1827

GEOPHYSICAL REPORT

on the

Induced Polarization and Magnetometer
Surveys

of the

Halo, Broatch and Ram Mineral Claims

situated in the

Aspen Grove Area
Nicola Mining Division

Latitude 49°55' North, Longitude 120°35' West
N.T.S. 92 H/15

Field Work
December 3 to 16, 1968
by

GEO-X SURVEYS LTD.

Instrument Operators: N. Wilson
J. Pasche
J. Cerne

on behalf of

NORRANCO MINING AND REFINING CO. LTD.

Report by:
D.R. Cochrane, P. Eng.

J. Cerne, M.S.

January 16, 1969.
Vancouver, B.C.

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1827

TABLE OF CONTENTS

A-1 GENERAL INTRODUCTION

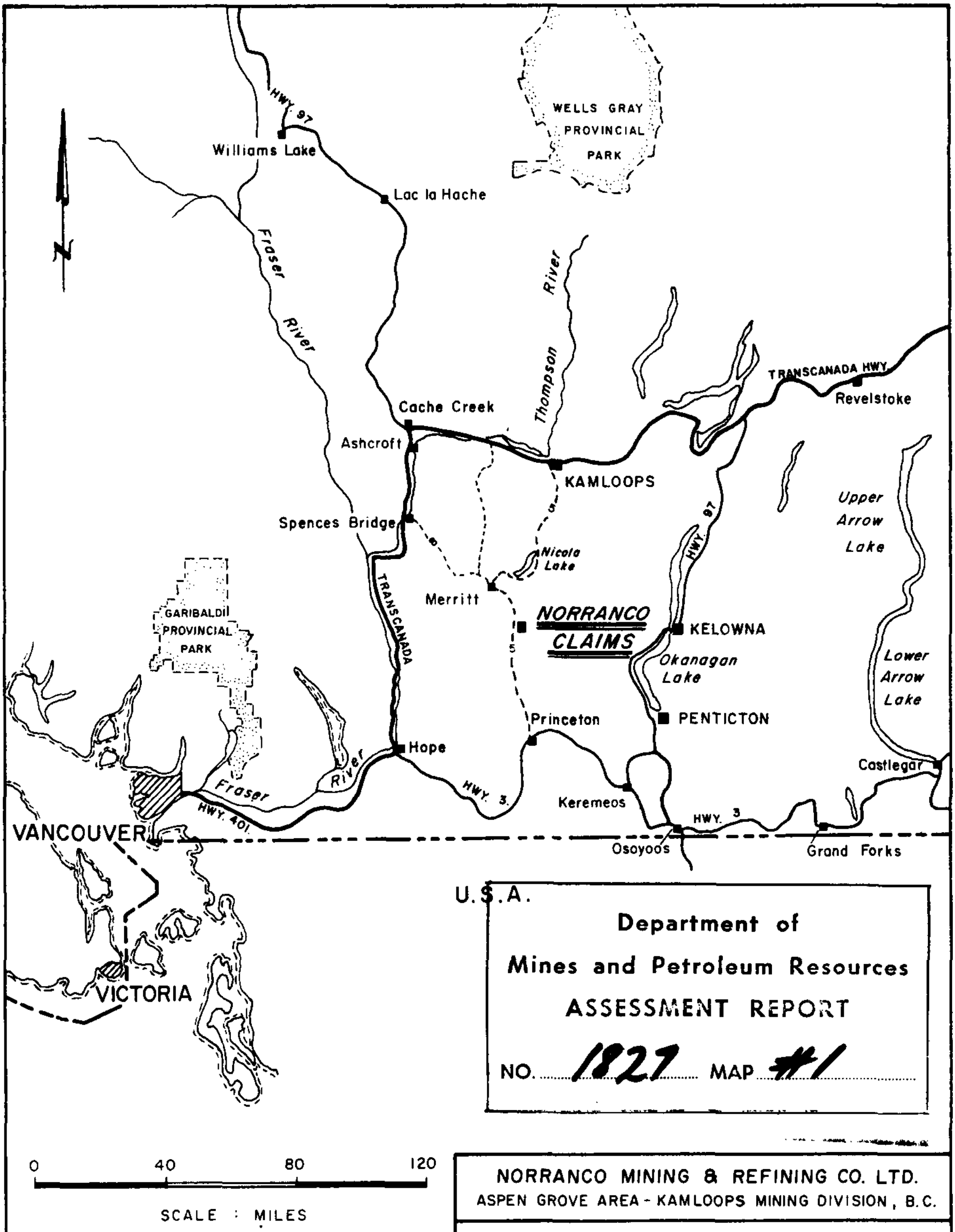
During the period of December 3 to 16, 1968, a Geo-X Surveys field crew completed 12.4 line miles of induced polarization and 11.4 line miles of magnetometer surveys on mineral claims in the Aspen Grove area. The property is situated roughly 2 miles northeast of the Aspen Grove store in the Nicola area of south central British Columbia.

The purpose of the work was to compile information to guide future exploration of the mineral property.

This report describes the instrumentation, field procedure, data normalization; and discusses the results of the surveys.

A-2 LOCATION AND ACCESS

The settlement of Aspen Grove is 23 miles south of Merritt on Highway #5, and 35 miles north of Princeton. The Halo and Broatch claims lie 2 miles northeast of the Aspen Grove store, and normal access is by a number of unsurfaced roads which proceed east from Highway #5 about one mile north of the store. The claims lie immediately south of the Golden Sovereign Group described in G.S.L. Memoir 243, and north of Alleyne Lake. Latitude 49°55' North; Longitude 120°35'West.



Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #1

NORRANCO MINING & REFINING CO. LTD.
ASPEN GROVE AREA - KAMLOOPS MINING DIVISION, B.C.

LOCATION MAP

GEO - X SURVEYS LTD.	DRAWN R.K.	DATED Dec. 23/1968	FIG. NO. 1
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A-3 CLAIMS AND OWNERSHIP

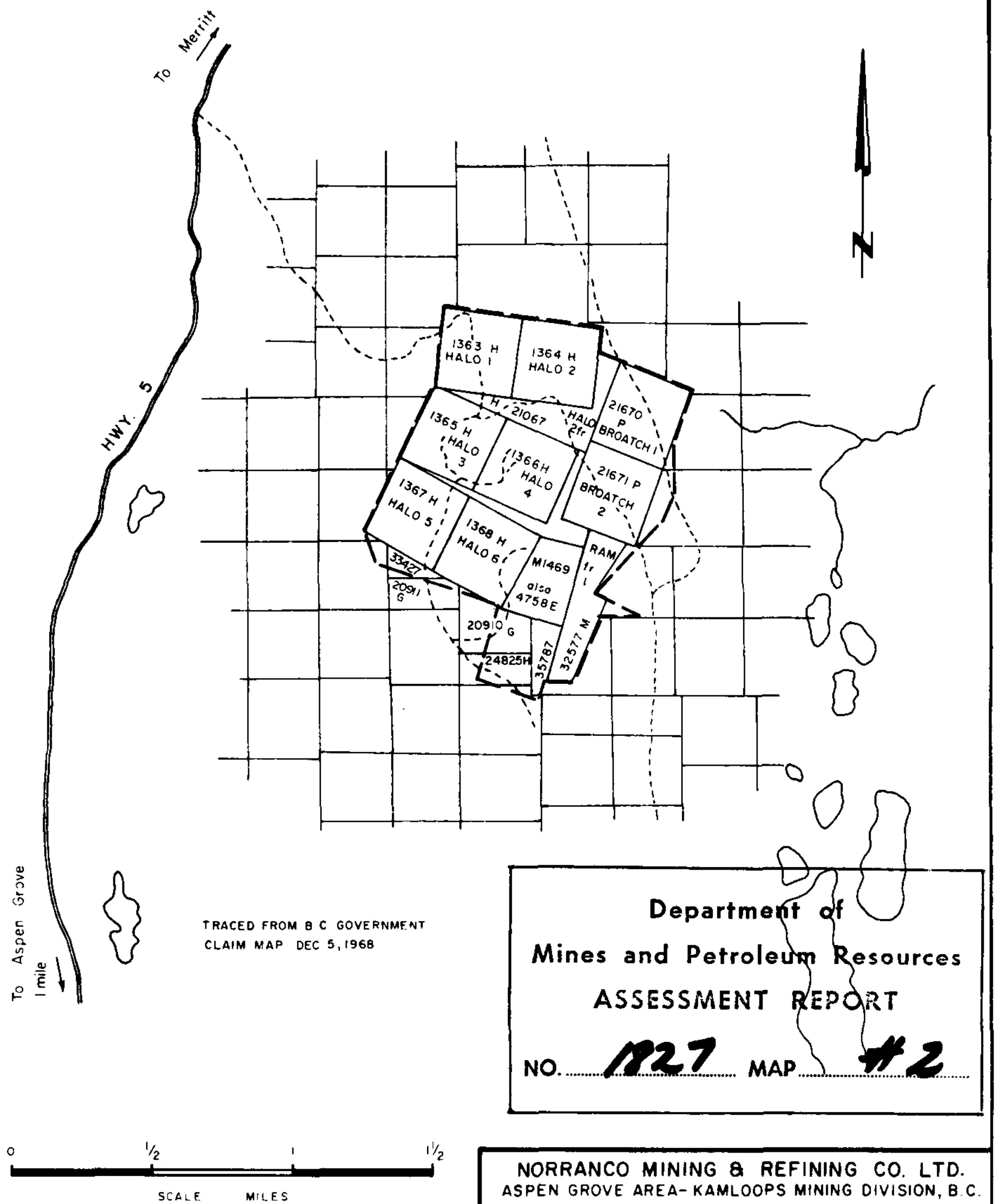
The Aspen Grove property of Norranco Mining and Refining, consists of a group of surveyed claims and fractions, collectively called the Halo group. It is comprised of the following:

Claim Name	Record Number
Halo #1 to #6 inclusive	1363 to 1368 inclusive
Halo fraction	
Halo #2 fraction	21067
Broatch #1 and #2	21670, 21671
Broatch #3 and 4	
Ram fraction	32577

They lie in a contiguous block in the Nicola M.D. and are outlined on the B.C. Department of Mines minerals map 92 H/15.

A-4 GEOMORPHOLOGY

The Halo group is situated in the Thompson plateau subdivision of the British Columbian interior plateau physiographic system. This is, in general, a gently rolling upland of low to moderate relief. The local Aspen Grove area, lies within the Fairweather Hills, with elevations normally between 3500 and 4500 feet. It is a rather impressive area of British Columbia, with a moderately dry climate,,with open fields,



Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #2

NORRANCO MINING & REFINING CO. LTD.
ASPEN GROVE AREA- KAMLOOPS MINING DIVISION, B.C.

CLAIMS MAP

GEO - X SURVEYS LTD.

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bushy draws and the landscape dotted with lakes.

The ground control grid lies at about 4000 feet in elevation and covers a small hill, gently sloping in all directions from near the center of the area surveyed.

The general region is underlain dominantly by Upper Triassic Nicola group intermediate volcanics with minor amounts of sediments. It is intruded by stocks, plugs and dikes of Jurrasic Coast Acidic intrusions. A series of north striking faults trend across the area surveyed. One of the focal points of economic interest is the Big Kid Breccia, consisting of altered brecciated diorite, with silicification, carbonatization and sporatic sections mineralized with magnetite, pyrite, chalcopyrite, bornite and chalcocite. A number of pits, adits, trenches and drill holes have partially explored the breccia.

It is believed that only a relatively thin mantle of glacial drift covers much of the bedrock.

A-5 GROUND CONTROL GRID

The ground control grid was established by Norranco Mining and Refining. It consists of a series of roughly east-west crosslines extending from a central north-south base line. The lines are generally 500 feet apart, extend from 19 to 83 north and roughly 2000 feet east and west of the base line.

They are cut out, with wooden pickets and flagging at 100 foot stations.

The grid on the maps accompanying this report is based on the operators notes and observations. It is the best possible representation from the data on hand. However, minor errors in positioning are inherent.

PART B - THE INDUCED POLARIZATION SURVEY

Part B-1 - General Considerations of the Pulse Type Induced Polarization Method

Two varieties of induced polarization surveys are in common use today in mineral exploration. The first is the time domain or pulse type method in which a steady direct current is impressed on the ground for a few seconds and then abruptly terminated. A fraction of a second after cessation of current impulse, the decay voltage, (caused by sub-surface capacitive-like storage) is measured. The second method is the variable (dual) frequency technique or frequency domain. In this variety, the percentage difference between the impedance (a.c. resistance) offered at two separate frequencies, is measured.

The Hewitt (HEW 100) I.P. unit is a time domain unit and the exact method of measurement is outlined in the field procedure section.

The reader is referred to Wait, J.R. (1966), for a thorough treatment of frequency domain, and Seigel, H.O. (1966) and/or Brant (1966), for a discussion of time domain.

I.P. effect occurs when a current is passed through a volume of rock containing electronic conductors. Geophysical electronic conductors, or "metallic minerals" include most sulphides, (pyrite, chalcopyrite, bornite, molybdenite) certain oxides, clays, graphite and certain micas.

Emperical methods have shown, however, that sulphides differ from other geophysical electronic conductors in that charge builds up on them in an exponential manner. In the field, this means that the impressed dV measured by the receiving pots climbs steadily during the current pulse. Also, sulphides sometimes demonstrate an almost unique polarization response, known as metallic polarization. Either type of response is the best test available for distinguishing sulphide response from that of other geophysical electronic conductors. Apart from the sulphides, minerals with highly unsatisfied basal lattice surfaces act as leaky condensers and give rise to I.P. effects. All common rocks are responsive to some degree, and this response is designated background. It is often equivalent to one volume percent of scattered pyrite, and probably due to unsatisfied charges at lattice imperfections, mineral and rock boundaries, fractures, and so on. Background in various parts of B.C. with the HEW-100 I.P. unit is as follows:

Area	Lithology	Background (mv/v)
Highland Valley	Guichon Batholith	2.5 to 4.0
Tonasket, Wash.	Granodiorite plug	Approx. 12.0
Aspen Grove	Nicola Volcanics	4.0 to 7.5
Princeton	Princeton sediments	Approx. 17.0
Cassiar	Lower Paleozoic sediments	1.5 to 5.0

Factors other than the amount of metallic conductors which affect I.P. response are grain size, conductivity of mineral, porosity, tortuosity (pore geometry), type of gangue minerals, composition and amount of pore fluid, degree of alteration, and mode of mineralization (disseminated, lode, vein type, etc.).

The apparent resistivity is also measured during the I.P. survey. Rogers, (1966), has pointed out that the resistivity of rock is only slightly influenced by changes in the sulphide content at low levels. Much of the change is due to other effects such as moisture content, fracturing, pore space, ground water, extent, degree and type of alteration, type of sulphides and mode of sulphide distribution, etc. However, alteration in combination with increased sulphide content, not uncommonly affects the resistivity significantly. Unfortunately, there are many additional causes for resistivity variation and rarely can sulphides be recognized or predicted from resistivity data alone.

Background d.c. apparent resistivity in various parts of B.C. with the HEW-100 I.P. unit follows:

Area	Lithology	Background (ohm-feet)
Highland Valley	Guichon Batholith	1600
Tonasket, Wash.	Granodiorite plug	3500
Aspen Grove	Nicola Volcanics	1000

Area	Lithology	Background (ohm-feet)
Princeton	Princeton sediments	500
Cassiar	Lower Paleozoic sediments	1000 - 2000

Previous to current impression, the receiving pots are balanced, and this, the self potential value in millivolts is often a useful geophysical tool. When metallic lustered sulphide minerals are situated in a suitable geological-hydrological environment, the sulphides oxidize and a natural or spontaneous "battery effect" occurs. Often the self potential effect over sulphide bodies is negative and in the order of a few hundred millivolts.

With a Wenner electrode configuration, the self potential and first derivative of the self potential are valuable information if the transit interval is equal to, or is one-half the "a" spacing distance. In other cases, where the "a" spacing and transit interval are not evenly propertional, the self potential results are of little useful value.

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Time Domain:

Brant, A.A. (1966) Examples of Induced Polarization Field

Results in the Time Domain - Society of Exploration Geophysicists' Mining Geophysics, Volume I, Case Histories.

Seigel, H.O. (1966) Three Recent Irish Discovery Case Histories using Pulse Type Induced Polarization - S.E.G. Volume I, Case Histories - p.p. 341

Rogers, G.R. Introduction to the Search for Disseminated Sulphides, S.E.G. Volume I.

B-2 Field Procedure

A Hewitt Enterprises Pulse Type IP was used throughout. the Norranco survey. Instrument specifications are described in Appendix IV.

The standard Wenner electrode array was employed with an "a" spacing (one third the distance between the current electrodes) of 300 feet. This spacing was utilized because of depth testing near the Big Kidd trench on December 3, 1968. In this area, the Wenner array was expanded from 80 to 500 feet at a series of intervals and response at a = 300 feet provided one of the better contrasts.

A brief description of the field procedure follows.

Prior to voltage application, the self potential is balanced, and recorded, between the two receiving pots "a" feet apart. Normally a voltage of 250, 500 or 1000 volts is impressed between the back electrode (one "a" behind the instrument) and front electrode (two "a" in front of the instrument). The electrodes in high ground resistivity stations, consist of a single steel or aluminum stake, and in low resistivity areas, of multiple aluminum foil electrodes situated about a central metal stake (to increase ground bearing, current and voltage). A four second pulse of d.c. current is applied, during which time the I (current in milliamperes) and dV (impressed EMF in millivolts) is observed and recorded. 0.3 seconds after cessation of pulse, the residual (decay) voltage is integrated for 0.8 seconds (on integration function #1). From these data, the apparent d.c. resistivity and normalized induced polarization value may be calculated, as described in the data reduction portion of this report.

A large 50 pound nickel-cadmium battery supplied power, and the external switching and eleven 45 volt batteries were used during some of the depth probe.

The transit interval was 300 feet along all the cross lines, and the front electrode positive.

B-3 Induced Polarization Data Reduction

The following information was recorded by Mr. N. Wilson and J. Pasche, the instrument operators at each pulse station:

1. The property, operator's initials, job and page number, "a" spacing, transit interval and remarks on topography.
2. The line and station co-ordinates;

3. The self potential reading in millivolts (S.P. mv);

4. The current in milliamperes (I ma);

5. The impressed emf in millivolts (dV mv);

6. The induced polarization decay voltage in millivolts (IP mv);

7. The resistor capacitor switch (R.C.) setting;

8. The current electrode voltage switch value;

9. The integration function switch (I.F. setting;

10. The pulse time in seconds.

From this data, the apparent resistivity is calculated from the following relation:

$$\rho = \frac{2\pi \times a \; dV}{I \; (ma)}$$

Where: ρ = apparent resistivity in ohm-feet

π = 3.1416

"a" = 1/3 distance between the current electrodes

The normalized IP value is obtained by utilization of the following relation:

$$\text{IP norm} = \frac{\text{IP mV}) \times 100 \times k \times R.C.}{dV \; (mV)}$$

Where: IP norm = normalized IP in millivolt seconds per millivolt or milliseconds

K = a constant depending on the IF setting.

R.C. = resistor - capacitor shunt.

A specific example from the data collected at 73+00 North, 5+00 East is tabulated below:

Pulse No.	I(ma)	dV	IP(mv)	R.C.	S.P.	I.F.	Remarks
1	240	300	2	3	10	1	500V
2	240	300	2	3		1	

Therefore: $\rho = \frac{2\pi \times 300}{240} \times 300 = 2356$ ohm feet

IP norm $= \frac{26.5 \times 100 \times 1 \times 3}{300} = 26.5$ millivolt seconds per volt.

These calculations were completed for each station on an Olivetti Underwood 101 desk top computer.

The final apparent resistivity, self potential, and normalized IP values were plotted on the accompanying figures (Scale 1":400') at a point midway between the receiving pots (i.e. 150 feet in front of the instrument position).

The plan of normalized IP was contoured at 17, 30, 43, 56 millisecond intervals (see Figure 5), the apparent resistivity at 1500, 2600, 3700, 4800 ohm foot marks (see Figure 4).

B-4 Discussion of Results

The results of the self potential, apparent resistivity and induced polarization are represented graphically in contour plan or profile as Figures 3, 4, 5 respectively. The reader is advised to refer to these Figures during the course of the following discussion.

A. Self Potential

Adjacent lines of self potential values are free floating and not reduced to a common base. Individual plotted values represent the potential, in millivolts, that was measured and recorded between two pots 300 feet apart. The reading is plotted midway between P_1 and P_2.

In general, the S.P. plan is patchy and irregular. The central area is generally high, and the periphery is low. Two large areas of negative S.P. response occur on the northern part of the property. The first extends from 63+00N to 82+50N, west of the base line, with a low value of negative 39 m.v. The other area extends from 49+00N to 82+50N, east of the base line, with a low of negative 63 m.v. A third zone of negative S.P. response is centered in the southeast corner of the property. The lowest value (-147 m.v.) recorded by the survey occurs in this zone, at 11+50E, 19+00N.

Two areas of rapid negative rate change occur in the same region. One (rate change of negative 136) is between

11+50E and 14+50E, 19+00N and the other (rate change of negative 87) is between 7+50E and 10+50E, 24+00N. Since rapid topographical changes occur in the area, these account at least partially, for the S.P. effects.

A third region of interest, with a rate change of negative 96, is between 18+50E and 15+50E, 73+00N.

B. Apparent Resistivities

The arithmetic mean (A.M.) of 187 d.c. apparent resistivities is 2571 ohm-feet, and the standard deviation (σ) is 1138 ohm-feet. Apparent resistivities ranged from a high of 8482 to a low of 754 ohm-feet.

The iso-resistivity plan (Figure 4) presents the contoured subsurface resistivity pattern at 1":400'. This type of Figure is often indicative of bedrock structure and lithology and thus is a guide to geology.

Anomalously low resistivity areas may indicate sulphides, moist subsurface conditions, altered zones, etc. Anomalously high areas are indicative of massive, unaltered bedrock.

Resistivity may be classified as follows:

Value (ohm-feet)		Classification
(less than)	AM - σ = 1500	Anomalously low.
	AM = 2600	Average.
(above)	AM+ σ = 3700	Anomalously high.
(above)	AM+2 σ = 4800	Anomalously higher.
(above)	AM+3 σ = 5900	Anomalously very high.

The iso-resistivity plan is dominated by an irregular, centrally located, above average and Anomalously high zone, bisected by an east-west trending zone of lows. This region covers approximately one quarter of the map area. Anomalously low zones appear as irregular patches.

The lowest reading, 754 ohm-feet, was recorded at 4+50E, 24+00N in a region of unusual electrical properties. Negative induced voltages were recorded in this area (see Figure 4), resulting in negative apparent resistivities (and also negative normalized induced polarization values). This phenomena may be caused by faults. In addition, a cliff was crossed twice in this area, so that topography may also have influenced the survey results.

The largest area of resistivity lows occurs in the northeastern corner of the survey area, with a low value of 943 ohm feet at 18+50E, 73+00N. Magnetic Anomaly #2 falls within this area, and Magnetic Anomaly #6 is near its southern boundary.

The "finger" of resistivity lows which extends to 3+50E, 78+00N is of interest, since I.P. Anomaly #1 is coincident.

The small (largest dimension roughly 500 feet) patch of low values centered at 14+00W, lines 60+00N and 63+00N roughly coincide with I.P. Anomaly #2.

The central area of Anomalously high resistivity includes Magnetic Anomaly #6. Magnetic Anomaly #3 is within 200 feet of its southern boundary. The juxaposition of a resistivity high and a magnetic high suggests that the magnetic Anomaly may be response to the magnetite bearing bedrock. This may also be the case for magnetic Anomaly #4, which is centered on a small zone of anomalously high resistivity.

A large area of below average resistivity surrounds magnetic Anomaly #1. The I.P. response for the area was also below average.

An anomalously low area (largest dimension 350 feet) centered on 2+50W, 39+00N coincides with I.P. Anomaly #3, and is at the point of a "finger" of below average resistivity values.

C. Induced Polarization

In general, the induced polarization map (see Figure 5) is dominated by two zones of above average response. The two zones are centered in the northern and southern halves of the property, and are separated by an embayment of below average response. The embayment is coincident with the Big Kid trench.

The arithmetic mean of 188 normalized induced polarization values is 16.8 millivolt seconds per volt (or milliseconds, m.s.) and standard deviation is 12.6. The high standard deviation is a reflection of the extremely broad range of I.P. values, The highest response encountered was 78.0 m.s. (which is uncommonly high) and the lowest 1.0 m.s.

Based on the above statistical information, the following categories may be established:

Value (m.s.)	Category
0 to 3.9	low
4 to 16.9	background low to average
17 to 29.9	above average
30 to 43	weak to moderately anomalous
above 43	stronly anomalous
above 56	very strongly anomalous

Using this classification, five I.P. anomalies were located on the Norranco property, and are listed in order of decreasing (probable) importance.

Anomaly #1 is strongly anomalous and is centered at 78+00N 0+50E, and has a high value of 57.1 m.s. It is intersected by an anomalously low resistivity area. The S.P. value there was moderately high, but it is virtually surrounded by two large areas of low S.P. The magnetic response is roughly average in the immediate area, as it is near each of the I.P. anomalies.

A depth probe conducted at the centre of Anomaly one indicated the following:

(a) The mineralized zone is about 225 feet long extending from 25 feet to 250 feet deep;

(b) The zone is oval shaped, with the long axis vertical, centered about 50 feet east of the base line;

(c) The electrical properties of the anomalous zone are relatively uniform suggesting a uniform zone of mineralization;

(d) The dV climbed during the pulse at 'a' spacings of 25' and 50', indicating sulphide mineralization close to the surface. An overburden thickness of five feet is indicated.

Anomaly #2 is moderately to strongly Anomalous and coincides with a resistivity low. It includes the area between 8+50W and 14+50W on line 60+00N. The high reading of 50.0 m.s. occurs on station 14+50W.

A depth probe was conducted on 14+50W, line 60+00N and indicated the following:

(a) the area was more Anomalous than expected;

(b) the mineralized zone extends for about 180 feet vertically, with the top roughly at a depth of 40 feet;

(c) the moderately Anomalous zone is irregular in shape, with a very strongly Anomalous zone centered about 100 feet below 14+00W, circular in shape, with a diameter of 50 feet;

(d) the electrical properties of the Anomalous zone showed more variation than Anomaly #1, but suggest fairly uniform mineralization;

(e) the overburden thickness is about 5 feet.

Anomaly #3 is very strongly anomalous, and lies directly on an inferred fault (centered on 2+50W, line 39+00N). The high reading of 78.0 m.s. occurs at this station, and is within a medium sized, moderately Anomalous zone. It is within a "finger" of resistivity lows, and the instrument operator noted that the dV climbed during the current pulse, often an indicator of sulphides.

A depth probe conducted at 3+00W, 39+00N indicated that the area was not as anomalous as would be suspected from the high survey I.P. response. The zone of highest response was somewhat small, and centered at a depth of 200 feet. The overburden here may be in the order of 18 feet thick.

Anomaly #4 is moderately to strongly anomalous (high of 43.4 m.s.) and is within 200 feet of a mapped fault. It is roughly circular in shape, and is centered on 8+50W, 78+00N. The resistivity here is below average (almost anomalously low), and an S.P. value of negative 17 was recorded. The 4 to 8 second current pulse ratio was favorable, which is often an indicator of sulphides, and the dV climbed during the current pulse.

Anomaly #5 is moderately anomalous (high of 37.5 m.s.), extends between 4+50E, 24+00N and 1+00E, 29+00N, and is in a faulted zone. There is a zone of S.P. low associated with it, and a small resistivity low. Furthermore, the instrument operator noted that the dV climbed during the current pulse at both ends of the Anomaly, and gave a favorable 4 to 8 second current pulse ratio. It lies within an area of above average magnetic response.

PART C THE MAGNETOMETER SURVEY

C-1 Magnetometer Field Procedure And Data Processing.

The ground magnetic survey was completed with a Sharpe MF-1 flux-gate vertical component magnetometer (see Appendix for instrument specifications).

Solar flares, and accompanying severe geomagnetic storms, occured several times during the survey period. Magnetometer surveying had to be discontinued during these periods, as the strength of the geomagnetic field fluctuated considerably.

Solar flare warnings and observations from the Space Disturbance Forecast Center in Boulder, Colorado were received daily, and used as a guide to schedule survey time.

To remove the diurnal time variations of the geomagnetic field from the data, a correction factor T must be determined (T = Standard Base Response - Base Reading). To determine T, a base station was selected (13+00W, line 63+00N) and a convenient standard base response assigned to it (2000 gammas). The operator traversed the grid area in a series of loops, checking in at the first station on the loop with a series of readings after each loop. The operator checks in at the base station at the start of each survey day and as often as possible during the day. In this manner the survey was completed and the time variation of the geomagnetic field recorded. From a graph of the time variation, and from the loop checks, T was determined for each reading. After adding the appropriate T to each reading, the corrected data was plotted and contoured at intervals of 1300, 2300, 3300, 4300 and 5300 gammas (see Figure 6).

C-2 Discussion of Magnetometer Survey Results

In general, the isomagnetic plan (see Figure 6) displays some north-south bias, interrupted by discontinuities. The north-south bias may be a reflection of faulting and bedrock trends; the patchiness is a manifestation of the volcanic bedrock. Rock type and isomagnetic zones appear to exhibit rough correlation.

The isomagnetic plan consists of two large areas of above average response, separated and surrounded by zones of low response.

The arithmetic mean of 602 corrected magnetometer readings is 2314 gammas and the standard deviation 949 gammas. The highest response obtained was 5820 gammas and the lowest was 100 gammas.

There are six areas of very high magnetic response (above 5000 gammas). They are listed below, in order of decreasing magnitude.

No.	Line	Station	Result (gammas)
1	44+00	22+00W	5820
2	63+00N	14+00E	5685
3	44+00N	8+00W	5580
4	33+00N	1+00W	5320
5	39+00N	19+00E	5295
6	44+00N	4+00W	5280

Perhaps the most interesting are; Anomalies #3 and #6, because of their proximity to I.P. Anomaly #3 — and Anomaly #2, because of the high gradient of the magnetic field in its vicinity. One hundred feet east of it, the reading is 435 gammas, resulting in a gradient of 52.5 gammas per foot. This high gradient falls on an extension of an indicated fault.

The low magnetic value (100 gammas at 5+00W, 63+00N) falls between a resistivity high (5655 ohm-feet, at 5+50W, 63+00N), and a below average resistivity zone (low of 2003 ohm-feet, at 2+50W, 63+00N), and again suggest a fault. Evidence such as this was used to infer other faults as well, and these are presented in the General Interpretation Map (Figure 8).

PART D SUMMARY AND GEOPHYSICAL COMPILATION

During the period of December 3-16, 1968, Geo-X Surveys Ltd. completed 12.4 line miles of induced polarization and 11.4 line miles of magnetometer surveys on the Aspen Grove property of Norranco Mining and Refining. The property, consisting of the Halo, Broatch and Ram claims, is situated about two miles northeast of the Aspen Grove store and one mile east of Highway #5.

A Hewitt Enterprises Pulse Type induced polarization unit, with a Wenner field array, and a Sharpe MF-1 magnetometer were utilized for the surveys.

The claims are centered on a small hill, and have a range in elevation of about 800 feet. The ground control grid was layed out roughly east-west, and cross lines are about 400 feet apart. Every line was surveyed with the magnetometer and I.P. equipment.

Testing with the I.P. unit on December 3, 1968, indicated that an "a" spacing of 300 feet was most suitable. This "a" spacing was used throughout the survey as the transit interval.

Maps (on a scale of 1":400') of the self potential, apparent resistivity, induced polarization, magnetic field strength and general interpretation accompany this report. The I.P. survey defined two zones of above average (higher than 17 m.s.), I.P. response, and five Anomalously high areas are indicated. The Big Kid trench area, previously shown to be economically interesting, was below average in I.P. response. Perhaps this is due to the decrease in chargeability which sometimes accompanies the mineralogical phase change from iron to copper sulphides. Therefore, economic target areas may not be entirely restricted to areas of high induced polarization. Consequently, based on this empirical relationship, embayments in the area of above average I.P. response may warrant further investigation. Further investigation is recommended for the five induced polarization anomalies summarized below.

I.P. Anomaly #1, centered at 0+50E, 78+00N is moderately to strongly anomalous (57.1 m.s. high). It is within a below average resistivity zone, and is centered (at a distance of roughly 300 feet) between zones of low S.P. and high magnetic response.

Anomaly #2 is moderately to strongly anomalous (50.0 m.s. high) and is centered between 8+50W and 14+50 on line 60+00N. It coincides with a resistivity low.

Anomaly #3 is strongly anomalous (78.0 m.s. high) and is centered on 2+50W, 39+00N. It is coincident with a resistivity low, and special effects suggest the presence of sulphides. However, detailing indicated that the mineralized zone may be rather small.

Anomaly #4 is moderately anomalous (43.4 m.s. high) and is centered on 8+50W, 78+00N. It is coincident with an S.P. low, below average resistivity, and sulphides are indicated by special effects.

Anomaly #5 is moderately anomalous (37.5 m.s. high), and is centered between 4+50E, 24+00N and 1+00E, 29+00N. It is coincident with low S.P. and resistivity, and special effects suggest the presence of sulphides.

A general interpretation is presented in the General Interpretation Plan. (see Figure 7)

Respectfully submitted,

PROFESSIONAL PROVINCE OF D. R. COCHRANE BRITISH COLUMBIA ENGINEER

January 16, 1969
Vancouver, B.C.

D. R. Cochrane, P. Eng.

J. Cerne, Geophysicist.

J. Cerne

APPENDIX I

PERSONNEL

Name:	COCHRANE, Donald Robert
Education:	B.Sc. - University of Toronto M.Sc. (Eng.) - Queen's University
Professional Associations:	Professional Engineer of British Columbia, Ontario and Saskatchewan. Jr. member of C.I.M.M., member of G.A.C., M.A.C. Geological Engineer.
Experience:	Engaged in the profession since 1962 while employed with Noranda Exploration Co. Ltd., Quebec Cartier Mines Ltd., Meridian Exploration Syndicate. Presently employed as Engineer with Geo-X Surveys Ltd. Experience in West Indies, Latin America, South America, United States and Canada.

APPENDIX I

PERSONNEL

NAME:	CERNE, James
EDUCATION:	B.S. Geology (June 1967) Case Institute of Technology - Cleveland, Ohio. M.S. Geophysics (August 1968) California Institute of Technology - Pasadena, California.
EXPERIENCE:	July 1965 - June 1967 - Metallurgy Dept., Case Institute of Technology - Student Asst. June - September 1967 - N.A.S.A. Manned Spacecraft CNT. Lunar and Earth Sciences Div., Geophysics Group, Houston, Texas. September 1967 - August 1968 - California Institute of Technology, Seismological Laboratory, Graduate Research Asst. September 1968 - present. Employed by Geo-X Surveys Ltd. as Geophysicist.

APPENDIX I

PERSONNEL

Name:	PASCHE, Juergen
Education:	Mittelschule - equivalent to Grade 12. Completed apprenticeship as precision mechanic with Carl Zeiss - Graduate Electrical Technology.
Experience:	3 years - Electro-Technician with SIEMENS of Braunschweig, Germany.
	3 1/2 years - Seismic Party Chief with PRAKLA Association for practical deposit research in Germany - including field experience in Switzerland, Italy, and North Africa.

APPENDIX I

PERSONNEL

Name:	WILSON, Norman George Robert
Education:	Junior Matriculation equiv., Grade 13 Math.
	2nd Year National Electrical Engineering.
Experience:	12 years Royal Air Force - Radar Technician.
	6 months British Government Communications - Radio Technician.
	Presently employed by Geo-X Surveys Ltd., since October 22nd, 1967 doing Induced Polarization, Electromagnetic and Magnetometer Surveys under Professional supervision.

APPENDIX I

PERSONNEL

Name:	KEY, Robert A.
Education:	Grade XII Diploma.
	1 year Petroleum Geology at the Institute of Technology and Arts in Calgary.
Experience:	2 years in Steam Heating Design Drafting.
	12 years with Mobil Oil Canada Limited, Senior Draftsman.

APPENDIX I

PERSONNEL

Name:	YIP, David Edward
Education:	Grade 12 - Majors: Science, Mathematics, Social Studies and Industrial Arts. Lake Cowichan Secondary School 1 year - Vancouver Vocational Institute - Drafting Training.
Experience:	Presently employed by Geo-X Surveys Ltd. since November 27, 1967 as Draftsman.

APPENDIX II

PERSONNEL AND DATES WORKED

A. FIELD CREW

W. Bellamy	Helper	Dec.4-9,11-16, 1968
R. Thomson	Helper	Dec. 3, 1968
J. Wiggins	Helper	Dec.3-9, 11-16, 1968.
J. Johnson	Helper	Dec.5-9, 11-16, 1968
K. Moldowan	Helper	Dec.3-9, 11 - 16, 1968
J. Pasche	Instrument Operator	Dec. 12-16, 1968
N. Wilson	Instrument Operator	Dec. 3-9, & 11, 1968
G. White	Geophysicist	Dec. 2-4, 1968
J. Cerne	Geophysicist	Dec. 3-9, 11, 12, 1968
D. Cochrane	Professional Engineer	Dec. 2-4, 1968

B. DATA PROCESSING & REPORT PREPARATION

D. R. Cochrane	Professional Engineer	Dec. 7, 20, 23 Jan. 13, 16, 1968
J. Cerne	Geophysicist	Dec. 16,18,20,27,30,31 Jan. 3-9, 13,14,17, 1968

C. DRAFTING & REPRODUCTION

D. Yip	Draftsman	Dec. 13, 16-17, 19 Jan. 9, 14, 16, 17
R. Key	Draftsman	Dec. 5,6,23,27,30 Jan. 6-10, 13-17
J. Carvajal	Draftsman	Dec. 28, Jan. 8, 17, 1968
M. Abrey	Secretary	Jan. 15, 16, 17

APPENDIX III

COST BREAKDOWN

The following is a cost breakdown of an I.P. and Magnetometer Survey covering the Halo and Broatch Claim Groups in the Aspen Grove Area of B.C., completed for Norranco Mining & Refining Co. through an Agreement with Geo-X Surveys Ltd. dated December 13, 1968.

10 line miles I.P. Survey @ $390/line mile	$3,900.00
2.4 line miles I.P. Survey @ $355/line mile	852.00
11.4 line miles Magnetometer Survey @ $50/line mile	570.00
3 days Orientation Detail @ $290/day	870.00
	$6,192.00

S.L. Sandner

APPENDIX IV

GENERAL SPECIFICATIONS OF THE HEWITT PULSE TYPE INDUCED POLARIZATION UNIT.

Transmitter Unit

Current pulse period (D.C. Pulse Manual initiated timer	1 - 10 seconds
Current measuring ranges	0 - 500 0 - 1000 Milliamperes 0 - 5000
Internal voltage converter 27 volt D.C. 350 watt output with belt back batteries	250 500 volts D.C. 1000 Nominal

500 watts using 27 volts aircraft batteries.

Transmitter can switch up to 3 amps at 1000 volts from generator or battery supply with resistive load. The switching is done internally in the transmitter unit. Remote control output can switch up to 10 kilowatts of power by using a separate control unit. A remote control cord is supplied with auxiliary equipment.

Receiver Unit

Self Potential Range	0-1000 millivolts 1 millivolt resolution
Impressed EMF Ranges	0 - 30 0 - 100 millivolts 0 - 300 0 - 1000
Input Terminals with Three Combinations	$P_1 - P_2$ $P_1 - P_0$ $P_2 - P_0$
Induced Polarization Ranges	0 - 30 0 - 60 millivolt 0 - 90 seconds

APPENDIX IV (Cont'd)

Integration Time Periods	.8 seconds 1.6 seconds
Tandem Integration Time Periods	3 ranges plus 4 integration combinations.
Delay Time from Cessation of Current Pulse	.3 seconds

(Combined Photo Electric Coupled Receiver and Transmitter)

Operation Temperature	-25° F - 120° F

POWER SUPPLY

Receiver Unit	4 Eveready E136 Mercury Batteries 2 Eveready E134 Mercury Batteries 2 Eveready E401 Mercury Batteries
Transmitter Unit	Sealed Rechargeable 8 amp. hr. belt pack capable of driving the converter at 350 watts for a minimum of one day's operation before recharge.

Manufactured by Hewitt Enterprises, Box 978A, Sandy, Utah, 84070
Phone: 801 571-0157

APPENDIX IV

Specifications for MF-1 Fluxgate Magnetometer

Maximum Sensitivity:	20 gammas (per scale division) on 1000 gamma range.
Readability:	5 gammas (1/4 scale division) on 1000 gamma range.
Ranges: (Full Scale)	1,000 Gammas 3,000 gammas 10,000 gammas 30,000 gammas 100,000 gammas
Maximum Range:	± 100,000 gammas
Latitude Adjustment Range:	10,000 to 75,000 gammas, Northern hemisphere convertible to: 10,000 to 75,000 gammas, Southern hemisphere or ± 30,000 gammas equatorial.
Dimensions: (including Battery Case)	7" x 4" x 16"
Weight: (including Battery Case)	9 lbs.
Batteries:	12 flashlight batteries ("C" cell)

Department of Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #3

WORK PROGRAM COMPLETED
LINE CUTTING PREPARATORY
TO GEOPHYSICAL SURVEY

—SYMBOLS—

- STREAM
- ROAD
- TRENCH
- OUTLINE OF LEGAL SURVEY

The lines shown in red represent the approximate location of lines actually cut on the claim blocks.

Norman Orr
Norman Orr

DAVID MINERALS LTD.

ASPEN GROVE PROPERTIES
KAMLOOPS M.D.

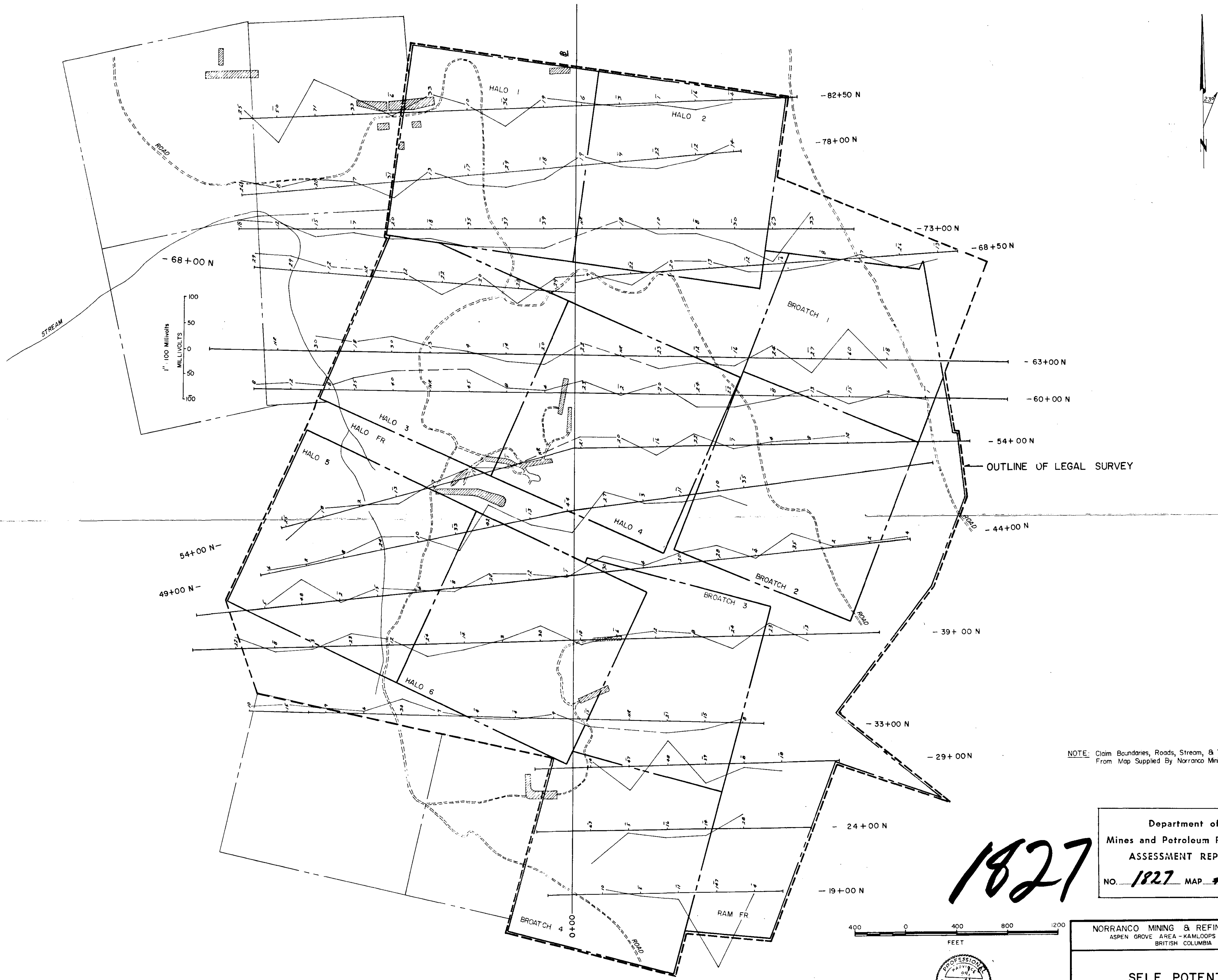
CHAIN & COMPASS TRAVERSE

PREPARED: TIDSBURY ENGINEERING LTD.

(Traverse after FRIDAY MINES, 1964) 1

Drawn: D.E. Snyder	Date: January 16, 1967
Scale: 1" = 400'	

1827



1827

LEGEND

TRENCHES

NOTE: Claim Boundaries, Roads, Stream, & Trenches Copied From Map Supplied By Norranco Mining & Refining Co Ltd

Department of Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #4

400 0 400 800 1200
FEET

HEWITT PULSE I.P.
WENNER ARRAY
a = 300'

TO ACCOMPANY THE GEOPHYSICAL SURVEY REPORT ON THE HALO & BROATCH CLAIMS OWNED BY NORRANCO MINING & REFINING CO. LTD. SITUATED IN THE ASPEN GROVE AREA, KAMLOOPS MINING DIVISION, BRITISH COLUMBIA BY DONALD R. COCHRANE, PROFESSIONAL ENGINEER, VANCOUVER, BRITISH COLUMBIA

NORRANCO MINING & REFINING CO. LTD.
ASPEN GROVE AREA - KAMLOOPS MINING DIVISION
BRITISH COLUMBIA

SELF POTENTIAL
(MILLIVOLTS)

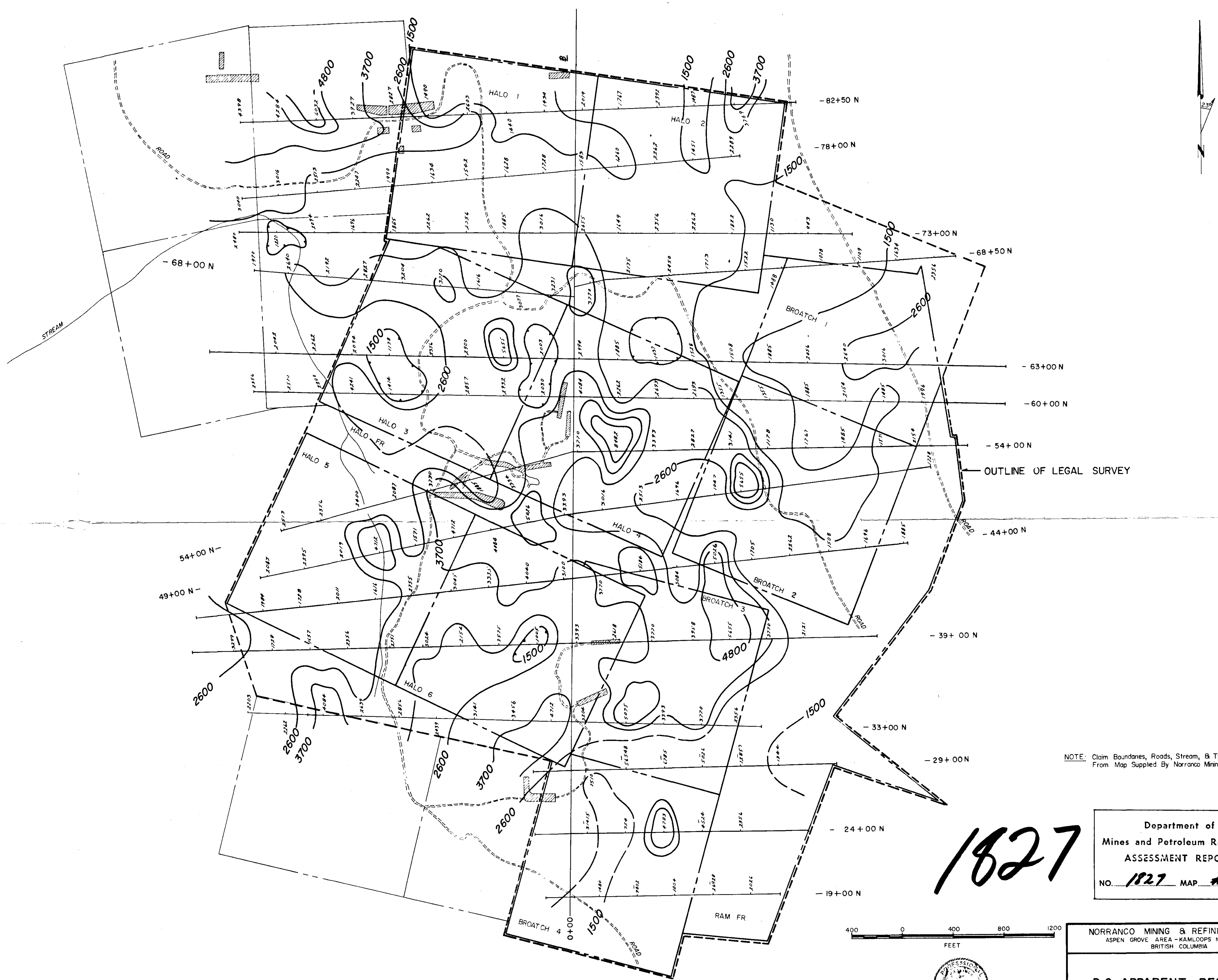
(2)

GEO - X SURVEYS LTD.

DRAWN	R.K. DEY	JOB NO	FIG NO
DATED	Dec 23/1968	1064	3
CHECKED			

LEGEND

TRENCHES



NOTE: Claim Boundaries, Roads, Stream, & Trenches Copied From Map Supplied By Norranco Mining & Refining Co Ltd

1827

Department of Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #5

400 0 400 800 1200
FEET

NORRANCO MINING & REFINING CO. LTD.
ASPEN GROVE AREA - KAMLOOPS MINING DIVISION
BRITISH COLUMBIA

D.C. APPARENT RESISTIVITY

CONTOUR INTERVAL : 1100 OHM FEET

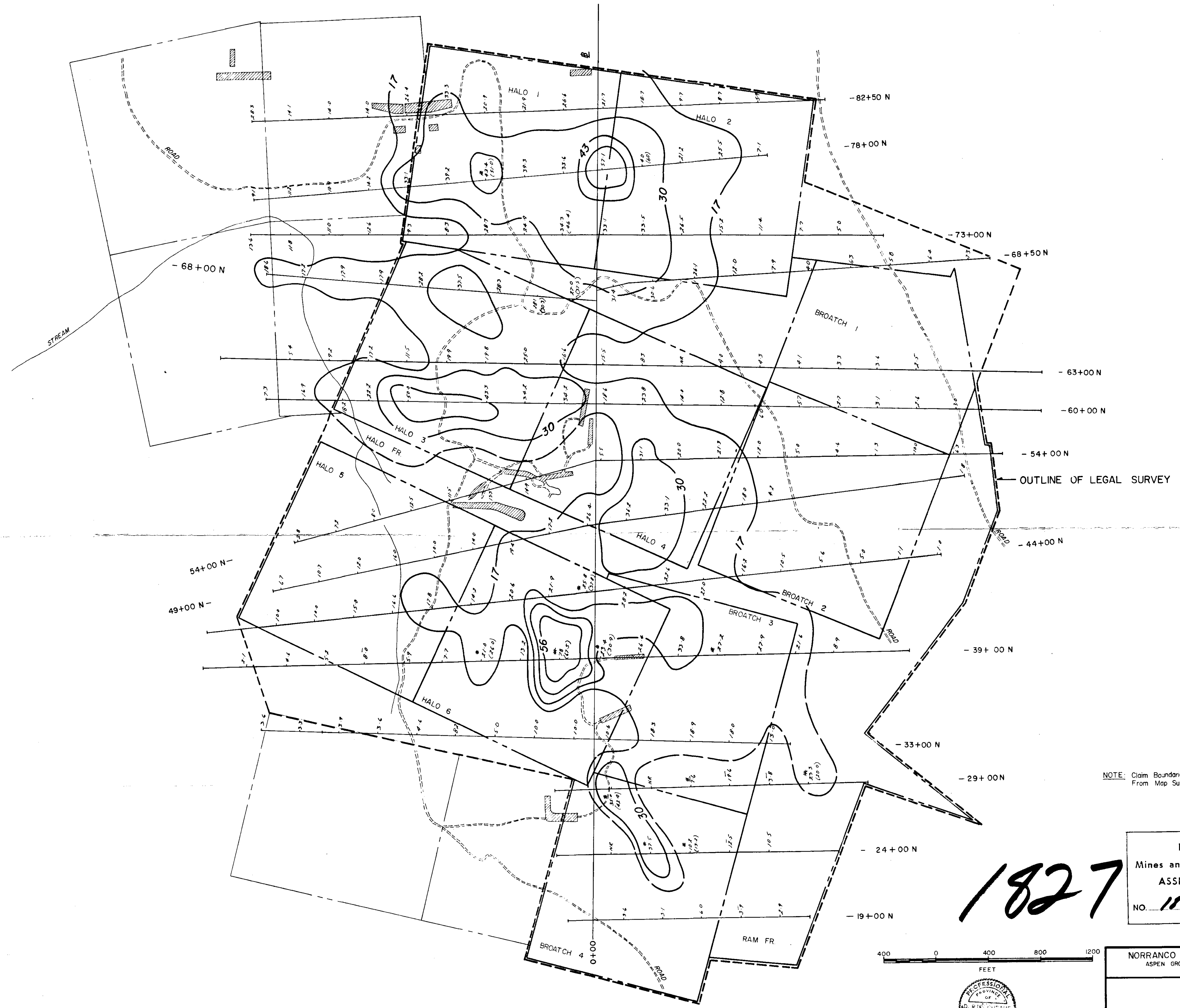
(3)

HEWITT PULSE I.P.
WENNER ARRAY
a = 300'

TO ACCOMPANY THE GEOPHYSICAL SURVEY REPORT ON THE HALO & BROATCH CLAIMS OWNED BY NORRANCO MINING & REFINING CO LTD SITUATED IN THE ASPEN GROVE AREA, KAMLOOPS MINING DIVISION, BRITISH COLUMBIA BY DONALD R COCHRANE, PROFESSIONAL ENGINEER, VANCOUVER, BRITISH COLUMBIA

GEO - X SURVEYS LTD.

DRAWN	R.K. DEY	JOB NO	FIG NO
DATED	Dec 23/1968	1064	4
CHECKED			



LEGEND

(hatched bar)	TRENCHES
*	CLIMBING D.V.
( )	8 SECOND PULSE

NOTE: Claim Boundaries, Roads, Stream, & Trenches Copied From Map Supplied By Norranco Mining & Refining Co Ltd

1827

Department of Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #6

400 0 400 800 1200
FEET

HEWITT PULSE I.P.
WENNER ARRAY
a = 300'

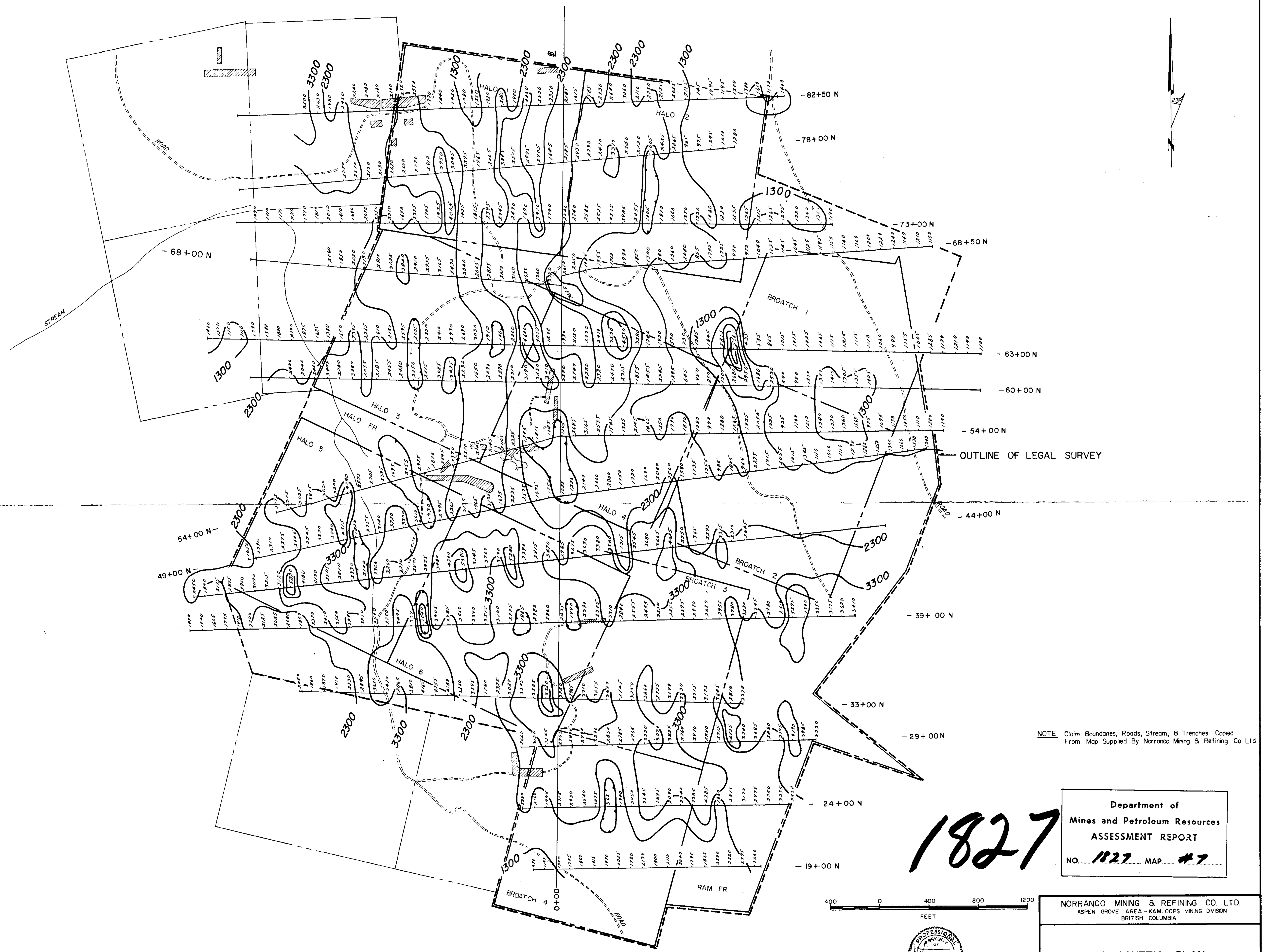
TO ACCOMPANY THE GEOPHYSICAL SURVEY REPORT ON THE HALO & BROATCH CLAIMS OWNED BY NORRANCO MINING & REFINING CO. LTD. SITUATED IN THE ASPEN GROVE AREA, KAMLOOPS MINING DIVISION, BRITISH COLUMBIA BY DONALD R. COCHRANE, PROFESSIONAL ENGINEER, VANCOUVER, BRITISH COLUMBIA

NORRANCO MINING & REFINING CO. LTD.
ASPEN GROVE AREA - KAMLOOPS MINING DIVISION
BRITISH COLUMBIA

NORMALIZED
INDUCED POLARIZATION
CONTOUR INTERVAL : 13 MILLISECONDS

GEO - X SURVEYS LTD.

DRAWN	R.K., DEY.	JOB NO	FIG NO
DATED	Dec 23/1968	1064	5
CHECKED			



LEGEND

TRENCHES

NOTE: Claim Boundaries, Roads, Stream, & Trenches Copied From Map Supplied By Norranco Mining & Refining Co Ltd

1827

Department of Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #7

400 0 400 800 1200
FEET

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. R. COCHRANE

TO ACCOMPANY THE GEOPHYSICAL SURVEY REPORT ON THE HALO & BROATCH CLAIMS OWNED BY NORRANCO MINING & REFINING CO LTD SITUATED IN THE ASPEN GROVE AREA, KAMLOOPS MINING DIVISION, BRITISH COLUMBIA BY DONALD R COCHRANE, PROFESSIONAL ENGINEER; VANCOUVER, BRITISH COLUMBIA

NORRANCO MINING & REFINING CO. LTD.
ASPEN GROVE AREA - KAMLOOPS MINING DIVISION
BRITISH COLUMBIA

ISOMAGNETIC PLAN
CONTOUR INTERVAL: 1000 GAMMAS

(6)

GEO - X SURVEYS LTD.

DRAWN	R.K. DEY	JOB NO	FIG NO
DATED	Dec 23/1968	1064	6
CHECKED			


BALD HILL TRENCH
BIG SIOUX TRENCH
HALO 1
HALO 2
HALO 3
HALO FR
HALO 4
HALO 5
HALO 6
BROATCH 1
BROATCH 2
BROATCH 3
BROATCH 4
RAM FR
ROAD
STREAM
BIG KID TRENCH
I.P. Anomaly 4
I.P. Anomaly 1.
I.P. Anomaly 2.
I.P. Anomaly 3.
I.P. Anomaly 5.
Isomagnetic Anomaly 1.
Isomagnetic Anomalies 3. 6.
Isomagnetic Anomaly 2.
Isomagnetic Anomaly 4.
Isomagnetic Anomaly 5.
- 82+50 N
- 78+00 N
- 73+00 N
- 68+50 N
- 68+00 N
- 63+00 N
- 60+00 N
- 54+00 N
54+00 N -
- 44+00 N
49+00 N -
- 39+ 00 N
- 33+00 N
- 29+ 00 N
- 24+00 N
- 19+00 N
0+00
OUTLINE OF LEGAL SURVEY
LEGEND
TRENCHES
I.P. ANOMALIES
ABOVE AVERAGE I.P.
ISOMAGNETIC ANOMALIES
RESISTIVITY LOW
FAULTS - GEOLOGICALLY INDICATED
FAULTS - GEOPHYSICALLY INDICATED
NOTE: Claim Boundaries, Roads, Stream, & Trenches Copied From Map Supplied By Norranco Mining & Refining Co Ltd.
Department of Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 1827 MAP #8
1827
400 0 400 800 1200
FEET
HEWITT PULSE I.P
WENNER ARRAY
a = 300'
TO ACCOMPANY THE GEOPHYSICAL SURVEY REPORT ON THE HALO & BROATCH CLAIMS OWNED BY NORRANCO MINING & REFINING CO LTD SITUATED IN THE ASPEN GROVE AREA, KAMLOOPS MINING DIVISION, BRITISH COLUMBIA BY DONALD R. COCHRANE, PROFESSIONAL ENGINEER, VANCOUVER, BRITISH COLUMBIA
NORRANCO MINING & REFINING CO. LTD.
ASPEN GROVE AREA - KAMLOOPS MINING DIVISION
BRITISH COLUMBIA
GENERAL INTERPRETATION
GEO - X SURVEYS LTD.
DRAWN RK. DEY
DATED Dec 23/1968
CHECKED
JOB NO 1064
FIG NO 7