John Brock

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Casino, Yukon - A Geochemical Discovery of An Unglaciated Arizona-Type Porphyry

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With Al's complements
AA.

Introduction

The first copper-molybdenum porphyry discovery in Yukon is being developed on Casino Silver Mines Ltd. property by Brameda Resources Ltd. The property is situated in the Dawson Range, 187 air miles northwest of Whitehorse near the eastern margin of the Coast Intrusives. The existence of a significant porphyry deposit in the Casino area was first inferred from gross geochemical indicators (gold-tungsten placer, leached capping and transported gossan, and peripheral silver-lead veins) in conjunction with an appreciation of the geomorphological history. The specific location of the deposit was determined by stream sediment sampling followed by grid soil sampling and geological mapping.

This paper illustrates how geochemistry led to the discovery and is intended to be an exploration case history rather than a scientific study. The Casino porphyry is of particular interest because of its close resemblance to Arizona deposits, and its unusual location in an area of partial permafrost within an unglaciated environment, that is almost completely uncontaminated by human activity. The authors believe that the process of secondary enrichment was active in recent times and postulate a unique condition for its formation.

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History

The Dawson Range was first prospected during the Klondike Gold Rush and most subsequent lode discoveries were made by placer miners. The first lode claims in the Casino area are believed to have been staked in 1901, possibly for gold, but records of this early work are obscure. The first placer claims were staked on Canadian Creek in 1911 and were examined in 1916 by D.D. Cairnes (1917) of the Geological Survey of Canada (G.S.C.). He noted the presence of ferberite in the placer and recognized the intense leaching and alteration of the Casino Stock, which he postulated as being the source of the gold and tungsten. Studies of the tungsten potential were made for the G.S.C. by A.R. Allen in 1940 (Bostock, 1941) and by H.S. Bostock in 1941 (1959). The gold and tungsten placer was further investigated by Canadian Tungsten and Hollinger Exploration in 1941, by Bralorne and Yuba Consolidated Gold Fields in 1942, and by Tecumseh Petroleums in 1953. The presence of molybdenite in the placer was noted in 1941. The dredging potential was further studied in 1962 by C.D.N. Taylor (private reports) for Nordex Exploration (Bostock, 1959).

Placer miner J. Meloy discovered galena veins near the headwaters of Casino Creek in the late 1930's and staked them in 1947. The first recorded lode exploration was by Rio Tinto

Canadian Exploration and Yukon Consolidated Gold Corporation in 1963 and by Casino Silver Mines Ltd. from 1964 to 1967 (Green and Godwin, 1964; Green, 1965 and 1966; Findlay, 1967). The exploration of the property entered a new phase in 1968 when control of Casino Silver Mines was acquired by the Brynelsen Group. Subsequent work, carried out by Archer, Cathro and Associates Ltd., under the direction of L.S. Trenholme, was turned toward the Casino Stock rather than the peripheral vein mineralization and led to the discovery of the porphyry deposit by drilling in June 1969.

Some seventy years of prospecting were required to discover the porphyry deposit, in spite of its size and prominent topographic position. This was due primarily to the ineffectiveness of conventional prospecting through the extensive residual till, and partially to changing economics. The unglaciated environment is, however, ideally suited for geochemical exploration which permitted easy definition of the Casino deposit for drill sampling. Among the first to recognize the potential of the Dawson Range was H.S. Bostock (1955) who predicted:

> The distribution of lode deposits made during the last few years suggests that the unglaciated region, lying north and west of Carmacks is being neglected ------ geochemistry has given prospectors a new tool that is usable nearly everywhere and may be the answer to the difficulties of hunting for lode deposits in the unglaciated region.

Among the earliest workers to apply geochemistry to the region were J.A. Coope (1966), J.R. Woodcock, and geologists with Canex Aerial Exploration Ltd. The porphyry copper potential of the Casino property was probably first recognized by Rio Tinto geologist W.B. Hester in 1963, and independently by H. Grant Harper in June 1967 and A.R. Archer in September 1967.

Geological Setting

Regional

The Casino property lies in the Dawson Range, a northwest trending belt of gentle summits of moderate elevation within the Yukon Plateau. The Yukon Plateau is an area of peneplanation and erosional maturity about 4000 feet in elevation lying between the walls of the St. Elias Mountains to the southwest and the Ogilvie Mountains to the northeast. Most of the western Yukon Plateau escaped glaciation during the Pleistocene and drainage is characterized by V-shaped valleys and an absence of lakes. The climate in recent times has been both cold and arid. Mean annual temperature is in the range of 21° to 24°F and annual precipitation is between 8 and 14 inches, of which half falls as snow. Much of the region is thinly permafrost covered. Vegetation consists of spruce thickets, willow and dwarf birch and alder to timberline at 4500 feet. Thick buckbrush extends from valley floors to well above timberline.

The property is situated along the northeast margin of the Klotassin Batholith, which defines the northeast side of the Coast Range Batholith. Potassium-argon dating of the Klotassin Batholith has given ages of 95 and 99 m.y. (Findlay, 1967, page 40) or upper Cretaceous. Its composition is usually medium-grained quartz monzonite or granodiorite. It intrudes the Yukon Group, a metasedimentary sequence of schist, gneiss, amphibolite, quartzite with minor limestone and conglomerate. The Yukon Group forms the base of the stratigraphic sequence in much of the Yukon and is considered to be Cambrian or older. The Klotassin Batholith and Yukon Group are intruded by a number of younger quartz rich stocks with which most mineralization is probably related.

All soils in the unglaciated portion of the Dawson Range are residual. Thickness varies according to slope and rarely exceeds three feet on hill tops and 20 feet on lower slopes. The upper soil layers are often poorly drained and water saturated during the summer due to impermeable, frozen sub-soil. Frost boiling and heaving, contrary to popular belief, does not result in appreciable intermixing of soil horizons. The most marked effect of permafrost is to greatly accelerate solifluction through downhill flowage of the water-saturated, upper soil layers. A typical soil section in the Dawson Range is three to twelve inches of poorly decomposed organic material or peat overlying a poorly developed light brown soil from a few inches to several feet in thickness, which, in turn, overlies frost-broken bedrock detritus from several feet to several tens of feet thick. The contact between the soil and the bedrock detritus is gradational. The pH usually ranges from 5 to 6.5. Recent volcanic ash that overlies much of the soil in southern Yukon does not extend as far north as Casino.

Property

The major part of the Casino property is underlain by granodiorite of the Klotassin Batholith. Several small, highly altered roof pendants of Yukon Group quartzite are found near the headwaters of Canadian Creek. Mineralization is associated with the Casino Stock which has been potassium-argon dated at 70 m.y., or early Tertiary, at the University of British Columbia (C.I. Godwin, personal communication). The stock has been intensely hydrothermally altered and this alteration extends at least 2000 feet into the surrounding granodiorite. The pattern shows classical porphyry copper zoning with a central core of K-feldspar and biotite alteration surrounded successively by argillic, quartz-sericite-pyrite and chloritic zones. The geology of the Casino Stock is shown on figure 1. The stock is about 2000 feet wide and 5000 feet long with the long axis trending west. The eastern half is largely coarse breccia with a quartz porphyry matrix and the western half is mainly feldspar porphyry. A quartz diorite phase of the Klotassin Batholith is found as a rim about 1000 feet wide on the northern side of the stock.

The Casino Stock has resisted erosion and forms a distinct prominence, Patton Hill, on the divide between Casino and Canadian Creeks (figure 2). True outcrop is almost completely absent and all mapping is from bedrock float or diamond drill core. The summit of Patton Hill is bare and vegetation on the lower slopes and in the upper Casino Creek and Canadian Creek valleys consists largely of buckbrush and moss with alder and dwarf birch and the occasional spruce thicket. A typical soil section on the slope of Patton Hill is shown on figure 3. Here, there are two inches of organic debris and moss overlying three inches of dark brown poorly decomposed organic material which overlies five inches of yellow-brown coarsely textured soil with clay grading over a further three inches to well drained bedrock fragments of undetermined depth. Soil sections closer to Canadian and Casino Creeks are similar except for an increasing thickness of the A and B horizon and a decreasing coarseness of the C horizon. All of the northern slopes are permanently frozen but southern slopes contain occasional unfrozen windows. Permafrost thickness is probably less than 50 feet.

Leaching and Mineralization

The entire Casino Stock and portions of the surrounding Klotassin Batholith have been leached to depths varying from 30 feet at Casino Creek to 350 feet at the top to Patton Hill. The leached capping over the breccia portion of the Casino Stock is grey-white and porous with brown limonite and yellow jarosite staining that produces an overall faint brown to tan gossan. The leached feldspar porphyry is darker and less porous. Malachite and occasionally azurite can very rarely be found coating fractures on leached fragments. No chalcopyrite, molybdenite or molybdenum oxides have been recognized on surface. Pyrite can sometimes be found when fragments of feldspar porphyry are broken. Drilling indicates that 50% to 70% of the copper has been removed from the leached zone and the remaining copper is largely in oxide form. The MoS_2 content of the leached zone is reduced about 70% but the molybdenum oxide content has not yet been determined and the actual depletion of molybdenum is unknown. The gold and silver content is not noticeably affected by leaching. Tungsten has rarely been detected in any of the holes drilled to date.

A zone of secondary copper enrichment between 100 and 300 feet thick lies below the leached capping. This enrichment is due to replacement of chalcopyrite and pyrite by chalcocite. Copper grades are improved approximately 100% over protore grade.

The main sulfide minerals in the protore are chalcopyrite, molybdenite and pyrite. The pyrite-chalcopyrite ratio is about 3. Holes drilled below the secondary enrichment have suggested mineralogical zoning with a slight decrease in copper and an increase in molybdenum with depth. The outline of mineralization in bedrock shown on the figures is the average grade of the secondary enriched zone. Copper and molybdenum values in bedrock have an abrupt cut-off on the south side of the Casino Stock but are gradational into the Klotassin Batholith in all other directions. Pyrite, besides being the major accessory mineral in the Casino Stock, is found in quantities from 1 to 2% in the surrounding Klotassin Batholith. This pyrite halo extends at least several thousand feet away from the Casino Stock in all directions. Other minor accessory minerals are magnetite, hematite, gypsum and tourmaline, and very rarely, fluorite, zeolites, galena and sphalerite.

The silver-lead veins are found in the Klotassin Batholith south of the Casino Stock. The best area of veining, which was explored underground in 1966, lies one mile south of the breccia portion of the Casino Stock. Several narrow silver-lead veins were explored on surface near the junction of Taylor and Casino Creeks. No vein silver-lead mineralization has been found in the Casino Stock. The main constituents of the veins are sphalerite and argentiferous galena with minor chalcopyrite and pyrite in a gangue of quartz and minor barite. The silver to lead ratio is usually between 1 and 2. The vein faults are strong and continuous but mineralization is too erratic in distribution to allow commercial development.

The gold-tungsten placer workings are confined to Canadian Creek and Patton Creek near their junction. The gold is sharp and is mostly fine and powdery but is occasionally present in wire and leaf form. Several nuggets up to 1/4 inch long were recovered in the early years. Fineness ranges from 860 to 900. Tungsten occurs as ferberite in mineral grains which are generally less than minus 10 mesh in size. Test work by Canadian Tungsten indicated a grade of 0.66 pounds of ferberite per cubic yard, or a little less than 150 parts per million (ppm) tungsten. Other very minor constituents of the placer are scheelite, molybdenite, zircon, cassiterite and tourmaline.

A ground water spring in Taylor Creek, just above its junction with Lyman Creek, is depositing a prominent limonite gossan in Taylor Creek downstream to its junction with Casino Creek, a length of 2400 feet. A light gossan can be seen coating pebbles in Casino Creek for a further several hundred feet downstream. None of the other streams in the area are precipitating limonite.

Geochemical Exploration

General

Patton Hill was soil sampled on 400 foot centres by Archer, Cathro and Associates Ltd. in August 1968. These samples were analyzed for copper, molybdenum, lead and tungsten in order to test geochemical characteristics of the soil and to locate specific areas of interest for diamond drilling. The presence of a porphyry deposit on Patton Hill was indicated by (a) intense hydrothermal alteration and the presence of limonite, jarosite, and very weak malachite staining in the leached surface rock, (b) the gold-tungsten placer which contained minor molybdenite, (c) weak pyritization in old drill holes exploring for silver-lead veins in the nearby Klotassin Batholith, (d) the transported gossan forming in Taylor Creek, (e) peripheral silver-lead veining and most important (f) extremely anomalous copper values in stream sediments that had been obtained from Casino Creek in 1966 by the previous operators. It was also recognized that the surface rocks were intensely weathered due to the lack of glaciation and that a zone of secondary enrichment might be present. In 1969, diamond drilling of the copper-molybdenum soil anomaly confirmed that ore-grade values were present below the leached capping. Additional geochemical work in 1969 included reassaying of 1968 soil samples for gold and silver; water sampling for copper; silt sampling for copper, molybdenum, lead, silver, gold and tungsten; and extension of the 1968 soil sampling grid for copper and molybdenum.

Soil and silt samples were collected in Kraft bags and dried in the field at room temperature. Analyses was done at a commercial laboratory where samples were reduced by screening to -80 mesh. Analyses for copper, molybdenum, lead, gold and silver were obtained by atomic absorption spectrometry of a hot aqua regia digestion. Aluminum chloride was added to facilitate detection of molybdenum and gold was determined after extraction with MIBK. Analyses for tungsten was colorimetric involving Tri-N-Butyl phosphate - CCl_4 solvent and a KSCN-$SnCl_2$ complexing reagent. Water samples were collected in 250 ml plastic bottles that were field cleaned with dilute hydrochloric acid. The copper content was determined by atomic absorption spectrometry of a hydrochloric acid extraction of an evaporated residue.

Threshhold ranges in the unglaciated portions of the Dawson Range, expressed in parts per million, are tabulated as follows:

	Cu	Mo	Pb	Ag	Au	W
Water	.025	.004	no data	no data	no data	no data
Silt	30- 50	2- 4	30- 50	1-2	.150	4- 5
Soil	50-100	5-10	50-100	1-2	.200	5-10

Threshholds for silts, and soils are derived from extensive regional data collected by the authors over a period of several years. Threshhold data for water has been provided by R.F. Horsnail of Amax Exploration.

Stream Sediment and Water Sampling

Stream sediment (silt) and water samples were collected in late August 1969 during a period of lower than average run-off. As the porphyry deposit had already been outlined by soil sampling and confirmed by several drill holes the stream sampling was done to study geochemical dispersion patterns rather than for exploration. Copper values in silt and water are shown on figure 4, molybdenum values in silt on figure 5 and silver and gold values in silt on figure 6. Silt analyses for tungsten and lead are not illustrated as most values are below threshhold. Canadian Creek which flows in a north-facing, permanently frozen valley has a pH ranging from 6.5 to 7.0, and is largely derived from surface runoff. The headwater of Casino Creek, which drains a south-facing valley, is more acidic due to introduction of ground water through windows in the permafrost. Water at the head of Taylor Creek has a pH of 5, whereas the spring in Taylor Creek, just above its junction with Lyman Creek, has a pH of only 2.6.

Copper is moderately anomalous in silts from Canadian Creek up to and including Patton Creek but is below threshhold in the water. A silt sample from the mouth of Canadian Creek (about 8 miles below the Patton Creek junction) assayed 104 ppm. Copper in the more acidic Casino Creek drainage is strongly anomalous both in silt and water. In fact, tin cans placed in the spring in Taylor Creek are rapidly replaced by copper. A silt sample three miles below the Taylor Creek junction (the furthest downstream sample taken from Casino Creek) assayed 440 ppm.

Molybdenum is strongly anomalous in silts from both Patton and Casino Creeks but decreases fairly rapidly downstream in both drainages to about twice threshhold. Silt from the mouth of Canadian Creek assayed 8 ppm and from three miles below Taylor Creek on Casino Creek assayed 6 ppm. The very acidic spring water in Taylor Creek appears to depress molybdenum values in the silts.

Gold and silver are weakly anomalous only more or less within the limits of bedrock mineralization. Acidity of the waters is not an obvious controlling factor. Silver is anomalous in Casino Creek below Lyman Creek because of silver-lead vein mineralization. Lead is below threshhold in silts within the area of the figures but becomes highly anomalous in Casino Creek below Lyman Creek due to silver-lead vein mineralization.

Soil Sampling

Soil samples were obtained by digging a 6 to 18 inch pit with a mattock to expose a suitable clay soil beneath the A horizon. Samples from slopes steeper than 5 degrees tend to be from a mixed B and C horizon while those from flatter slopes are usually from the upper portion of the B horizon. Figure 3 illustrates a typical soil section on a 10 degree slope. As can be seen, copper has no variation between the B and C horizons while molybdenum and lead are about 50% lower in the B horizon. Silver and gold are slightly below threshhold in the B horizon but are strongly anomalous in the B plus C horizon. Tungsten does not vary between the B and C horizons but shows a surprising and unexplained increase in the A_1 horizon. The pH of the soil at Casino is typical of most Yukon residual soils, ranging from 5 to 6.5. Figures 7 to 10 show the soil response for copper, molybdenum, silver and gold respectively. The assay range and number of samples shown in the left lower corner of the maps includes a few samples from beyond the map boundary. The soil response for lead and tungsten has not been illustrated in plan because neither metal shows a well defined pattern. Log normal profiles for all metals along a common section are shown on figures 11 to 13. This particular section line has been chosen because the east side of Patton Hill is the only area where soil movement downhill from the deposit does not terminate on creeks.

Both copper and molybdenum show a surprisingly similar pattern. Above threshhold response is closely related to bedrock mineralization and seems even to reflect the sharp cut-off of bedrock mineralization to the south and the more gradational cut-off to the north. The eastern portion of the profile indicates that neither metal has carried much beyond the boundary of mineralization on a 10 degree slope. Solifluction down this slope is rapid and it is obvious that both metals are leaching from the upper soil horizons about as fast as the soil is creeping downhill. The sharp cut-off to the west is due to the change of slope at Canadian Creek. The soil anomaly for copper and molybdenum on the western side of figures 7 and 8 has been explored by two drill holes that indicate it is caused by a weakly mineralized roof pendant of Yukon Group quartzite.

Both gold and silver are anomalous over the Casino Stock where sampling was from a B plus C horizon. As shown by the soil profile (figure 12) the values for both metals fall below threshhold where the slope flattens and a B horizon was sampled. This effect is also well illustrated by the soil section in figure 3. Silver and, to a lesser extent, gold exceed threshhold values in the Klotassin Batholith south of the Casino Stock. This may be related to the silver-lead veins that are found in this direction.

The lead response (figure 13) has a typical background pattern over the Casino Stock. Three above threshhold values near Casino Creek are due to silver-lead veining. In this environment, a vein of galena 6 inches in width on a 10 degree slope with good continuity of mineralization along strike, would be expected to show above threshhold values at least 2000 feet downslope and strongly anomalous values up to 1000 feet downslope (Archer, 1967).

Tungsten in the soil exhibits an erratic distribution with above threshhold values generally more common over the Casino Stock.

Comments

Copper and molybdenum are both excellent regional indicators in stream sediments at Casino and are found in above threshhold quantities many miles from the source. A regional survey with a density of one sample per 10 square miles would have been more than adequate for locating the area of interest. Silver and lead can be used regionally to locate areas of silver-lead veining that might be peripheral to porphyry deposits.

Copper and molybdenum response in soils is more or less proportional to underlying bedrock mineralization and neither is widely dispersed, even where solifluction is rapid. Silver and gold may be useful indicators but care must be taken to sample below the B horizon.

Permafrost does not appear to have an appreciable effect in the soil response for the metals used. However, it does have the effect of directing copper-rich spring waters to unfrozen windows on south slope drainage. The present water table appears (on the basis of scanty drill hole evidence) to generally coincide with the top of the secondary enriched zone except at the summit of Patton Hill where it is about 200 feet lower. It is possible that the spring on Taylor Creek has only broken through the permafrost in relatively recent times and is responsible for this drop. This premise is partially confirmed by the fact that the size of gossan along Taylor Creek is not large compared with the present rate of gossan formation. It seems likely that permafrost has provided a barrier to ground water movement out of Patton Hill and that the extremely acid, metal-rich water has remained relatively static over a long period of time, enabling the process of secondary enrichment to take place. Such a long period of cold, dry weathering is substantiated by the lack of soil development in the Dawson Range even though the area exhibits erosional maturity.

Acknowledgements

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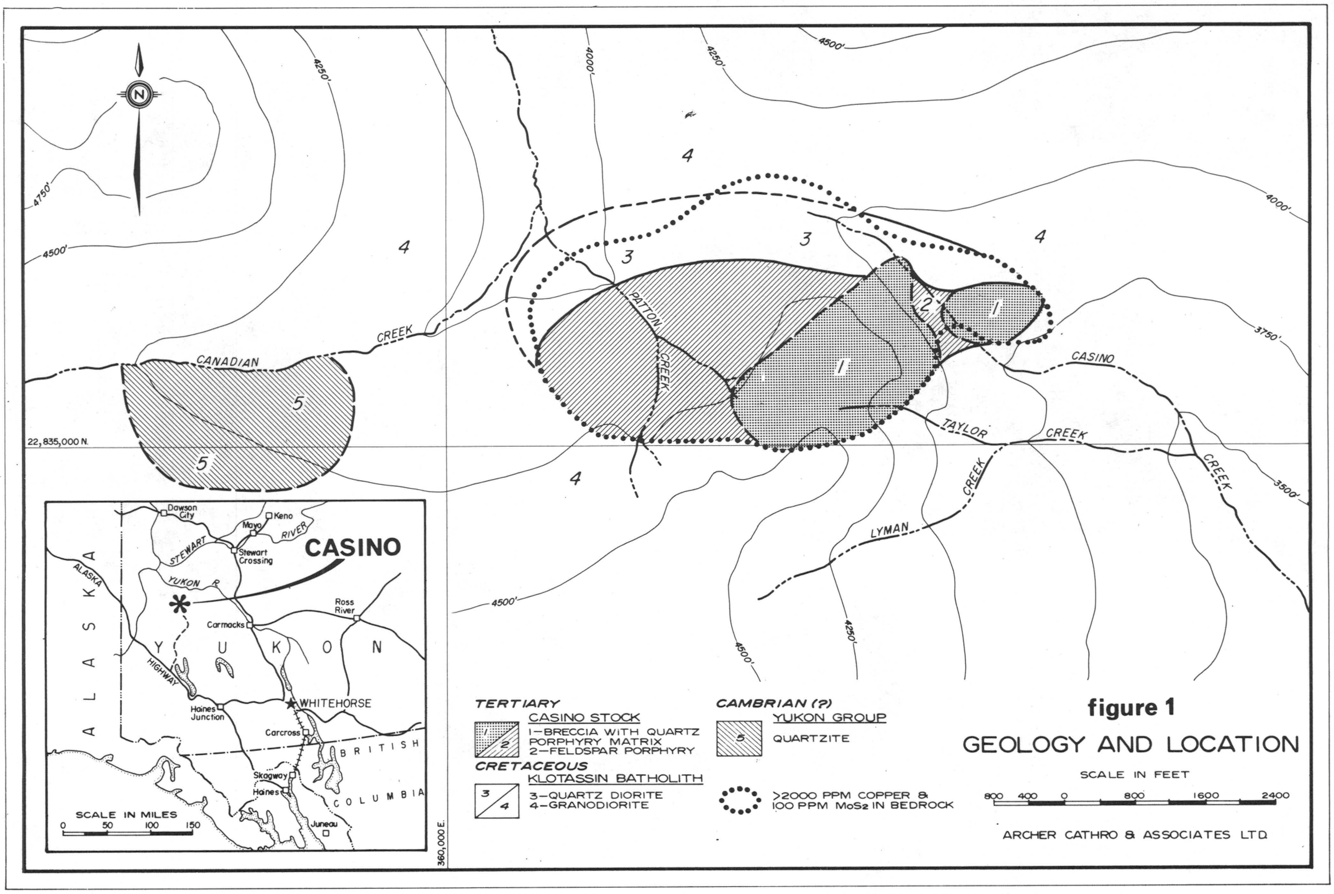
4750'
4500'
4250'
4000'
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4000'
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4250'
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4
3
3
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5
1
1
2
CANADIAN
CREEK
PATTON
CREEK
CASINO
TAYLOR
CREEK
CREEK
LYMAN
CREEK
22,835,000 N.
360,000 E.
Dawson City
Keno
Mayo
STEWART
RIVER
Stewart Crossing
CASINO
YUKON R.
Ross River
Carmacks
ALASKA
Y U K O N
HIGHWAY
Haines Junction
WHITEHORSE
Carcross
BRITISH
COLUMBIA
Skagway
Haines
Juneau
SCALE IN MILES
0 50 100 150
TERTIARY
CASINO STOCK
1—BRECCIA WITH QUARTZ PORPHYRY MATRIX
2—FELDSPAR PORPHYRY
CRETACEOUS
KLOTASSIN BATHOLITH
3—QUARTZ DIORITE
4—GRANODIORITE
CAMBRIAN (?)
YUKON GROUP
QUARTZITE
>2000 PPM COPPER & 100 PPM MoS2 IN BEDROCK
figure 1
GEOLOGY AND LOCATION
SCALE IN FEET
800 400 0 800 1600 2400
ARCHER CATHRO & ASSOCIATES LTD.

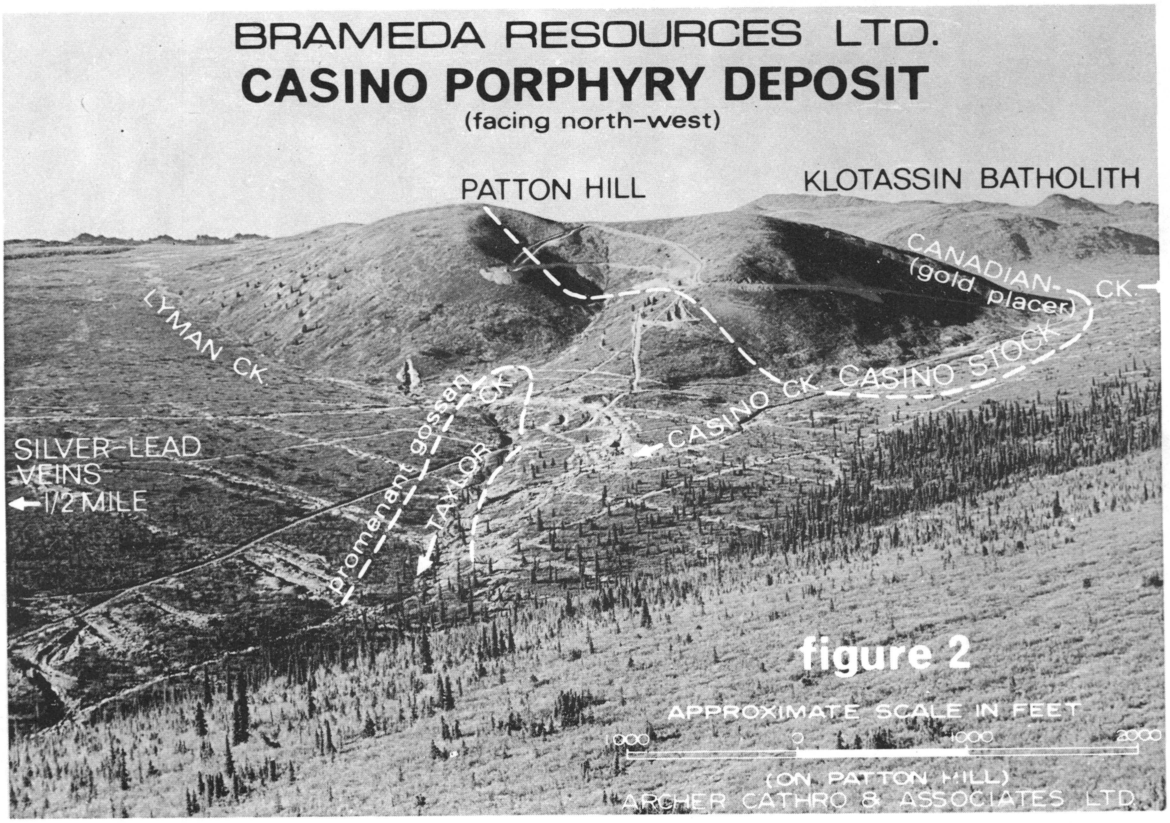

BRAMEDA RESOURCES LTD.
CASINO PORPHYRY DEPOSIT
(facing north-west)
PATTON HILL
KLOTASSIN BATHOLITH
CANADIAN
(gold placer)
CK.
LYMAN CK.
CASINO STOCK
CASINO CK.
SILVER-LEAD VEINS
1/2 MILE
promenant gossen
TAYLOR CK.
figure 2
APPROXIMATE SCALE IN FEET
1000 0 1000 2000
(ON PATTON HILL)
ARCHER CATHRO & ASSOCIATES LTD.

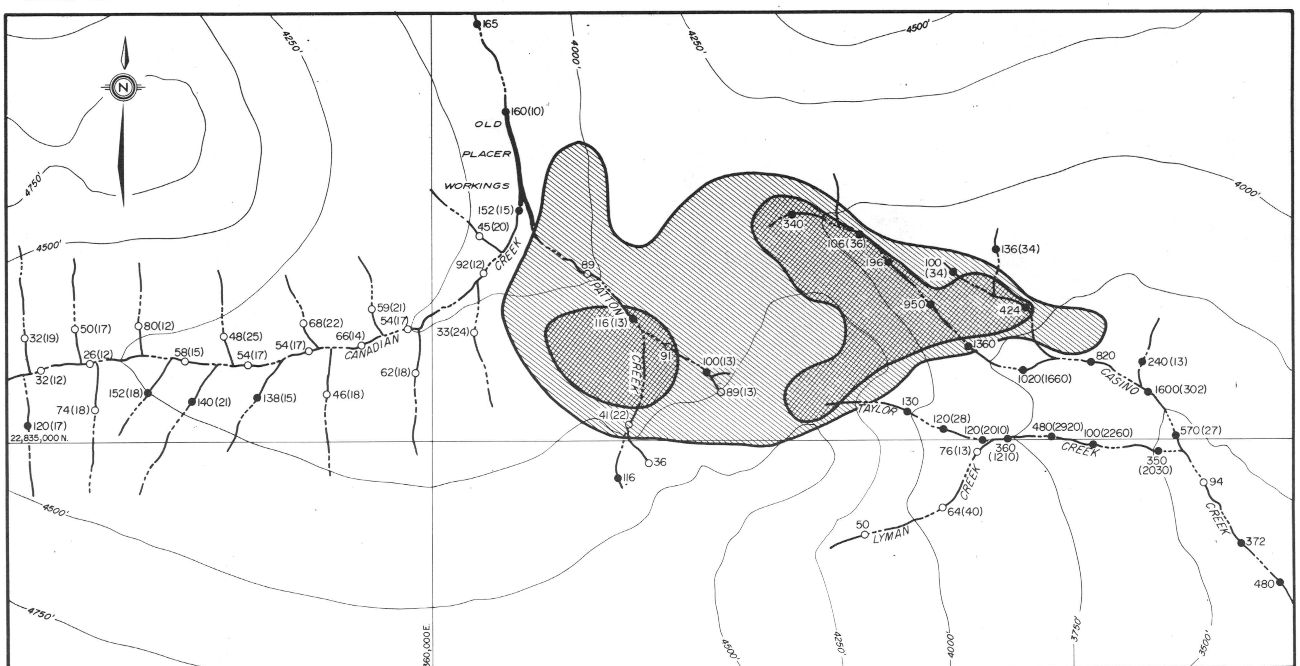
figure 3

SECTION LOCATION 22,837,000 N., 363,500 E.
SLOPE 10°

TYPICAL SOIL SECTION–PATTON HILL

Horizon	Thickness 10° Slope	Copper	Moly-bdenum	Silver	Gold	Lead	Tungsten	Character	Horizon thickness on shallow slopes
Ao	2"	no sample						Grass clumps moss, black humus	10"—24"
A1	3"	212	8	1.98	.105	18	10	Brown organic debris, roots, some clay	6"—8"
B	5"	415	26	1.98	.140	25	4	Light to dark brown clay soil, some rusty lenses	18"—36"
B + C	3"	365	40	4.29	.420	66	4	Clay soil with "C" rock fragments mixed inhomogeneously	12"—24"
C	–	405	38	3.80	.350	50	4	Rock fragments rarely more than 3" across, often well washed	
	Average Total: 1 Foot	Parts per million							Average Total: 8 Feet

THE GEOCHEMICAL RESPONSE CHANGES ONLY SLIGHTLY WITH SLOPE ANGLE



THE DAWSON RANGE HAS A REGIONAL THRESHOLD OF 30–50 PPM COPPER IN SILTS AND 25 PPB IN WATER

○ COPPER ASSAY IN PPM–SILT (PPB–WATER)

● ANOMALOUS SAMPLES (100 PPM Cu. IN SILT)

>4000 PPM Cu IN BEDROCK

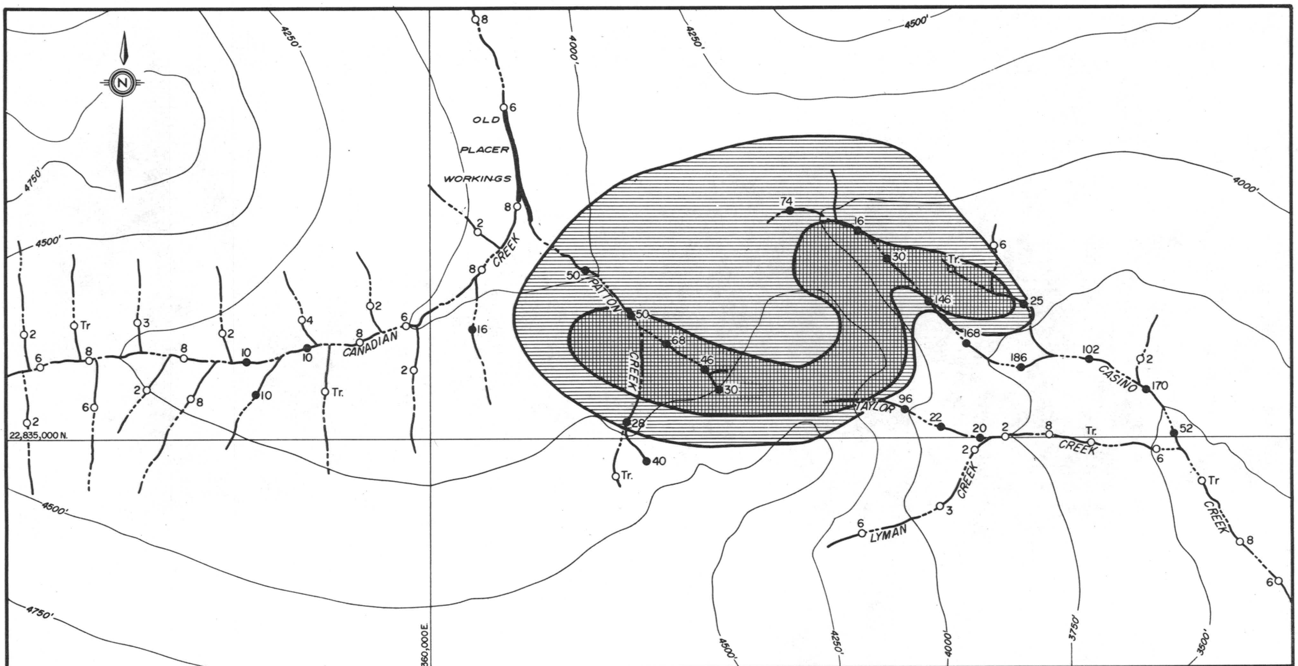
>2000 PPM Cu IN BEDROCK

figure 4
COPPER IN SILTS AND WATER

SCALE IN FEET

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.



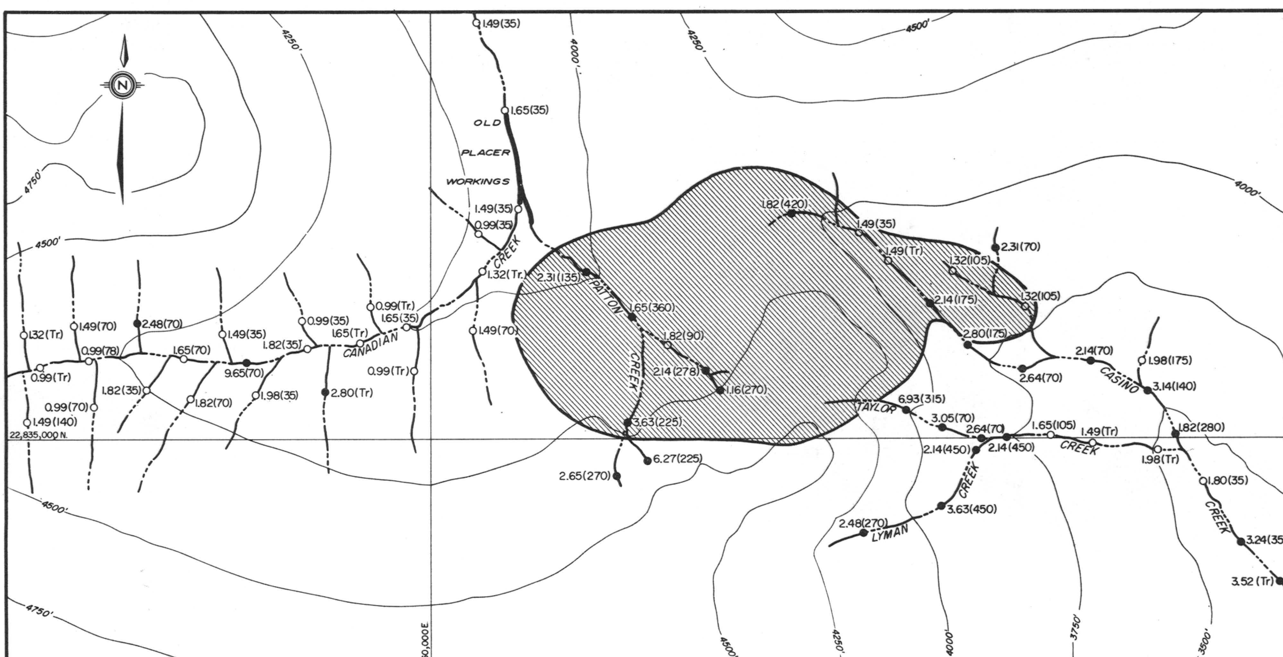
THE DAWSON RANGE HAS A THRESHOLD OF 2–4 PPM MOLYBDENUM IN SILTS

○ MOLYBDENUM ASSAY IN PPM
● ANOMALOUS VALUES (10 PPM)
>300 PPM MoS_2 IN BEDROCK
>100 PPM MoS_2 IN BEDROCK

figure 5
MOLYBDENUM IN SILTS

SCALE IN FEET
800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.



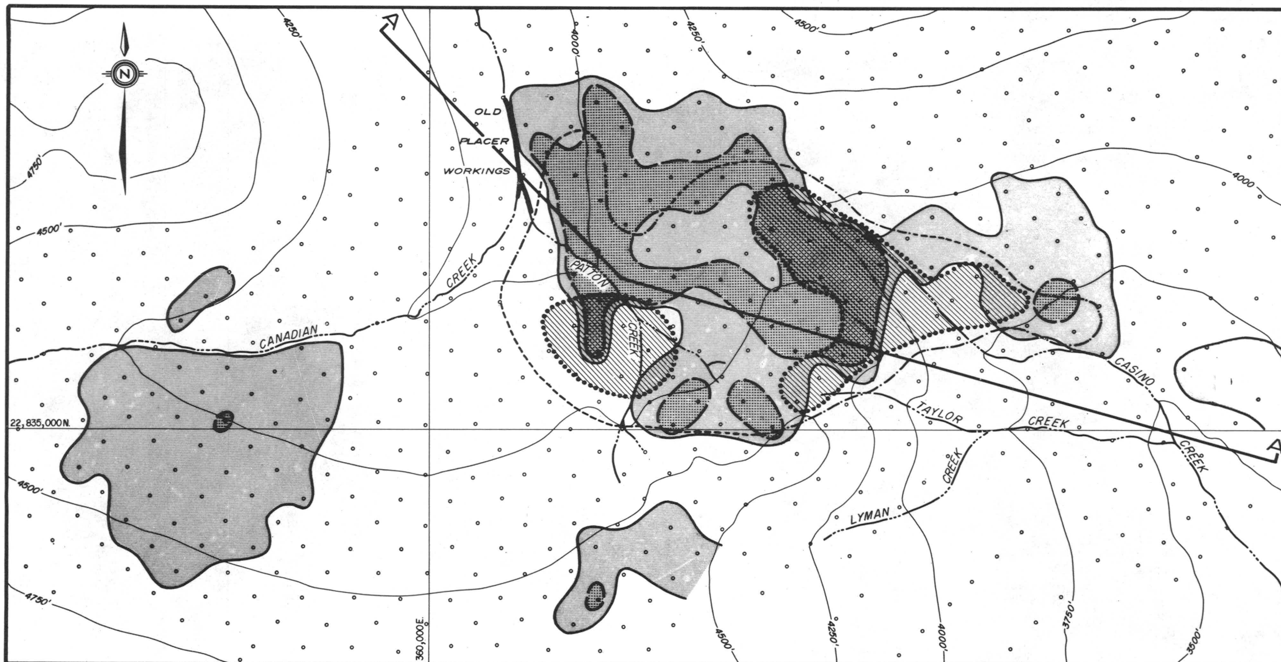
THRESHOLD IN DAWSON RANGE IS 2 PPM SILVER AND 150 PPB GOLD IN SILTS

○ SILVER (GOLD) ASSAY IN PPM (PPB)
● ANOMALOUS VALUES (>2 PPM AG OR >150 PPB Au)
>2000 PPM Cu & 100 PPM MoS_2 IN BEDROCK

figure 6
SILVER AND GOLD IN SILTS

SCALE IN FEET
800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.



ASSAY RANGE (PPM)	NUMBER OF SAMPLES
8–16	29
17–32	175
33–64	254
65–128	181
129–256	74
257–512	28
513–1024	11
1024+	6

LEGEND

- >4000 PPM IN BEDROCK
- >2000 PPM IN BEDROCK (WELL DEFINED–PROJECTED)
- >250 PPM IN SOIL
- >100 PPM IN SOIL
- SAMPLE POSITION

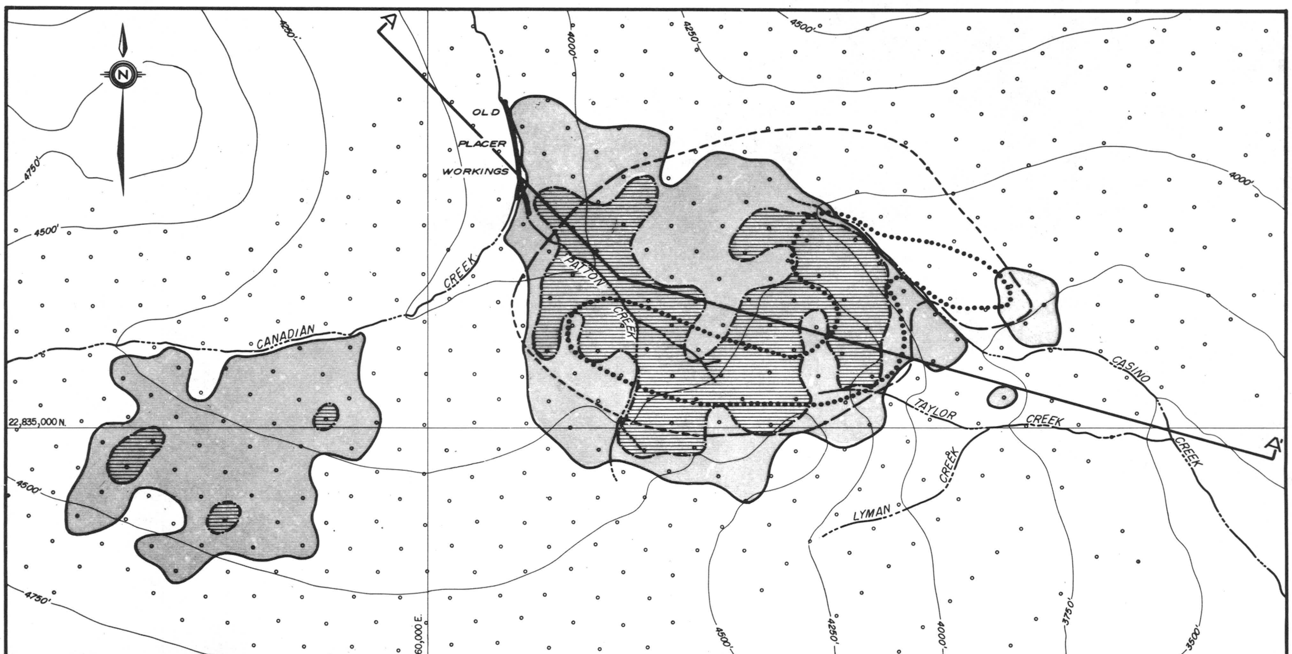
figure 7

COPPER IN BEDROCK AND SOIL

SCALE IN FEET

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.



ASSAY RANGE (PPM)	NUMBER OF SAMPLES
0–2	408
3–4	85
5–8	95
9–16	50
17–32	37
33–64	25
65–128	19
129–256	9
256+	2

LEGEND

- >300 PPM MoS_2 IN BEDROCK
- >100 PPM MoS_2 IN BEDROCK (WELL DEFINED–PROJECTED)
- >40 PPM MOLYBDENUM IN SOIL
- >10 PPM MOLYBDENUM IN SOIL
- SAMPLE POSITION

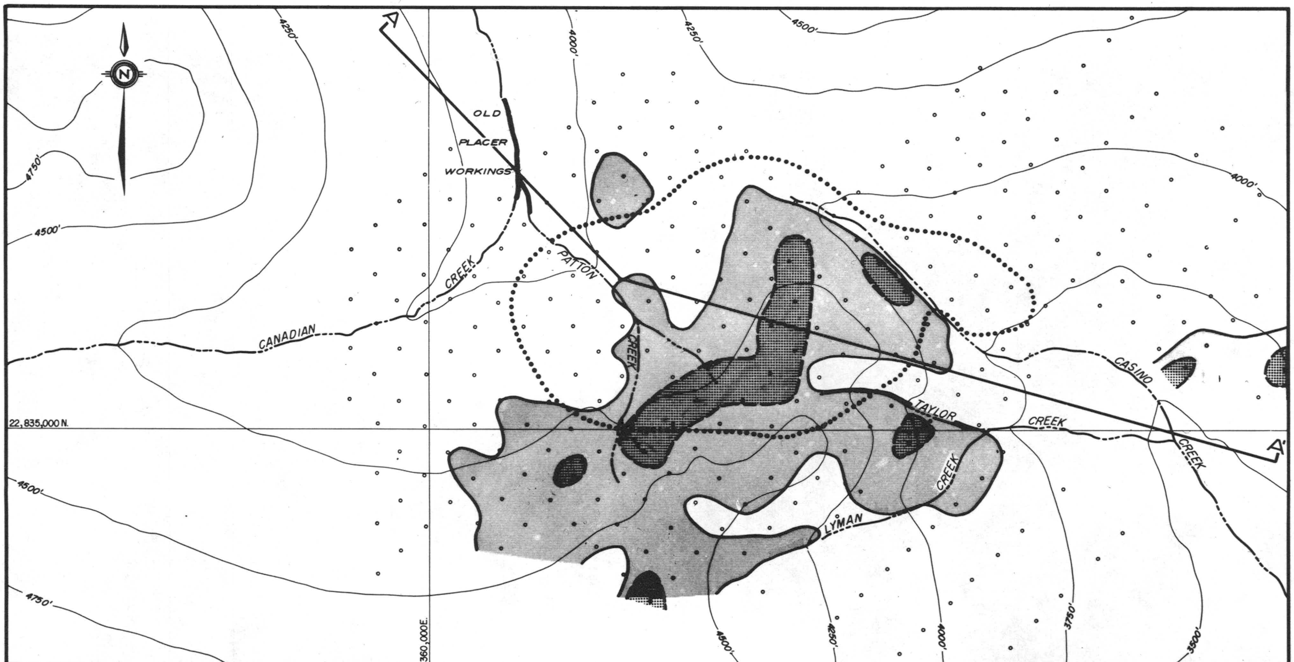
figure 8

MOLYBDENUM IN SOIL & BEDROCK

SCALE IN FEET

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.



ASSAY RANGE (PPM)	NUMBER OF SAMPLES
0—0.9	71
1—1.9	156
2—2.9	27
3—3.9	21
4—4.9	8
5+	8

LEGEND

- >2000 PPM COPPER & 100 PPM MoS_2 IN BEDROCK
- >4 PPM SILVER IN SOIL
- >2 PPM SILVER IN SOIL
- SAMPLE POSITION

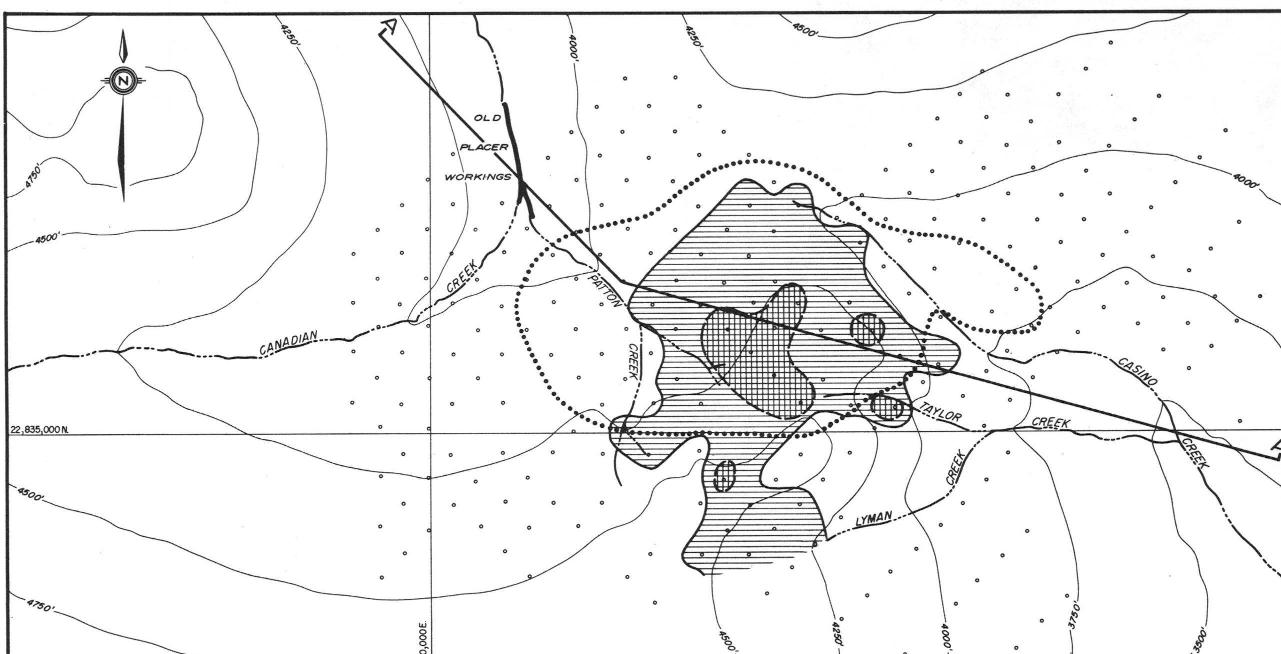
figure 9

SILVER IN SOIL

SCALE IN FEET

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.



ASSAY RANGE (PPB)	NUMBER OF SAMPLES
0—60	85
61—120	90
121—240	56
241—500	15
501—1000	10

LEGEND

- >2000 PPM COPPER & 100 PPM MoS_2 IN BEDROCK
- >500 PPB GOLD IN SOIL
- >200 PPB GOLD IN SOIL
- SAMPLE POSITION

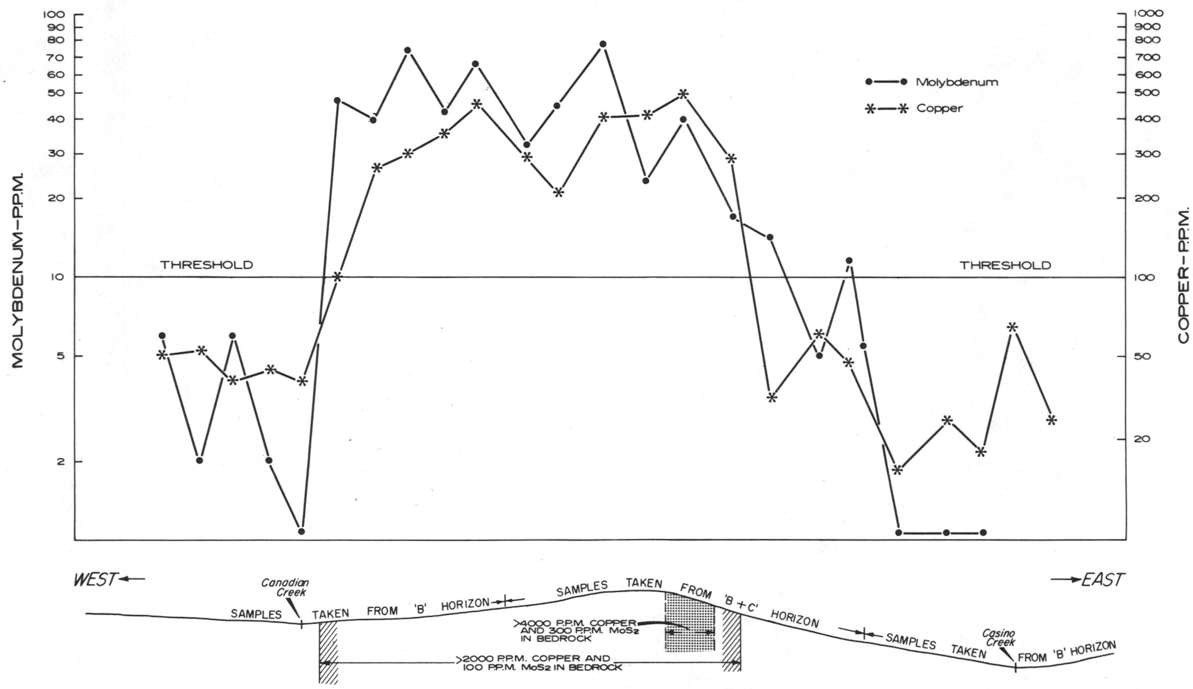
figure 10

GOLD IN SOIL

SCALE IN FEET

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.



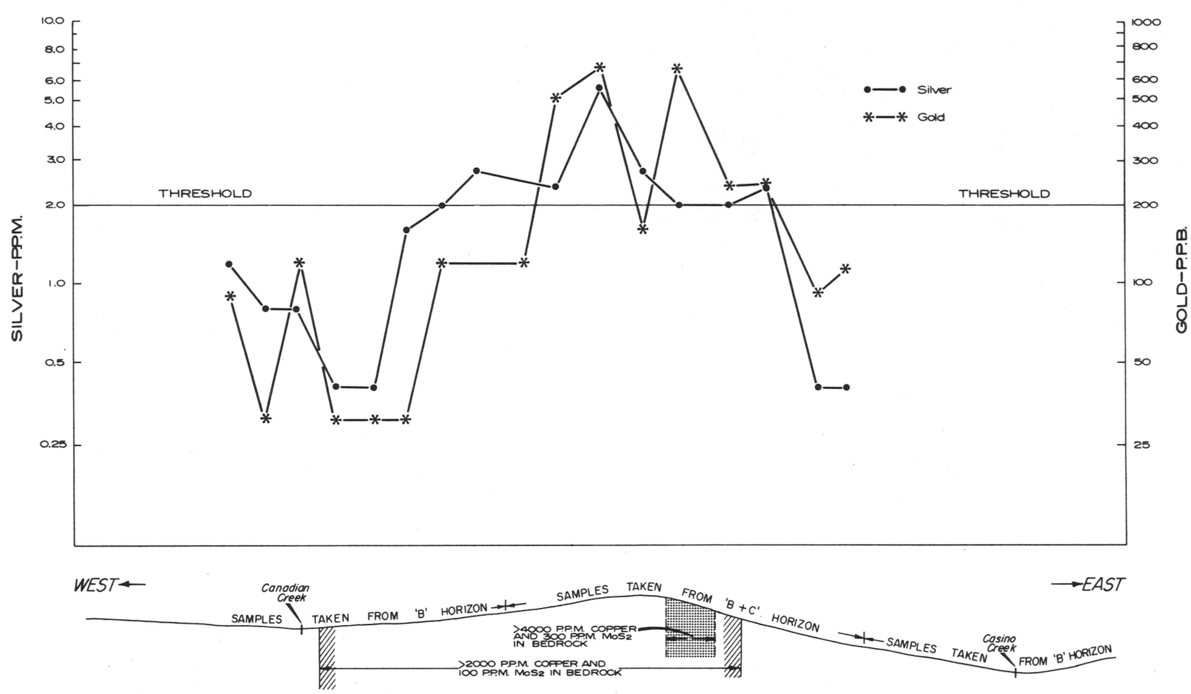
PROFILE OF COPPER AND
MOLYBDENUM ALONG SECTION A–A'

SCALE IN FEET (VERTICAL & HORIZONTAL)

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.

figure 11



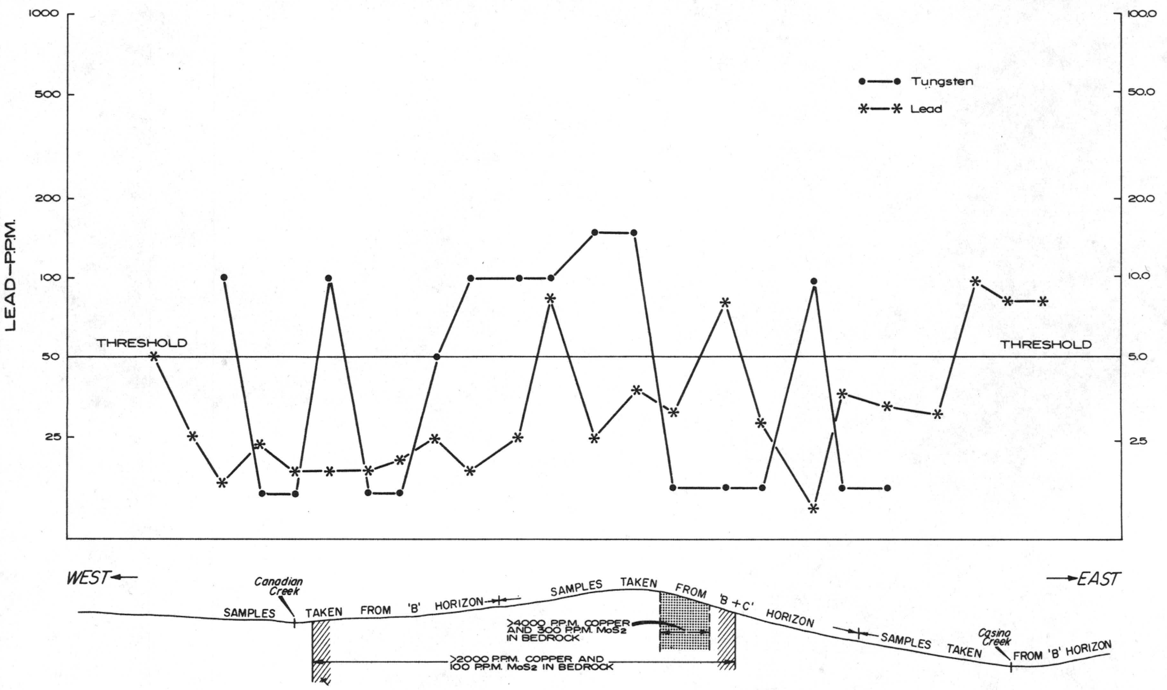
PROFILE OF GOLD AND
SILVER ALONG SECTION A–A'

SCALE IN FEET (VERTICAL & HORIZONTAL)

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.

figure 12



PROFILE OF TUNGSTEN AND LEAD ALONG SECTION A–A'

SCALE IN FEET (VERTICAL & HORIZONTAL)

800 400 0 800 1600 2400

ARCHER CATHRO & ASSOCIATES LTD.

figure 13