HILL/RUST GROUP 105 K-5
105 K-6

SUMMARY REPORT

HILL-RUST GROUP

(JACOLA MINES LTD.)

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SUMMARY REPORT

HILL-RUST PROPERTY
(Jacola Mines Limited)
Faro Area, Yukon

for

HECLA OPERATING COMPANY

by

Harold Linder, Ph.D., P.Eng.

31 January 1970

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I. INTRODUCTION

The writer was in charge of the 1969 exploration program on the Hill-Rust property, under the direction of Mr. P.I. Conley. Exploration was carried out by Hecla Mining Company of Canada Ltd. on behalf of Hecla Operating Company. The original program was to cover the property with a gravity survey, and the writer visited the property June 12 to 15 during the early stages of the survey. The property was again visited July 26 to 29, and during this visit the writer discovered lead-zinc mineralization which justified an expanded exploration program and made the property a prime area for exploration.

The writer carried out geologic mapping of the area of interest from August 25 to September 27 and also directed an I.P. survey and road construction. The property was again visited November 9 to 16.

II. SUMMARY AND CONCLUSIONS

The Hill-Rust property of Jacola Mines Limited is being explored by Hecla Operating Company under an agreement dated June 1, 1967 by which Hecla may earn a 70% interest in the property. The property is located 125 miles north-northeast of Whitehorse, Yukon, and 5 miles northwest of the Anvil Mine and airstrip, in an area of moderately rugged relief. Elevations on the 128 claim property range from 3200' to 6000', but most of the area of interest is at or above tree line at 4600'.

Present access is by helicopter or by foot from the Anvil airstrip, but construction of approximately one mile of bulldozer trail will allow tracked vehicle access from the airstrip. The airstrip has daily scheduled flights and is connected to Whitehorse by 240 miles of good quality gravel road.

The Hill-Rust property is of interest because it is apparently underlain by the same rock units which contain the Anvil ore bodies. The Anvil Mine began production in September, 1969 with announced reserves of 63 million tons of ore grading 3.40% lead, 5.72% zinc and 1.19 oz/ton silver.

Hecla Operating Company began exploration of the property in 1967. In 1969, the property was covered by a gravity survey and when minor lead-zinc occurrences were discovered near the prime gravity anomaly, this area was also covered by an I. P. survey and detailed geologic mapping.

The Hill-Rust property is underlain by interbedded Cambrian (?) phyllite, phyllitic quartzite and calc-silicate units which have been intruded by the Cretaceous (?) Anvil batholith. The batholith contact lies near the northern property boundary, and several quartz diorite sills, probably related to the batholith, have intruded the metasediments as far as one mile from the batholith contact. Olivine gabbro intrusive is also present. The metasediments trend N30°W and dip 30°S, parallel to the regional structure. Geologic mapping suggests that much complex isoclinal folding is present, as well as later faulting.

The gravity survey located 15 anomalies, designated A to P. Anomalies A and B are the most promising and only A was investigated in detail. Anomalies C to P are smaller, but some of these may be extensions of A or B, and others may collectively be of an interesting size. Anomaly A has dimensions of 4800' by 1000' and a maximum amplitude of 1.4 milligals. Making certain assumptions, the anomaly source could be a relatively flat-lying mass in excess of 30 million tons which comes to within 200' of surface and appears to plunge west. Anomaly B is less well-defined, but if it is continuous, it has dimensions of 5000' by 500' with a maximum amplitude of 1.06 milligals.

The very dense calc-silicate unit appears to underlie both Anomalies A and B and undoubtedly makes some contribution to the gravity anomalies. The gravity data will be reinterpreted on the basis of known geology and measured specific gravities, but the reinterpretation will depend on sub-surface geology, which can only be assumed.

Numerous small semi-banded occurrences of lead-zinc mineralization were found in the calc-silicate unit in the area of Gravity Anomaly A. The lead-zinc occurrences range from only a few scattered grains of galena and sphalerite to mineralized widths of several inches, with a maximum width of one foot. Individual occurrences have lengths of only a few feet, but mineralization appears to occur discontinuously along one or more horizons which parallel Anomaly A for at least 3000 feet. The best grab sample assay, representing a width of approximately 6 inches, assayed 3.00% lead, 2.10% zinc and 5.60 oz/ton silver.

An I. P. survey over Gravity Anomaly A indicated an anomalous area at depth which coincides in part with the gravity anomaly. Five profiles on lines spaced 800' apart exhibited above normal chargeabilities which could be due to a large volume of rock containing from 2% to in excess of 10% by volume of metallically conducting material. Rocks exposed in this area may contain up to 5% pyrrhotite and pyrite, but it should also be noted that sphalerite generally gives no I. P. response.

Gravity Anomaly A is an excellent exploration target because of the coincidence of gravity and I. P. anomalies with associated minor lead-zinc occurrences in a geologically favorable area. Further work may show that Gravity Anomalies B to P are also significant. Gravity Anomaly A, subject to reinterpretation of the gravity data, could result from the dense calc-silicate unit and the associated I. P. anomaly could result from barren sulfides. However, the numerous minor lead-zinc occurrences show that at least some mineralization is present in the area. It appears significant that the gravity and I. P. anomalies generally coincide and suggest a flat-lying source with variable dip, as the known sulfide bodies in the Anvil district have a similar occurrence. Drilling will be required to determine whether the geophysical anomalies have an economically significant source.

III. RECOMMENDATIONS

The following $100,000 exploration program is recommended for the Hill-Rust property. The program will allow a reasonable drill test of Gravity Anomaly A, a partial drill test of Gravity Anomaly B, and will also determine whether additional work is required on Gravity Anomalies C to P.

1. Five thousand feet of diamond drilling is recommended, including 4,000 feet in six holes to test Gravity Anomaly A and 1,000 feet in two holes to test Gravity Anomaly B, as listed below:

Proposed Hole	Location	Dip	Length	Purpose
J1	L132W, 13N	90°	500'	Test Gravity Anomaly A
J2	L140W, 10N	45°N	1000'	"
J3	L164W, 20N	90°	1000'	"
J4	L148W, 15N	90°	500'	"
J5	L156W, 20N	90°	500'	"
J6	L124W, 11N	90°	500'	"
J7	L148W, 66N	90°	500'	Test Gravity Anomaly B
J8	L124W, 65N	90°	500'	"
			5000'	

Most of the proposed holes are vertical because the gravity and I. P. results suggest a generally flat-lying source. Drill hole locations, attitudes and depths may be changed on the basis of earlier drill results. One Longyear Model 38 drill, or its equivalent, using BQ wireline equipment, should complete the program in three months.

2. Approximately one mile of bulldozer road should be constructed to provide tracked vehicle access to the property. Bulldozer trenching to bedrock should also be attempted in areas of interest.

3. A tracked vehicle should be obtained to provide access to the property.

4. Gravity Anomalies C to P should be examined in detail to determine if they warrant further work.

5. The existing grid should be covered with a magnetometer survey.

6. The property should be geologically mapped at 1" = 400' and areas of interest should be mapped at 1" = 100'.

Estimated Costs of Proposed 1970 Exploration Program

Diamond drilling (5000' @ $13/ft.)	$ 65,000
Payroll and supervision (4 months @ $2500)	10,000
Bulldozer (200 hours @ $30)	6,000
Tracked vehicle	6,000
Geologic mapping (4 months @ $1500)	6,000
Magnetometer survey (30 line miles @ $50)	1,500
Camp and supplies	5,500
	$ 100,000

IV. LOCATION AND ACCESS

The Hill-Rust property is located 125 air-miles north-northeast of Whitehorse, Yukon in the Whitehorse Mining Division at Latitude 62°24' North and Longitude 133°30' West (Fig. 1). The Anvil mine and airstrip are located 5 miles southeast of the property.

The Anvil airstrip is serviced daily by Great Northern Airlines scheduled DC 3 flights from Whitehorse. The airstrip is accessible by 240 miles of good quality gravel road from Whitehorse, via Carmacks. Alternate routes are via the Canol road or the Watson Lake-Ross River road.

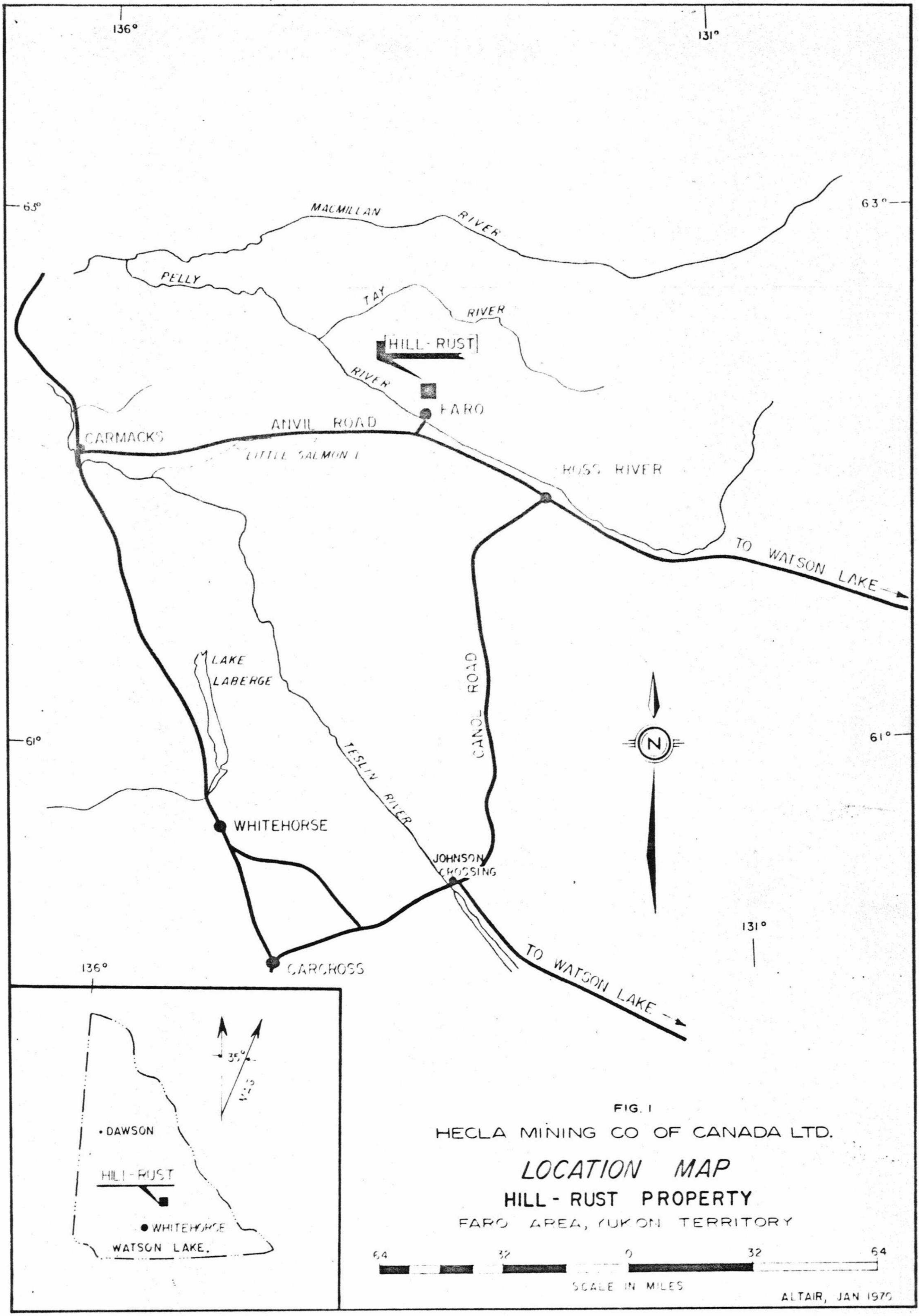

FIG. 1

HECLA MINING CO OF CANADA LTD.

LOCATION MAP

HILL - RUST PROPERTY

FARO AREA, YUKON TERRITORY

A bulldozer trail suitable for tracked vehicles only extends 3 miles from the Anvil airstrip to within 2 miles of the property. Attempts to complete this trail in 1969 were unsuccessful because of swampy ground, permafrost conditions and contractor difficulties. Tracked vehicle access to the property will greatly reduce exploration costs, and completion of this trail to the area of proposed drilling should be possible in early 1970 when the ground is frozen.

Access to the property during 1969 was by Trans-North Turbo Air helicopter, either from the Anvil airstrip or directly from Whitehorse. It is possible to walk from the property to the Anvil airstrip in approximately 3 hours, but because of the climb required, it is impractical to walk to the property from the airstrip.

V. TOPOGRAPHY AND CLIMATE

The Hill-Rust property lies in a moderately rugged area and extends from an elevation of 3200' on Rose Creek to 6000' on an unnamed mountain. Lower elevations are heavily forested and swampy, but most of the area of interest lies at or above the tree line at 4600'. Buck brush near tree line makes line-cutting and access difficult, but the area above tree line is gently rolling and although locally swampy, travel and access are relatively easy.

Climate is typical for this elevation in the Central Yukon and should present no unusual mining difficulties as the Anvil pit is located only 5 miles away at a similar elevation. June 1969 was unusually hot and dry with an extreme fire hazard, while July and August were unusually cold and wet. Snow banks at higher elevations persisted until late July and wet snow fell in both July and August. September and October were relatively sunny and cool with snowfall down to 4000' elevation, most of which melted in a few days. In mid-November, the property was covered by at least one foot of snow with temperatures as low as -30° F.

VI. HISTORY

Discovery of the Anvil ore bodies in 1965 prompted a staking rush in the area, and the Hill and Rust claims were staked and recorded on March 21, 1966 by Dynasty Investments Limited and subsequently donated to Jacola Mines Limited. The claims were covered by an airborne EM and magnetometer survey in July 1966, and a program of exploration was recommended to the above companies by Mr. Ross D. Lawrence in a report dated June 2, 1967.

Hill
Rust
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Fubar
Heck

DA
LA
DEE

Hecla Operating Company optioned the claims from Jacola Mines Limited in an agreement dated June 1, 1967 and has continued exploration of the property to date.

Mr. W.G. Wahl, Geophysical Consultant, interpreted the results of the airborne geophysical survey in a report dated March 20, 1967, and recommended ground geophysical and geochemical surveys to determine the cause of two designated airborne anomalies, Anomaly 1 and Anomaly 2.

In 1967, Archer, Cathro and Associates Ltd. carried out an extensive program of geologic mapping and soil geochemistry directed chiefly at the two airborne anomalies. Their report dated August 7, 1967, concluded that Anomaly 1 was caused by an olivine gabbro body, and that Anomaly 2 could not be substantiated by ground geophysical surveys. They also concluded, chiefly on the basis of negative soil geochemical results and geologic mapping, that probably no significant mineralization occurred close to surface, but that mineralization could occur at depth because of the favorable stratigraphic horizon which underlies the property.

The Fubar claim group was staked and recorded July 28, 1967 to cover adjoining ground on which other claims had lapsed.

Huntec Ltd. carried out a combined ground EM, magnetic and I.P. survey in late 1967 over the airborne anomalies, and in a report dated December 1967, recommended no further work on these areas.

Mr. Robert S. Adamson, Consultant and former Chief of Exploration for Anvil Mining Corporation, reviewed the work done on the Hill-Rust property and in a report dated July 1, 1968, recommended a gravity survey to cover the most promising part of the Hill-Rust property.

The Heck claims were staked and recorded July 20, 1968 and the La, Dee and Da claims were staked and recorded September 13, 1968 to cover adjoining ground on which other claims had lapsed. The Hec claims were staked and recorded January 9, 1970 to cover possible extensions of Gravity Anomaly B.

Exploration by Hecla Operating Company in 1969 is described in this report.

VII. CLAIMS

The Hill-Rust property (Fig. 2) consists of 128 claims which are listed in Appendix A.

Jacola Mines Limited is the recorded owner of 46 claims and Hecla Mining Company of Canada Ltd. and Hecla Operating Company are the recorded owners of the remaining 82 claims.

All of the Hill-Rust property claims are in good standing until July 30, 1970. Assessment credit of 95 claim years was received for the gravity survey and line-cutting costs during 1969, and $700 was paid in lieu of work for 7 claim years credit. It should be noted that for most claims only physical work will be acceptable for assessment credit in the future, as geological, geophysical and geochemical work may only be used during the first three years from the record date.

The claims have not been surveyed, but numerous claim posts were located during the course of field work within a few hundred feet of their location as shown on government claim maps.

VIII. REGIONAL GEOLOGY

The geology of the area is shown on GSC Map 13-1961 (Tay River map sheet NTS 105K, 1" = 4 miles), 1961, by J.A. Roddick and L.H. Green. More detailed information on the geologic setting of the Anvil district ore bodies is given by D.J. Tempelman-Kluit in GSC Paper 68-1A, pp. 43-52, and GSC Paper 69-1A, pp. 38-39.

The area is underlain by metasedimentary rocks which trend northwest, parallel to the Tintina Trench, and which have been intruded by the Anvil batholith. Tempelman-Kluit has mapped two units, Unit 2 and Unit 3, of Cambrian (?) age but of uncertain relative ages. He states: "Unit 2 is a 2000-foot thick sequence of argillaceous calc-silicate rocks that represents an originally limy, thin-bedded and fine-grained, dominantly sedimentary succession. The unit includes in its upper part (?) a 200- or 300-foot thick section in which beds of light grey marble, some as much as 50-feet thick, are prominent. Thin lenses of amphibolite, probably of volcanic origin, are common."

Unit 3, which contains all of the known ore bodies, is a phyllite unit probably about 3,000' thick which contains "....greenstone lenses as much as 50 feet thick that are probably tuffaceous; the phyllite itself may contain a considerable proportion of tuffaceous material." Tempelman-Kluit has subdivided Unit 3 into two members whose relative ages are unknown.

The "lower" is about 1,000' thick and contains medium grey quartz-rich phyllite with dark grey graphitic phyllite near its base and small chloritic greenstone lenses and tuffaceous phyllite in its upper part. The "upper" member is about 3,000' thick and contains pale greenish-grey non-quartzose phyllite with many large greenstone lenses and 10-foot thick sections of phyllitic tuff. Distinction of the "lower" member is based on the presence of quartz and graphite in the phyllite and on the absence of thick greenstone lenses. The sulfide bodies discovered to date occur in the "lower" member some distance "above" the graphitic horizons and a considerable distance "below" the lowest thick greenstones.

The rocks have been deformed and Tempelman-Kluit states: "Transposition or gleitbrett structures and a related strong crenulation foliation characterize the style of the Cambrian strata and obscure their internal stratigraphy."

The Anvil batholith is of probable early Upper Cretaceous age (80 - 90 million years) and forms a granitic core which appears to have domed the intruded sedimentary and metasedimentary rocks.

The grade of regional (?) metamorphism increases northward from low-grade (sericite) at Swim to intermediate grades (chlorite) at Vangorda to moderate grade (biotite and andalusite) at Faro. Contact metamorphism is apparently limited to the immediate area of the batholith contact.

IX. ANVIL DISTRICT ORE OCCURRENCES

A. Geology

The major known massive sulfide bodies, the Vangorda, Swim and Faro deposits, have been described in detail by Dr. A.E. Aho in the CIM Bulletin of April 1969, pp. 397-409.

The Swim deposit is 1200 feet long and consists of two moderately dipping sulfide lenses connected by a thinner lense underlain by another layer of sulfides. The sulfides are localized in bleached phyllites which are enclosed in moderately dipping graphitic chloritic phyllites. Reserves of 5 million tons of 9.5% combined lead-zinc and 1.5 ounces per ton silver have been outlined.

The Vangorda deposit is a series of flat-lying overlapping lenses of massive to disseminated sulfides, 3200 feet long, 490 feet wide and up to 150 feet thick, enclosed in a chlorite-sericite schist underlain by graphitic schist. Reserves of 9.4 million tons of 3.16% lead, 4.96% zinc, .27% copper, 1.76 ounces per ton silver and .02 ounces per ton gold have been outlined, with an additional 12.6 million tons of low-grade to barren sulfides. The upper part of the body has been eroded and the deposit may have been much larger originally. The deposit appears stratigraphically controlled with localization in a flat-lying fold which parallels the regional trend.

The Faro deposit, which began production in September 1969, consists of 3 bodies with a combined tonnage of 63 million tons averaging 3.40% lead, 5.72% zinc, and 1.19 ounces per ton silver, assuming a cut-off grade of 5% combined lead-zinc and a tonnage factor of 8.5. Faro No. 1, the largest body, is 4700 feet long, 1100 feet wide and up to 200 feet thick. The ore bodies are flat-lying within limy and tuffaceous quartz-biotite-sericite schists or phyllites which have been intruded by border phases of the Anvil batholith. An alteration halo of sericite schist and quartzose "metaquartzite" up to 100 feet wide surrounds the ore bodies.

All of the Anvil district deposits are mineralogically similar and the primary sulfides, in order of abundance, are pyrite, pyrrhotite, sphalerite, galena and minor chalcopyrite. The sulfides have a granular texture and generally increase in grain size to the north, paralleling the increase in metamorphic grade. The sulfides constitute about 50% of each deposit and appear generally strata-bound.

Tempelman-Kluit states: "The general shape of the deposits is tabular; the plane in which they lie conforms broadly to the crenulation foliation in the enclosing phyllitic strata and their long axes coincide with the intersection of this foliation and the bedding of the host rocks."

Tempelman-Kluit concludes: "Local controls for emplacement of sulfides are as yet unknown. There is no evidence that graphite content of host rocks, proximity to granitic rocks, and relationship to the Tintina fault or northeast striking faults, cited elsewhere as possible controls, are significant."

"In the writer's opinion, the deposits are early (i.e. Cambrian?) replacements of consolidated or unconsolidated quartz-rich parts of a tuffaceous Cambrian sediment. These sediments were later deformed, perhaps synchronously with regional (?) metamorphism in post-Cambrian, pre-Devonian time. Volcanism may have played an important part in the original emplacement of the sulfides. During deformation and metamorphism of the host rocks the sulfides were recrystallized and the alteration envelope formed. The Faro body was probably recrystallized for a second time during emplacement of the Anvil batholith."

B. Exploration Methods

A variety of geophysical and geochemical methods have been used in exploration for massive sulfide bodies in the Anvil district. According to Dr. Aho, the Faro No. 1 deposit has a magnetic anomaly of moderate intensity, but only weak EM response, whereas the Faro No. 2 deposit has a strong EM anomaly but little or no associated magnetic anomaly. Strong geochemical anomalies were found where overburden was not thick, but values were diluted and very erratic within a few hundred feet of their source. Aho states: "However, a gravity survey showed No. 1 orebody as a 'textbook' example of an oval-shaped anomaly, up to 1500 feet by 2500 feet or more in extent, with maximum relief of about 1.5 milligals, and early drill-hole data gave a fairly accurate estimate of 48.5 million tons of sulfides. Induced polarization also showed response over the orebodies."

Aho concludes: "....it would appear that, although slower and more expensive, gravity and I.P. Methods might be the best methods of exploration in the Anvil district after regional targets had been narrowed down by airborne magnetic surveys and checked on the ground by geochemical and other methods. This may be the best approach for discovering this type of deposit, but the exploration is still dependent on the art of interpretation and decisions on the significance of anomalies. In this district, geochemical anomalies can be masked by overburden; magnetic anomalies can be caused by greenstone, volcanics, intrusives or accessory pyrrhotite in the phyllites; most EM response is caused by graphite or other conditions; many smaller gravity anomalies are caused by bedrock or overburden variations; and I.P. response can be caused by uneconomic sulfides and other conditions."

X. PROPERTY GEOLOGY

A. Introduction

Geologic mapping at 1" = 400' was started in 1969 after discovery of several lead-zinc occurrences. Mapping was originally confined to the surveyed lines spaced 800 feet apart in the area of Gravity Anomalies A and B, but was extended to areas between lines where time permitted. The geological map (Fig. 3) therefore does not include all of the outcrops present. Some data from the 1" = 1320' map of R.J. Cathro has also been included.

Areas of frost heave often appeared to be a reliable indication of bedrock and some areas of frost heave, including lead-zinc occurrences, are therefore plotted as outcrops on Fig. 3. Individual strike and dip measurements, however, may not be representative of true attitudes because of frost heaving.

Geologic mapping successfully located additional lead-zinc occurrences and indicated the rock types present and their general attitudes. Additional mapping is desirable as it will better define the extent and structure of rock units and may allow subdivision of the units.

B. Rock Types

1. Phyllite

Dense black biotite-rich phyllite with few quartzose layers occurs as mappable lenses and layers although it often grades into phyllitic quartzite. The phyllite varies from massive to fissile with bedding or foliation marked by biotite, or less commonly, chlorite layers. Non-magnetic iron oxide minerals are common and up to 5% pyrrhotite may be present. Quartz pods and stringers are also common. Near the batholith contact, the phyllite is strongly schistose and biotite-rich.

Some layers within the phyllite are unusually dense and highly chloritized and have a "woody" texture due to rodding of the mafic minerals. These layers may have been thin greenstone flows within the phyllite unit and are probably the "thin lenses of amphibolite" which Tempelman-Kluit states are common in Unit 2.

No lead-zinc mineralization occurs in the phyllite unit.

2. Phyllitic Quartzite

Grey-green thin to thick banded non-calcareous phyllitic quartzite is the most abundant rock type on the Hill-Rust property. All gradations from relatively pure quartzite to phyllite are present within the unit, but the normal rock is composed of quartzite layers with varying amounts of phyllitic impurities. Some of the quartzose layers may be tuffaceous. Layer thicknesses vary from one-half inch to microscopic, with an average of about one-twentieth of an inch. The layers may have either sharply defined or vague boundaries, and many layers, especially the impure phyllitic layers, tend to be only semi-continuous and often give a "wispy" appearance to the rock. More-detailed mapping may allow subdivision of the phyllitic quartzite into thin-banded and thick-banded members.

The unit as a whole is relatively homogenous, but locally, over thicknesses of 3 to 5 feet, layers vary from quartzite to phyllite and may include moderately calcareous layers. Lenses of volcanic greenstone may also be present.

The phyllitic quartzite weathers from rusty brown to silvery white with phyllitic sheen, reflecting development of white mica along bedding or foliation planes. Quartz-rich layers weather massively whereas phyllite-rich layers are fissile and locally may weather as "paper slates". The unit appears schistose near the Anvil batholith contact.

The phyllitic quartzite has undergone considerable structural deformation. Chevron folding often occurs in biotite-rich phyllite layers and these layers often form boudins separated by quartz fillings. Isoclinal drag folds on a 4" to 6" scale are common, and presumably also on larger scales, although they were not recognized. Quartz pods and lenses up to several feet in thickness are common and locally pass laterally into thin rusty sulfide-rich layers 2" to 3" in thickness.

No lead-zinc mineralization occurs in the phyllitic quartzite, but minor amounts of pyrrhotite, pyrite and chalcopyrite are present.

3. Calc-Silicate Unit

(a) General

One or more calc-silicate units are interlayered with the phyllitic quartzite and phyllite and this unit contains all of the known lead-zinc occurrences. The unit is subdivided into three members: marble, calcareous quartzite and skarn. The members are interbedded and represent an originally limy sequence with varying amounts of carbonate and argillaceous material.

The basic rock type is a bedded calcareous quartzite which contains interlayered carbonate-rich horizons now metamorphosed to marble. Layers of suitable composition have been altered to skarn and some skarning was also noted along small fractures, especially at the periphery of the calc-silicate unit. The marble and many of the skarn occurrences are bedded in detail, but at the map scale they appear as discontinuous lenses within the calc-silicate unit.

Two calc-silicate units separated by phyllite and phyllitic quartzite units outcrop in the area of Gravity Anomaly A and Gravity Anomaly B. It is not known whether these are truly separate units due to cyclic deposition, or only one unit repeated by faulting or complex isoclinal folding.

(b) Calcareous Quartzite

The calcareous quartzite member is a light green to greenish-pink, moderately to strongly calcareous quartzite which forms most of the calc-silicate unit. Carbonate-rich layers and lenses occur within the member, and where possible, these have been mapped separately as marble. Certain layers, probably those more argillic in composition, were susceptible to skarning and have also been mapped separately where possible. Some skarning also occurs along small fractures in the calcareous quartzite, especially near its contacts with the phyllitic quartzites.

The calcareous quartzite has thin delicate banding, often marked by subtle color changes, and contains relatively little phyllitic material. Reddish-brown garnets, often banded, are common. The calcareous quartzite-phyllitic quartzite contact is fairly sharp, although some inter-layering does occur. The amount of carbonate, as measured by field HCl test, appears to increase progressively toward the center of the member. The intrusive sills seem to have little effect on the calcareous quartzite, although at one contact the quartzite contained noticeably less carbonate up to 50 feet from the contact.

One thin section of calcareous quartzite was studied by Mr. T. Richards, University of British Columbia. It was composed of garnets set in a fine-grained intergrown matrix of strongly corroded diopside, irregular quartz, vesuvianite (idocrase) and carbonate. The calcareous quartzite is therefore mineralogically similar to the skarn member.

The calcareous quartzite contains about two-thirds of the known lead-zinc occurrences and is apparently the most favorable host rock for mineralization. It may also contain up to 3% semi-banded pyrrhotite or, less commonly, pyrite and minor chalcopyrite.

(c) Marble

The marble is a distinctive white to grey, thin-banded, crinkly weathering quartz-rich rock with minor amounts of biotite in thin discontinuous and contorted layers. It appears to be an exceptionally pure calcareous quartzite and is gradational into and interlayered with calcareous quartzite and skarn. The marble has a thickness of up to 50 feet and occurs in either one or two bands, apparently with fair continuity. Thinner bands occur throughout the calc-silicate unit and one band was noted at L170W, 45N within the phyllitic quartzite.

No lead-zinc mineralization occurs in the marble unit and only traces of other sulfides are present.

(d) Skarn

Buff-colored to red-green very dense skarn occurs within the calc-silicate unit in layers and lenses varying from 50 feet to only a few inches in thickness. The skarn is generally layered but local skarn also occurs along fractures in calcareous quartzite. Several varieties of skarn are present. The most common is a buff-colored highly calcareous skarn with numerous small banded garnets. A second type is a reddish-green moderately calcareous skarn with large red garnets up to one inch in diameter. Still another variety has a distinctive spotted texture of green porphyroblasts set in a buff-colored matrix. Skarn was observed only in the immediate area of Gravity Anomaly A.

Four thin sections of skarn were examined by Mr. T. Richards, University of British Columbia. The rocks contain variable amounts of garnet, diopside and vesuvianite (idocrase) with lesser amounts of quartz, calcite and chlorite (?). From 30 to 60% brownish-red grossularite garnet is present and occurs as weakly birefringent euhedral to anhedral aggregates with oscillatory zoning. About 30% diopside occurs as fine to coarse-grained anhedral aggregates and as elongated tabular crystals which are partially corroded to secondary carbonate. Richards states that the elongated diopside crystals are grown in a random array, indicating formation in a static environment. Vesuvianite (idocrase) ranges from 25% to trace amounts and occurs as yellowish tabular or radiating weakly zoned subhedral crystals and aggregates, often associated with diopside. Up to 15% calcite occurs as fine to coarse-grained wedge-shaped crystals interstitial to the dominant minerals. Minor amounts of chlorite (?) were noted as radiating rosettes in one section. Richards states that considerable late alteration or retrograde effects were noted, mainly the breakdown of diopside to fine-grained carbonate plus chlorite (?) and minor carbonate and quartz veins. Calcite and quartz appeared compatible and no wollastonite was noted.

The origin of the skarn is not known. Skarn at L139W, 13N and at L148W, 20N is in apparent contact with quartz diorite sills, but most of the skarn has no obvious relationship to the intrusive. The skarn could be related to a body of intrusive at depth.

The skarn has a distinctive ragged reddish-orange weathered surface. The skarn contains about one-third of the known lead-zinc occurrences but only minor amounts of other sulfides.

4. Greenstone

Small greenstone lenses or layers may occur within the phyllite and phyllitic quartzite units but the only definite occurrences of greenstone lie south of the base line outside the map area. A large body of greenstone occurs about 25S between L172W and L196W and has an associated airborne magnetic anomaly. The airborne magnetic survey suggests that other greenstone bodies are also present in this area.

The greenstone is a rusty-weathering dense black basalt or gabbro with variable grain size. Phenocrysts are common and the coarse-grained varieties are plagioclase-rich. Sufficient magnetite is present to explain the associated airborne magnetic anomalies and minor amounts of pyrrhotite and chalcopyrite also occur in the greenstone. The contacts with phyllitic rocks, were exposed, are generally conformable and all of the greenstone examined appears to be volcanic flows or sills interlayered with the phyllitic rocks.

5. Intrusive

The main mass of the Anvil batholith lies immediately north of the map area (Fig. 3.). The Anvil batholith reportedly ranges from granodiorite to quartz monzonite in composition, but all of the intrusive rocks on the property are quartz diorite, with minor amounts of feldspar porphyry.

A quartz diorite outcrop at L172W, 60N is probably part of the main batholith mass, and the small intrusive stringers at L160W, 65N appear to be associated with the batholith contact. The small quartz diorite outcrop at L123W, 73N appears sill-like, but may also be associated with the batholith contact.

Two sill-like intrusive bodies are indicated on Fig. 3 and are fairly well defined by outcrop and frost heave areas. The northern body appears to extend from L172W, 35N to L124W, 22N and the southern body from L174W, 5N to L138W, 15N. The intrusive bodies are locally conformable but on a larger scale appear to cut the metasediments. Other smaller, less extensive sills probably also occur.

The sills and larger intrusive bodies are composed of a grey medium to coarse-grained biotite-rich quartz diorite which may contain biotite or amphibole phenocrysts greater than 1 inch in diameter. The intrusive often appears "contaminated" and in one sill a rounded mafic inclusion 3" x 6" was noted. The intrusive is massive and relatively unfractured. Sill contacts are sharp and generally conformable although minor intrusive stringers occur, and the sills may have foliation parallel to adjacent bedding. At one location, a fine-grained light-colored contact was noted, and elsewhere minor amounts of dark biotite-rich feldspar porphyry are present. Locally, the intrusive is altered to a biotite-rich, easily weathered phase.

The intrusive contains magnetite and 3 to 5% pyrrhotite and chalcopyrite. These sulfides are also common in wall rock adjacent to the intrusive.

Small intrusive plugs containing chalcopyrite are also reported to occur on the adjoining Flagstone and Kim Explorations properties.

6. Olivine Gabbro

An olivine gabbro body forms a distinctive cone-shaped hill about 250 feet high on L100W. It was not examined this season, but was examined and described by R.J. Cathro in 1967. The outcrops have a vague north-south alignment and steep-dipping joints but the contacts are covered and it is not known whether the body is a stock, dike or sill. Cathro believes it may be a feeder-dike to a volcanic flow which has been removed by erosion.

The olivine gabbro is a dense, very fine-grained black rock with up to 5% magnetite occurring as clots. In thin section it reportedly consists of one-third olivine and two-thirds amphiboles. The body is magnetite-rich on the west side and feldspar-rich on the east side. A schistose greenstone band within the gabbro strikes N15°W and dips 40°W, conformable to the regional structure.

The magnetite-rich olivine gabbro is responsible for a 1480 gamma airborne magnetic anomaly (Anomaly 1) which first drew attention to the Hill-Rust property. The magnetic anomaly is up to 3500 feet long and 600 feet wide at its northern end and lenses out to the south. The zone trends N15°W. A strong electromagnetic response is coincident with the eastern flank of the magnetic anomaly.

There is no evidence to suggest that the olivine gabbro is more extensive than shown on Fig. 3, and it is unlikely that olivine gabbro is the source of either Gravity Anomaly A or Gravity Anomaly B.

C. Structure

The general metasedimentary sequence which underlies the property appears to be a basal phyllite unit overlain by the calc-silicate unit (with calcareous quartzite, marble and skarn members) and the phyllitic quartzite unit. The sequence is marked by much interbedding and alternating rock types and probably represents a generally transgressive but fluctuating shore line with original sediments varying from near shore muds and silts to deeper water carbonate and relatively clean quartz sands. The general sequence of basal phyllite, calc-silicate unit and phyllitic quartzite occurs near L48W, 73N and is repeated near L148W, 60N. A similar but more complex sequence occurs near Gravity Anomaly A and has associated semi-banded lead-zinc mineralization. The repetition of this sequence may result from cyclic deposition, isoclinal folding or faulting.

The Hill-Rust property apparently lies on the general strike of the Faro ore horizon, but insufficient geologic mapping has been done to correlate units. The Faro ore bodies occur in a quartzose horizon in phyllitic rocks, and it has been suggested that the quartzite marks a stream channel in deltaic muds. The writer suggests that the Hill-Rust calcareous quartzite may correlate with the Faro quartzite, which would then be too extensive to be a stream channel sediment. The greater carbonate content of the Hill-Rust quartzite could be the result of a facies change with Hill-Rust representing a deeper water environment. This hypothesis could also explain the presence of graphitic phyllites underlying the Faro ore bodies and their apparent absence at Hill-Rust and the fact that the general Faro host rocks are apparently more phyllitic than those at Hill-Rust.

The bedded rocks, with few exceptions, strike N30°W and dip 30°S, parallel to the regional structure. This apparent structural simplicity is probably deceptive because other evidence suggests that the rocks have been extensively deformed, chiefly by complex isoclinal folding, but also by later faulting. Isoclinal drag folding of beds 4 to 6 inches thick is very common and probably also occurs on a larger scale. The dominant planar feature appears to be original bedding, but it is possible, especially in phyllitic rocks, that original bedding has been replaced by a secondary foliation. The interpretation shown on Fig. 3 suggests that the marble horizon near L148W, 60N connects with the exposure at L181W, 46N and that this may connect with the horizon near L156W, 30N. The latter horizon could be folded again with the nose near L148W, 20N and connect with the marble lense extending from L146W, 20N to L172W, 20N. Alternatively, the various marble outcrops may be only lenses at different stratigraphic horizons within the calc-silicate unit.

Several major faults are probably present, although they were not identified in the field. A N60°W fault with northside-down movement near 62N between L172W and L148W could cause repetition of the calc-silicate unit. A north to N30°E fault near L116W, 10N may cause the relatively abrupt termination of Gravity Anomaly A. A smaller fault may trend N60°E parallel to the intrusive between L140W, 7N and L136W, 21N and another fault may trend north from L144W, 9N to L148W, 25N, parallel to the stream.

Several large tension zones containing barren quartz with widths of up to 3 feet were noted in mapping. One zone is located at L162W, 18N and trends N75°W for 100 feet and another is located at L164W, 5N and trends N15°W for 100 feet. A gossan with barren quartz and highly silicified skarn and local lead-zinc mineralization, marking either a shear zone or tension fracture filling, also occurs at L168W to L172W, 21+50N.

It is difficult to relate the Hill-Rust geology to the regional mapping of Tempelman-Kluit, but it appears that the area mapped in Fig. 3 is part of his "Unit 2". The calc-silicate unit probably correlates with the "200- or 300-foot thick section in which beds of light grey marble some as much as 50 feet thick, are prominent." Also as in Unit 2, thin lenses of amphibolite (?) are present within the phyllitic quartzite.

The area south of the Hill-Rust base line appears to be similar to Tempelman-Kluit's "upper" member of Unit 3, as large greenstone lenses are present in a generally non-quartzose phyllite. Airborne EM results suggest conductive phyllites, possibly graphitic, near Rose Creek, which may correlate with the "lower" member of Tempelman-Kluit's Unit 3. The geology of this area, however, is not well known.

In summary, it appears that on the Hill-Rust property, Tempelman-Kluit's Unit 2 extends from the Anvil batholith contact to near the base line and is overlain by the "upper" member of Unit 3, which in turn is overlain by the "lower" member of Unit 3. Tempelman-Kluit states that the known ore bodies occur in the "lower" member of Unit 3, which does not correlate with the Hill-Rust mineralization in the calc-silicate unit, but these could be time equivalent because of facies changes. It is also possible, of course, that more than one mineralized horizon may be present in the Anvil batholith.

D. Mineralization

Thirty occurrences of lead-zinc mineralization in outcrop and reliable frost heave are plotted on Fig. 3, and several other occurrences were noted in less reliable frost heave. None of the occurrences are of economic size, and they range from only a few grains of galena and sphalerite to several per cent sulfides over widths of up to one foot. Most have exposed widths of only a few inches and lengths of only a few feet. The occurrences are significant because they show that minor amounts of lead-zinc mineralization are scattered over a large area, and are associated with the calc-silicate unit in the immediate area of Gravity Anomaly A. The occurrences may mark one or more lead-zinc horizons within the calc-silicate unit, with strike length in excess of 3000 feet.

The occurrences consist of sphalerite and galena with minor amounts of pyrrhotite, pyrite and chalcopyrite. Mineralization occurs only in the calc-silicate unit, chiefly in the calcareous quartzite member and less often in the skarn member. Mineralization does not occur in the marble member or outside the calc-silicate unit. In detail, mineralization occurs in quartzite layers and only rarely in phyllitic layers. Galena and sphalerite occur as semi-banded fine to medium-sized grains, with occasional coarse grains, along specific bedding planes. Locally, individual bands of massive galena-sphalerite may be up to 1/4 inch in thickness.

Although almost all of the lead-zinc mineralization is semi-banded, some occurrences are also related to fractures. At L149W, 20+50N, minor amounts of sphalerite and galena occur in a phyllitic band within a garnetiferous calcareous quartzite, one of only two known occurrences with phyllite. The mineralization also appears related to three fractures spaced 4 to 6 inches apart which trend N25°W, parallel to bedding, and dip 85°S. Mineralization in skarn at L156+50W, 19+50N is basically semi-banded but possibly also related to fractures. The mineralization at L170W, 21+50N is also basically semi-banded but may be associated with a tensional (?) quartz-filled fracture. In general, the lead-zinc mineralization is basically semi-banded and local apparent association with fractures is probably due to later mobilization during metamorphism.

A grab sample (L-01) of mineralization from the original showing at L160W, 26N, representing a width of approximately 6 inches, assayed 3.00% lead, 2.10% zinc, 5.60 ounces per ton silver, less than .01% copper and less than .003 ounces per ton gold. A spectrographic analysis of this sample (Appendix B) showed .5 to 5% manganese and traces (.01-.10%) of bismuth, cadmium, cobalt, titanium and zirconium. Another grab sample (L-65) from a frost heave block at L171+70W, 27+50N, representing a width of approximately one foot, assayed 1.55% lead, .84% zinc and 1.75 ounces per ton silver. Assays and spectrographic analyses (Appendix B) of eleven other grab samples gave much lower results for lead, zinc, and silver, and showed that little or no barium is present. The assays given above suggest that the Hill-Rust mineralization may contain proportionally more silver than mineralization at the Faro deposit.

Weathered surfaces of rocks containing lead-zinc have a distinctive chocolate-brown to sooty-black color that is easily recognized with experience. This is often associated with the orange weathered surface of the calc-silicate unit. Galena is apparently stable under surface conditions, as unaltered galena grains often occur in weathered rocks at surface. Sphalerite is apparently unstable, as it occurs only in relatively fresh rock below the weathered surface.

The distribution of the lead-zinc showings suggest that they may occur at one or more definite stratigraphic horizons within the calc-silicate unit. Continuous mineralization could be present along this horizon, but probably it is discontinuous along strike. The complex structural deformation of the calc-silicate unit makes interpretation difficult, but there is a possibility that the two calc-silicate limbs containing lead-zinc showings are isoclinally folded and connected at depth under Gravity Anomaly A. No lead-zinc showings were found northwest of L172W, but the calc-silicate unit appears to be folded near L180W, 46N and may also underlie Gravity Anomaly B.

Sulfide bodies in the Anvil district are generally surrounded by an irregular area of bleached rocks up to 100 or 200 feet thick. Only minor bleaching was observed at Hill-Rust and although it occurs in the area of Gravity Anomaly A, it is not related to known mineralization. Bleaching occurs in phyllitic quartzite at L139+70W, 13+50N and at L137+50W, 13N, and in calcareous quartzite at L172W, 11+50N.

The origin of the Hill-Rust mineralization is not known, but is presumably similar to that at Faro and other lead-zinc deposits in the Anvil district.

XI. GEOPHYSICS

A. Airborne Magnetic and EM Survey

The Hill-Rust property was covered by helicopter airborne magnetic and EM survey by Lockwood Survey Corporation Ltd. in July 1966 with a mean flight line spacing of 1000 feet and a mean terrain clearance of 200 feet. The results were interpreted by W.G. Wahl, Geophysical Consultant, in a report dated March 20, 1967.

Two main anomalous areas were located. Anomaly 1 had a magnetic relief of 1480 gammas and dimensions of 3500 feet by 600 feet. A strong EM response was coincident with the eastern flank of the anomaly, which trends N15°W. Anomaly 2, located approximately between L172W, 20N and L188W, 40N, is a strong EM response and a weak parallel magnetic anomaly with northerly trend. Both anomalies were covered by ground EM, magnetic and I.P. surveys carried out by Huntec in late 1967. Anomaly 1 coincides with the olivine gabbro area shown on Fig. 3 and the ground surveys over Anomaly 2 did not confirm the airborne survey anomalies. It should be noted that Anomaly 2 lies on a proposed geologic fold which may join Gravity Anomaly A and Gravity Anomaly B.

Little additional information can be obtained from the airborne results. Several prominent magnetic anomalies located south of the Rust group have not been investigated in detail, but are assumed to be related to greenstone within the metasediment sequence. A weak or deeply buried magnetic anomaly, possibly discontinuous, appears to trend north-northwest from L116W, Base Line, to L204W, 45N. In the area of Gravity Anomaly A, the aeromagnetic pattern parallels the geologic structure and is relatively flat, with relief up to 50 gammas. The area south of the Hill and Rust claims to Rose Creek has relatively high conductivity, possibly because of graphite content in the phyllite believed to underlie this area.

B. Gravity Survey

1. General

A gravity survey covering 28.5 line miles was conducted over much of the Hill-Rust property by Overland Exploration Services Ltd. in June and July 1969. Readings were made with a Worden gravity meter at 100 foot stations on lines spaced 800 feet apart. Stations were surveyed and leveled and repeat readings were all within .05 milligals. All readings were adjusted for diurnal tidal drift, Bouguer free-air correction, latitude correction and terrain corrections. A density factor of .060 for a surface density of 2.65 was used in the interpretation. As will be discussed below, the surface density may in fact be greater than 2.65.

The gravity data was interpreted by Overland from the profiles of the survey lines. A regional gradient was determined, and the resulting anomalies shown on a residual gravity map. Model studies of positive anomalies which could be related to sulfide bodies and calculations of depth and magnitude assumed a density contrast of .9 between host rock and the anomaly source. Overland states that this contrast supports most of the calculations and that it can be construed that the source of most of the major anomalies is either dense sulfide bodies or extremely dense basic rock intrusions. As will be discussed, the latter could presumably apply to the very dense calc-silicate unit as well. A third possibility that the major anomalies could arise from extreme variation in overburden thickness is considered unlikely from the gravity pattern present and from observations of outcrop distribution.

Fifteen gravity anomalies, designated A to P, were located by the survey. Gravity Anomalies A and B are the largest and most interesting, although if some of the other smaller anomalies are interconnected or are extensions of A and B they could also be of interest.

Gravity Anomaly A (Fig. 3) extends from L116W, 3N to L164W, 21N, parallel to bedding, and has a maximum amplitude of 1.40 milligals and approximate dimensions of 4800 feet by 1000 feet. Overland states that with an assumed density of 3.5, the source is a large massive lense with a minimum depth of 200 feet on L132W. The main body of the source appears to be relatively flat-lying with southerly dip on the east and northerly dip on the west, with a possible westerly plunge. If the entire anomaly is due to a sulfide mass, then the source volume is in excess of 30 million tons.

Gravity Anomaly B (Fig. 3) extends from L100W, 63N to L148W, 65N, parallel to bedding and is described by Overland as possibly the most interesting anomaly in the area. It is defined by only 3 lines spaced 2400 feet apart and has a maximum amplitude of 1.06 milligals, but if it is continuous, it has the largest source mass. The source appears relatively shallow and Overland estimates its depth is less than 100 feet and possibly very near surface on L124W. The source appears to dip north, in contrast to the exposed bedrock which dips 30°S.

The Overland report concludes: "We feel that this prospect has the highest order of potential that can be found on a heavy ore gravity exploration program."

Some other features of the residual gravity map can be mentioned briefly, although detailed discussion must await further geologic mapping. It is possible that Anomaly A is only part of a very large discontinuous arc-shaped structure marked by a series of gravity anomalies extending from Anomaly G on the southeast, through A, westward through D and K and then southwest to L. Another possibility is that B was originally the eastern extension of A and has been displaced northward by a north-trending fault marked by small negative values at L116W, 15N and at L100W, 55N. The cause of the pronounced gravity low of -1.92 milligals at L164W, 6N is not known, as geologic mapping shows the area to be underlain by phyllitic quartzite and a quartz diorite sill with only a thin cover of overburden.

It is of interest that the Gravity Anomaly A source appears to "roll" from a south dip on the east to a north dip on the west, although all exposed rocks dip approximately 30°S. The sources of Gravity Anomalies B and C also dip north, although as far as known, all associated outcrops also dip approximately 30°S. This suggests either that the gravity anomaly source is not completely bedded or that the structure at depth is complex.

Detailed geologic mapping of the area of Gravity Anomaly A, and to a lesser extent, Gravity Anomaly B, has revealed the presence of the dense calc-silicate unit which undoubtedly makes some contribution to the gravity anomalies. The gravity data will be reinterpreted by Overland on the basis of this new information. The reinterpretation will, of course, be dependent on the distribution of the calc-silicate unit at depth, which can only be assumed without drilling.

2. Specific gravities

The specific gravities of a limited number of surface specimens were measured by Chemex Labs Ltd. and are listed below. Some of these specimens have been assayed and the results are given in Appendix B. All contain less than 1% combined lead-zinc, except L44 which contains .03% lead and 2.60% zinc, and L65 which contains 1.55% lead and .84% zinc.

Sample No.	Rock Type	Specific Gravity	
L33	quartz diorite porphyry	2.72	
L55	biotite feldspar porphyry	2.59	
L70	quartz diorite	2.68	
		2.66	average for intrusive rocks
L63	marble	2.75	"average" for marble
L 3	phyllitic quartzite	2.94	
L18	phyllitic quartzite	2.85	
L30	phyllitic quartzite	2.86	
		2.88	average for phyllitic quartzite
L 1	phyllite	2.91	
L62	phyllite (greenstone ?)	3.02	
L74	phyllite	2.98	
L90	phyllite (greenstone ?)	2.88	
		2.94	average for phyllite
L65	calcareous quartzite	3.32	
L28	" "	3.04	
L29	" "	3.05	
L50	" "	3.42	calc-sil.
L59	" "	3.30	=
		3.22	average for calcareous quartzite
L75	buff skarn	2.92	
L44	" "	3.28	
L45	" "	3.36	
L47	" "	3.57	
L52	" "	3.28	
L46	skarn	3.08	
L25	green-pink skarn	3.43	
L36	green-pink skarn	2.96	
		3.23	average for skarn

The limited specific gravity data suggests the following generalizations:

(1) Intrusive has the lowest specific gravity with an average of about 2.66
(2) The marble has a specific gravity of 2.75, based on only one determination.
(3) The phyllitic quartzite appears slightly less dense than the phyllite, with averages of 2.88 and 2.94 respectively. The specific gravities vary within limited but overlapping ranges.
(4) The calcareous quartzite and skarn specific gravities vary over a larger range and are essentially identical.

It should be noted that "normal" specific gravity is the 2.88 value obtained for phyllitic quartzite, rather than the 2.65 value assumed by Overland in the gravity interpretation. Also, the contrast between phyllitic quartzite and skarn (or calcareous quartzite) averages .35 but may be as great as .69. This contrast, however, is still less than the .9 contrast assumed in the gravity interpretation and suggests that the dense calc-silicate unit may not be the only source of the gravity anomalies. This new specific gravity data will be used by Overland in reinterpretation of the gravity survey.

C. Induced Polarization

Seigel Associates conducted an I. P. survey over Gravity Anomaly A from September 20 to 28, 1969. The results were interpreted in a report by Mr. Jon Baird dated October 31, 1969, and are summarized below.

Chargeability and resistivity profiles were run on L116W to L172W, which were originally cut for the gravity survey and are spaced 800 feet apart. The pole-dipole array was used, and each of the lines was profiled using electrode spacings of 200 and 400 feet and station intervals of 200 feet. Some lines were also covered with 100 and 800 foot electrode spacings. At L172W, 10N a Wenner expanding array test was carried out to determine the variation of chargeability and resistivity with depth, using electrode spacings from 10 feet to 1000 feet.

The survey revealed background chargeabilities from 3.0 to 9.0 milliseconds and relatively uniform resistivities both laterally and vertically with values between 500 and 1000 ohm-meters. With this background, a uniform distribution of 1% by volume of metallically conducting material would be expected to add about 6 milliseconds to the background level. It should be noted that the percentages of metallically conducting material given above are by volume and not weight per cent. Also, sphalerite is not a metallically conducting material and so will not affect the I. P. responses. In addition, if the metallically conducting grains are relatively large or well-connected, the I. P. response per percentage of sulfide may be less than normal.

Except for those profiles covered by 800 foot electrode spacing, the survey did not provide continuous lateral coverage between lines so the results are discussed separately for each line.

L116W has anomalous chargeabilities from 13S to 3N with a peak value of 44 milliseconds using 100 foot electrode spacing. The response could be caused by 7% by volume of metallically conducting material which may come to within 50 feet of surface near 8S.

L124W is anomalous from the base line to 18N and from 50N to 70N. The chargeability response increases with increasing electrode spacing and the best response is with an 800 foot electrode spacing, which suggests the source is at a depth of about 200 feet. The amplitude of the response is somewhat less than would be expected for bodies containing a high percentage of sulfides.

L132W is anomalous from 4N to 20N with a peak response of 30.0 milliseconds on the 200 foot electrode spacing, which indicates a source containing about 5% by volume of metallically conducting material.

L140W has a peak response of 30 milliseconds for the 800 foot electrode spacing but much lower responses for the 400, 200 and 100 foot electrode spacing separations. The bulk of the source appears to lie at a depth greater than 300 feet but some of the anomalous material may be within 50 feet of surface near 17N. The source could contain in excess of 10% by volume of metallically conducting material.

L148W has a pattern similar to L140 with lower amplitudes. The peak chargeability of 15.5 milliseconds was obtained using an 800 foot electrode spacing, which suggests a source depth greater than 300 feet. There is also a slight chargeability rise above background near 62N which may indicate a source containing 1% more by volume of metallically conducting material than surrounding rocks.

L156W, L164W, and L172W give only background chargeabilities for 200 and 400 foot electrode spacings.

The Wenner expander test at L172W, 10N shows no marked change in resistivity with depth, but a steady increase of chargeability amplitude with increasing electrode spacing. The peak chargeability of 11.5 milliseconds for the 1000 foot electrode spacing indicates the possibility of a high chargeability source occuring at depth in this area.

The I.P. results suggest a relatively flat-lying source, with a northerly dip on L116W and southerly dips on L132W and L140W. Since the highest chargeability responses occur for the short electrode spacings on the easternmost lines of the survey (L116W) and for the wide electrode spacings near the westerly anomalous lines (L148W), the anomalous source may be interpreted as plunging to the west and possibly increasing in metallically conducting content at depth to the west.

Mr. Baird concludes: "Since this anomaly has the I.P. characteristics expected of the lead-zinc ore bodies of the Faro area, and since the gravity survey indicates that the material causing the I.P. anomaly also has high specific gravity characteristics of these deposits, exploratory diamond drilling would appear to be warranted."

XII. GEOCHEMISTRY

Soil geochemistry is generally considered an excellent exploration method in the Anvil district and the Hill-Rust property was covered by a geochemical survey in 1967. The results were decidedly negative and Cathro concluded: "Considering the low geochemical response, the excellent sampling conditions, and the high mobility of ground water on the property, it seems very unlikely that significant mineralization exists within the upper 100' - 200'."

No geochemical surveys were made in 1969 but the previous results are reinterpreted below on the basis of present knowledge and a suggestion made as to why the survey did not detect the numerous lead-zinc showings discovered in 1969.

A large area, including almost all of the area covered in Fig. 3, was covered by a geochemical grid with 500 foot stations on lines spaced 1000 feet apart. Two grids, grids A and B, were covered in greater detail with stations spaced 200 feet on lines spaced 400 feet apart. Grid A covered the olivine gabbro area shown in Fig. 3 and grid B covered an area north of a line joining L148W, 30N and L180W, base line, including most of the lead-zinc showings. Soil samples were collected from the B horizon and analyzed for lead, zinc and copper by hot acid extraction.

The geochemical results on grid A, covering the olivine gabbro area, were not significant, as would now be expected. On grid B and on the large grid area, scattered high values were obtained but they form only an indistinct pattern.

On grid B the most anomalous area is at old station 4E, 6S (near L160W, 31N) where coincident values of 8300 ppm lead, 2325 ppm and 1250 ppm zinc, and 480 ppm copper are found. No lead-zinc mineralization was noted at this locality but two lead-zinc showings occur downslope within 400 feet. The very high lead and zinc geochemical values suggest strongly that some sphalerite and galena, probably mechanically derived, are present at this station, which is within or near the calc-silicate unit. No further information is obvious from the copper and lead geochemical results, but zinc values greater than 100 ppm generally mark the calc-silicate unit and indicate that it trends northwest over Gravity Anomaly A then turns and trends east over Gravity Anomaly B, as is suggested by the geological interpretation in Fig. 3.

On the large grid, lead results give a general background of about 30 ppm and there are no areas which could be considered anomalous. The copper results indicate only one small area which could be considered weakly anomalous. This area approximately coincides with Gravity Anomaly A and has copper values as high as 298 ppm with an average of about

55 ppm in a background of about 30 ppm. The zinc values do not form a distinct pattern but in general are weakly anomalous, with values up to 220 ppm, in the area of Gravity Anomaly B. A few values also occur downslope from Gravity Anomaly A.

Galena is apparently stable under surface conditions, as indicated by its fresh occurrence in weathered surfaces, and its transport is probably chiefly mechanical rather than chemical. A geochemical survey would therefore be expected to give only background values, with a few very high anomalous values where mechanically derived galena was present in the soil sample. This is, in fact, the pattern observed. Sphalerite apparently weathers readily as indicated by its absence in weathered surfaces. Because the mineralization occurs in a carbonate environment (the calc-silicate unit), zinc probably forms a carbonate ion complex, remains mobile and is quickly diluted away from its source.

In summary, the geochemical results, as previously interpreted, give little indication that numerous surface occurrences of lead-zinc are present. This is probably because the mineralization occurs in a carbonate environment.

XV. FUTURE EXPLORATION

Exploration of the Hill-Rust property in 1969 outlined an excellent exploration target, Gravity Anomaly A, and several secondary exploration targets which justify the recommended $100,000 exploration program for 1970.

The exploration program proposed below will allow a reasonable drill test of Gravity Anomaly A, a partial drill test of Gravity Anomaly B, and will also determine whether additional work is required on Gravity Anomalies C to P.

1. Five thousand feet of diamond drilling is recommended, including 4,000 feet in 6 holes to test Gravity Anomaly A and 1,000 feet in 2 holes to test Gravity Anomaly B, as listed below:

Proposed Hole	Location	Dip	Length	Purpose
J1	L132W, 13N	90°	500'	Test Gravity Anomaly A
J2	L140W, 10N	45°N	1000'	"
J3	L164W, 20N	90°	1000'	"
J4	L148W, 15N	90°	500'	"
J5	L156W, 20N	90°	500'	"
J6	L124W, 11N	90°	500'	"
J7	L148W, 66N	90°	500'	Test Gravity Anomaly B
J8	L124W, 65N	90°	500'	"
			5000'	

Most of the proposed holes are vertical because the gravity and I. P. results suggest a generally flat-lying source. Drill hole locations, attitudes and depths may be changed on the basis of earlier drill results. One Longyear Model 38 drill, or its equivalent, using BQ wireline equipment, should complete the program in three months.

This program should be considered a minimum test of Gravity Anomaly A because bodies with significant tonnages might be missed if some of the proposed drill holes are omitted, and only a preliminary test of Gravity Anomaly B. Examination of Gravity Anomalies C to P may indicate further drill targets.

2. Approximately one mile of bulldozer road should be constructed to provide tracked vehicle access to the property. This construction may be relatively difficult because of the permafrost conditions and swampy ground that will be encountered, but it is essential to avoid the very expensive alternative of helicopter support. Bulldozer trenching to bedrock should also be attempted in areas of interest, where practical. Such areas include the known lead-zinc occurrences and areas where the gravity or I. P. anomalies appear to have a shallow source, such as at L116W, 8S, L140W, 17N and L124W, 65N.

3. A tracked vehicle should be obtained for use in transporting supplies and personnel from the Anvil airstrip to the property.

4. Gravity Anomalies C to P should be examined in detail to determine if they warrant further work.

5. The existing grid should be covered with a magnetometer survey. This survey may show that magnetic anomalies are associated with the gravity and I. P. anomalies and should give some indication of rock type distribution and trends in areas of overburden.

6. The property should be geologically mapped at 1" = 400' and areas of interest should be mapped at 1" = 100'. Geologic mapping is necessary

to evaluate the numerous known gravity anomalies and it may also locate new lead-zinc occurrences.

Estimated Costs of Proposed 1970 Exploration Program

Diamond drilling (5000' @ $13/ft.)	$ 65,000
Payroll and supervision (4 months @ $2500)	10,000
Bulldozer (200 hours @ $30)	6,000
Tracked vehicle	6,000
Geologic mapping (4 months @ $1500)	6,000
Magnetometer survey (30 line miles @ $50)	1,500
Camp and supplies	5,500
	$ 100,000

Harold Linder, Ph.D., P.Eng.

APPENDIX A

LIST OF CLAIMS

Jacola Mines Limited

Claims	Grant Numbers	Record Date	Expiry Date
HILL 1 - 6	99509 - 99514	February 16, 1966	August 16, 1970
HILL 7 - 9	99515 - 99517	"	"
HILL 11	99519	"	"
HILL 13 - 18	99521 - 99526	"	"
HILL 19 - 24	99527 - 99532	"	"
HILL 25 - 29	99533 - 99537	"	August 16, 1971
HILL 30	99538	"	August 16, 1970
HILL 31	99539	"	August 16, 1971
HILL 32	99540	"	August 16, 1970
RUST 1 - 4	Y3441 - Y3444	March 21, 1966	September 21, 1970
RUST 17	Y3457	"	"
RUST 18	Y3458	"	September 21, 1971
RUST 19 - 22	Y3459 - Y3462	"	September 21, 1970
RUST 24	Y3464	"	"
RUST 34 - 38	Y3474 - Y3478	"	"

Hecla Operating Company and Hecla Mining Company of Canada Ltd.

Claims	Grant Numbers	Record Date	Expiry Date
FUBAR 1	Y20447	July 28, 1967	July 28, 1971
FUBAR 2	Y20448	"	July 28, 1972
FUBAR 3 - 4	Y20449 - Y20450	"	July 28, 1971
FUBAR 5	Y20451	"	July 28, 1972
FUBAR 7 - 8	Y20453 - Y20454	"	"
FUBAR 9	Y20463	"	"
FUBAR 10	Y20464	"	July 28, 1973
FUBAR 11 - 12	Y20465 - Y20466	"	July 28, 1972
FUBAR 23 - 26	Y20469 - Y20472	"	"
FUBAR 27 - 30	Y20473 - Y20476	"	"
FUBAR 31	Y20479	"	"
FUBAR 32 - 34	Y20480 - Y20482	"	"
FUBAR 35 - 36	Y20477 - Y20478	"	"
HECK 1 - 4	Y25554 - Y25557	July 30, 1968	July 30, 1971
HECK 5 - 6	Y25558 - Y25559	"	July 30, 1972
HECK 7 - 8	Y25560 - Y25561	"	July 30, 1971
HECK 9	Y25562	"	July 30, 1972
HECK 10 - 12	Y25563 - Y25565	"	July 30, 1971
HECK 13 - 16	Y25570 - Y25573	"	July 30, 1970
HECK 17 - 20	Y25574 - Y25577	"	July 30, 1971
HECK 21 - 22	Y25566 - Y25567	"	"
HECK 23	Y25568	"	July 30, 1970
HECK 24	Y25569	"	July 30, 1971

Hecla Operating Company
and
Hecla Mining Company of Canada Ltd.

Claims	Grant Numbers	Record Date	Expiry Date
DA 1 - 2	Y29769 - 29770	September 13, 1968	September 13, 1971
DA 3	Y29771	"	September 13, 1970
DA 4 - 7	Y29772 - Y29775	"	September 13, 1971
DA 8 - 13	Y29776 - Y29781	"	September 13, 1970
LA 30 - 32	Y29782 - Y29784	"	September 13, 1971
DEE 45 - 46	Y29785 - Y29786	"	September 13, 1970
HEC 1 - 15		January 9, 1970	January 9, 1971

Total: 128 claims.

CHEMEX LABS LTD.

1416 CROWN STREET
NORTH VANCOUVER, B.C.
CANADA
TELEPHONE: 988-6955

• CHEMISTS • GEOCHEMISTS • ANALYSTS • ASSAYERS

CERTIFICATE OF ANALYSIS

NO. 5306

INVOICE NO. 1668

DATE RECEIVED August 4/69

DATE ANALYSED August 4/69

TO: Hecla Mining Co. of Can. Ltd.,
Ste. 2009 - 1177 W. Hastings St.,
Vancouver, B. C.

ATTN:

SAMPLE NO.: L-01	% Copper	% Lead	% Zinc	Oz/Ton Gold	Oz/Ton Silver
Aug4/69	<0.01	3.00	2.10	<0.003	5.60

Certified by ....

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NORTH VANCOUVER, B.C.
CANADA
TELEPHONE: 988-6955

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CERTIFICATE OF ANALYSIS

NO. X 3353

TO: Hecla Mining Co. of Can. Ltd.
Board of Trade Tower,
Ste.2009 - 1177 W. Hastings St.,
Vancouver, B. C.

ATTN:

INVOICE NO. 1759

DATE RECEIVED

DATE ANALYSED

SAMPLE NO.: L-01	Aug 4/69
Antimony	ND
Arsenic	ND
Beryllium	ND
Bismuth	T
Cadmium	T
Cerium	ND
Columbium	ND
Chromium	ND
Cobalt	T
Copper	FT
Gallium	ND
Germanium	FT
Iron	M
Lead	M
Lithium	ND
Manganese	LM
Mercury	ND
Molybdenum	ND
Nickel	ND
Silver	TL
Tantalum	ND
Thorium	ND
Tin	ND
Titanium	T
Tungsten	ND
Uranium	ND
Vanadium	ND
Yttrium	ND
Zinc	M
Zirconium	T

Legend
Key to Symbols

H-10% plus   L-0.1-1%
MH-5-15%   TL-0.05-0.5%
M-1-10%   T-0.01=0.1%
LM-0.5-5%   FT-0.01% or less
ND- Not detected

Certified by ...

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NORTH VANCOUVER, B.C.
CANADA
TELEPHONE: 988-6955

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CERTIFICATE OF ANALYSIS

NO. 6236

INVOICE NO. 1967

TO: Hecla Mining Co. of Can. Ltd.,
#2009 1177 W. Hastings St.,
Vancouver, B.C.

DATE RECEIVED Sept. 4, 1969

DATE ANALYSED Sept. 11, 1969

ATTN: Mr. P. Conley, Mr. E. Linder

cc. Mr. McKinney, Stewart, B.C.

SAMPLE NO.:	% Copper	% Lead	% Zinc	oz./ton Silver	oz./ton Gold	Specific Gravity
31153 L47	0.01	0.01	0.30	0.06	0.003	3.57
31154 L44	<0.01	0.03	2.60	0.35	<0.003	3.28
31155 L59	<0.01	<0.01	0.67	0.02	<0.003	3.30
31156 L28	<0.01	<0.01	0.04	0.01	<0.003	3.04
31157 L36	<0.01	0.17	0.13	0.19	<0.003	2.96
31158 L29	<0.01	0.17	0.17	0.57	<0.003	3.05
31159 L25	<0.01	<0.01	<0.01	0.02	<0.003	3.43
31160 L52	<0.01	<0.01	0.01	0.01	<0.003	3.28
31161 L46	<0.01	<0.01	0.02	0.01	<0.003	3.08
31162 L45	<0.01	<0.01	<0.01	0.01	<0.003	3.36
31163 L50	<0.01	<0.01	<0.01	0.01	<0.003	3.42

Certified by [signature]

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NORTH VANCOUVER, B.C.
CANADA
TELEPHONE: 988-6955

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CERTIFICATE OF ANALYSIS

NO. X-R 3645

TO: Hecla Mining Co. of Can. Ltd.,
Board of Trade Tower,
#2009 - 1177 W. Hastings St.,
Vancouver, B. C.

INVOICE NO. 2083

DATE RECEIVED

DATE ANALYSED Sept. 26/69

ATTN: Mr. P. Conley

cc: Mr. J. E. McKinney, Stewart, B.C.

SAMPLE NO.:	#L47 31153	#L44 31154	#L59 31155	#L28 31156	#L36 31157	#L29 31158
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND
Bismuth	ND	ND	ND	ND	ND	ND
Cadmium	ND	T	ND	ND	ND	ND
Cerium	ND	ND	ND	ND	ND	ND
Columbium	ND	ND	ND	ND	ND	ND
Chromium	ND	ND	ND	ND	ND	ND
Cobalt	ND	ND	ND	ND	ND	ND
Copper	FT	FT	FT	FT	FT	FT
Gallium	ND	ND	ND	ND	ND	FT
Germanium	ND	ND	ND	ND	ND	ND
Iron	MH	MH	M	M	M	M
Lead	FT	T	ND	ND	TL	TL
Lithium	ND	ND	ND	ND	ND	ND
Manganese	TL	L	TL	TL	TL	TL
Mercury	ND	ND	ND	ND	ND	ND
Molybdenum	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND
Silver	ND	FT	ND	ND	FT	FT
Tantalum	ND	ND	ND	ND	ND	ND
Thorium	ND	ND	ND	ND	ND	ND
Tin	ND	ND	ND	ND	ND	ND
Titanium	L	L	TL	TL	L	L
Tungsten	ND	ND	ND	ND	ND	ND
Uranium	ND	ND	ND	ND	ND	ND
Vanadium	FT	FT	FT	FT	FT	FT
Yttrium	ND	ND	ND	ND	ND	ND
Zinc	TL	LM	TL	T	T	TL
Zirconium	ND	FT	ND	ND	ND	ND

Key to Symbols

H- 10% plus L - 0.1-1%
MH - 5-15% TL - 0.05-0.5%
M - 1-10% T - 0.01-0.1%
LM - 0.5-5% FT - 0.01% or less
ND - Not detected

Certified by [signature]

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NORTH VANCOUVER, B.C.
CANADA
TELEPHONE: 988-6955

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CERTIFICATE OF ANALYSIS

NO. X-R 364

TO: Hecla Mining Co. of Can. Ltd.,
Baoard of Trade Tower,
Ste. #2009 - 1177 W.Hastings St.,
Vancouver, B.C.

INVOICE NO. 2083

DATE RECEIVED

DATE ANALYSED Sept. 26/69

ATTN: Mr. P. Conley

cc: Mr. J. E. McKinney, Stewart, B. C.

SAMPLE NO.:	#L25 31159	#L52 31160	#L46 31161	#L45 31162	#L50 31163
Antimony	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND
Bismuth	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND
Cerium	ND	ND	ND	ND	ND
Columbium	ND	ND	ND	ND	ND
Chromium	ND	ND	ND	ND	ND
Cobalt	ND	ND	ND	ND	ND
Copper	FT	FT	FT	FT	FT
Gallium	FT	ND	ND	FT	FT
Germanium	ND	ND	ND	ND	ND
Iron	M	M	M	M	MH
Lead	FT	ND	ND	FT	FT
Lithium	ND	ND	ND	ND	ND
Manganese	L	L	L	TL	TL
Mercury	ND	ND	ND	ND	ND
Molybdenum	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	FT	ND
Silver	ND	ND	ND	ND	ND
Tantalum	ND	ND	ND	ND	ND
Thorium	ND	ND	ND	ND	ND
Tin	ND	ND	ND	ND	ND
Titanium	L	L	TL	TL	TL
Tungsten	ND	ND	ND	ND	ND
Uranium	ND	ND	ND	ND	ND
Vanadium	FT	T	FT	FT	FT
Yttrium	ND	ND	ND	ND	ND
Zinc	T	T	T	T	T
Zirconium	ND	ND	ND	ND	ND

Key to Symbols

H - 10% plus   L - 0.1-1%
MH - 5-15%   TL - 0.05-0.5%
M - 1-10%   T - 0.01-0.1%
LM - 0.5-5%   FT - 0.01% or less
ND - Not detected

Certified by [signature]

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CANADA
TELEPHONE: 988-6955

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CERTIFICATE OF ANALYSIS

NO. X-R 3645

INVOICE NO. 2083

DATE RECEIVED Sept.

DATE ANALYSED Sept. 26/69

TO: Hecla Mining Co. of Can. Ltd.,
Board of Trade Tower,
Ste. 2009 - 1177 W. Hastings St.,
Vancouver, B. C.

ATTN: Mr. P. Conley

cc: Mr. J.E.McKinney, Stewart, B. C.

SAMPLE NO.:	% Barium
31153 L47	Trace
31154 L44	Nil
31155 L59	Nil
31156 L28	0.03
31157 L36	Trace
31158 L29	Trace
31159 L25	Trace
31160 L52	Trace
31161 L46	Nil
31162 L45	Nil
31163 L50	Nil

Certified by [signature]

C.:EMEX LABS LT:D.

1416 CROWN STREET — NORTH VANCOUVER, B.C. — TELEPHONE 988-6955

Hill-Rest

H. L.

Certificate of Analysis

No. 6834

To: Hecla Mining Co. of Can. Ltd.,
Board of Trade Tower,
Ste. 2009 - 1177 W. Hastings St.
Vancouver, B. C.

Atten.: Mr. P. Conley

Invoice No. 2129

SAMPLE No.	% Lead	% Zinc	Oz/Ton Silver
L-65	1.55	0.84	1.75

Date Received Oct. 2/69

Date Analysed Oct. 6/69

CERTIFIED BY [signature]