85-219 - 13711

THISTLE PROPERTY, 1984

ASSESSMENT REPORT

TITLE: SOIL SAMPLING, MAGNETOMETER AND I.P.-RESISTIVITY, DIGHEM AIRBOURNE EM AND MAGNETOMETER SURVEYS AND DIAMOND DRILLING PROGRAM ON THE THISTLE PROPERTY, VANCOUVER ISLAND, B. C., 1984.

CLAIMS INVOLVED: L91G, L92G, L93G (CROWN GRANTS), L95G AND L97G (REVERTED), CROW, SUE, LEVI, MUSEUM, QUILL #1-8, LORE #1-3 AND RAND.

TOTAL CLAIMS-UNITS OF PROPERTY: 100 UNITS

LOCATION: ALBERNI AND VICTORIA MINING DISTRICTS

N.T.S.: 92F/2E
49° 06' LATITUDE
124° 39' LONGITUDE
FRANKLIN RIVER-RIFT CREEK AREA, 20 AIR-KMS SOUTHEAST OF PORT ALBERNI, SOUTH-CENTRAL VANCOUVER ISLAND, B.C.

OWNER OF CLAIMS: NEXUS RESOURCE CORPORATION

OPERATOR OF CLAIMS: WESTMIN RESOURCES LIMITED

WORK PERIOD: JUNE 25 TO OCTOBER 26, 1984

REPORTS BY: PART I : GARY BENVENUTO (WESTMIN RESOURCES LIMITED): SOIL SAMPLING SURVEY, GEOPHYSICAL SURVEYS AND DIAMOND DRILLING PROGRAM.

PART II: PETER WALCOTT (AND ASSOCIATES LIMITED): I.P.-RESISTIVITY SURVEYS ON DOUGLAS, THISTLE MINE, T.M. 70 ROAD, SADDLE, PANTHER ROAD SHOWING AND RIFT CREEK GRIDS.

PART III: PAUL A. SMITH (DIGHEM LTD.): DIGHEM III SURVEY OF THISTLE PROPERTY.

GEOLOGICAL BRANCH
ASSESSMENT REPORT

13,711

Part 1
of 3

TABLE OF CONTENTS

PART I

PAGE

TABLE OF CONTENTS

PART I PAGE

FIGURES, TABLES AND PLATES IN PART I

FIGURES

TABLES

PLATES

IN POCKET

APPENDICES

APPENDIX

PART I

SOIL SAMPLING, I.P.-RESISTIVITY AND DIGHEM AIRBOURNE GEOPHYSICAL SURVEYS, AND DIAMOND DRILLING PROGRAM ON THE THISTLE PROPERTY, VANCOUVER ISLAND, B. C., 1984

INTRODUCTION

LOCATION (92F/2E)

The Thistle property is located 20 airkilometers southeast of Port Alberni, south-central Vancouver Island, B.C. The property encompasses the headwaters-area of the Franklin River and Rift Creek (also known as the West Fork of the Nitinat River) (see Figure 1). The approximate centre of the property is at 49° 06' latitude and 124° 39' longitude.

ACCESS

The Thistle property is accessible by truck, from Port Alberni via the Bamfield road, and the Museum Main road, both of which are unpaved logging roads. The Thistle mine area is reached by following the Thistle Main road which branches to the north, off Museum Main road. The Panther Road showing area is located 1.4 kms southeast of the Thistle mine, but is reached by following the Museum Main road to the M2A road (also known as the Panther road), which branches to the north off Museum Main. By truck, it requires 40 minutes to travel the 31 kms to the Thistle mine from Port Alberni, and 45 minutes to travel to 34 km from Port Alberni to the Panther Road showing area.

PHYSIOGRAPHY

The topography and vegetation in the area of the property is relatively variable at both large and small scales. The Thistle mine area is located at the headwaters of the Franklin River. The mine is on the westerly facing slope of the Franklin River valley, which, in the area of the mine has an average slope of about 40°. The Panther Road showing area is separated from the Thistle mine area by a broad, low relief saddle separating the Franklin River Valley from the Rift Creek Valley. This area is located on the easterly flank of Limestone Mountain (peak at 1514 m) and is of relatively low topographic relief, with slopes varying from 10 to 35°.

Much of the area of the property, at higher elevations, is covered by mature forest comprising Douglas Fir, Balsam Fir, Hemlock and Cedar. However, at lower elevations, below about 800 to 950 m, decades of periodic logging has resulted in areas covered by various stages of second and probably third generation forest growth. The Thistle mine area is, in part, covered by mature forest, in part by an old logging slash, and in part by immature, second growth forest. The area of Franklin River is covered by incredibly dense thickets of salmonberry, alder, devil's club, blackberry and thimbleberry. The Panther Road showing area is covered in part by an old logging slash that contains sparse, 2 m high evergreens, but abundant fireweed, huckleberry bushes and well concealed deadfall, and in part by mature forest scheduled to be logged in 1985.

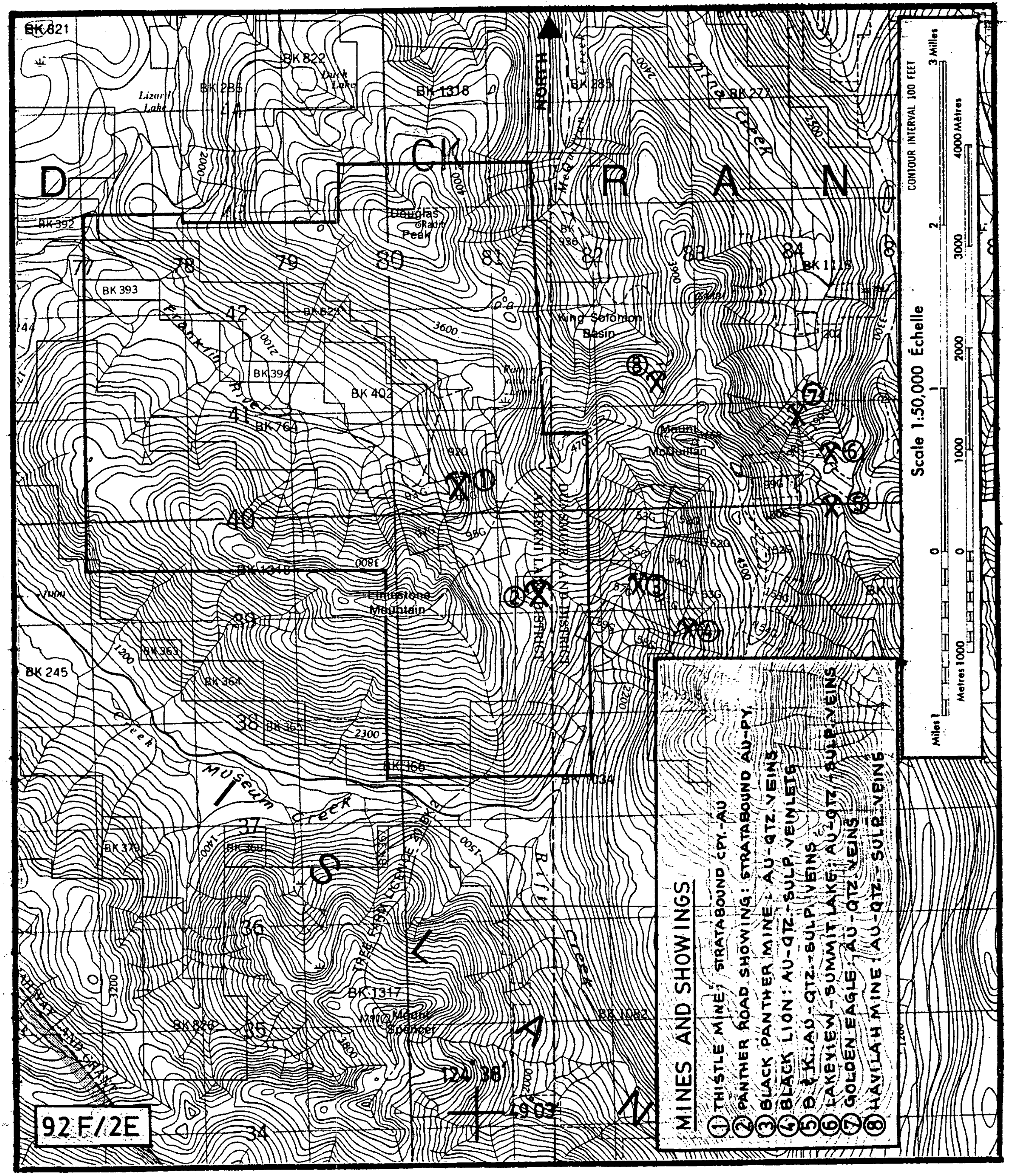


Figure 1: 1:50,000 Scale topographic map showing location of the Thistle property and locations of the main, past-producing mines and showings of significant mineralization in the Franklin River - Rift Creek area.

GEOLOGY

The southwestern third of the Thistle property is underlain by basaltic flows and pillowed basalt of the Upper Triassic Karmutsen Formation. The Karmutsen Formation is underlain to the northeast by the limestones, marbles and bedded tuffs of the Early Permian to Pennsylvanian Buttle Lake Formation, which forms the top of the Sicker Group. The Buttle Lake Formation is underlain to the northeast and east by a complexly interlayered succession comprising predominantly basaltic flows and agglomerates or flow breccias and secondarily, massive to thin-bedded tuffs. The part of the Sicker Group that underlies the Buttle Lake Formation, may range in age from Mississippian to Devonian or older. The Thistle mine and the Panther Road showing are located in this complex succession.

The area of the Thistle mine is approximately 85% covered with soil, colluvium or glacial till. The area of the Panther Road showing is about 75 to 85% covered with similar types of overburden.

PROPERTY DEFINITION

The Thistle property consists of 103 claim-units optioned by Westmin Resources Ltd. of 904 Four Bentall Centre, 1055 Dunsmuir Street, Vancouver, B.C., from Nexus Resource Corp. of 206-475 Howe Street, Vancouver, B.C., on August 5, 1983. The claims cover an area of about 22 square kilometers on map sheet 92F/2E and are located in the Alberni Mining District, except for the southeastern corner of the property which straddles the boundary with the Victoria Mining

Division (see Figure 2). All the claims are owned by Nexus Resource Corp. except L.95 and 97G. The claims information is as follows:

Sue: 20 units, record number 488(6), recorded June 28, 1979.

Crow: 20 units, 489(6), recorded June 28, 1979.

Levi: 16 units, 490(6), recorded June 28, 1979.

Rand: 16 units, 731(2), recorded February 29, 1980.

Museum: 15 units, 1223(5), recorded May 6, 1981.

Quill #1-8: 8 units, 1391-1398(2), recorded February 11, 1982.

Lore #1-3: 3 units, 575-577(8), recorded August 17, 1981; (Victoria Mining District).

CROWN GRANTS:

L91G: Lot number 242, Thistle mineral claims, 51.65 acres.

L92G: Lot number 240, Pansy claim, 49 acres.

L93G: Lot number 241, Primrose claim, 47 acres.

REVERTED CROWN GRANTS:

L95G: lot 244, Rose mineral claim, 378(2), 51 acres; owner of gold and silver rights: David Murphy; under option-to-purchase agreement with Nexus; recorded February 20, 1979.

L97G: lot 243, Jumbo mineral claim, 379(2), 40.5 acres; owner of gold and silver: David Murphy; under option-to-purchase agreement with Nexus; recorded February 20, 1979.

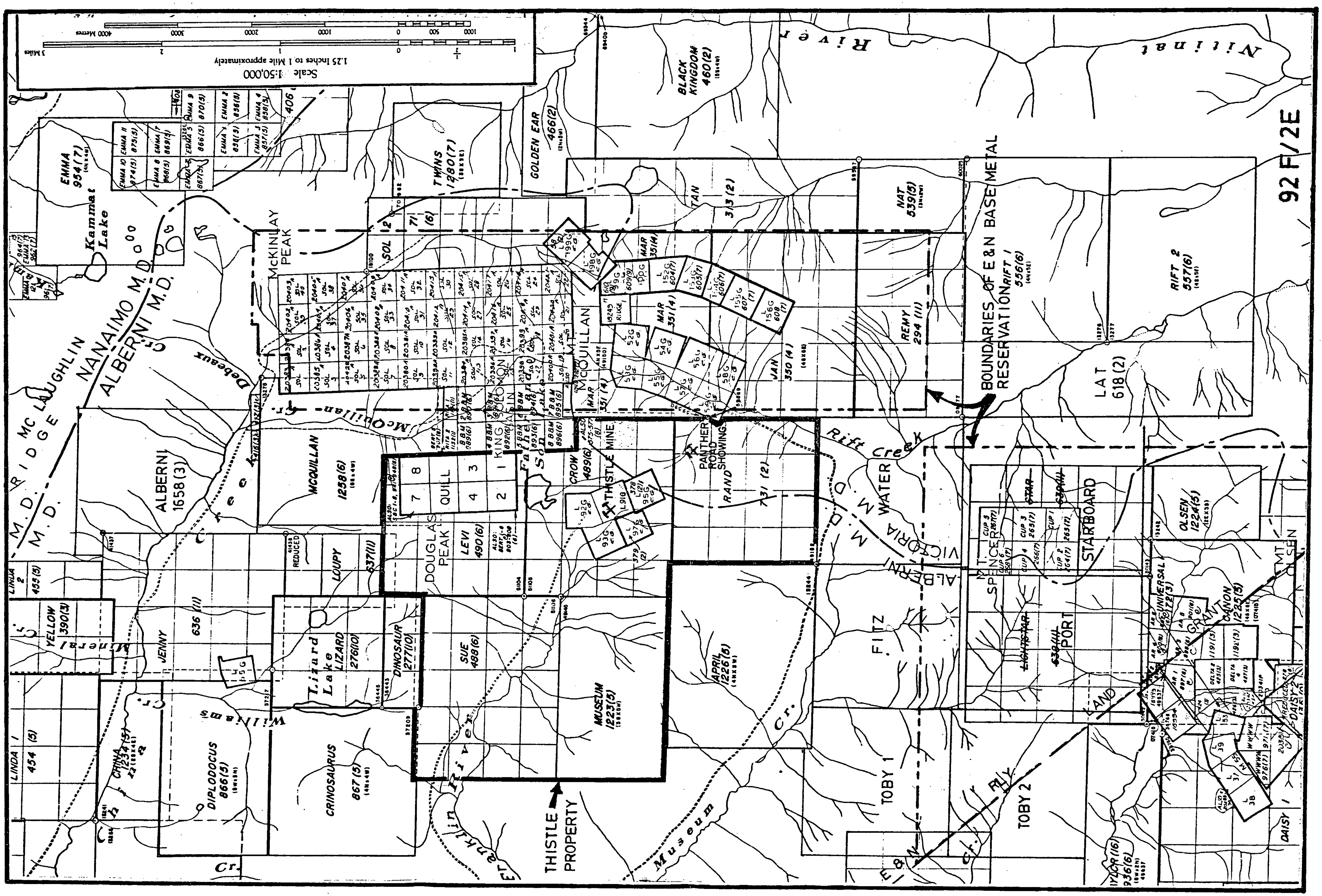


FIGURE 2: Claims map

EXPLORATION AND MINING HISTORY

The area of Franklin River and Rift Creek has been relatively extensively prospected since the 1890's. Within the area, two small deposits were mined, producing small tonnages of high grade ore. The Thistle mine, at the head of Franklin River, is located within the Thistle property (approximately in the northwest corner of L91G) (see Plates I:A, II and Figure 1). It produced about 6,920 tons grading 4.9% Cu, 0.3 oz. Ag/t and 0.4 oz. Au/t from thin lenses and layers of chalcopyrite-pyrite-calcite-quartz, between 1938 and 1942 (under the ownership of United Prospectors Ltd. of Victoria). The Black Panther mine is located on the east side of Rift Creek, 2 km east of the Thistle mine and in claims held by Lode Resources Ltd. that adjoin the Thistle property to the east (Figure 1). This mine produced about 1,900 tons of ore grading 0.5 oz. Ag/t and 0.27 oz. Au/t, from 7 to 90 cm thick, quartz veins, between 1947 and 1950.

The Thistle property is located within the old E.&N. Railway Land Grant, which included the base metal rights. Between 1963 and 1967, Gunnex Ltd. optioned the base metal rights from E.&N. Railway, on the area of the Land Grant, and conducted regional exploration surveys. In the area of the Thistle property, Gunnex conducted an airbourne magnetometer survey, and some regional geologic mapping, prospecting and silt and rock sampling surveys, including a brief visit to the Thistle mine (located in Crown Grants that were not part of the original Land Grant).

In 1965, Vanada Exploration Ltd. conducted exploration surveys in the immediate area of the Thistle mine. The surveys included soil sampling (314 samples, 50 x 200 ft. grid, analyzed for Cu), and magnetometer and self-potential surveys. Vananda also drilled four holes (137.2, 145, 142.6 and 107 m long, B-Q core) to test the structure beneath the Thistle mine and the northwesterly strike-projection of the mineralization at the mine

The drill hole core logs (which are supposed to be in open file in Victoria, but are missing, but were obtained from Nexus) indicate the holes intersected about 15 bands of massive pyrite, some with chalcopyrite, that varied in width from less than 2.5 cm up to 15 cm, in general. However, one band was 30 cm wide and another 76 cm wide (the only reported intersection that was assayed: 0.05% Cu and 0.01 oz. Au/t). In 1966, Vananda Exploration dropped their option on the five Crown Grants that encompass the Thistle mine, apparently because they were discouraged by the results of drilling.

After the exploration work by Vananda, there are no records of any exploration surveys having been conducted in the area of the Thistle property until 1979. In 1979 and 1980, Kargen Development Corp., the original owner of the Sue, Crow, and Levi claims, conducted soil sampling surveys for Cu, Pb and Zn on a grid covering 0.9 x 1.4 km in the southwest corner of the Levi claim and east-central Sue claims. The survey detected a patchy area of soil samples with anomalous concentrations of Cu (250 to 650 ppm) that covers an area of about 250 x 1000 m.

In 1981, Western Geophysical Aero Data Ltd. conducted an airbourne V.L.F.E.M. and magnetometer survey over the Crow, Sue, Levi, Rand, Mar, Jan and Remy claims for Nexus Resource Corp. (who optioned, then purchased the Crow, Sue and Levi claims from Kargen Development Corp.). Within the Thistle property one, strong V.L.F. anomaly was detected in the area about 500 m east of the Thistle mine, in the east-central Crow claim.

In 1982, Glen White Geophysical Consulting and Services, Ltd. of Vancouver, B.C., conducted I.P.-resistivity, Crone pulse E.M., magnetometer and soil sampling (Cu, Pb, Zn) surveys on a 250 x 600 m grid centred on the Thistle mine in L91G, for Nexus Resource Corp. The results of these surveys were filed as assessment work in early 1983, and will not be discussed in detail here.

In November, 1982, Sawyer Consultants Inc. of Vancouver, conducted geologic mapping and rock sampling in the Thistle mine area, for Nexus. The results of this work was also filed for assessment purposes, in early 1983.

In July and August, 1981, Ashworth Explorations Ltd. conducted soil sampling and V.L.F. E.M. surveys for Nexus, on a grid centred on the Panther road showing in the northeast corner of the Rand claim and 1.4 km southeast of the Thistle mine. The Panther road showing was discovered in mid-1981, by Nexus (which they called the "New Vein" showing), and consists of a 2.2 m wide interval of pyritic basalt, including 80 cm of massive pyrite, which assayed 0.05 oz. Ag/t and 0.490 oz. Au/t with 900 ppm Cu, across the 2.2 m width. Ashworth collected 16 soil samples, 30 m apart, on two grid lines located 12.5 m to the north and to the south of the road showing (samples analyzed for Cu, Ag and As). In addition, Ashworth conducted a V.L.F. survey on 12 grid lines, trending east-west, spaced 25 m apart and, on the average, 240 m long. The survey covered about 100 m of the southeasterly; and 225 m of the northwesterly strike-projection of the mineralization at the showing, but did not appear to detect any significant anomalies. The soil sampling and V.L.F. surveys were filed as assessment work in early 1982.

In 1983, Westmin Resources Ltd. had two small grids cut for soil sampling, I.P.-resistivity and magnetometer surveys to attempt to locate possible strike-extensions of the mineralized intervals at the Thistle mine and the Panther Road showing. The Thistle mine grid is centred on the mine, and consists of 6 lines, 425 to 500 m long, that trend 062° and are spaced approximately 100 m apart, for a total length of 3.63 kms. The Panther Road showing grid is centred on the showing and, in 1983, consisted of 8 lines, generally 500 m long, that trend 078° and are spaced 50 m or 75 m apart, for a total length of 3.9 km. The spacing of sample stations along the Thistle mine grid is 25 m (surface distance). Stations along the Panther Road showing grid lines are 15 m along the central 210 m of each line, and 25 m along the "outer" portions of the lines. 128 soil samples were collected on the Thistle mine grid and 199 soil samples from the Panther Road showing grid; these were analyzed for Cu, Pb, Zn, Ag and Au. The survey on the Thistle grid delineated one significant area 200 and 310 m northwest of the mine, delineated by five soil samples with anomalous concentrations of Cu (251 to 392 ppm) and very high to anomalous concentrations of Au (95 to 125 and 370 ppb). On the Panther Road showing grid, a total of 25 soil samples with high background concentrations of Au (30 to 85 ppb) and 6 soil samples with anomalous Au (155 to 750 ppb) were collected in 1983. Four samples with anomalous Au also contained anomalous Cu and two other samples just anomalous Cu. Eleven of these samples delineated two areas 185 m northwest, and 200 southeast of, and on the inferred trend-projection of the Panther Road showing. In 1983, an I.P.-resistivity survey (pole-dipole array, n=1 to 4, a = 25 m) was conducted along 4 of the 6 grid lines on the Thistle mine grid (totalling 2.2 km). This survey detected a broad zone of higher chargeabilities and lower resistivities centred on a line that trends northwesterly from the area between the lower and upper glory hole of the Thistle mine. The I.P.-resistivity survey conducted on the three central lines of the Panther Road showing grid (pole-dipole array, n = 1 to 4, a = 15 m and 30 m, total of 1.185 kms) detected a narrow zone of higher chargeability and lower resistivity centred on the showing; however, no anomalous results on the lines 50 m northwest and 50 m southeast of the showing were detected, indicating a very limited trend-length of the mineralized interval. The results of the soil sampling and I.P.-resistivity surveys conducted by Westmin Resources on the Thistle mine and Panther Road showing grids in 1983, were filed for assessment purposes.

SUMMARY OF SURVEYS AND WORK DONE BY WESTMIN RESOURCES IN 1984

In 1984, Westmin Resources completed 8.4 kms of linecutting, the collection of 1003 soil samples, 9.8 kms of I.P.-resistivity survey and 1,167 m of diamond drilling on the Thistle property. The details of the soil sample surveys and I.P.-resistivity surveys are summarized in the table below. The locations of the various grids are shown in Plate I.

TABLE 1: DETAILS OF THE GRIDS FOR LINECUTTING, SOIL SAMPLE SURVEY AND I.P.-RESISTIVITY SURVEY

GRID	LINECUTTING		SOIL SAMPLE SURVEY			I.P.-RESISTIVITY SURVEY		CLAIMS
	# OF LINES	TOTAL LENGTH	# OF LINES	TOTAL LENGTH	# OF SAMPLES	# OF LINES	TOTAL LENGTH	
DOUGLAS	5	2.175 kms	-	-	-	5	2.25 kms	Levi
FATHER & SON	-	-	9	8.825 km	347	-	-	Crow, Levi, Quill, L92G
THISTLE MINE	-	-	-	-	-	3	0.9	L91, 92, 93G
SADDLE	4	2.55	8	5.0	209	3	1.175	Crow, L95, 97G
PANTHER ROAD SHOWING	2	1.14	3	1.54	76	7	3.775	Rand, Crow
PANTHER ROAD	-	-	13	7.125	292	-	-	Rand
RIFT CREEK	3	1.26	3	1.26	63	3	1.17	Rand
T.M. 70 ROAD	-	-	1	0.08	16	1	0.525	Crow
TOTAL	14	7.125	37	23.83	1003	22	9.795	

LINECUTTING

Between June 25 and July 2, 1984, Van Alphen Exploration Services of Smithers, B. C. cut a total of 7.125 Kms of grid line on four grids, in preparation for the I.P.-resistivity surveys. The grid lines were cut with a chain saw and the stations marked with plastic flagging.

SOIL SAMPLING SURVEYS

Between June 25 and July 4, 1984, Van Alphen Exporation Services also collected a total of 976 soil samples of the "B" horizon, on 5 grids (I colleted 16 soil samples along the T.M. 70 road grid line and re-sampled 11 sites from which soil samples with anomalous Au and/or Cu were collected by Van Alphen). The soil samples were collected with a mattock and analysed for Cu, Pb, Zn, Ag and Au by Min-En Labs. Ltd. of 705 West 15th Street, North Vancouver, B. C. At the lab, the samples were dried at 95°C and screened with an 80 mesh sieve. 5 or 10 grams of the sample were pretreated with a nitric and perchloric acid solution, then digested with an Aqua Regia solution and finally diluted with HCl. The sample was then analysed for Cu, Pb, Zn and Ag by an atomic absorption spectrophotometer using a CH_2H_2-air flame. At least 75% of the original sample solutions were oxidized, and treated with Methyl Iso-Butyl Ketone. The solution was then analyzed for Au by atomic absorption instruments, with a detection limit of 5 ppb. The results of the analyses for Cu, Pb, Zn and Ag are reported on Plates II:A, B and C in parts per million (ppm), and for Au in parts per billion (ppb).

INDUCED POLARIZATION-RESISTIVITY SURVEYS

Peter Walcott and Associates Ltd. of 605 Rutland Court, Coquitlam, B. C., conducted I.P.-resistivity surveys on 6 grids, for a total of 9.8km grid line surveyed. The surveys were conducted by five men between July 4 and 21, 1984, and utilized a pole-dipole array for four level of readings (n = 1 through 4), with an a-spacing of 15 or 25 m. On the Douglas Grid, however, a gradient array was used, with an a-spacing of 25 m.

MAGNETOMETER SURVEY

On July 21, 1984, Peter Walcott and Associates Ltd. conducted a magnetometer survey on two grids southeast of the Thistle mine (lines 200 S and 300 S of the Thistle Mine grid; total length of 725 m). The spacing of the measurements is 12.5 m (surface distance). This survey completed the magnetometer survey on the Thistle mine grid that was partly finished in 1983.

THE GRIDS

Douglas Grid

The Douglas grid is located in southwestern Levi and consists of 5 lines, 100 m apart and generally 450 to 525 m long, trending north-south. Four of the five lines coincide with soil sample survey grid lines that were run by Glen White in 1980 for Kargen Development Corp. The purpose of Douglas grid cut in 1984 was to conduct a gradient array, I.P.-resistivity survey over the central part of an area from which 23 soil samples with anomalous Cu were collected by White in 1980.

Father and Son Grid

The Father and Son grid comprises 9 lines totalling 8.83 kms, and trending 062°. This grid was laid out to cover the area between the soil sampling survey completed in southwestern Levi by Glen White in 1979 and 1980, and Westmin's soil sampling on the Thistle mine grid completed in 1983. The Father and Son grid covers the northwestern trend-projection of the mineralization at the Thistle mine, and includes three lines of sampling that extend northeasterly into the Father and Son Lakes area. A total of 347 soil samples were collected from this grid.

Thistle Mine Grid

The Thistle mine grid was established in 1983 by Westmin for the purpose of locating possible northwesterly and/or southeasterly trend-projections of the mineralization at the Thistle mine. The grid consists of 6 lines from 425 to 500 m long and one line 300 m long that generally trend 062°, and are spaced about 100 m apart. In 1984, an I.P.-resistivity survey and magnetometer survey on the two most southerly grid lines completed the geophysical survey on the Thistle mine grid began in 1983. In addition, an I.P.-resistivity survey was conducted along 200 m of line 0, just northwest of the mine site, at an a-spacing of 12.5 m, to provide a more detailed survey of that conducted in 1983 at an a-spacing of 25 m.

Saddle Grid

The saddle grid covers the saddle, an area of generally low relief, between the Thistle mine grid and the Panther Road showing grid, and the southeasterly and the northwesterly trend-projections of the mineralization exposed at the Thistle mine and at the Panther Road showing, respectively. The grid comprises 8 lines with a total length of 5 km. The lines are spaced 100 m apart and trend 055°. Soil sampling at 25 m intervals was completed along all 8 lines (for a total of 209 samples). Four of the eight grid lines (every other line) was cut for an I.P.-resistivity survey. However, only two lines of

I.P.-resistivity survey were completed on the grid (lines 5 S and 10 S).

Panther Road Showing Grid

This grid is located in the southeastern Crow and northeastern Rand claims and is approximately centred on the Panther Road showing of gold-bearing massive pyrite. Two cut lines were added in 1984, to the southern part of the grid established in 1983. The grid now consists of 10 lines, generally 500 to 600 m long, that trend 078°, for a total length of 5.4 kms. The lines are spaced 75 m apart except for the three central lines which are spaced 50 m apart. In 1984, a total of 76 soil samples were collected from three gird lines (the western part of L.120N, all of lines 275 S and 350 S). A pole-dipole array, I.P.-resistivity survey was conducted on seven lines for a total survey length of 3.78 kms.

Panther Road Grid

This grid adjoins the Panther Road showing grid to the south and comprises 13 grid lines from 525 to 600 m long and trending either 078° or 088°, for a total length of 7.13 kms. The purpose of this grid was for a soil samling survey across favourable lithologies. A total of 292 soil samples were collected at 25 m intervals along this grid.

Rift Creek Grid

This grid adjoins the Panther Road grid to the south and is located in the southeast corner of the Rand claim. The southernmost line of the grid is centred on the Panther Road south showing which consists of a 0 to 10 cm thick zone of semi-massive pyrite with 0.062 oz. Au/t. The grid consists of three cut lines 420 m long, that trend 88° and are spaced 75 m apart. Stations along the grid lines are 15 m apart in the central part of the grid, and 30 m apart along the "outer" parts of the grid lines. Both a soil sampling survey and a pole-dipole array, I.P.-resistivity survey were conducted on this grid.

T.M. 70 Road Grid Line

This grid line follows the T.M. 70 road, and is about 480 to 1000 m west of the Thistle mine. The line is 525 m long and flagged with stations at 25 m intervals. The purpose of establishing the grid line was to conduct a pole-dipole array, I.P.-resistivity survey ($n = 1$ through 4, $a = 25$ m) across a weak E.M. anomaly detected by the Dighem airbourne E.M. survey in March, 1984. The anomaly was detected on two flight lines (16 and 17, fiducials 356 and 493, respectively) on points located 280 m and 420 m west of the intersection between T.M. 70 and Thistle Main roads, or approximately crossing T.M. 70 road at station 25 m E on the grid line.

16 soil samples were collected from the road bank along the T.M. 70 road line, at 5 m intervals; this short (80 m) line of sampling is centred on an anomaly detected by the I.P.-resistivity survey along T.M. 70, approximately centred half-way between stations 175 m E and 200 m E. The results of this soil sample survey are plotted on the pseudo-section for the I.P. survey on T.M. 70.

DIGHEM AIRBOURNE EM-MAGNETOMETER SURVEY

Dighem Ltd. of 7010 - 1 First Canadian Place, Toronto, Ontario (M5X 1C7) conducted a helicopter mounted Dighem III survey over the Thistle property on March 7, 1984. The survey utilized coaxial and coplanar coils for EM measurements taken at two frequencies (900 Hz and 7,200 Hz), and measured two channels of magnetics (fine and course count). More details of survey equipment are given in the report submitted by Dighem (Part III).

The survey covered an area from 1.7 to 2.7 km wide (SW-NE) and 6.6 kms long (NW-SE), and was planned to cover most of the Sicker Group rocks exposed on the property, including the Buttle Lake Formation (which forms the top of the Sicker Group). 34 lines were flown on an average azimuth of 57°. The lines vary, in general, from 1.5 to 2.8 km long, and are spaced, on the average, 200 m apart, but varying from 90 to 260 m apart. A total of 66 kms of survey was flown.

The purpose of the airbourne survey was to determine the location of possible weak or strong conductors in areas of extensive overburden or forest cover, that might provide the focus for further exploration outside the Thistle mine and Panther Road showing areas. In addition, we hoped that the survey would provide the basis for mapping out some of the major lithologic units and structures on the Thistle property, including especially the "mine flow unit" which hosts the mineralization at the Thistle mine and the Panther Road showing; this unit is characterized by the irregular occurrence of weakly to strongly magnetic basalts, due to disseminated magnetite.

DIAMOND DRILLING PROGRAM

Longyear Canada Ltd. of 721 Aldford Avenue, Annacis Island, New Westminister, B. C., drilled a total of 1167.1 m (3,829 ft.) of diamond drill holes using a Longyear 38 wireline drill, and obtaining B-Q core size, between October 4 and 26, 1984 (see Table 2). Eight of the total of nine holes were drilled from three road sites located 155 m west, 250 m northwest, and 312 m north of the Thistle mine (see Plate I.) to test the favourable lithologic succession and the I.P.-resistivity anomalies on the northwesterly trend-projection of the mineralization at the Thistle mine. Two of the drill sites were on Thistle Main road and one on the T.M.E. road. The latter site was obtained by "squamishing" a creek crossing on Thistle Main, 420 m northwest of the Thistle mine, and clearing, with a

The diamond drill holes were surveyed with an instrument manufactured by Sperry-Sun which determines the azimuth and inclination of the drill hole at depth. The results of these surveys are shown on the first page of the drill log for each hole. As with all surveys, problems were encountered in some of the holes. In hole 84-3 one azimuth measured is inconsistent with those of the other two tests, and is probably incorrect. Survey of hole 84-8 resulted in three azimuths which are totally inconsistant with the azimuth of the hole at the collar. A survey was not obtained just below the casing in 84-8 because of the very high water pressure of water draining from the hole. Failure of the survey instrument to measure reasonable-appearing azimuths in the cases mentioned above could be the result of highly magnetic rocks in proximity to the survey instrument or to a failure of the survey mechanism itself.

HOLE #	LENGTH (m)	INCLINATION	AZIMUTH*	COLLAR ELEV. (m)	LOCATION OF COLLAR **	
					GEOGRAPHIC	U.T.M. GRID COORDINATES
84-1	228.6	-45°	252°	854	T.M.E. road, 312 m at 352° from 300 adit of Thistle mine, L92G claim	5440632N/ 580507E
84-2	107.9	-63°	243°	854	Same as 84-1	Same as 84-1
84-3	105.5	-27°	069°	854	Same as 84-1	Same as 84-1
84-4	137.2	-10°	060°	745	East side of Thistle Main road, 255 m at 318° from 300 adit of T.M.; 175 m at 227° from 84-1; L92G-L93G claim boundary	5440233N/ 580377E
84-5	91.4	-55°	050°	745	Same as 84-4	Same as 84-4
84-6	107.6	-81°	247°	745	Same as 84-4	Same as 84-4
84-7	128.9	-42°	247°	745	Same as 84-4	Same as 84-4
84-8	199.0	00°	062°	728	East side of Thistle Main Road; 156 m along 283° from 300 adit; 154.5 m along 172° from 84-4; east-central L93G claim	5440080N/ 580397E
84-9	61.2	90°	-	702	Centre of T.M. 70 road; 565 m west (276°) of 300 adit; 410 m west (274°) of 84-8; northwest corner of L93G claim	5440393N/ 579978E

NOTES: * azimuths are from Sperry-Sun survey tests just below casing, for 84-1 thru 7.

** collars located with a hip chain or tape measure, and compass.

TABLE 2: Location, orientation and length of diamond drill holes 84-1 through 9, drilled on the Thistle property, October, 1984.

ROAD REPAIRS

Panther Main Road

A major washout occurred along the Panther Road during the winter of 1983 as an indirect result of an improper road repair contracted by Westmin in the fall of 1983. On November 18, 1983, Rayner and Bracht Ltd. of 4442 Tenth Avenue, Port Alberni, under contract by Westmin Resources, repaired a washout caused by heavy runoff, on Panther Road (M2A) at a creek crossing located 980 m (straight line) northeast of the intersection of Panther Main and Museum Main roads. Unfortunately, I could not supervise the road repair, and despite my instructions over the telephone, Rayner and Bracht filled in the washout at the creek crossing and diverted the creek water down the ditch alongside Panther Road. Later, when paying the bill for the road repairs, I commented to Rayner and Bracht that the washout was improperly repaired and should have been "squamished". In the winter of 1983-84, perhaps in January or February, heavy rains turned the creek into a torrent, and at a point about 200 m down the Panther Road (to the south), a wood culvert became blocked. The water diverted into the road ditch at the previouslyin-filled creek crossing, washed across the road at a point where the road changes gradient to near horizontal. This led to a washout of Panther Road with rather imposing dimensions: 24.4 m long, 12 m wide, and 4.6 m deep.

Engineers from MacMillan Bloedel Ltd., who own the timber and surface rights in the area of the washout, notified Westmin of the washout and firmly held us responsible. Rayner and Bracht refused to repair the washout at their cost, and MacMillan Bloedel insisted on repairing the washout themselves, at Westmin's expense. On May 23, 1984, MacMillan Bloedel cut down and partly filled the washout so that it was passable. On July 10, 18 and 19, MacMillan Bloedel drilled and blasted a nearby roadcut for ballast, and filled the washout to the previous road level, as well as set a new culvert. The charges to Westmin were $8,239. (detailed in Appendix A).

Thistle Main Road

Heavy runoff during the fall and winter of 1983 caused damage to the Thistle Main road at a creek crossing about 600 m west of the intersection between Thistle Main and T.M. 70 roads (northwest Crow claim). On June 8, 1984, Joe Carvalho of 2171 Cameron Drive, Port Alberni, under contract by Westmin, spent 3 hours with a bulldozer repairing this portion of the Thistle Main road to provide access for the soil samplers, linecutters and geophysical crew, to the Douglas Creek, Father and Son, and Thistle Mine grids.

DETAILED TECHNICAL DATA AND INTERPRETATION

GEOCHEMICAL SOIL SAMPLE SURVEY

Anomalous Concentration Thresholds for Cu, Pb, Zn, Ag and Au

The thresholds for anomalous and high background concentrations of Cu, Pb, Zn, Ag and Au in soil samples collected on the Thistle property in 1983 (316 samples) and 1984 (973), were determined from log-probability plots (Figures 3A through 3E). The plots show that Cu, Pb (for concentrations greater than 15 ppm), Zn (for concentrations greater than 10 ppm) and Ag (for concentrations above 0.6 ppm) are log-normally distributed (plot as a straight line). For Au, the distribution of concentrations greater than 15 ppb is nearly log-normal and comprises essentially a single population; concentrations below 15 ppb form a different population.

Based on the assumption that highest 2% of the concentrations of Cu, Pb, Zn, Ag and Au in soil samples are anomalous, the anomalous thresholds, as determined from log-probability plots are as follows: Cu: 260 ppm, Pb: 31 ppm, Zn: 140 ppm, Ag: 1.7 ppm and Au: 105 ppb (see Table 3). The thresholds for high background concentrations of Cu, Pb, Zn, Ag and Au were chosen at inflection points along the log-probability curves (listed in Table 3). These thresholds are convenient and instructive for the purpose of contouring maps of the analyses.

TABLE 3: Anomalous and high background concentration thresholds for soil samples collected from the Thistle property in 1983 and 1984.

METAL	ANOMALOUS		HIGH BACKGROUND		MEAN	
	CONC. (ppm)	CUM. %	CONC. (ppm)	CUM. %	CONC. (ppm)	CUM. %
Cu	≥260	2	≥120	14	42	50
Pb	≥31	2	≥25	11	17.5	50
Zn	≥140	2	≥90	10	45	50
Ag	≥1.7	2	≥1.2	17	0.9	50
Au	≥105 ppb	2	≥35 ppb	12	10 ppb	50

Results

Plates II:A, B and C show the soil sample analyses plotted for the various grids on a topographic map at a scale of 1:2000. These maps include the analyses for Cu and Au from 1983 surveys which are necessary to prepare the maps showing the contours for anomalous and high background concentrations of Cu, pb, Zn, Ag and Au (Plates III A, B and C), for all the grids.

FIGURES 3A - 3E: Log probability plots for Cu, Pb, Zn, Ag and Au in soil samples collected from all the grids on the Thistle property, in 1983 and 1984. These plots show the log probability of the cumulative percent of soil samples versus the concentration of the metal in the soil samples. The threshold for anomalous concentrations of the metals is assumed to be that concentration corresponding to 2% cumulative samples. The threshold between high background and lower background concentrations of the metals is chosen at obvious inflection points along the log probability curve.

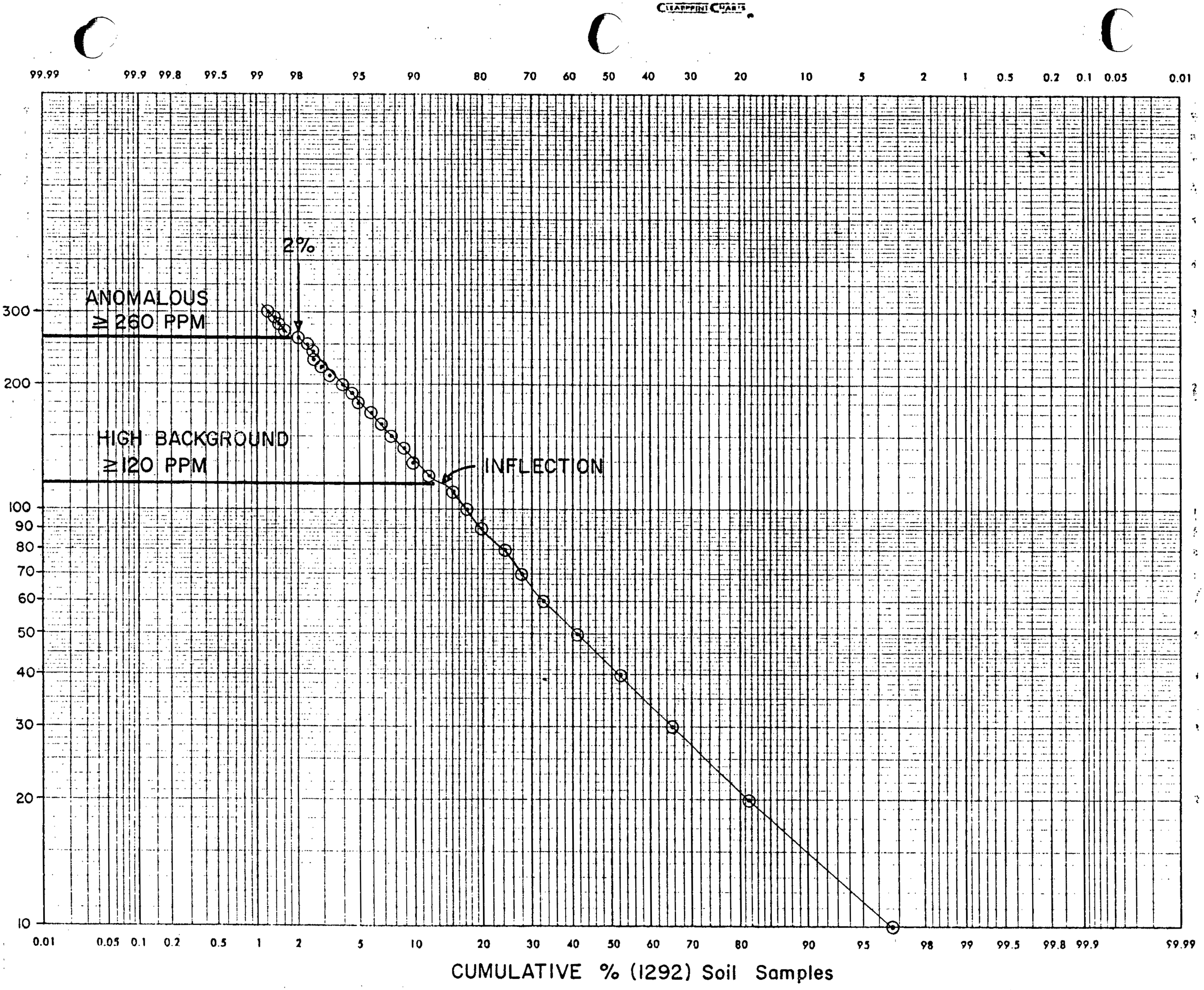

CLEARPRINT CHARTS
99.99 99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
COPPER (ppm)
300
200
100
90
80
70
60
50
40
30
20
10
2%
ANOMALOUS
≥ 260 PPM
HIGH BACKGROUND
≥ 120 PPM
INFLECTION
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.99
CUMULATIVE % (1292) Soil Samples

FIGURE 3A

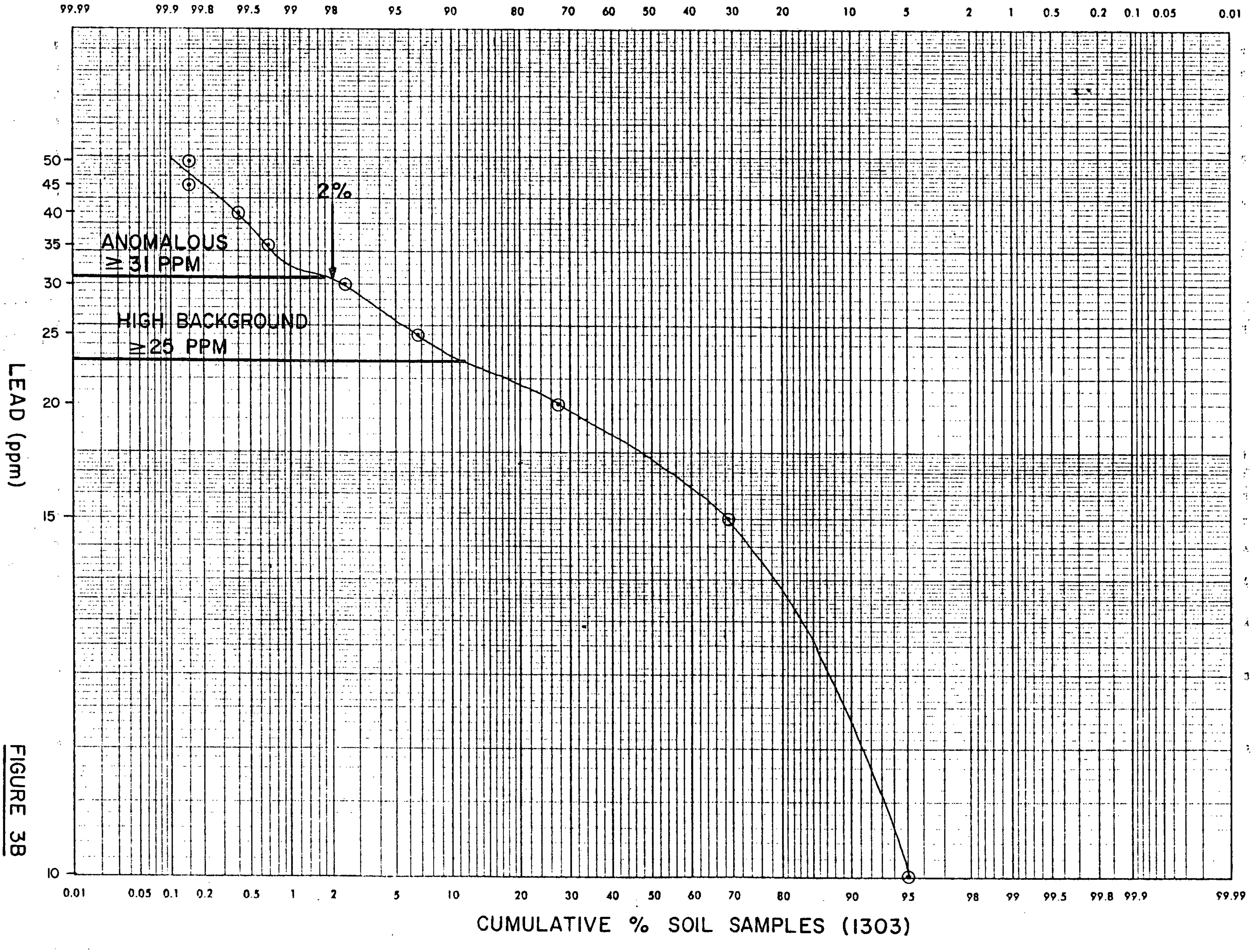

99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
50
45
40
35
30
25
20
15
10
2%
ANOMALOUS
≥ 31 PPM
HIGH BACKGROUND
≥ 25 PPM
LEAD (ppm)
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
CUMULATIVE % SOIL SAMPLES (1303)

FIGURE 3B

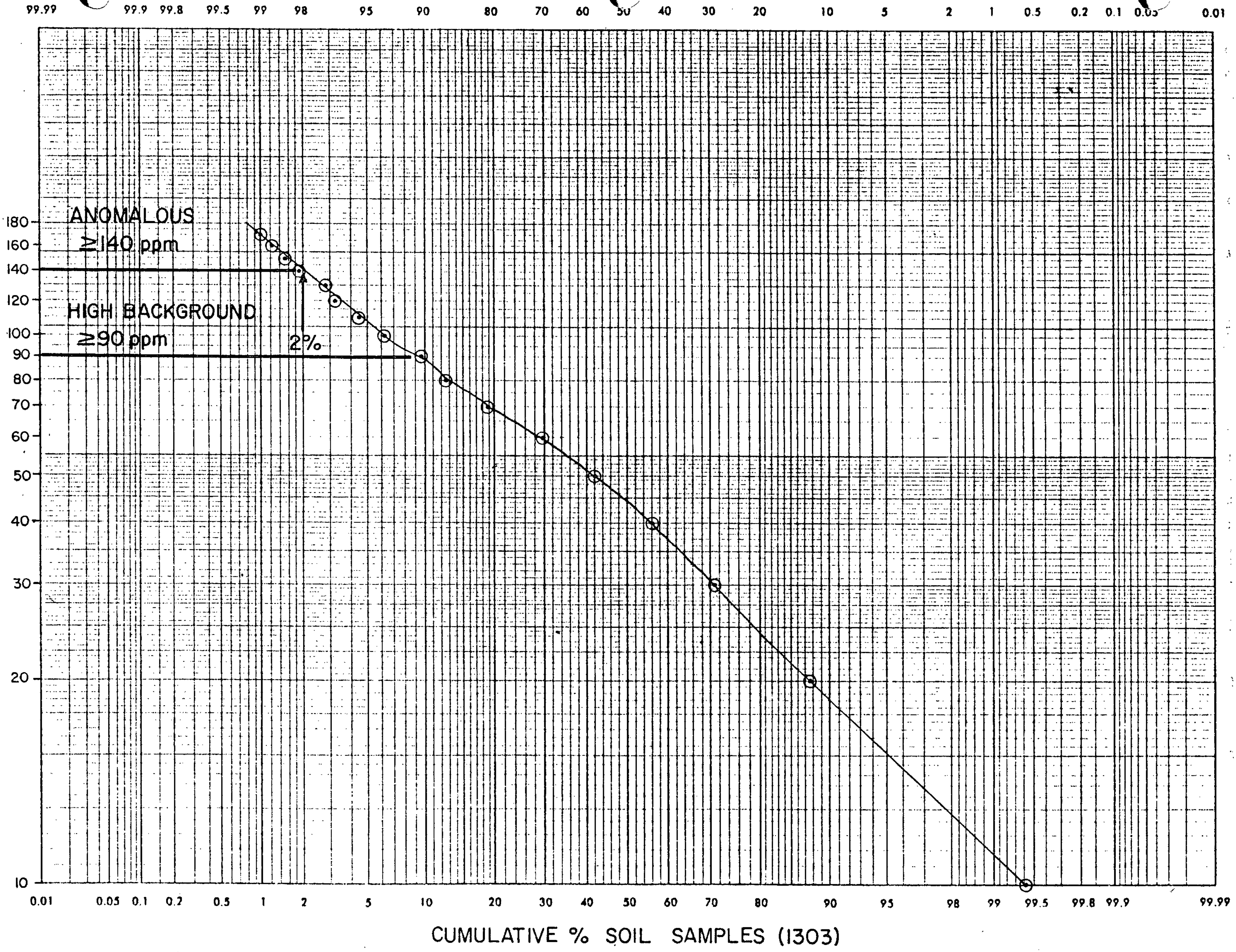

ANOMALOUS
≥140 ppm
HIGH BACKGROUND
≥90 ppm
2%
ZINC (ppm)
180
160
140
120
100
90
80
70
60
50
40
30
20
10
99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
CUMULATIVE % SOIL SAMPLES (1303)

FIGURE 3C

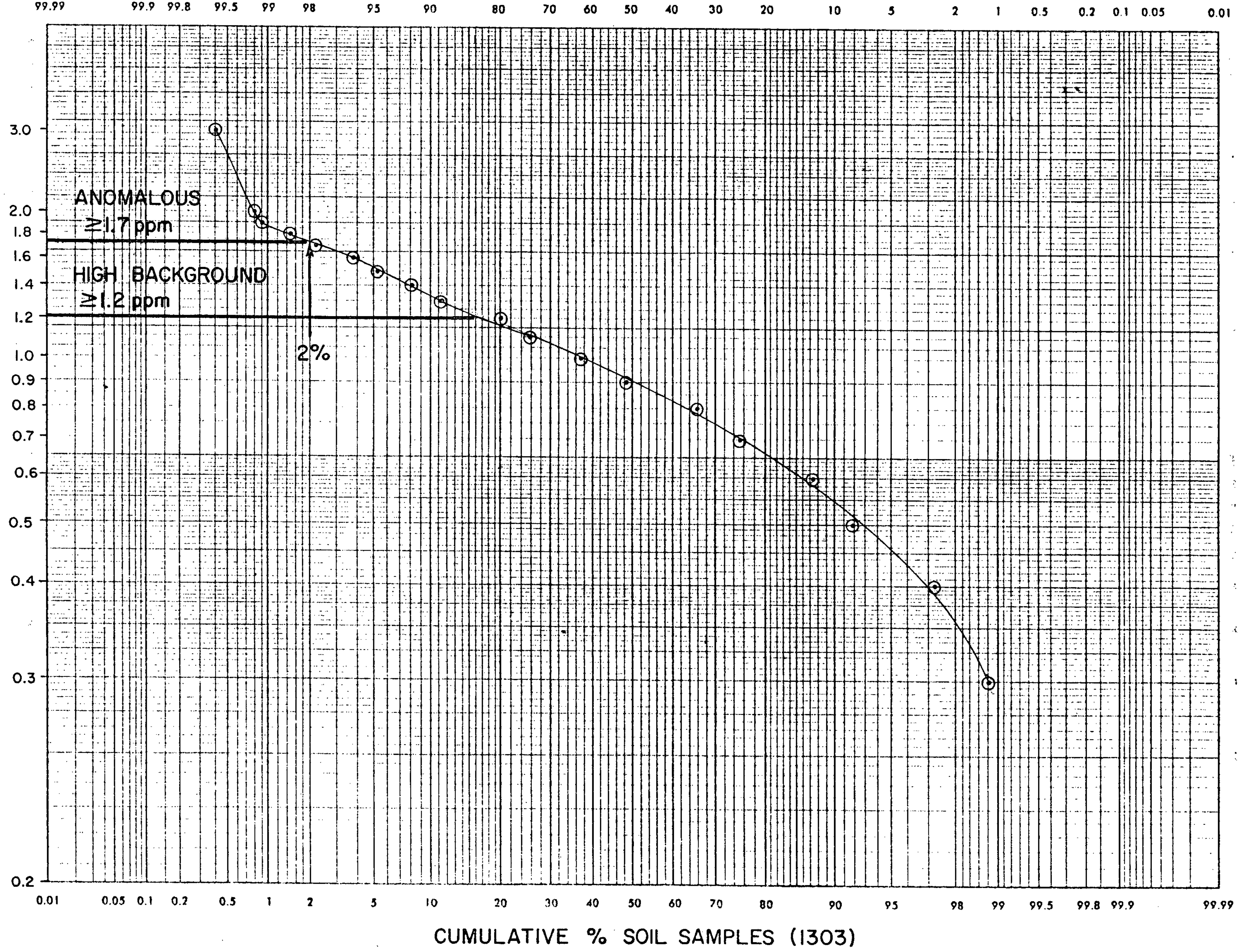

99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
ANOMALOUS
≥1.7 ppm
HIGH BACKGROUND
≥1.2 ppm
2%
3.0
2.0
1.8
1.6
1.4
1.2
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
SILVER (ppm)
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
CUMULATIVE % SOIL SAMPLES (1303)

FIGURE 3D

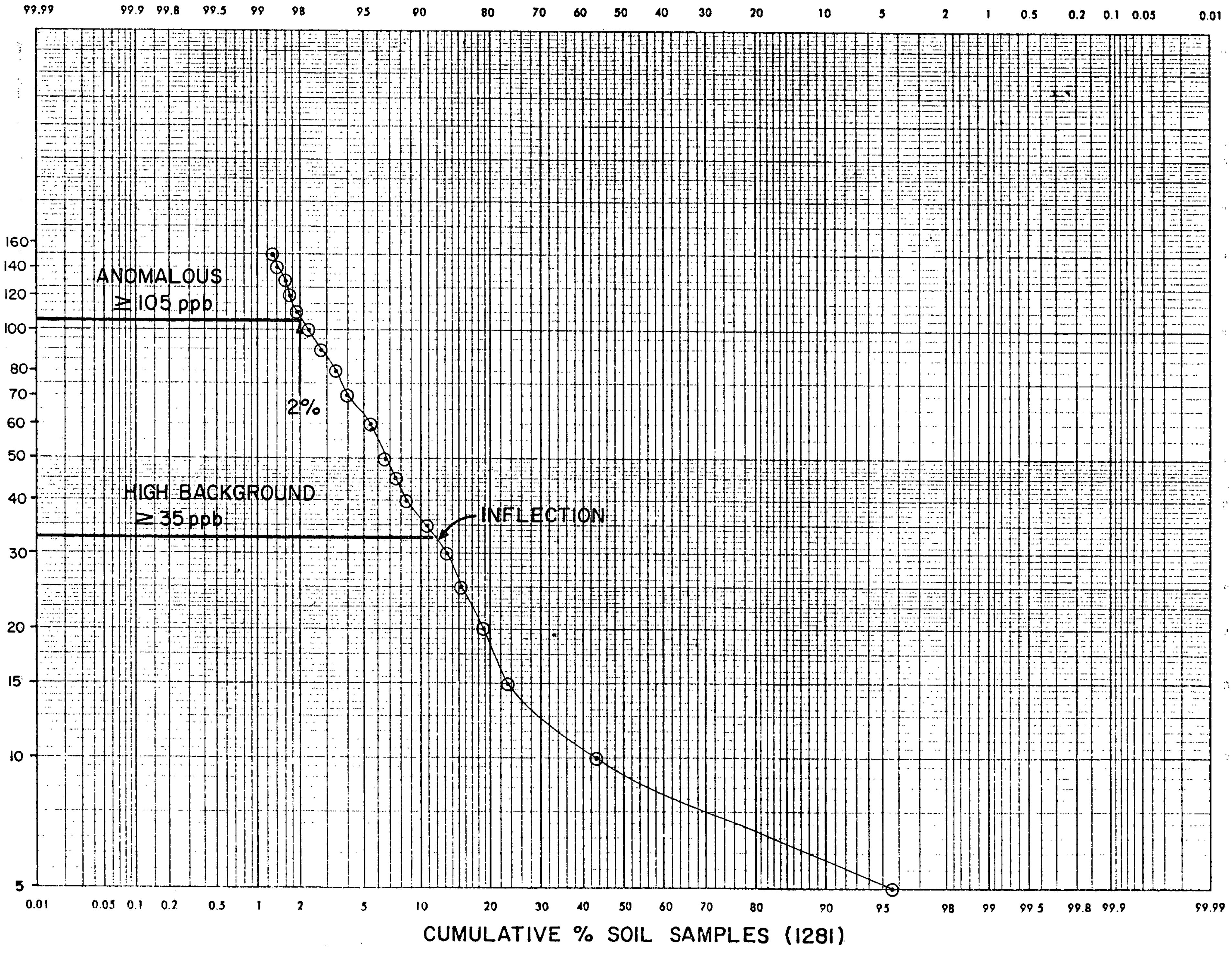

99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
160
140
120
100
80
70
60
50
40
30
20
15
10
5
GOLD (ppb)
ANOMALOUS
≥ 105 ppb
2%
HIGH BACKGROUND
≥ 35 ppb
INFLECTION
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
CUMULATIVE % SOIL SAMPLES (1281)

FIGURE 3E

A total of 24 soil samples sites from which samples with anomalous or very high background concentrations of Cu and/or Au (and Zn) were investigated during the summer of 1984. At 10 of these sites, I re-sampled the soil in the original hole which yielded anomalous Cu and/or Au, to determine whether the anomalies could be duplicated. The results of the re-sampling are shown on the soil geochemistry maps below the analyses of the original sample. These investigations have led to the locating of several occurrences of fracture-controlled pyrite and chalcopyrite, but of no exposures of significant appearing, stratabound mineralization.

Father and Son Grid

Soil sampling on this grid does not provide any indication that there is significant mineralization sub-, or outcropping in the area 400 m to 1,200 m northwest, and on the trend-projection of the mineralization at the Thistle mine. Only 3 samples with anomalous concentrations of Cu were collected from widely separated sites on this grid; and one with anomalous Au. However, 10 samples with high background Cu were collected from an area about 300 m along and up to 100 m wide, that is approximately centred on the overgrown part of the Thistle Main road, about 900 to 1200 m north of the Thistle mine. Prospecting in this area failed to locate any mineralization.

The single sample with anomalous Au (150 ppb), was collected from this grid at about 70 m northwest of Son Lake. Earlier prospecting in this area was unfruitful.

250 to 450 m north of the sample with anomalous Au, along grid lines 70 and 275 m north of Father Lake, three soil samples with higher background Au (35 to 40 ppb), three samples with weakly anomalous Pb (30 to 36 ppm) and Ag (1.7 to 2.1 ppm), one of which contains weakly anomalous Zn (152 ppm), and one other sample with weakly anomalous Ag (1.8 ppm), were collected. The majority of these samples were collected from a very gently sloping area of extensive overburden just north of Father Lake. Examination of the float boulders in this area did not result in locating a possible source for the higher concentrations of Au, Ag, Pb and Zn.

Saddle Grid

Soil samples collected from this grid contain the highest proportion of high background and anomalous Au (average of 7.4 samples per km of grid lines), but the second lowest proportion of high background and anomalous Cu (average of 2.8 samples per km of grid line) of the six grids sampled in 1983 and 1984. Sample sites with high background to anomalous Au and Cu define a complex pattern of distribution. With the exception of three samples with high background Au, all the samples with high background and anomalous Au and Cu were collected from an area that measures 250 to 350 m wide (NE-SW) by 700 m long, which spans the central part of the grid.

Prospecting of roadcuts along logging spurs constructed in 1984 in the southeastern half of the grid area, indicates that copper staining and small concentrations of chalcopyrite (to a few percent), relatively commonly occur on fractures cutting basaltic rocks. It is possible that this fracture-controlled mineralization is the primary source of anomalous Au and Cu in the soil samples from this grid.

In the northeastern part of the Saddle grid, soil samples containing anomalous Pb and Zn were collected from an irregular area on the southwest to west facing slope above and northeast of the saddle. The area is 200 m long (northwesterly) by 50 to 75 m wide, and is defined by 5 soil samples containing anomalous Zn (182 to 499 ppm), two of which also contain weakly anoamlous Pb (32 and 40 ppm), and two samples containing weakly anomalous Pb (34 ppm). This is the most extensive Pb-Zn soil anomaly detected on the Thistle property grids. Examination of new roadcuts of bedrock in the area of this anomaly failed to determine the source of the anomalous Pb and Zn in the soil samples.

Panther Road Showing Grid

Two grid lines, 75 m apart, were added to the south end of the Panther Road showing grid to test the area south of an "open-ended", broad, Au anomaly detected by the 1983 soiling sampling survey on the grid. This anomaly consists of four samples with 70 to 85 ppb Au and one with 155 ppb Au from five consecutive sites 15 m apart, 200 m south, and on the trend projection of the Panther Road showing.

Soil sampling at 15 m intervals along the new grid lines 75 m south of the 1983 Au soil anomaly, failed to detect anomalous Au. However, on the new grid line 150 m south of the Au soil anomaly, and on trend with it, a soil sample with 115 ppb Au was collected.

Panther Road Grid

This soil sample grid covers the area from 0.45 to 1.3 kms south of the Panther Road showing. Soil sample analyses from this grid are characterized by a large number of high background (56 samples) and anomalous (10) Cu concentrations, but a relatively low proportion of high background (17 samples) and anomalous (7) Au concentrations. These samples were collected from areas widely scattered throughout the grid. However, the greatest proportion of these were collected in the central part of the grid, from a very irregular bounded area about 275 to 390 m wide (east-west) by about 200 m (generally) to 500 m long (north-south). This area lies about midway between the Panther Road showing and the Panther Road south showing, which are separated by 2 kms. Three strings from 120 to 185 m long, of consecutive soil samples (at 25 m intervals), on three consecutive grid lines, with high background (to anomalous) Cu, suggest extensive downslope dispersal of the bedrock source of Cu.

Fourteen sites from which anomalous and/or high background concentrations of Cu and/or Au were collected, have been investigated, but significant mineralization in bedrock has not been located. Seven sites from which soil samples with anomalous Cu and/or anomalous Au were collected on the grid, were re-sampled. Analyses of five of the seven re-samples confirm the presence of anomalous Cu and/or Au. Anomalous Au was not detected in two of the re-samples from sites where the original sample contained anomalous Au.

Rift Creek Grid

This grid consists of three lines, one through the Panther Road south showing near the south boundary of the Thistle property, and two lines 75 and 150 m north of the showing (0-10 cm with 25-35% pyrite and with 0.062 oz. Au/t). Five soil samples with high background concentrations of Au (35 to 70 ppb) were collected from scattered sites on the grid. One of these (with 50 ppb Au) was collected about 8 m east of the resistivity "low" that trends northerly from about 8 m east of the road showing, at a site 150 m north of the showing. The lack of anomalous Au in soil samples collected in the area of the northerly trend-projection of the showing, may be a reflection of the fact that the area is covered by extensive overburden, including highly heterolithic till.

I.P.-RESISTIVITY SURVEYS

The report submitted to Westmin Resources by Peter Walcott and Associates, who conducted the I.P.-resistivity surveys on the Thistle property in 1984, are included with this report as Part II. Below are my comments on the survey results.

Data Analysis

In order to determine anomalous levels for chargeability and resistivity measurements, log probability and arithmetic probability plots were constructed from the frequency distribution of measurements taken by P. Walcott during the 1983 and 1984 I.P. surveys on the Thistle mine, Saddle, Panther Road shwoing, Rift Creek and T.M. 70 road grids (not including Douglas grid which was conducted using the gradient array) (see Figures 4A to 4D). The plots for chargeability show that the chargeabilities higher than 6.2 milli-sec. have a log-normal distribution, with the anomalous level (2% cumulative %) at about 15 milli-sec. However, below the 6.2 milli-sec. level, chargeability more closely approximates an arithmetic distribution. The plots for apparent resistivity (1822 measurements) show that resistivity measurements above about 6000 ohm-m, have a log-normal distribution, with the anomalous level at 1625 ohm-m (2% cum. %). Below 6000 ohm-m, resistivity measurements more closely approximate an arithmetic distribution (with anomalously low resistivities below 1600 ohm-m at the 2% cum. %).

Douglas Grid

Chargeability measurements from this gradient array survey outline a very broad zone of higher chargeabilities roughly centred on Thistle Mine road. There is no clear relationship between the highest chargeabilities and anomalous Cu in soil samples. I suspect the high chargeabilities are a reflection of increased concentrations of disseminated magnetite within the 'diabase' that underlies much of the area. However, the map of resistivities shows that there is a fairly distinct correlation between lower resistivities and anomalous Cu in the soil samples. This confirms the results, at least in part, of the prospecting in the area - chalcopyrite and pyrite are apparently confined to fractures cutting 'diabase' and only locally disseminated in minor concentrations within the 'diabase'. It appears that these fractures make the 'diabase' somewhat more conductive than surrounding 'diabase'. Thus, it appears that the area of the anomalous Cu and Au in soil samples does not warrant a high priority at this time.

Thistle Mine Grid

The portion of grid line 0 passing northwest of the Thistle mine about 12 to 17 m, was re-surveyed with an a-spacing of 12.5 m. It is interesting to note in the pseudo-section that the highest chargeability measured, is located at some depth, nearly midway between the mineralized intervals at the lower and upper glory holes (16.4 m-sec.). This area should be tested with a diamond drill hole.

Lines 200 south and 300 south of the Thistle mine were also surveyed to complete the Thistle mine grid. It does not appear to me that the mineralized mine sequence has much, if any, strike-extension to the southeast of the mine, based on the I.P. surveys on Lines 100, 200 and 300 south, unless the mineralization lies at depth beyond the detection limit of the I.P. survey. This conclusion is based on the fact that the broad chargeability "high" and resistivity "low" centred on the area between the two glory holes at the mine, was not detected on the lines to the southeast of the mine.

T.M. 70 Road Grid Line

This pole-dipole survey (a-spacing of 25 m) detected a broad (130 m for n = 1) zone of anomalously low resistivities approximately centred on the approximate axis of the Dighem anomaly (about Station 25 m E). This area also coincides with the location of the base of a major unit of bedded basaltic tuffs and cherty tuffs that may underlie? the Thistle mine sequence. The chargeabilities in the area of the lower resistivities, however are relatively uniform but increase with depth. It appears that both the Dighem and the I.P. surveys failed to detect a discrete conductor, but rather a broad zone of somewhat higher conductivity. Perhaps this a reflection of widespread pyrite along fractures (locally apparent within the basaltic tuffs).

FIGURES 4A - 4D: Probability plots of I.P. - resistivity measurements from surveys, in 1983 and 1984, on the Thistle mine, T.M. 70 Road, Saddle, Panther Road showing and Rift Creek grids on the Thistle property. Figures 4A and 4B show plots of the log probability and the arithmetic probability, respectively, of the cumulative percent of chargeability measurements versus the chargeability values. Figures 4C and 4D show log probability and arithemetic probability, respectively, for apparent resistivity measurements. The threshold between anomalous and background values is assumed to correspond to the 2% cumulative measurement point along the curves. The values of chargeability and resistivity used for constructing contours shown in Plates IXC1,2, IXG1,2, and IXH2, correspond to inflection points along the probability curves.

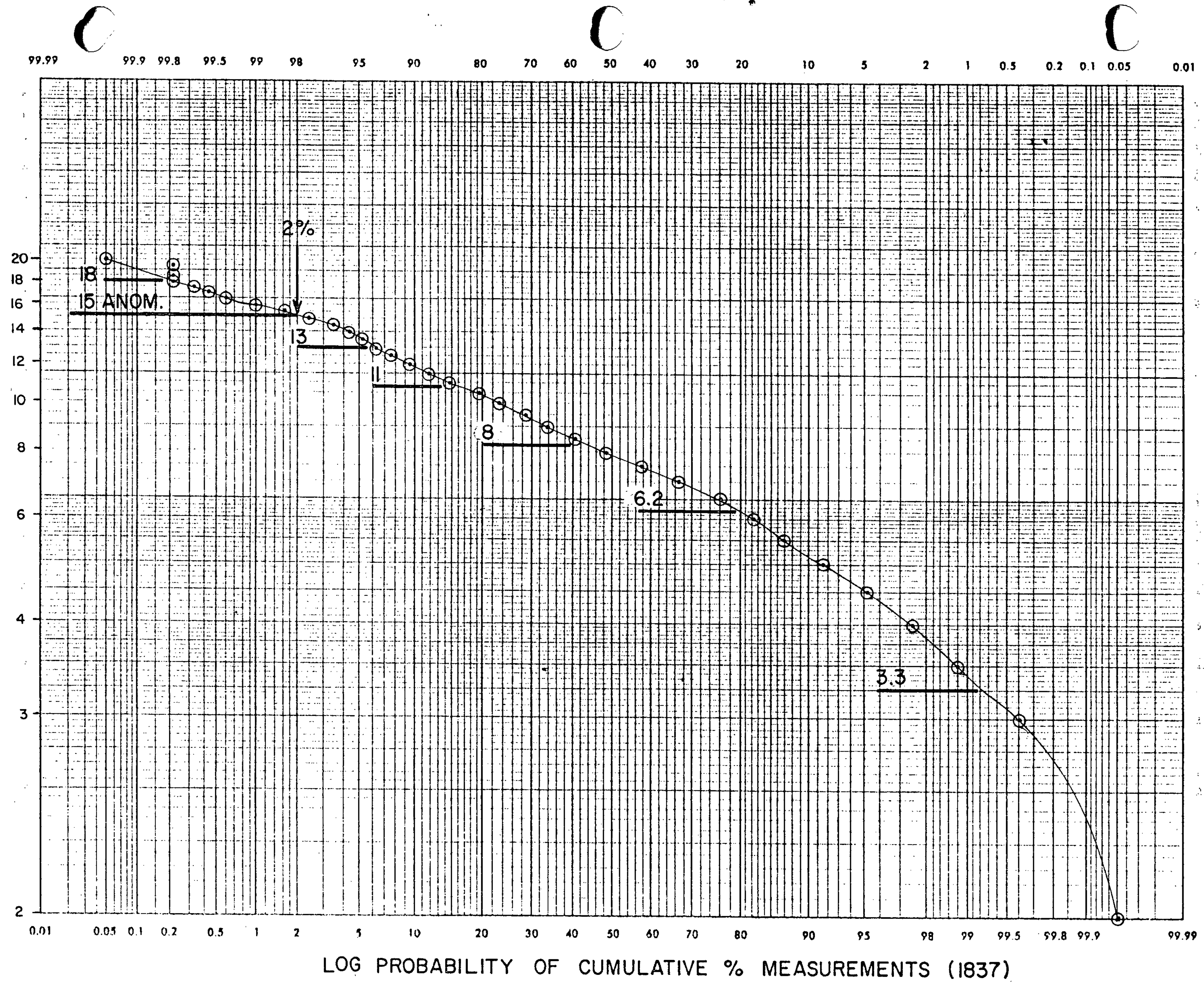

99.99 99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
20
18
16
14
12
10
8
6
4
3
2
CHARGEABILITY (milli-sec.)
2%
18
15 ANOM.
13
11
8
6.2
3.3
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.99
LOG PROBABILITY OF CUMULATIVE % MEASUREMENTS (1837)

FIGURE 4A

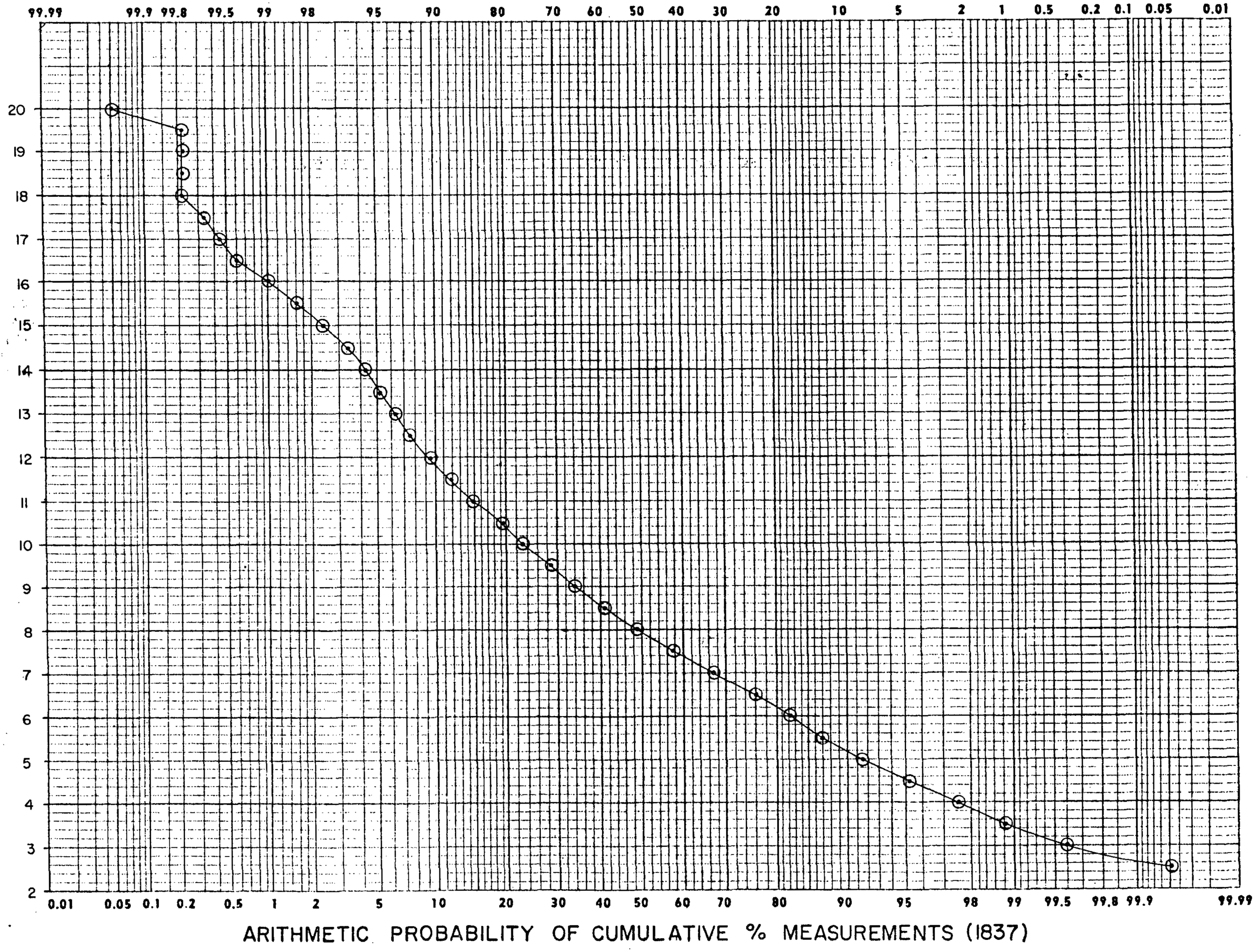

99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
CHARGEABILITY (milli-sec.)
ARITHMETIC PROBABILITY OF CUMULATIVE % MEASUREMENTS (1837)

FIGURE 4B

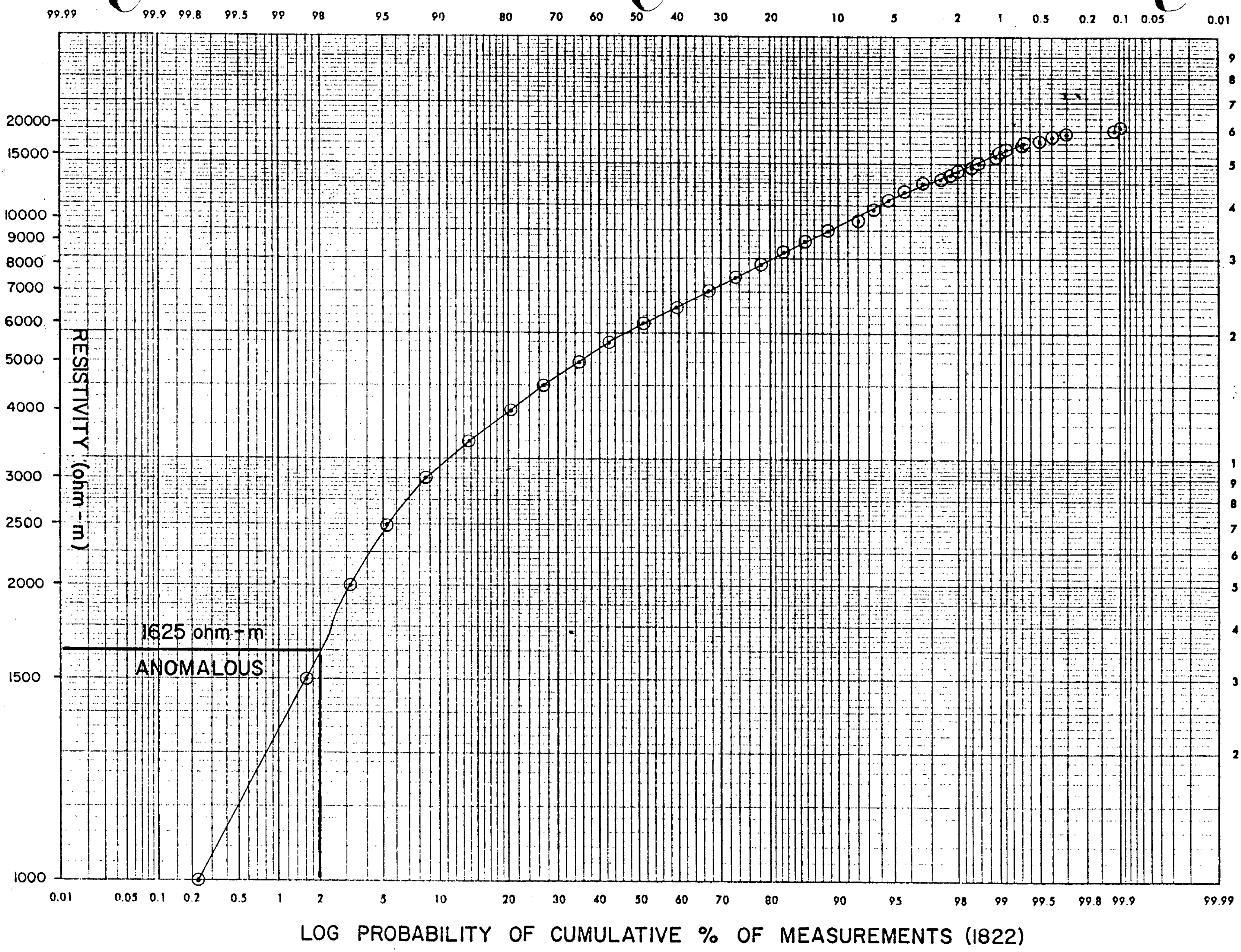

99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
20000
15000
10000
9000
8000
7000
6000
5000
4000
3000
2500
2000
1500
1000
RESISTIVITY (ohm-m)
1625 ohm-m
ANOMALOUS
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99
LOG PROBABILITY OF CUMULATIVE % OF MEASUREMENTS (1822)

FIGURE 4C

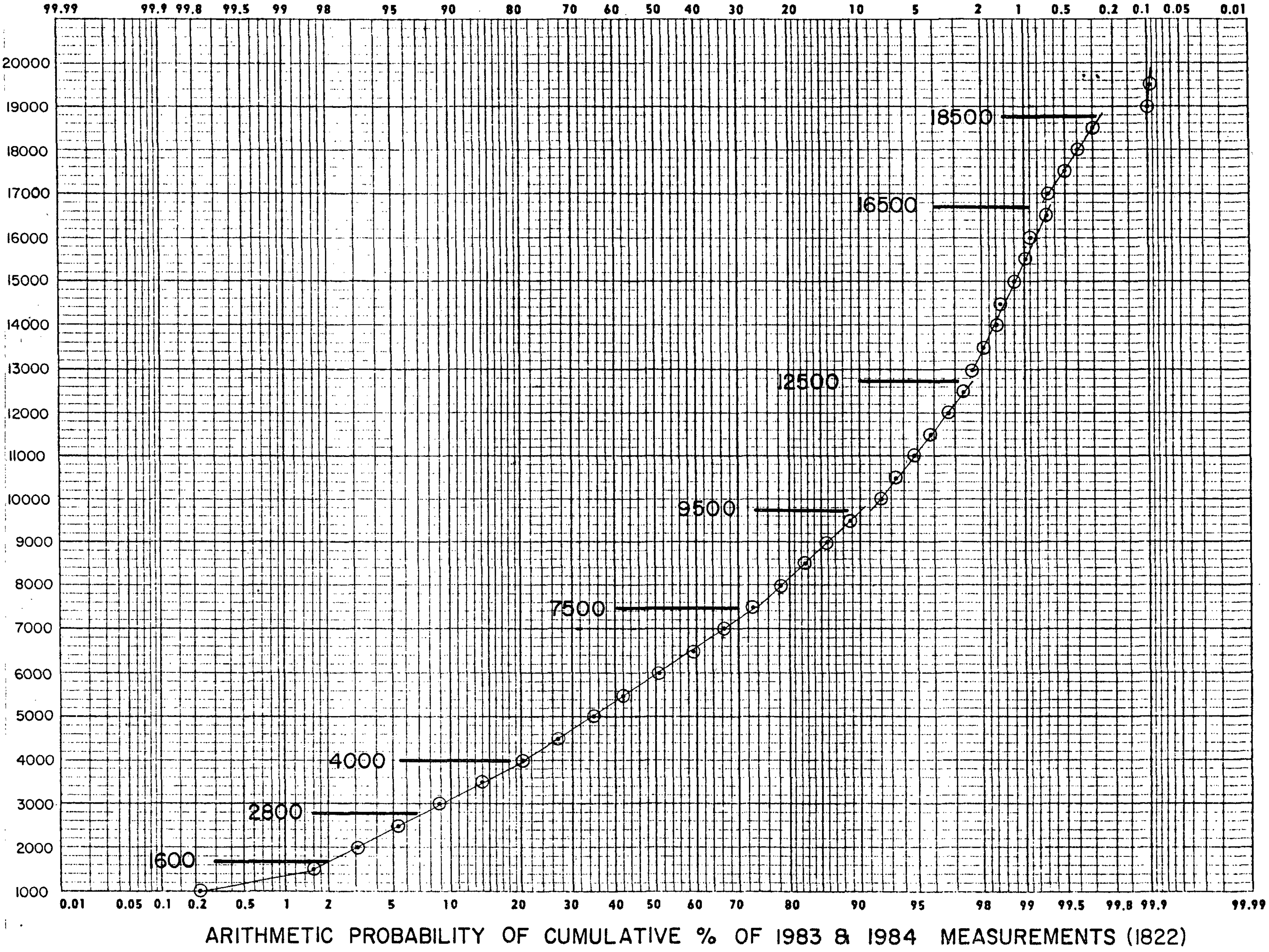

99.99 99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
18500
16500
12500
9500
7500
4000
2800
1600
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.99
ARITHMETIC PROBABILITY OF CUMULATIVE % OF 1983 & 1984 MEASUREMENTS (1822)
RESISTIVITY (ohm-m)

FIGURE 4D

However, at about 150 m to 175 m east of the axis of the Dighem EM conductor, there is a distinct zone of anomalously low resistivities and anomalously high chargeabilities, that suggest a conductor with limited depth extent (or perhaps shallow dipping). This anomaly was tested with a diamond drill (hole 84-9) which shows its source to be graphitic fractures and disseminated pyrite in bedded, black to grey cherts which carry anomalous gold.

Saddle Grid

Two lines of pole-dipole array I.P. survey were completed on this grid. One line is located 400 m southeast of the Thistle mine and the other, 550 m northwest of the Panther Road showing. These two lines of I.P. were reconnaissance in nature, designed to test the recessive area of the Saddle.

The I.P. survey on the line 5S detected a narrow zone of low resistivities and somewhat higher chargeabilities, that is located on the inferred southeasterly trend-projection of the Thistle Mine mineralization. However, the resistivity "low" lies on the northwesterly trend-projection of a prominent topographic lineament and shear zone? that bounds the northeast side of the saddle, and which may be its source. Soil sampling along this part of line 5S failed to detect anomalous Cu or Au in the soils. The I.P. survey on the line 550 m northwest of the Panther Road showing, failed to detect an anonaly that can be directly correlated to the trend-projection of the mineralization at the showing.

Panther Road Showing Grid

This grid is centred on the Panther road showing in the northeast Rand claim. (Incidentially, the MacMillan-Bloedel road construction crew built a log bridge to drain a creek across Panther road, exactly at the site of the road showing).

The I.P. surveys on grid lines 50 m north and south of the Panther road showing, in 1983, indicated the mineralized interval at the showing does not extend to these lines (nor have substantial depth potential at the showing). Nor is there any obvious indications from the I.P. measurements on the lines 120, 190 and 260 m northwest of the showing, that there is significantly thick mineralization along the trend-projection from the showing, to respond to the I.P. survey. However, on the lines 125 m and 200 m southeast of the road showing, there is some indication of a narrow zone of mineralization on the southeasterly trend-projection of the showing.

Along line 200 south (200 m south of the road showing), at about 8 m west of the baseline, the I.P. survey detected a narrow anomaly of lower resistivities and higher chargeabilities. This area may be on the southeasterly trend-projection of the road showing mineralization, but coincides with a narrow break in slope where the ground is nearly level. This area has been prospected several times with no success. Soil samples collected from stations 15 m west to 45 m east of the baseline contain 70 to 155 ppb Au (here the line follows a small draw). A soil sample collected in 1984, at 10 m west of the baseline, contains

1900 ppb Au. The I.P.-resistivity anomaly and coincident soil anomaly at 10 m west of the baseline warrant testing with a drill hole.

The pseudo-section for the I.P. survey on line 200 south also shows a 30 m-wide zone of lower resistivities centred at 143 m east, and a 15 m-wide zone of very high chargeabilities centred on 120 m east. The resistivity low may coincide approximately with a covered zone of schistosity based on geologic mapping in the area. The chargeability anomaly could be caused by disseminated pyrite within the schistose zone, or disseminated magnetite within the 'diabase' that is exposed in a roadcut near the centre of the anomaly.

Rift Creek Grid

The Rift Creek grid is centred on a narrow (to 10 cm thick) zone of semi-massive pyrite with 0.062 oz. Au/t, exposed in a small roadcut on Panther Road. The showing apears to be located about 10 m north of the south boundary of the Rand claim (and the Thistle property).

The survey detected a narrow (30 m or less) zone of very low resistivities approximately centred 8 m east of the showing (beneath the road) and a narrow zone (30 m or less) of higher chargeabilities centred about 38 m east of the showing (line 1900 S)). Apart from the roadcut containing the showing, there is no outcrop in the area on which to base an interpretation of the source of the anomaly, which, it seems high unlikely, results from a narrow (10 cm) zone of semi-massive pyrite exposed in the roadcut. The I.P. results suggest, rather, that there is a zone of mineralization somewhere between 8 to 38 m east of the showing, that occurs beneath the road and overburden to the east of the road.

The narrow I.P. anomaly detected on line 1900 S through the road showing appears to extend to the north and was detected on lines 75 and 150 m north of the showing (where lower resistivities coincide with higher chargeabilities). However, on the line 150 m north of the showing, the zone is marked by a single reading of relatively high chargeability and three readings of somewhat lower resistivities, which suggests the anomaly weakens northwards from the showing. Soil samples from the lines 75 and 150 m north of the showing did not contain anomalous Cu or Au.

I believe there is sufficient encouragement from the I.P. survey to conduct further exploration in the area of the showing.

DIGHEM AIRBOURNE EM-MAGNETOMETER SURVEY

The Dighem survey detected about 20 widely scattered, EM anomalies, varying from very weak to strong. Five of the anomalies appear to have sources with lengths less than the line spacing of 200 m; The remaining anomalies appear to have sources with lengths that vary from 1.8 to perhaps 2.1 kms.

The areasin which 15 of the 20 anomalies were detected, were investigated in 1983 and 1984. Prospecting in the immediate areas of the anomalies has failed to locate any significant mineralization in bedrock or float. There appears to be four "ready" explanations for the anomalies: faults, conductive overburden (till and lake sediment), fracture-pyrite, and in one case, a prominent cliff.

The Dighem survey line that passes 50 m northwest of the Thistle mine shows a very weak increase (1 ppm) in the quadrature component in the approximate area of the northwest trend-projection of the mineralized mine sequence at the upper glory hole. On the line that passes over the Panther Road showing (#25), there is a very broad zone of slightly higher (1 ppm) readings on the co-planar and co-axial channels of EM, that is approximately centred on a point about 100 m southwest of the showing. Thus, it appears that significant mineralization of a similar nature to that at the Thistle mine and the Panther Road showing, may only cause very weak responses on a Dighem-type survey.

Further details of the airbourne survey are given in the report submitted by Dighem Ltd., include with this report as Part III.

DIAMOND DRILLING PROGRAM

The drill program provided a relatively extensive test to depths of 60-100 m, of the favourable lithologic succession northwest of, and on trend with, the mineralization at the Thistle mine. All but one hole were designed to test the areas of highest chargeabilities and lowest resistivities detected in 1983. Three holes were drilled from an upper road setup 310 m north of the mine; four holes were drilled from a lower road setup 250 m northwest of the mine. One flat hole was drilled from a road setup 155 m west of the mine. A vertical hole was drilled from T.M. 70 road, 565 m west of the Thistle mine.

Lithologic Succession and Mineralization

The lithologic succession and mineralization intersected in D.D.H.s 84-1 through 84-9, is summarized on vertical cross-sections, Plates IV:A through D. Table 4 lists all samples of core that were assayed for Au and Ag, and analyzed, geochemically, for Cu, Pb and Zn.

The lithologic succession encountered in holes 84-1 through 84-8 can be divided into four major units that dip moderately to steeply northeast, and are upright. From down to up section, these units consists of:

1. Thin bedded to laminated, basaltic (sausserite?-altered) tuff, cherty tuff (to locally basaltic chert) with a few percent laminations to thin beds of graphitic? chert. The tuffs and

cherts commonly contain minor to 1%, locally to 2%, disseminated pyrite which appears to be the source of higher chargeabilities in this area.

2. The bedded basaltic tuffs are overlain by the mine flow unit which is about 225 m thick in the area of holes 84-1 through 7, and consists of thick to thin (1 to 70 m thick) flows interlayered with 15 or so intervals of agglomerates and/or flow breccias 1 to 25 m thick, and 8 intervals of basaltic crystal tuff, lapilli tuff and bedded cherty, basaltic tuffs a few centimeters to 4 m thick. The flows and agglomerates consist of variations of hornblende, feldspar porphyry, feldspar, hornblende microporphyry (locally amygduloidal), metavitrophyric basalt, and very finely crystalline to medium crystalline and diabasic-appearing basalt.

The mine flow unit rocks commonly contain minor to 2% disseminated pyrite, minor to 1% fracture-pyrite and minor to 2% disseminated magnetite, which appear to be the source of the higher chargeabilities and lower resistivities associated with the unit.

The mine flow unit rocks are characterized by variable epidote, sericite, and chlorite alteration at a wide variety of scales. Most of the significant pyrite-chalcopyrite mineralization occurs within the chlorite alteration zones as 1 to 3%, locally to 15% disseminations, stringers, in fractures and locally in veinlets and veins of semi-massive to massive pyrite, locally with chalcopyrite.

A total of 79 chlorite alteration zones were noted in core; they vary from 2-53 cm in width, but average 16 cm (total width of 11.85 m in all holes). 29 of the 37 samples of chlorite altered basalt zones analyzed, contain an average of 0.014 oz. Au/t (about 480 ppb) and highly variable concentrations of Cu, which varies from 11 to 790 ppm (but one with 2.16% Cu, and one with greater than 1% Cu; not included in average), with an average of 748 ppm Cu. However, anomalous concentrations of Au are not restricted to the chlorite alteration zones because 32 samples of basalt with only minor to 1-3% disseminated and fracture pyrite contain an average of 0.008 oz. Au/t, and 16 samples with minor to no apparent sulphides contain an average of 0.007 oz. Au/t. In a broad manner, the highest chargeabilities and lowest resistivities correspond to the location of intersections with a significant proportion of chloritic, pyritic alteration zones.

Within the chlorite alteration zones there are six intersections of massive to semi-massive pyrite, locally with a few percent chalcopyrite, that vary in width from 2 to 27 cm. These carry an average of 0.18 oz. Au/t, but Au varies from 0.046 to 0.284 oz. Au/t. The second highest assay for Au was 0.284 oz/t from 8 cm of massive, fracture-pyrite. The highest assay for gold was from hole 84-1, at a down hole depth of 178.7 m. This 20 cm long sample of basalt with chloritic shears and one, 1-1.8 cm thick band of semi-massive pyrite, assayed 0.514 oz. Au/t and 0.64 oz. Ag/t. The Au and Cu concentrations are an order of magnitude lower than those for the massive pyrite-chalcopyrite layers at the Thistle mine which carry up to 2 oz. Au/t and 12% Cu.

Within D.D.H.'s 1 to 8 there were no ore grade concentrations of Au and Cu over mining widths, although 110 of the 241 core samples analyzed, carry anomalous concentrations of Au.

3. The mine flow unit is overlain by an about 55 m thick succession of massive basaltic lapilli tuffs with intervals of bedded cherty tuffs and four basaltic flows.

4. The tuff-flow succession is overlain by a more than 10 m thick succession of interlayered, andesitic lithic tuffs, agglomerates and flows.

Hole 84-8 is a flat hole collared 155 m west of the Thistle mine and was intended to test the mine flow unit to the northwest of the mine, in the immediate area of a hole drilled in 1965 by Vananda Exploration, which intersected 3, 15 cm wide intervals of massive pyrite in chlorite altered basalt which they apparently did not assay. Hole 84-8 intersected a 27 cm wide layer of pyrite-calcite-quartz-chlorite altered basalt-magnetite-chalcopyrite at about 7 m west of, and 30 m below the Vananda intersections of massive pyrite. The 27 cm layer assayed 0.158 oz. Au/t and less than 0.01% Cu.

A ninth hole was drilled from the T.M. 70 road, 565 m west of the Thistle Mine, to a depth of 200 ft. (61.2 m) to test a prominent zone of very high chargeabilities and anomalously low resistivities detected on the T.M. 70 road grid line, in an area of extensive overburden. The hole intersected thin bedded basaltic tuff, cherty tuff, and chert with graphitic chert intervals and beds. The graphitic chert contains up to a few percent disseminated pyrite, locally concentrated to 50-80% in thin laminations, and is cut by graphitic and locally pyritic fractures. The graphite and pyrite are the source of the I.P.-resistivity anomaly. One 90 cm long sample of graphitic, pyritic cherty assayed 0.012 oz. Au/t (and 335 ppm Cu) and three samples of similar chert, 45, 60 and 90 cm long, assayed 0.006 and 0.008 oz. Au/t. The four narrow samples with anomalous Au concentrations and sedimentary-appearing pyrite were taken over an interval of bedded cherty and cherty tuffs about 15 m true thickness. This points to the potential for a gold deposit within these bedded tuffs that are apart from the mine flow unit and which may warrant further exploration.

Respectively submitted,

Gary Benvenuto
Project Geologist
Westmin Resources Limited

APPENDIX A

DETAILED EXPENDITURES for line-cutting, soil sampling survey, I.P.-resistivity survey, airbourne geophysical survey and diamond drilling program on the Thistle property, 1984

I. DETAILS OF THE GRIDS FOR LINECUTTING, SOIL SAMPLE SURVEY AND I.P.-RESISTIVITY SURVEY

GRID	LINECUTTING		SOIL SAMPLE SURVEY			I.P.-RESISTIVITY SURVEY		CLAIMS
	# OF LINES	TOTAL LENGTH	# OF LINES	TOTAL LENGTH	# OF SAMPLES	# OF LINES	TOTAL LENGTH	
DOUGLAS	5	2.175 kms	-	-	-	5	2.25 kms	Levi
FATHER & SON	-	-	9	8.825 km	347	-	-	Crow, Levi, Quill, L92G
THISTLE MINE	-	-	-	-	-	3	0.9	L91, 92, 93G
SADDLE	4	2.55	8	5.0	209	3	1.175	Crow, L95, 97G
PANTHER ROAD SHOWING	2	1.14	3	1.54	76	7	3.775	Rand, Crow
PANTHER ROAD	-	-	13	7.125	292	-	-	Rand
RIFT CREEK	3	1.26	3	1.26	63	3	1.17	Rand
T.M. 70 ROAD	-	-	1	0.08	16	1	0.525	Crow
TOTAL	14	7.125	37	23.83	1003	22	9.795	

II. LINECUTTING

A. Work period: June 25 to July 2, 1984

B. Contractor : Van Alphen Exploration Services of P. O. Box 754, Smithers, B. C.

C. Cost of linecutting:

7.125 kms of grid line cut x $425./km = $3,028.00 TOTAL

III. SOIL SAMPLE SURVEY

A. Work period: June 25 to July 4, 1984

B. Contractor : Van Alphen Exploration Services of Smithers, B. C.

C. Cost of soil sample survey:

1. Cost of collecting samples:

   1003 samples x $5.25/sample (fixed cost billed by contractor) = $5,266.00 SUB TOTAL

2. Cost of analyzing soil samples for Cu, Pb, Zn, Ag and Au, by Min-En Laboratories Ltd. of 705 West 15th Street, North Vancouver, B. C.:

   1003 samples x $10.30/sample = $10,331.00 SUB TOTAL

3. Supplies and freight:

   a. Supplies: 1000 sample bags: $114.00 SUB TOTAL

   b. Freight: $102.20 SUB TOTAL

4. Drafting of soil geochemistry analyses maps by Victrina Diaz of Westmin Resources Ltd.:

   10 days of drafting x $107.00/day = $1,070.00 SUB TOTAL

5. Accommodation of 3 soil samplers and linecutters from Van Alphen Exploration Services, paid for by Westmin Resources Ltd. (June 25 to July 5, 1984): $371.00 SUB TOTAL
6. Supervision, layout of grids, packing soil samples:
    a. G. Benvenuto (project geologist): 4 days x $173/day = $692.00 SUB TOTAL
    b. B. Thomae (field assistant): 4 days x $97.30/day = $389.00 SUB TOTAL
7. Total cost of soil sample survey (totals of #1-6 above): $18,335.00 TOTAL
8. Total cost of soil sample survey per sample: $18,335/1003 samples = $18.28/sample

IV. I.P.-RESISTIVITY GEOPHYSICAL SURVEY

A. Work period: July 4 to 21, 1984

B. Contractor : Peter E. Walcott & Assoc. Ltd. of 605 Rutland Court, Coquitlam, B. C., V3J 3T8, with a crew of 5 men.

C. Survey: 9.795 kms total, 6 grids, pole-dipole array (n = 1-4; 7,545 kms) and gradient array (2.25 kms), a = 15 or 25 or 30 m.

D. Cost of I.P.-resistivity survey as billed by Peter E. Walcott:

1. Labour: operator and helpers:	$16,810.00 SUB TOTAL
2. Magnetic survey - 2 men and equipment:	$ 450.00 SUB TOTAL
3. Travel, vehicle, meals:	$ 3,573.27 SUB TOTAL
4. Drafting and report writing:	$ 2,049.00 SUB TOTAL
5. Total of billed costs:	$22,882.00 SUB TOTAL

E. Cost of accommodation of I.P. crew, paid for by Westmin Resources Ltd.: July 3-21, 1984: $1,145.00 SUB TOTAL

F. Total cost of I.P.-resistivity survey (total C & D above):

$24,027.00 TOTAL

V. AIRBOURNE GEOPHYSICAL SURVEY

A. Work period: March 7, 1984

B. Contractor : Dighem Ltd. of Suite 7010, 1 First Canadian Place, Toronto, Ontario, M5X 1C7

C. Survey: Dighem III, helicopter mounted, electromagnetic and magnetometer survey along a total of 66 kms of grid line (34 lines, 1.5-2.8 km long, about 200 m apart, covering an area 1.7 to 2.7 kms wide by 6.6 kms long).

D. Total cost of Dighem survey billed at flat rate:

$12,000.00 TOTAL

VI. DIAMOND DRILLING PROGRAM

A. Work period: October 4 to 26, 1984

B. Contractor: Longyear Canada Inc. of 721 Aldford Avenue, Annacis Island, New Westminster, B. C., V3M 5P5

C. Drilling program: total of 1,167.1 m (3,829 ft.), nine holes, from four sites (total of six set-ups), size B-Q core, using a Longyear 38, wireline drill rig, skid mounted, with a bulldozer on site; two crews of two drillers, two shifts per day.

D. Cost of drilling as billed by contractor (Longyear Canada Inc.):

1. Drilling footage rate total (overburden at \$18.60/ft. and bedrock at \$16.15/ft. (-25° to -90°) or \$18.60/ft. (for 0° to -25°): \$64,901.00 SUB TOTAL
2. Drill rig moves: \$10,276.50 SUB TOTAL
3. Mobilization and demobilization: \$3,500.00 SUB TOTAL
4. Casing left in the holes: \$2,900.00 SUB TOTAL
5. Reaming cave into hole: \$85.00 SUB TOTAL
6. Sperry-Sun drill hole surveys (labour): \$1,487.50 SUB TOTAL
7. Sperry-Sun survey equipment rental: \$1,943.61 SUB TOTAL
8. Road maintenance: \$595.00 SUB TOTAL (due to heavy rains)
9. Core boxes: 144, BQ boxes: \$1,194.70 SUB TOTAL
10. SUB TOTAL of direct billed costs: \$86,883.00 SUB TOTAL

E. Costs of drilling program incurred by Westmin Resources other than direct drilling costs:

1. Diamond drill core logs and sampling of core for assay:
    a. Core logging by G. Benvenuto of Westmin Resources Ltd.: 17.5 days x \$173.00/day = \$3,028.00 SUB TOTAL
    b. Further sampling of drill core for assay:
        G. Benvenuto, 5 days x \$173.00/day = \$865.00 SUB TOTAL
        R. Lebeuf (core splitter), 5 days x \$70.20/day = \$351.00 SUB TOTAL
2. Ship drill core from Port Alberni to Campbell River, B. C. (Discovery Terminal, Spit Road): \$265.00 SUB TOTAL

3. Costs of assaying and geochemical analyses of drill core samples (by Chemex Labs Ltd. of 212 Brooksbank Avenue, North Vancouver, B. C.):

   241 core samples assayed for Au and Ag, and geochemical analyses for Cu, Pb, and Zn x $20.39/sample = $4,914.00 SUB TOTAL

4. Freight: ship core samples to Vancouver for analysis:

   $74.00 SUB TOTAL

5. Preparation of drill sites (holes 84-1 and 84-4) with Case 455B bulldozer-backhoe, by C. Cameron Contracting Ltd. of 6034 River Road, Port Alberni, B. C., V9Y 6Z6 (including grading of Thistle Main road and removing alder from T.M.E. logging road spur): Transport machine at $45/hour x 2 hours and operating machine at $49/hour x 8.5 hours = $506.50 SUB TOTAL

6. Typing of drill hole logs:

   35 hours x $16.80/hour = $588.00 SUB TOTAL

7. Drafting of plan map showing location of diamond drill hole collars, and drill hole sections (4), by Victrina Diaz of Westmin Resources:

   7 days x $107/day = $749.00 SUB TOTAL

E. TOTAL COST OF DIAMOND DRILLING PROGRAM: $98,224.00 TOTAL

VII. REPORT WRITING

Preparation and writing of assessment report (on diamond drilling and soil sampling surveys) by G. Benvenuto, project geologist for Westmin Resources Ltd. of P. O. Box 8000, Campbell River, B. C., V9W 5E2:

7 days x $173/day = $1,211.00 TOTAL

VIII. PHYSICAL WORK

A. Road repairs to Thistle Main road (900 m west of the Thistle mine) on June 8, 1984 by Joe Carvalho of 2171 Cameron Drive, Port Alberni, with a Case 1150B bulldozer and backhoe:

3 Hours operating x $60/hour = $180.00 SUB TOTAL

B. Road repairs: repair a major washout on Panther road (M2A) located in the southeast corner of the Rand claim, 830 m (straight-line distance) from the intersection of Panther Road and Museum Main roads. The washout measured 24.4 m long, 12 m wide and 4.6 m deep. The road was repaired by MacMillan Bloedel Ltd., Cameron Division of P. O. Box 550, Port Alberni, B. C., under the direction of Al Petrie (rates quoted below are based on ""Province of B. C. Equipment Rental Rates", 1984-85):

1. "Squamish" washout to provide access for engineers, fallers and road construction crews, May 23, 1984: low bed truck and trailer: 2 hours at $87.50/hour, cat: 8 hours at $106.25/hour, and crew transportation: 1 day at $28.50/day: $1,053.00 SUB TOTAL

2. May 29, 1984: contract low bed and tank drill to drill rock cut for road fill: $148 and 16 hours x $126,50/hour (drilling) and crew transportation: 2 days x $28.50/day = $2,229.00 SUB TOTAL

3. July 10, 1984: blast rock for road fill: hyraulic drill to pump explosives: 4 hours at $126.50/hour, crew transportation: 1 day at $28.50/day, 16 bags of Amex explosives at $25.00/bag, and cat to clear road: 1 hour at $111.00/hour = $1,045.00 SUB TOTAL

4. July 18, 19, 1984: prepare road bed, place culvert and fill over culvert: excavator: 16 hours at $128.75/hour, cat: 8 hours at $111.00/hour, contract ballast truck: 8 hours at $46.02/hour, crew transportation, 2 days at $28.50/day, and 40 ft. of 24" diameter culvert pipe at $359.00 = $3,732.00 SUB TOTAL

5. Cost of repairing Panther Road washout: $8,059.00 SUB TOTAL

C. TOTAL COST OF ROAD REPAIRS TO THISTLE MAIN AND PANTHER ROADS (A and B, above) = $8,239.00 TOTAL

IX. TOTAL EXPENDITURES ON ALL SURVEYS

A.	Linecutting:	$ 3,028.00
B.	Soil sample survey:	$ 18,335.00
C.	I.P.-resistivity survey:	$ 24,027.00
D.	Airbourne geophysical survey:	$ 12,000.00
E.	Diamond drilling program:	$ 98,224.00
F.	Report writing:	$ 1,211.00
G.	Physical work (road repairs):	$ 8,239.00
	TOTAL:	$165,064.00

X. APPORTIONMENT OF COSTS OF SURVEYS TO CLAIMS OF THISTLE GROUP FOR ASSESSMENT PURPOSES

A. Claims data

CLAIM	RECORD NUMBER	UNITS	DATE RECORDED	PREVIOUS YEAR OF EXPIRY
Sue	488(6)	20	June 28, 1979	1986
Crow	489(6)	20	June 28, 1979	1986
Levi	490(6)	16*	June 28, 1979	1986
Rand	731(2)	16	February 29, 1980	1986
Museum	1223(5)	15	May 6, 1981	1986
Quill #1-8	1391-1398(2)	8	February 11, 1982	1987
Lore #1-3	575-577(8)	3	August 17, 1981	1986
Rose (L95G)	378(2)	1	February 20, 1979	1986
Jumbo (L97G)	379(2)	1	February 20, 1979	1986

* reduced from 20 units, February, 1984

B. Application of survey expenditures in 1984 to Thistle Group

CLAIM	COST OF WORK APPLIED	# OF YEARS	NEW DATE OF EXPIRY
Sue	$ 32,000	8	June 28, 1994
Crow	$ 36,000	9	June 28, 1995
Levi	$ 25,600	8	June 28, 1994
Rand	$ 25,600	8	February 29, 1994
Museum	$ 24,000	8	May 6, 1994
Quill #1-8	$ 12,800	8	February 11, 1995
Lore #1-3	$ 4,800	8	August 17, 1994
Rose	$ 2,000	10	February 20, 1996
Jumbo	$ 2,000	10	February 20, 1996

TOTAL $164,800

APPENDIX B

WESTMIN RESOURCES LIMITED

EXPLORATION | VANCOUVER ISLAND REGION

STATEMENT OF QUALIFICATIONS

I, Gary Louis Benvenuto, of the town of Campbell River, British Columbia, hereby certify that:

1. I am a geologist, residing at 4125 Discovery Drive, #7, in Campbell River, B. C. with a business address of Westmin Resources Limited, P. O. Box 8000, Campbell River, B. C.
2. I graduated with a B.Sc. degree in geology from California State University at Los Angeles in 1972 and with a Ph.D. degree in geology from Queen's University, Kingston, Ontario in 1978.
3. I am an associate member of the Geological Association of Canada.
4. I have practiced exploration geology with Cominco Ltd. from May to October, 1979 and with Westmin Resources Limited from January, 1980 to present.

Dated:

Signed: ______________________________

Gary Benvenuto
Project Geologist
Westmin Resources Limited

PETER E. WALCOTT & ASSOC. LTD.

A GEOPHYSICAL REPORT

ON

INDUCED POLARIZATION SURVEYS

Mt. McQuillan, Vancouver Island

British Columbia

FOR

WESTMIN RESOURCES LIMITED

Campbell River, B.C.

BY

PETER E. WALCOTT & ASSOCIATES LIMITED

Vancouver, B.C.

December 1984

TABLE OF CONTENTS

APPENDIX

MAPS AND PSEUDOSECTIONS ACCOMPANYING PART II (in file folder)

PLATE NO.

IX:A. Douglas grid: gradient array, chargeability and resistivity and contours.

IX:B Thistle Mine grid: pseudo-sections of chargeability and resistivity, and magnetometer survey profiles for:
  1. Lines 0+00, 2+00 South and 3+00 South .

IX:C1. Thistle Mine grid: contoured chargeability values (n=1).
C2. Thistle Mine grid: contoured apparent resistivity (n=1).

IX:D. T.M. 70 Road grid line: pseudo-section of chargeability and resistivity.

IX:E. Saddle grid lines 5+00 South and 10+00 South: pseudosections of chargeability and resistivity.

IX:F. Panther Road showing grid, chargeability and apparent resistivity in pseudo-sections for:
  1. Lines 260 N, 190 N, 120 N.
  3. Lines 125 S, 200 S, 275 S, 350 S.

PLATE NO.

IX:G. Panther Road showing grid: contoured values for n=1 for:
  1. Chargeability.
  2. Apparent Resistivity.

IX:H. Rift Creek grid: chargeability and apparent resistivity:
  1. Pseudo-sections.
  2. Contoured values for n=1.

INTRODUCTION.

Between July 3rd and 22nd, 1984, Peter E. Walcott & Associates Limited carried out limited induced polarization surveys over six grids in the Mount McQuillan area, Vancouver Island, British Columbia, for Westmin Resources Limited. This was a continuation of a previous survey carried out in November 1983.

The surveys were carried out over six grids called the Thistle, Panther, Rift, Saddle, T.M. 70 and Douglas grid respectively.

Measurements (first up to fourth separation) of apparent chargeability - the I.P. response parameter - and resistivity were made over various lines on these grids using the pole-dipole method of surveying with various dipoles of 12.5, 15, 25 & 30 metres respectively. An exception to this was on the Douglas grid where the gradient array was employed. Magnetic profiles were also made along some lines at 25 metre station intervals using a total field magnetometer on the Thistle, Saddle & T.M. 70 grids.

The progress of the survey was severely impeded in places by the steepness and rugged nature of the terrain but the weather exhibited wonderful co-operation on this occasion as different from that on the previous survey.

The data from the pole-dipole work are presented in pseudo-section form on individual line profiles bound in this report whereas the gradient array data are presented in contour form on Maps W-349-1 & 2 that accompany this report. The magnetic data are presented in profile form on the appropriate pseudo-section. In addition contour maps of the data from both surveys on the Thistle, Panther & Rift grid has been compiled by Mr. Gary Benvenuto, the project geologist for Westmin Resources, and included here on Maps W-349-3 to 8 respectively.

PURPOSE.

The purpose of the survey was to continue with the investigation of the small Thistle and Panther showings - the original purpose of the 1983 survey.

PREVIOUS WORK.

As the showings have been worked or known for many years a great deal of exploration work has been done over and around them over the years. Most recently an induced polarization survey was carried out over the Thistle Mine area by Glen E. White Consulting & Services Ltd. in 1982, and a similar survey started by Peter E. Walcott & Associates Limited in November 1983 (see report by Peter E. Walcott dated January 1984).

SURVEY SPECIFICATIONS.

The induced polarization (I.P.) survey was carried out using a pulse type system, the principal components of which are manufactured by Huntec Limited and Phoenix Geophysics Limited of Metropolitan Toronto, Ontario.

The system consists basically of three units: a receiver (Huntec), a transmitter and a motor generator (Phoenix). The transmitter which provides a maximum of 3.0 kw d.c. to the ground, obtains its power from a 3.0 400 c.p.s. three phase alternator driven by a gasoline engine. The cycling rate of the transmitter is 2 seconds "current-on" and 2 seconds "current-off" with the pulses reversing continuously in polarity. The data recorded in the field consists of careful measurements of the current (I) in amperes flowing through electrodes C_1 and C2, the primary voltage (V) appearing between the two potential electrodes, P_1 and P2, during the "current-on" part of the cycle, and the apparent chargeability (M_a) presented as a direct readout using a 200 millisecond delay and a 1000 millisecond sample window.

The apparent resistivity (P_a) in ohm metres is proportional to the ratio of the primary voltage and the measured current, the proportionality factor depending on the geometry of the array used. The chargeability and resistivity are called apparent as they are values which that portion of the earth sampled would have if it were homogeneous. As the earth sampled is usually inhomogeneous the calculated apparent chargeability and resistivity are functions of the actual chargeability and resistivity of the rocks.

The survey was carried out using the "pole-dipole" method of surveying. In this method the current electrode C_1, and the two potential electrodes, P_1 and P_2, are moved in unison along the survey lines. The spacing "na" (n an integer) between C_1 and P_1 is kept constant for each traverse at a distance roughly equal to the depth to be explored by that traverse, while that of P_1 to P_2 (the dipole) is kept constant at "a". The second current electrode C_2 is kept constant at "infinity".

Thus usually on a "pole-dipole" array traverse with an electrode spacing of 50 metres a body lying at a depth of 25 metres will produce a strong response, whereas the same body lying at a depth of 50 metres will only just be detected. By running subsequent traverses at different electrode separations, more precise estimates can be made of depth, width, thickness and percentage of sulphides of causative bodies located by the I.P. method.

SURVEY SPECIFICATIONS cont'd

The survey over the Thistle grid was completed using a 25 metre dipole with first to fourth separation measurements taken. Additionally a section of Line 0 covering the showing was rerun with a 12.5 metre dipole.

The work on the Panther grid was completed using the same technique as before namely 15 metre dipole work in the centre of the lines and 25 or 30 metre work towards the extremities.

A similar technique was used on the Rift, whereas the Saddle and T.M. 70 were covered with the 25 metre, n 1 to 4, approach.

The Douglas grid was surveyed using the gradient array with 25 metre stations and a 25 metre measuring dipole.

The magnetic survey on the Thistle, Saddle & T.M. 70 grids was carried out using a GSM-8 proton precession magnetometer manufactured by GEM Systems Inc. of Don Mills, Ontario. This instrument measures variations in the earth's magnetic field to an accuracy of ± 1 gamma. Corrections for diurnal variations were made by tying-in to previously established base stations at intervals not exceeding two hours.

In all some 105 kilometres of I.P. surveying and 1.7 kilometres of magnetic surveying were carried out.

DISCUSSION OF RESULTS.

It should be mentioned here that the writer is composing this report without the benefit of the previous report data which was forwarded to Westmin, the geology and the data from several drill holes that were put down to test the nature of the causative source of some chargeability highs.

For a more meaningful review of the data the results should be studied in conjunction with the geology. However from a perusal of the former it can be noted that:

(1) The background chargeability is of the order of 4 to 7 milliseconds.

(2) The possible existence of a strong anomalous zone striking northwesterly and parallelling the topography on the western edges of the grids is suggested by the anomalous zones of Line 120N Panther grid, Line 10S Saddle grid and the eastern edge of the T.M. 70 traverse, although here the resistivity is somewhat lower than on the other two.

(3) The zone on the eastern edge of the Thistle grid on Lines 1N to 3S appears to continue across Line 5S & 10S on the Saddle to Lines 260N, 190N and possibly 120N and 50N on the Panther grid.

(4) High chargeability readings are obtained on the larger separations across Line 10S on the Saddle grid.

(5) While high chargeability readings are obtained over the majority of the Douglas grid, the same northwesterly trend is evident from the contoured results.

(6) The anomalies attributed to the showings on the Thistle, Panther and possible the Rift grids are small and of limited extent and better defined on small separations.

The resistivity data as before do little but reflect outcrop and overburden conductivity and are somewhat inaccurate due to the ruggedness of the terrain. However a definite resistivity low is seen over Rift creek, and a similar low on the western edge of the Rift grid could indicate a contact and/or fault zone - a slightly higher undefined chargeability zone is associated with this contact.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

Between July 3rd and 22nd, 1984, Peter E. Walcott & Associates Limited extended their coverage of induced polarization surveying in the Mt. McQuillan area of Vancouver Island for Westmin Resources Limited.

On this occasion parts of six grids were covered by mostly pole-dipole work of varying separations as discussed in the report.

The results as previously did locate the presence of a number of chargeability zones. These zones would appear to apparently be classified into two kinds (a) formational, as exemplified by the stronger and larger anomalous zones with possible causative sources of pyrite and/or graphite and (b) discrete, the small localized anomalies that appear to be a signature of the mineralization of the Thistle and Panther showings.

These latter, several of which occur on the Panther, would appear to be the object of further investigation, and presumably were investigated by the follow-up drill programme.

A further review of the data should be undertaken in conjunction with the geological information for a better understanding of the same.

Respectfully submitted,

PETER E. WALCOTT & ASSOCIATES LIMITED

Peter E. Walcott, P.Eng.
Geophysicist

Vancouver, B.C.

December 1984

APPENDIX

COST OF SURVEY.

Peter E. Walcott & Associates Limited undertook the survey on a daily basis. Mobilization and interpretational costs were extra so that the total cost of the services provided was $22,882.11.

PERSONNEL EMPLOYED ON SURVEY.

Name	Occupation	Address	Dates
Peter E. Walcott	Geophysicist	Peter E. Walcott & Assoc. 605 Rutland Court, Coquitlam, B.C. V3J 3T8	Nov. 8th, Dec. 15th, 1984
G. MacMillan	Geophysical Operator	"	July 3rd - 22nd, Sept. 3rd - 16th, 1984
C. Mandryk	"	"	July 3rd - 20th, 84
D. Kennedy	Geophysical Assistant	"	"
W. Jackson	"	"	"
R. Summerfield	"	"	July 3rd - 22nd, 84
J. Walcott	Typing	"	December 17th, 84

CERTIFICATION.

I, Peter E. Walcott, of the Municipality of Coquitlam, British Columbia, hereby certify that:

1. I am a Graduate of the University of Toronto in 1962 with a B.A.Sc. in Engineering Physics, Geophysics Option.
2. I have been practising my profession for the last twenty two years.
3. I am a member of the Association of Professional Engineers of British Columbia and Ontario.
4. I hold no interest, direct or indirect in the Thistle, Panther, etc. properties nor do I expect to receive any.

Peter E. Walcott, P.Eng.

Vancouver, B.C.

December 1984

I.P. Pseudo Sections

▬	Anomalous Zone.
▥	Possible Anomalous Zone.
⏢	Zone undefined at ends.

REPORT NO. 192-A

DIGHEM^{III} SURVEY

OF THE

FATHER AND SON LAKE AREA, VANCOUVER ISLAND, B.C.

FOR

WESTMIN RESOURCES LIMITED

BY

DIGHEM LIMITED

TORONTO, ONTARIO
APRIL 26, 1984

P.A. SMITH
GEOPHYSICAL INTERPRETER

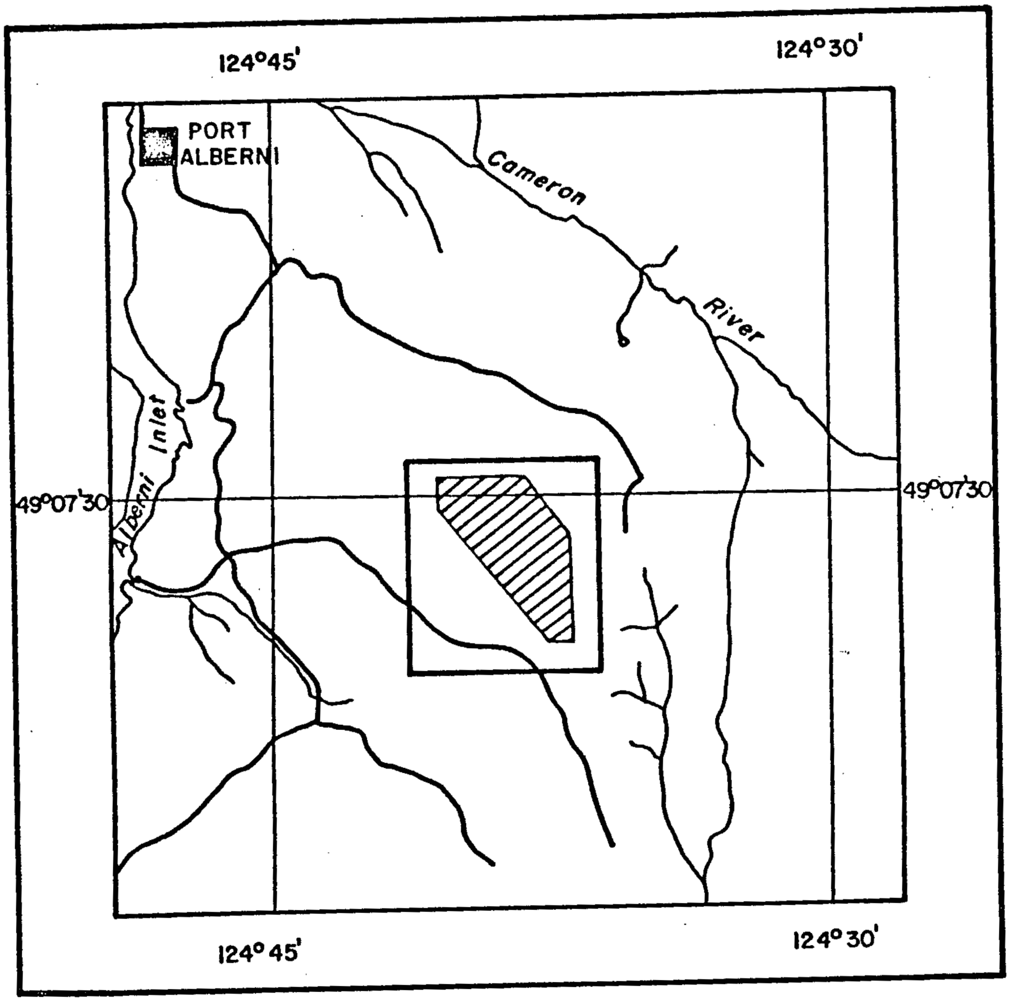
SUMMARY AND RECOMMENDATIONS

A total of 51 km (32 miles) of survey was flown in March 1984, over the Father and Son lake area, Vancouver Island, B.C., for Westmin Resources Limited.

The survey outlined several discrete bedrock conductors associated with areas of low resistivity. Most of these anomalies appear to warrant further investigation using appropriate surface exploration techniques. Areas of interest may be assigned priorities for follow-up work on the basis of supporting geological and/or geochemical information.

The area of interest contains at least 14 anomalous features, many of which are considered to be of moderate to high priority as exploration targets.

LOCATION MAP



Scale 1:250,000

FIGURE 1

THE SURVEY AREA

CONTENTS

MAPS ACCOMPANYING THIS REPORT (in file binder)

PLATE NO.

X:A. Profiles (digital) showing magnetics, EM (vertical coaxial and horizontal coplanar in-phase and quadrature at 900 and 7200 Hz., difference functions for in-phase and quadrature, and anomaly recognition function), conductance, log resistivity, apparent depth to conductor and apparent weight percent of magnetite.

X:B. EM anomaly map: 1:10,000 scale orthophotograph.

X:C. Resistivity map.

X:D. Total field magnetics.

X:E. Enhanced magnetics

APPENDICES:
A. The Flight Record and Path Recovery.
B. EM Anomaly List.

INTRODUCTION

A DIGHEM^{III} survey totalling 51 line-km was flown with a 200 m line-spacing for Westmin Resources Limited, on March 5, 1984, near Port Alberni, Vancouver Island, B.C. (Figure 1). Approximately 51 km of coverage was obtained in the Father and Son Lake area.

The C-GDEM turbine helicopter flew at an average airspeed of 50 km/h with an EM bird height of approximately 50 m. Ancillary equipment consisted of a Sonotek PMH 5010 magnetometer with its bird at an average height of 65 m, a Sperry radio altimeter, a Geocam sequence camera, an RMS GR-33 analog recorder, a Sonotek SDS 1200 digital data acquisition system and a DigiData 1640 9-track 800-bpi magnetic tape recorder. The analog equipment recorded four channels of EM data at approximately 900 Hz, two channels of EM data at approximately 7200 Hz, two ambient EM noise channels (for the coaxial and coplanar receivers), two channels of magnetics (coarse and fine count), and a channel of radio altitude. The digital equipment recorded the EM data with a sensitivity of 0.20 ppm at 900 Hz, 0.40 ppm at 7,200 Hz, and the magnetic field to one nT (i.e., one gamma).

Appendix A provides details on the data channels, their respective sensitivities, and the flight path recovery procedure. Noise levels of less than 2 ppm are generally maintained for wind speeds up to 35 km/h. Higher winds may cause the system to be grounded because excessive bird swinging produces difficulties in flying the helicopter. The swinging results from the 5 m^2 of area which is presented by the bird to broadside gusts. The DIGHEM system nevertheless can be flown under wind conditions that seriously degrade other AEM systems.

It should be noted that the anomalies shown on the electromagnetic anomaly map are based on a near-vertical, half plane model. This model best reflects "discrete" bedrock conductors. Wide bedrock conductors or flat-lying conductive units, whether from surficial or bedrock sources, may give rise to very broad anomalous responses on the EM profiles. These may not appear on the electromagnetic anomaly map if they have a regional character rather than a locally anomalous character. These broad conductors, which more closely approximate a half space model, will be maximum coupled to the horizontal (coplanar) coil-pair and are clearly evident on the resistivity map. The resistivity map, therefore, may be more valuable than the electromagnetic anomaly map, in areas where broad or flat-lying conductors are considered to be of importance.

In areas where magnetite causes the inphase components to become negative, the apparent conductance and depth of EM anomalies may be unreliable.

In areas where EM responses are evident only on the quadrature components, zones of poor conductivity are indicated. Where these responses are coincident with strong magnetic anomalies, it is possible that the inphase component amplitudes have been suppressed by the effects of magnetite. Most of these poorly-conductive magnetic features give rise to resistivity anomalies which are only slightly below background. These weak features are evident on the resistivity map but may not be shown on the electromagnetic anomaly map. If it is expected that poorly-conductive sulphides may be associated with magnetite-rich units, some of these weakly anomalous features may be of interest.

SECTION I: SURVEY RESULTS

CONDUCTORS IN THE SURVEY AREA

The survey covered a single grid with 51 km of flying, the results of which are shown on the map sheets accompanying this report. Table I-1 summarizes the EM responses in the area with respect to conductance grade and interpretation.

The electromagnetic anomaly maps show the anomaly locations with the interpreted conductor shape, dip, conductance and depth being indicated by symbols. Direct magnetic correlation is also shown if it exists. The strike direction and length of the conductors are indicated when anomalies can be correlated from line to line. When studying the map sheets for follow-up planning, consult the anomaly listings appended to this report to ensure that none of the conductors are overlooked.

Father and Son Lake

The magnetic maps indicate a geological structure which trends approximately northwest/southeast. Magnetic relief varies from a low of about 55,890 nT at the western end of

TABLE I-1

192 FATHER & SON LAKE

CONDUCTOR GRADE	CONDUCTANCE RANGE	NUMBER OF RESPONSES
6	> 99 MHOS	0
5	50-99 MHOS	0
4	20-49 MHOS	0
3	10-19 MHOS	0
2	5- 9 MHOS	0
1	< 5 MHOS	10
X	INDETERMINATE	4
TOTAL		14

CONDUCTOR MODEL	MOST LIKELY SOURCE	NUMBER OF RESPONSES
B	DISCRETE BEDROCK CONDUCTOR	9
S	CONDUCTIVE COVER	4
H	ROCK UNIT OR THICK COVER	1
TOTAL		14

(SEE EM MAP LEGEND FOR EXPLANATIONS)

line 5, to a high of more than 56,310 nT in the vicinity of anomaly 3xA. A well defined magnetic low, which may reflect a faulted geological contact, extends in a general southeasterly direction from the western limit of line 3 to anomaly 7A. A second similar feature extends southeast from the western end of line 6 to line 9, where it exhibits an apparent offset to the northeast towards anomaly 9xA, continuing in a general southeasterly direction towards the western end of line 18. A third zone of low magnetic intensity also strikes southeast from fiducial 22B on line 15, through fiducial 880 on line 26, where it exhibits a change in strike to the south through fiducial 1516 on line 33. The change in magnetic patterns between lines 20 and 21 suggests a possible fault which strikes northeast/ southwest between these lines.

The causative sources of the positive magnetic anomalies are more clearly depicted on the enhanced magnetic map. At least four distinct magnetic trends are evident which are attributed to moderately thick rock units of weak to moderate magnetic intensity. It is interesting to note the apparent north-south strike direction of some of the more subtle features in the northern portion of the survey area.

The resistivity map indicates that most of the area comprises highly resistive rocks, exhibiting values in excess of 1,000 ohm-m except in the northwestern quadrant of the sheet. There are three areas (excluding Father and Son Lake) which give rise to moderate resistivity lows. These three zones contain most of the interesting EM anomalies and are probably due to bedrock, rather than surficial, conductivity.

Anomaly 2xB-3xA

These two x-type responses reflect a north-south trending, weak bedrock conductor which may be open to the north. The conductor axis is associated with the peak of a well defined isolated magnetic anomaly which appears to extend southeast to line 4. Response 3xA exhibits a direct magnetic correlation of 210 nT. The inphase amplitudes, and the estimated conductance and resistivity values derived therefrom, appear to have been suppressed by the effects of magnetite. The absence of an EM anomaly on line 4 near fiducial 783 is also due to the effects of magnetite, as evidenced by the negative inphase responses in this area. This weak conductor is deemed to be an interesting target, particularly if magnetite-rich rocks in the survey area are considered to be possible hosts for economic mineralization.

Anomalies 3A-6A,
7A-8A

The grade 1 anomalies comprising these two conductive axes are moderately broad with little or no response on the low frequency difference channels, DIFI and DIFQ. The broad poorly conductive unit defined by these anomalies could therefore be due to conductive overburden, rather than a bedrock source, as indicated by the 'B?' anomaly classification. The line-to-line correlation, however, combined with the apparent relationship to enhanced magnetic anomalies, tends to suggest a possible bedrock source. These conductors may both be related to a common stratigraphic horizon which has been folded or offset by a dextral fault between anomalies 6A and 7A. The northern segment, however, appears to be associated with the western flank of an enhanced magnetic anomaly, while the southern segment occurs on an east flank. This would tend to indicate that the two segments are, in fact, related to separate bedrock features. Both conductors are in alignment with the northwest/southeast geological strike inferred from the magnetic data, and both occur within 200 m of a pronounced magnetic low (fault?) which parallels these conductors to the southwest. Although both conductors appear to be due to moderately broad or flat-lying (northeast-dipping?) zones of poor conductivity, both are considered to be moderately attractive targets which warrant follow-up. The significance of these conductors is enhanced by their proximity to a probable major fault and their relationship to a well defined low resistivity zone and weak magnetic anomalies. Conductor 3A-6A is open to the northwest.

Anomaly 5B-6B

The grade 1 anomalies which form conductor axis 5B-6B yield responses which are typical of conductive overburden. Surficial conductivity may be masking a possible weak bedrock conductor in this area, but this conductor is considered to be of moderately low priority.

Anomalies 15A, 16A, 9xA, 33xA

Anomalies 15A and 16A are contained within a low resistivity zone associated with a small lake and are attributed to conductive overburden.

Anomaly 9xA suggests a zone of thick conductive overburden or a buried weakly conductive rock unit which is considered to be of minor interest. This anomaly, however, appears to be situated at the southeast end of the low resistivity zone which hosts conductor 7A-8A and may be related to the latter. The apparent discontinuity in magnetic trends in the vicinity of 9xA might be indicative of a fault or contact in this area, which tends to enhance the significance of this low priority target.

Anomaly 33xA is a weak x-type response which may reflect a deeply buried bedrock conductor, although aerodynamic noise is considered to be a contributing factor.

With the exception of response 33xA, there are no discrete EM conductors evident in the southern half of the survey area. It is possible that some of the more subtle resistivity lows, and some of the extremely weak responses (i.e., near fiducial 624 on line 23), may indicate areas of interest.

SECTION II: BACKGROUND INFORMATION

ELECTROMAGNETICS

DIGHEM electromagnetic responses fall into two general classes, discrete and broad. The discrete class consists of sharp, well-defined anomalies from discrete conductors such as sulfide lenses and steeply dipping sheets of graphite and sulfides. The broad class consists of wide anomalies from conductors having a large horizontal surface such as flatly dipping graphite or sulfide sheets, saline water-saturated sedimentary formations, conductive overburden and rock, and geothermal zones. A vertical conductive slab with a width of 200 m would straddle these two classes.

The vertical sheet (half plane) is the most common model used for the analysis of discrete conductors. All anomalies plotted on the electromagnetic map are analyzed according to this model. The following section entitled **Discrete conductor analysis** describes this model in detail, including the effect of using it on anomalies caused by broad conductors such as conductive overburden.

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

Geometric interpretation

The geophysical interpreter attempts to determine the geometric shape and dip of the conductor. This qualitative interpretation of anomalies is indicated on the map by means of interpretive symbols (see EM map legend). Figure II-1 shows typical DIGHEM anomaly shapes and the interpretive symbols for a variety of conductors. These classic curve shapes are used to guide the geometric interpretation.

Discrete conductor analysis

The EM anomalies appearing on the electromagnetic map are analyzed by computer to give the conductance (i.e., conductivity-thickness product) in mhos of a vertical sheet model. This is done regardless of the interpreted geometric shape of the conductor. This is not an unreasonable procedure, because the computed conductance increases as the electrical quality of the conductor increases, regardless of its true shape. DIGHEM anomalies are divided into six

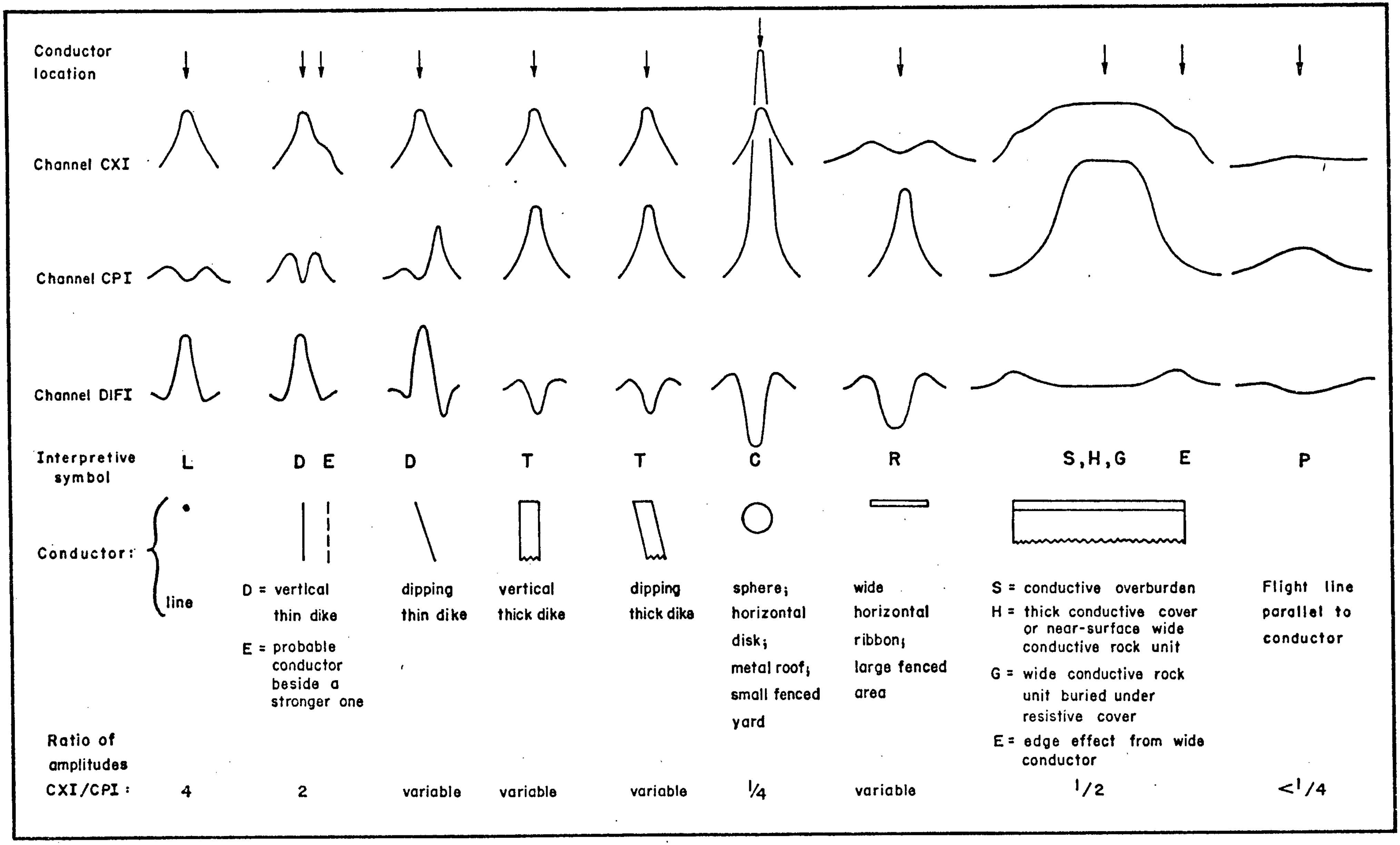


Figure II - 1 Typical DIGHEM anomaly shapes grades of conductance, as shown in Table II-1. The conductance in mhos is the reciprocal of resistance in ohms.

Table II-1. EM Anomaly Grades

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

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

Conductive overburden generally produces broad EM responses which are not plotted on the EM maps. However, patchy conductive overburden in otherwise resistive areas

---

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

can yield discrete anomalies with a conductance grade (cf. Table II-1) of 1, or even of 2 for conducting clays which have resistivities as low as 50 ohm-m. In areas where ground resistivities can be below 10 ohm-m, anomalies caused by weathering variations and similar causes can have any conductance grade. The anomaly shapes from the multiple coils often allow such conductors to be recognized, and these are indicated by the letters S, H, G and sometimes E on the map (see EM legend).

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

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

The presence of sphalerite or gangue can result in ore deposits having weak to moderate conductances. As an example, the three million ton lead-zinc deposit of Restigouche Mining Corporation near Bathurst, Canada, yielded a well defined grade 1 conductor. The 10 percent by volume of sphalerite occurs as a coating around the fine grained massive pyrite, thereby inhibiting electrical conduction.

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

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

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

Flight line deviations occasionally yield cases where two anomalies, having similar conductance values but dramatically different depth estimates, occur close together on the same conductor. Such examples illustrate the reliability of the conductance measurement while showing that the depth estimate can be unreliable. There are a number of factors which can produce an error in the depth estimate, including the averaging of topographic variations by the altimeter, overlying conductive overburden, and the location and attitude of the conductor relative to the flight line. Conductor location and attitude can provide an erroneous depth estimate because the stronger part of the conductor may be deeper or to one side of the flight line, or because it has a shallow dip. A heavy tree cover can also produce errors in depth estimates. This is because the depth estimate is computed as the distance of bird from conductor, minus the altimeter reading. The altimeter can lock onto the top of a dense forest canopy. This situation yields an erroneously large depth estimate but does not affect the conductance estimate.

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

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

DIGHEM electromagnetic maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with geology when planning a follow-up program. The actual conductance values are printed in the attached anomaly list for those who wish quantitative data. The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of conductors in terms of length, strike and dip, geometric shape, conductance, depth, and thickness (see below). The accuracy is comparable to an interpretation from a high quality ground EM survey having the same line spacing.

The attached EM anomaly list provides a tabulation of anomalies in ppm, conductance, and depth for the vertical sheet model. The EM anomaly list also shows the conductance and depth for a thin horizontal sheet (whole plane) model, but only the vertical sheet parameters appear on the EM map. The horizontal sheet model is suitable for a flatly dipping thin bedrock conductor such as a sulfide sheet having a thickness less than 10 m. The list also shows the resistivity and depth for a conductive earth (half space) model, which is suitable for thicker slabs such as thick conductive overburden. In the EM anomaly list, a depth value of zero for the conductive earth model, in an area of thick cover, warns that the anomaly may be caused by conductive overburden.

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

X-type electromagnetic responses

DIGHEM maps contain x-type EM responses in addition to EM anomalies. An x-type response is below the noise threshold of 3 ppm, and reflects one of the following: a weak conductor near the surface, a strong conductor at depth (e.g., 100 to 120 m below surface) or to one side of the flight line, or aerodynamic noise. Those responses that have the appearance of valid bedrock anomalies on the flight profiles are indicated by appropriate interpretive symbols (see EM map legend). The others probably do not warrant further investigation unless their locations are of considerable geological interest.

The thickness parameter

DIGHEM can provide an indication of the thickness of a steeply dipping conductor. The amplitude of the coplanar anomaly (e.g., CPI) increases relative to the coaxial anomaly (e.g., CXI) as the apparent thickness increases, i.e., the thickness in the horizontal plane. (The thickness is equal to the conductor width if the conductor dips at 90 degrees and strikes at right angles to the flight line.) This report refers to a conductor as thin when the thickness is likely to be less than 3 m, and thick when in excess of 10 m. Thin conductors are indicated on the EM map by the interpretive symbol "D", and thick conductors by "T". For base metal exploration in steeply dipping geology, thick conductors can be high priority targets because many massive sulfide ore bodies are thick, whereas non-economic bedrock conductors are often thin. The system cannot sense the thickness when the strike of the conductor is subparallel to the flight line, when the conductor has a shallow dip, when the anomaly amplitudes are small, or when the resistivity of the environment is below 100 ohm-m.

Resistivity mapping

Areas of widespread conductivity are commonly encountered during surveys. In such areas, anomalies can be generated by decreases of only 5 m in survey altitude as well as by increases in conductivity. The typical flight record in conductive areas is characterized by inphase and quadrature channels which are continuously active. Local EM peaks reflect either increases in conductivity of the earth or decreases in survey altitude. For such conductive areas, apparent resistivity profiles and contour maps are necessary for the correct interpretation of the airborne data. The advantage of the resistivity parameter is that anomalies caused by altitude changes are virtually eliminated, so the resistivity data reflect only those anomalies caused by conductivity changes. The resistivity analysis also helps the interpreter to differentiate between conductive trends in the bedrock and those patterns typical of conductive overburden. For example, discrete conductors will generally appear as narrow lows on the contour map and broad conductors (e.g., overburden) will appear as wide lows.

The resistivity profile (see table in Appendix A) and the resistivity contour map present the apparent resistivity using the so-called pseudo-layer (or buried) half space model defined in Fraser (1978)[2]. This model consists of a resistive layer overlying a conductive half space. The depth channel (see Appendix A) gives the apparent depth below surface of the conductive material. The apparent depth is simply the apparent thickness of the overlying resistive layer. The apparent depth (or thickness) parameter will be positive when the upper layer is more resistive than the underlying material, in which case the apparent depth may be quite close to the true depth.

The apparent depth will be negative when the upper layer is more conductive than the underlying material, and will be zero when a homogeneous half space exists. The apparent depth parameter must be interpreted cautiously because it will contain any errors which may exist in the measured altitude of the EM bird (e.g., as caused by a dense tree cover). The inputs to the resistivity algorithm are the inphase and quadrature components of the coplanar coil-pair. The outputs are the apparent resistivity of the

---

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

conductive half space (the source) and the sensor-source distance. The flying height is not an input variable, and the output resistivity and sensor-source distance are independent of the flying height. The apparent depth, discussed above, is simply the sensor-source distance minus the measured altitude or flying height. Consequently, errors in the measured altitude will affect the apparent depth parameter but not the apparent resistivity parameter.

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

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

(a) The resistivity map portrays the absolute value of the earth's resistivity.
(Resistivity = 1/conductivity.)

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

The resistivity map might be likened to a total field map and the EM map to a horizontal gradient in the direction of flight[3]. Because gradient maps are usually more sensitive than total field maps, the EM map therefore is to be preferred in resistive areas. However, in conductive areas, the absolute character of the resistivity map usually causes it to be more useful than the EM map.

---

[3] The gradient analogy is only valid with regard to the identification of anomalous locations.

Interpretation in conductive environments

Environments having background resistivities below 30 ohm-m cause all airborne EM systems to yield very large responses from the conductive ground. This usually prohibits the recognition of discrete bedrock conductors. The processing of DIGHEM data, however, produces six channels which contribute significantly to the recognition of bedrock conductors. These are the inphase and quadrature difference channels (DIFI and DIFQ), and the resistivity and depth channels (RES and DP) for each coplanar frequency; see table in Appendix A.

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

The DP channels, which give the apparent depth to the conductive material, also help to determine whether a conductive response arises from surficial material or from a conductive zone in the bedrock. When these channels ride above the zero level on the electrostatic chart paper (i.e., depth is negative), it implies that the EM and resistivity profiles are responding primarily to a conductive upper layer, i.e., conductive overburden. If both DP channels are below the zero level, it indicates that a resistive upper layer exists, and this usually implies the existence of a bedrock conductor. If the low frequency DP channel is below the zero level and the high frequency DP is above, this suggests that a bedrock conductor occurs beneath conductive cover.

Channels REC1, REC2, REC3 and REC4 are the anomaly recognition functions. They are used to trigger the conductance channel CDT which identifies discrete conductors. In highly conductive environments, channel REC2 is deactivated because it is subject to corruption by highly conductive earth signals. Similarly, in moderately conductive environments, REC4 is deactivated. Some of the automatically selected anomalies (channel CDT) are discarded by the geophysicist. The automatic selection algorithm is intentionally oversensitive to assure that no meaningful responses are missed. The interpreter then classifies the anomalies according to their source and eliminates those that are not substantiated by the data, such as those arising from geologic or aerodynamic noise.

Reduction of geologic noise

Geologic noise refers to unwanted geophysical responses. For purposes of airborne EM surveying, geologic noise refers to EM responses caused by conductive overburden and magnetic permeability. It was mentioned above that the EM difference channels (i.e., channel DIFI for inphase and DIFQ for quadrature) tend to eliminate the response of conductive overburden. This marked a unique development in airborne EM technology, as DIGHEM is the only EM system which yields channels having an exceptionally high degree of immunity to conductive overburden.

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

EM magnetite mapping

The information content of DIGHEM data consists of a combination of conductive eddy current response and magnetic permeability response. The secondary field resulting from conductive eddy current flow is frequency-dependent and consists of both inphase and quadrature components, which are positive in sign. On the other hand, the secondary field resulting from magnetic permeability is independent of frequency and consists of only an inphase component which is negative in sign. When magnetic permeability manifests itself by decreasing the measured amount of positive inphase, its presence may be difficult to recognize. However, when it manifests itself by yielding a negative inphase anomaly (e.g., in the absence of eddy current flow), its presence is assured. In this latter case, the negative component can be used to estimate the percent magnetite content.

A magnetite mapping technique was developed for the coplanar coil-pair of DIGHEM. The technique yields channel "FEO" (see Appendix A) which displays apparent weight percent magnetite according to a homogeneous half space model.[4] The method can be complementary to magnetometer mapping in certain cases. Compared to magnetometry, it is far less sensitive but is more able to resolve closely spaced magnetite zones, as well as providing an estimate of the amount of magnetite in the rock. The method is sensitive to 1/4% magnetite by weight when the EM sensor is at a height of 30 m above a magnetitic half space. It can individually resolve steeply dipping narrow magnetite-rich bands which are separated by 60 m. Unlike magnetometry, the EM magnetite method is unaffected by remanent magnetism or magnetic latitude.

---

[4] Refer to Fraser, 1981, Magnetite mapping with a multi-coil airborne electromagnetic system: Geophysics, v. 46, p. 1579-1594.

The EM magnetite mapping technique provides estimates of magnetite content which are usually correct within a factor of 2 when the magnetite is fairly uniformly distributed. EM magnetite maps can be generated when magnetic permeability is evident as indicated by anomalies in the magnetite channel FEO.

Like magnetometry, the EM magnetite method maps only bedrock features, provided that the overburden is characterized by a general lack of magnetite. This contrasts with resistivity mapping which portrays the combined effect of bedrock and overburden.

Recognition of culture

Cultural responses include all EM anomalies caused by man-made metallic objects. Such anomalies may be caused by inductive coupling or current gathering. The concern of the interpreter is to recognize when an EM response is due to culture. Points of consideration used by the interpreter, when coaxial and coplanar coil-pairs are operated at a common frequency, are as follows:

1. Channels CXS and CPS (see Appendix A) measure 50 and 60 Hz radiation. An anomaly on these channels shows

that the conductor is radiating cultural power. Such an indication is normally a guarantee that the conductor is cultural. However, care must be taken to ensure that the conductor is not a geologic body which strikes across a power line, carrying leakage currents.

2. A flight which crosses a line (e.g., fence, telephone line, etc.) yields a center-peaked coaxial anomaly and an m-shaped coplanar anomaly.[5] When the flight crosses the cultural line at a high angle of intersection, the amplitude ratio of coaxial/coplanar (e.g., CXI/CPI) is 4. Such an EM anomaly can only be caused by a line. The geologic body which yields anomalies most closely resembling a line is the vertically dipping thin dike. Such a body, however, yields an amplitude ratio of 2 rather than 4. Consequently, an m-shaped coplanar anomaly with a CXI/CPI amplitude ratio of 4 is virtually a guarantee that the source is a cultural line.

3. A flight which crosses a sphere or horizontal disk yields center-peaked coaxial and coplanar anomalies with a CXI/CPI amplitude ratio (i.e., coaxial/coplanar) of 1/4. In the absence of geologic bodies of this geometry, the most likely conductor is a metal roof or

---

[5] See Figure II-1 presented earlier.

small fenced yard.[4] Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

4. A flight which crosses a horizontal rectangular body or wide ribbon yields an m-shaped coaxial anomaly and a center-peaked coplanar anomaly. In the absence of geologic bodies of this geometry, the most likely conductor is a large fenced area.[4] Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

5. EM anomalies which coincide with culture, as seen on the camera film, are usually caused by culture. However, care is taken with such coincidences because a geologic conductor could occur beneath a fence, for example. In this example, the fence would be expected to yield an m-shaped coplanar anomaly as in case #2 above. If, instead, a center-peaked coplanar anomaly occurred, there would be concern that a thick geologic conductor coincided with the cultural line.

---

[4] It is a characteristic of EM that geometrically identical anomalies are obtained from: (1) a planar conductor, and (2) a wire which forms a loop having dimensions identical to the perimeter of the equivalent planar conductor.

6. The above description of anomaly shapes is valid when the culture is not conductively coupled to the environment. In this case, the anomalies arise from inductive coupling to the EM transmitter. However, when the environment is quite conductive (e.g., less than 100 ohm-m at 900 Hz), the cultural conductor may be conductively coupled to the environment. In this latter case, the anomaly shapes tend to be governed by current gathering. Current gathering can completely distort the anomaly shapes, thereby complicating the identification of cultural anomalies. In such circumstances, the interpreter can only rely on the radiation channels CXS and CPS, and on the camera film.

TOTAL FIELD MAGNETICS

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

The magnetometer data are digitally recorded in the aircraft to an accuracy of one nT (i.e., one gamma). The digital tape is processed by computer to yield a total field magnetic contour map. When warranted, the magnetic data also may be treated mathematically to enhance the magnetic response of the near-surface geology, and an enhanced magnetic contour map is then produced. The response of the enhancement operator in the frequency domain is illustrated in Figure II-2. This figure shows that the passband components of the airborne data are amplified 20 times by the enhancement operator. This means, for example, that a 100 nT anomaly on the enhanced map reflects a 5 nT anomaly for the passband components of the airborne data.

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

Because the enhanced magnetic map bears a resemblance to a ground magnetic map, it simplifies the recognition of trends in the rock strata and the interpretation of

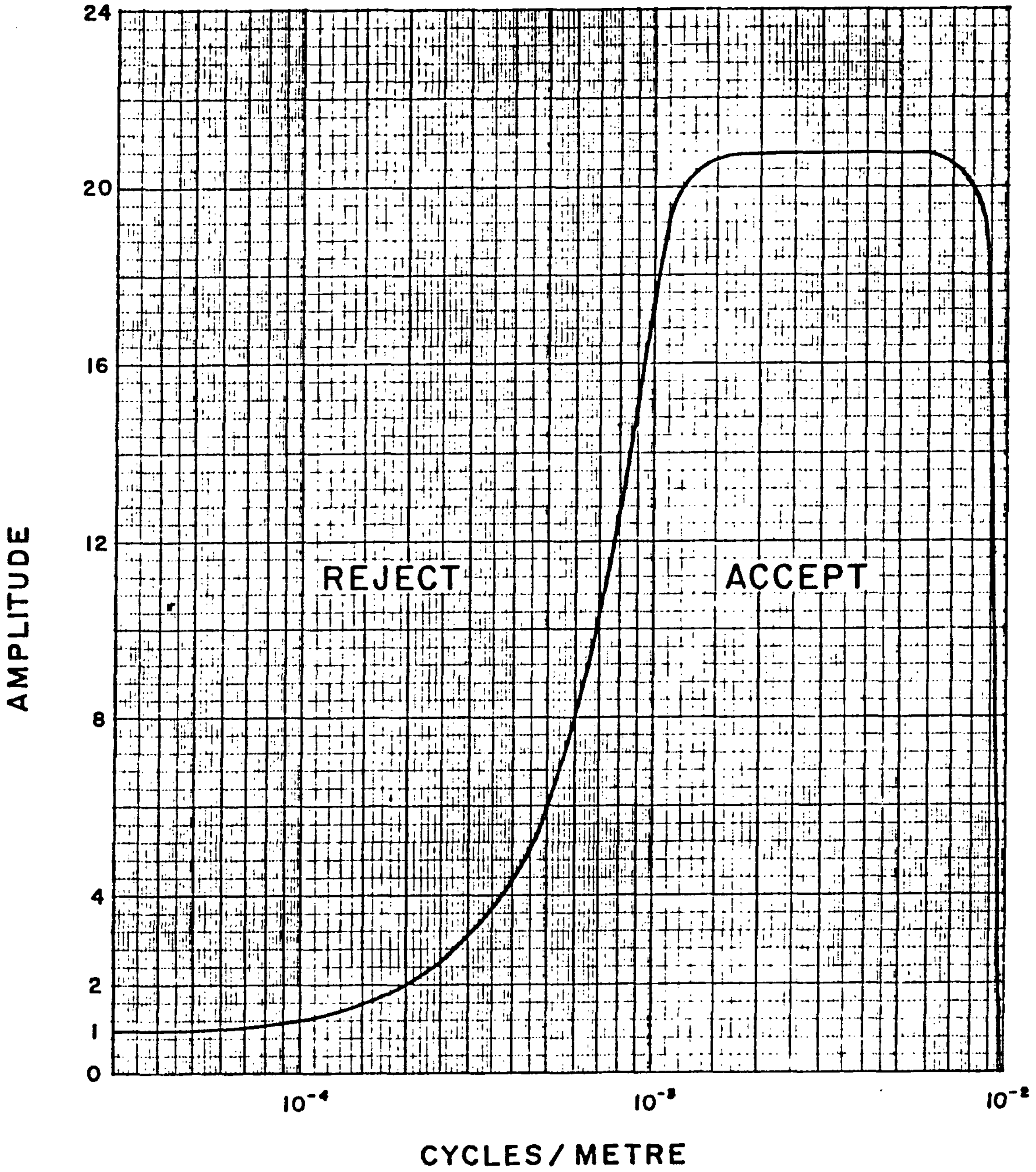


Figure II-2 Frequency response of magnetic enhancement operator.

geological structure. It defines the near-surface local geology while de-emphasizing deep-seated regional features. It primarily has application when the magnetic rock units are steeply dipping and the earth's field dips in excess of 60 degrees.

MAPS ACCOMPANYING THIS REPORT

Four map sheets accompany this report:

Electromagnetic Anomalies	1 map sheet
Resistivity	1 map sheet
Total Field Magnetics	1 map sheet
Enhanced Magnetics	1 map sheet

Respectfully submitted,
DIGHEM LIMITED

P.A. SMITH
Geophysical Interpreter

APPENDIX A

THE FLIGHT RECORD AND PATH RECOVERY

Both analog and digital flight records were produced. The analog profiles were recorded on chart paper in the aircraft during the survey. The digital profiles were generated later by computer and plotted on electrostatic chart paper at a scale of 1:10,000. The digital profiles are listed in Table A-1.

In Table A-1, the log resistivity scale of 0.03 decade/mm means that the resistivity changes by an order of magnitude in 33 mm. The resistivities at 0, 33, 67, 100 and 133 mm up from the bottom of the digital flight record are respectively 1, 10, 100, 1,000 and 10,000 ohm-m.

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

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

Table A-1. The Digital Profiles

Channel Name (Freq)	Observed parameters	Scale units/mm
MAG	magnetics	10 nT
ALT	bird height	3 m
CXI (900 Hz)	vertical coaxial coil-pair inphase	1 ppm
CXQ (900 Hz)	vertical coaxial coil-pair quadrature	1 ppm
CXS (900 Hz)	ambient noise monitor (coaxial receiver)	1 ppm
CPI (900 Hz)	horizontal coplanar coil-pair inphase	1 ppm
CPQ (900 Hz)	horizontal coplanar coil-pair quadrature	1 ppm
CPS (900 Hz)	ambient noise monitor (coplanar receiver)	1 ppm
CPI (7200 Hz)	horizontal coplanar coil-pair inphase	1 ppm
CPQ (7200 Hz)	horizontal coplanar coil-pair quadrature	1 ppm
	Computed Parameters	
DIFI (900 Hz)	difference function inphase from CXI and CPI	1 ppm
DIFQ (900 Hz)	difference function quadrature from CXQ and CPQ	1 ppm
REC1	first anomaly recognition function	1 ppm
REC2	second anomaly recognition function	1 ppm
REC3	third anomaly recognition function	1 ppm
REC4	fourth anomaly recognition function	1 ppm
CDT	conductance	1 grade
RES (900 Hz)	log resistivity	.03 decade
RES (7200 Hz)	log resistivity	.03 decade
DP (900 Hz)	apparent depth	3 m
DP (7200 Hz)	apparent depth	3 m
FEO% (900 Hz)	apparent weight percent magnetite	0.25%

APPENDIX B

EM ANOMALY LIST

192 FATHER & SON LAKE

	COAXIAL 900 HZ		COPLANAR 900 HZ		COPLANAR 7200 HZ		VERTICAL DIKE		HORIZONTAL SHEET		CONDUCTIVE EARTH	
ANOMALY/ FID/INTERP	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	COND MHOS	DEPTH* M	COND MHOS	DEPTH M	RESIS OHM-M	DEPTH M
LINE 3 (FLIGHT 4)												
A 632 B?	2	1	0	2	8	15	1	0	1	60	615	23
LINE 4 (FLIGHT 7)												
A 735 B?	1	3	0	5	17	31	1	0	1	41	440	12
LINE 5 (FLIGHT 7)												
A 588 B	2	2	0	3	15	27	1	0	1	47	417	16
B 651 S?	0	2	0	3	8	27	1	0	1	28	903	0
LINE 6 (FLIGHT 7)												
A 450 B?	1	2	0	4	9	36	1	0	1	36	775	4
B 506 S?	0	2	0	3	7	19	1	0	1	38	739	3
LINE 7 (FLIGHT 7)												
A 304 B?	0	2	0	3	8	13	1	7	1	52	889	15
LINE 8 (FLIGHT 5)												
A 105 B?	1	1	0	2	9	12	1	4	1	61	463	27
LINE 15 (FLIGHT 6)												
A 271 S	0	1	0	2	6	25	1	0	1	5	1418	0
LINE 16 (FLIGHT 6)												
A 404 S	1	2	0	3	11	35	1	0	1	8	784	0

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.