200 W
100 W
BASELINE
I.P.
100 E
200 E
300 E
400 E
500 E
600 E
700m EAST
MAG NORTH
23°
N
DDH #1
DDH #2
DDH #3
EM GRID
SCALE IN METRES
40 20 0 40 80 120 160 200 240 280
To accompany geophysical report by David G Mark Geophysicist.
CONTOURS
Contour interval - 1 Standard deviation
78 ppm (sub-anomalous)
110,155 ppm (anomalous)
PARAMETERS
Mean background value 54 ppm
Sub-anomalous threshold value 78 ppm
Anomalous threshold value 110 ppm
MINERAL RESOURCES BRANCH
ASSESSMENT REPORT
7031
GEOTRONICS SURVEYS LTD.
LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.
SOIL GEOCHEMISTRY SURVEY
ZINC
DATA + CONTOURS
DRAWN BY: CB ALTAIR
JOB No 78-45
DATE: AUG 1978
SCALE 1:3000 (1cm.=30m)
FIG No 6




To accompany geophysical report by David G. Mark Geophysicist.

**CONTOURS**

Contour interval - 1 Standard deviation

35 ppm (sub-anomalous)

53, 80 ppm (anomalous)

**PARAMETERS**

| | |
|---|---|
| Mean background value | 23 ppm |
| Sub-anomalous threshold value | 35 ppm |
| Anomalous threshold value | 53 ppm |

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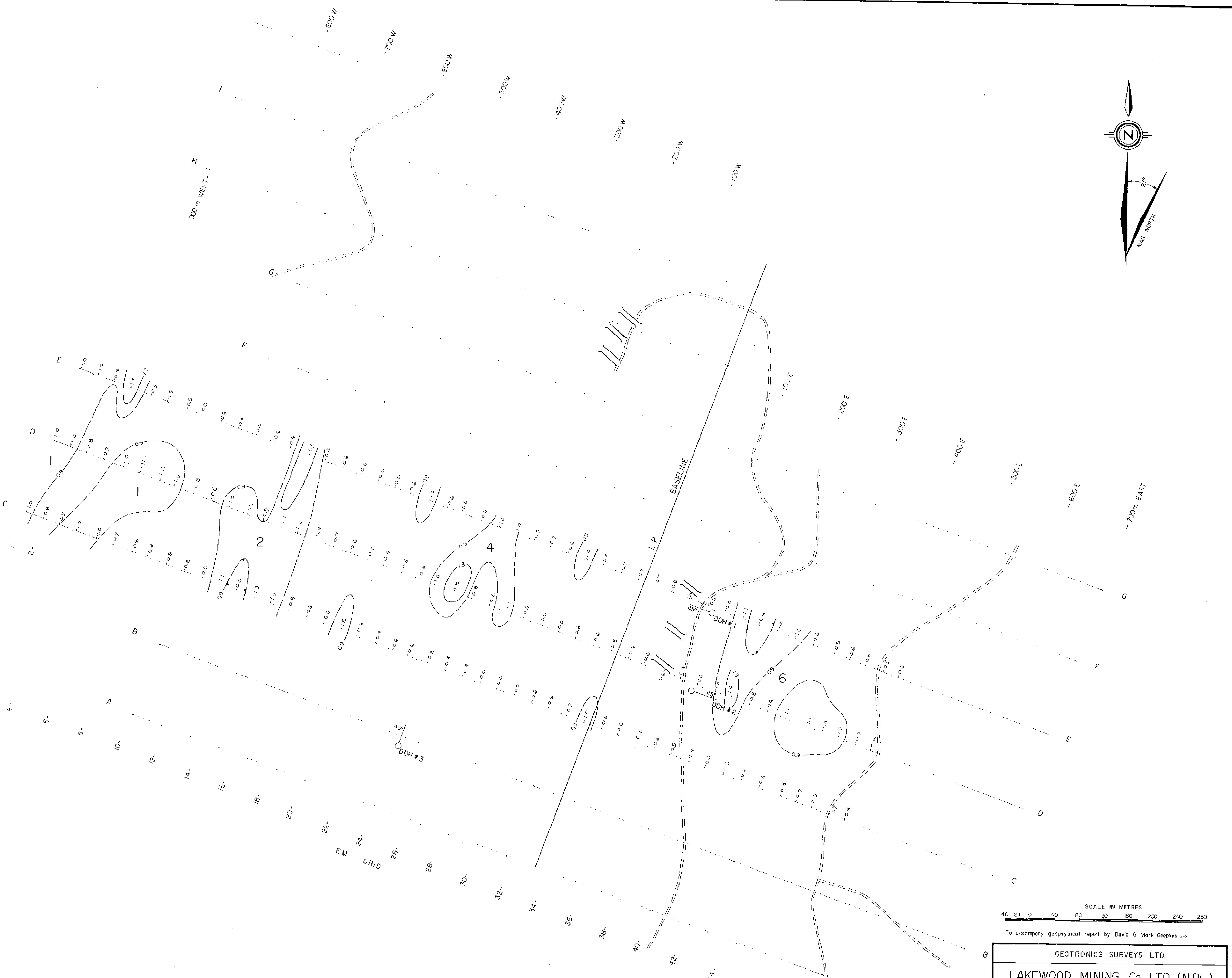
LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.

*SOIL GEOCHEMISTRY SURVEY*
*COPPER*
*DATA + CONTOURS*

| DRAWN BY: | JOB No. | DATE: | SCALE: | FIG. No. |
|---|---|---|---|---|
| C.B. ALTAIR | 78-45 | AUG 1978 | 1: 3000 (1cm.=30m) | 7 |




SCALE IN METRES

40 20 0 40 80 120 160 200 240 280

To accompany geophysical report by David G. Mark Geophysicist

GEOTRONICS SURVEYS LTD.

LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.

*SOIL GEOCHEMISTRY SURVEY*
*SILVER*
*DATA + CONTOURS*

| DRAWN BY: | JOB No. | DATE: | SCALE: | FIG No. |
|---|---|---|---|---|
| C.B. ALTAIR | 78-45 | AUG 1978 | 1:3000 (1cm.=30m.) | 8 |

CONTOURS

Contour interval - 1 Standard deviation

0.9 ppm (sub-anomalous)

1.3 ppm (anomalous)

PARAMETERS

| | |
|---|---|
| Mean background value | 0.7 ppm |
| Sub-anomalous threshold value | 0.95 ppm |
| Anomalous threshold value | 1.3 ppm |

7031

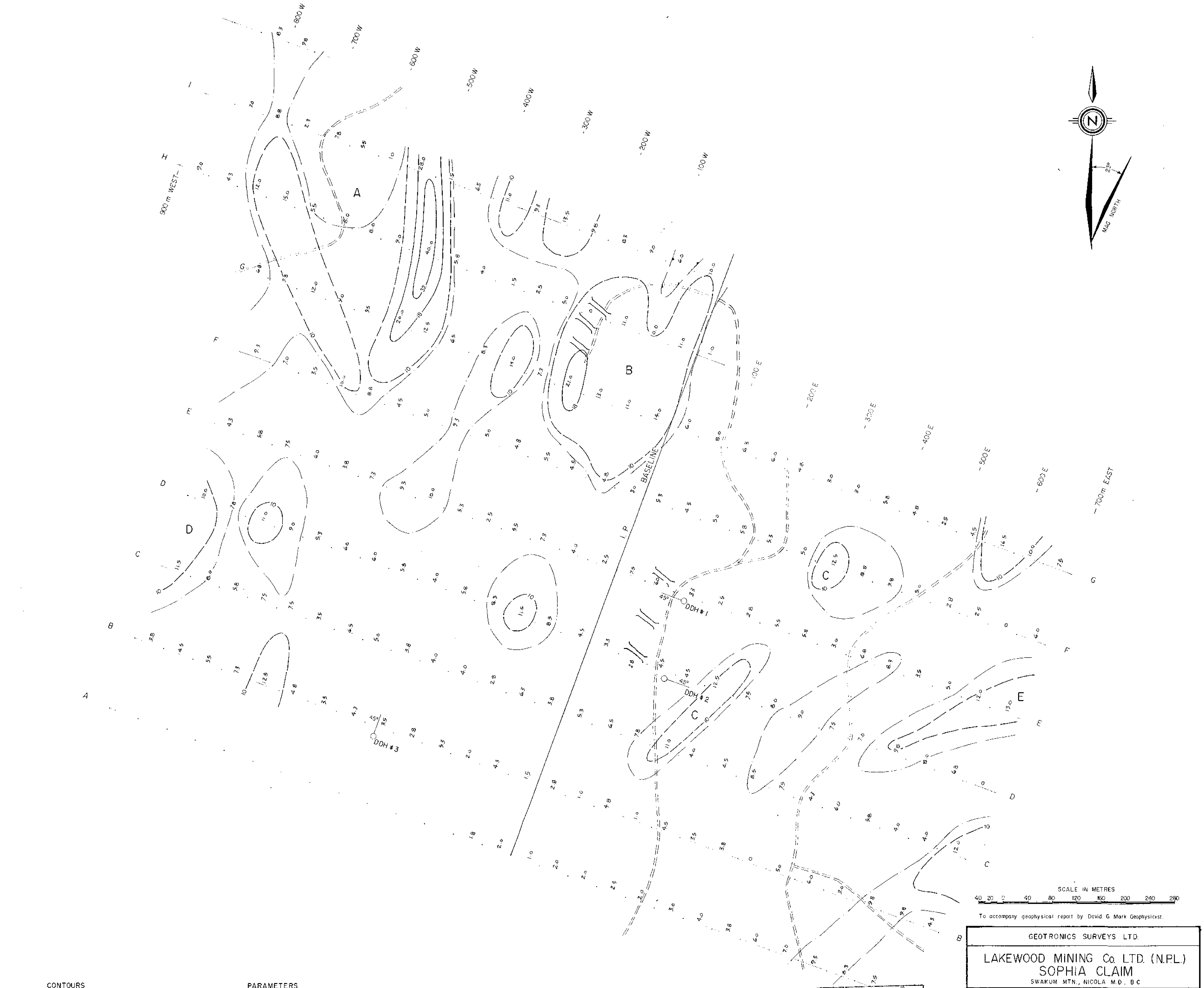



GEOTRONICS SURVEYS LTD.

LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.

*SOIL GEOCHEMISTRY SURVEY*
*TUNGSTEN*
*DATA + CONTOURS*

| DRAWN BY: | JOB No. | DATE: | SCALE: | FIG. No |
|---|---|---|---|---|
| C.B. ALTAIR | 78-45 | AUG 1978 | 1:3000 (1cm.=30m) | 9 |




CONTOURS

Contour interval - 1 standard deviation

8% (possibly anomalous)

10% (sub-anomalous)

18, 32 % (anomalous)

PARAMETERS

| | |
|---|---|
| Mean background value | 6.2 % |
| Sub-anomalous threshold value | 10.8 % |
| Anomalous threshold value | 18.5 % |

INSTRUMENTATION SABRE MODEL 21
TYPE: FREQUENCY EFFECT
FREQUENCIES: 0.3 Hz 10 Hz
ARRAY: DIPOLE - DIPOLE
ELECTRODE SPACING: 50 meters
DIPOLE SEPARATION 50 meters
UNITS: %



SCALE IN METRES

40 20 0 40 80 120 160 200 240 280

To accompany geophysical report by David G Mark Geophysicist.

GEOTRONICS SURVEYS LTD.

# LAKEWOOD MINING Co. LTD. (N.P.L.)
# SOPHIA CLAIM

SWAKUM MTN., NICOLA M.D., B.C.

## *INDUCED POLARIZATION SURVEY FREQUENCY EFFECT DATA + CONTOURS*

| DRAWN BY | JOB No | DATE | SCALE: | FIG No |
|---|---|---|---|---|
| C.B. ALTAIR | 78-45 | AUG 1978 | 1 3000 (1cm = 30m) | 10 |


SCALE IN METRES

40 20 0 40 80 120 160 200 240 280

To accompany geophysical report by David G. Mark Geophysicist

GEOTRONICS SURVEYS LTD.

LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.

*INDUCED POLARIZATION SURVEY*
*RESISTIVITY*
*DATA + CONTOURS*

| DRAWN BY: | JOB No. | DATE: | SCALE: | FIG. No |
|---|---|---|---|---|
| C.B ALTAIR | 78-45 | AUG 1978 | 1:3000 (1cm = 30m) | 11 |

MINERAL RESOURCES BRANCH
7031

## CONTOURS

Contour interval - 1 Standard deviation(except for mean background contour)

60, 100 ohm-meters

500, 1200, 2800, 6600 ohm meters

## PARAMETERS

| | | |
|---|---|---|
| Anomalous low threshold value | 40 ohm-meters | |
| Sub-anomalous low threshold value | 90 " | " |
| Mean background value | 215 " | " |
| Sub-anomalous high threshold value | 510 " | " |
| Anomalous high threshold value | 1200 " | " |

INSTRUMENTATION: SABRE MODEL 21
TYPE: FREQUENCY EFFECT
FREQUENCIES: 0.3 Hz 10Hz
ARRAY: DIPOLE - DIPOLE
ELECTRODE SPACING: 50 meters
DIPOLE SEPARATION: 50 meters
UNITS: ohm-meters


To accompany geophysical report by David G Mark Geophysicist

**CONTOURS**

Contour interval - 1 Standard deviation

60

140, 350, 840

**PARAMETERS**

| | |
|---|---|
| Mean background value | 25 |
| Sub-anomalous threshold value | 60 |
| Anomalous threshold value | 140 |

INSTRUMENTATION: SABRE MODEL 21
TYPE: FREQUENCY EFFECT
FREQUENCIES: 0.3 Hz 10Hz
ARRAY: DIPOLE - DIPOLE
ELECTRODE SPACING: 50 meters
DIPOLE SEPARATION: 50 meters
UNITS: (% ohm - meters) x 1000

7031

GEOTRONICS SURVEYS LTD.

LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.

*INDUCED POLARIZATION SURVEY*
*METAL FACTOR*
*DATA + CONTOURS*

| DRAWN BY: | JOB No | DATE: | SCALE | FIG No |
|---|---|---|---|---|
| CB ALTAIR | 78-45 | AUG. 1978 | 1:3000 (1cm.=30m) | 12 |


900 m WEST
- 800 W
- 700 W
- 600 W
- 500 W
- 400 W
- 300 W
- 200 W
- 100 W
- 100 E
- 200 E
- 300 E
- 400 E
- 500 E
- 600 E
- 700m EAST
BASELINE
I.P.
EM GRID
DDH #3
HIGH
N
23°
MAG NORTH
SCALE IN METRES
40 20 0 40 80 120 160 200 240 280
To accompany geophysical report by David G. Mark Geophysicist.
LEGEND
LEAD
ZINC
COPPER
SILVER
TUNGSTEN
INDUCED POLARIZATION
HIGH RESISTIVITY HIGH
RESISTIVITY LOW
SUB-ANOMALOUS CONTOURS
VLF-EM - CENTER OF CONDUCTIVE ZONES
MINERAL RESOURCES BRANCH ASSESSMENT REPORT
7031
GEOTRONICS SURVEYS LTD.
LAKEWOOD MINING Co. LTD. (N.P.L.)
SOPHIA CLAIM
SWAKUM MTN., NICOLA M.D., B.C.
COMPILATION MAP
DRAWN BY: CB ALTAIR
JOB No. 78-45
DATE: AUG 1978
SCALE: 1:3000 (1cm.=30m)
FIG. No 13