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GEOLOGY AND ROTARY DRILLING
AT THE
CASINO DEPOSIT, YUKON TERRITORY

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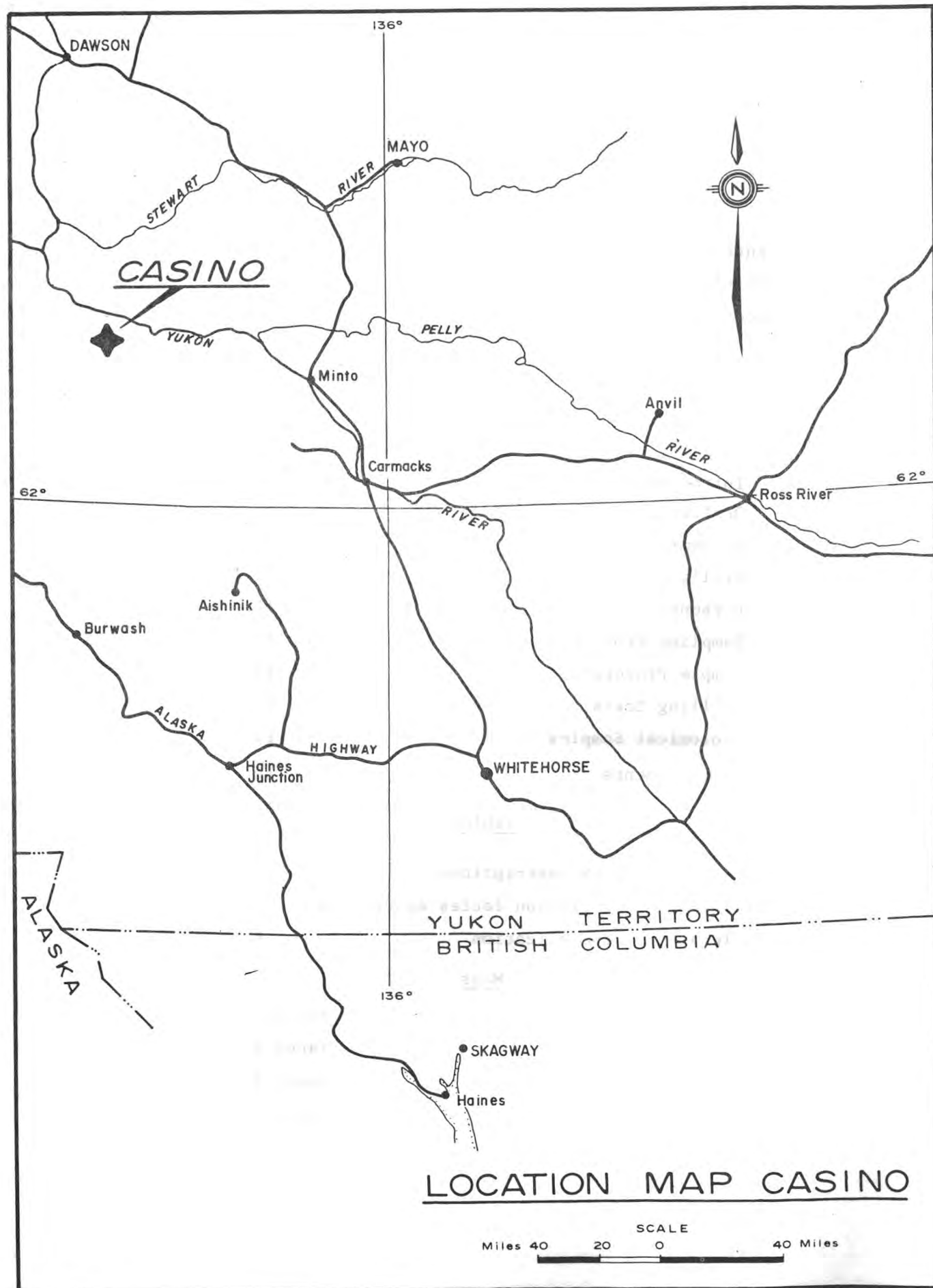
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INTRODUCTION

The Casino deposit is the first major copper-molybdenum discovery in Yukon Territory. It was discovered in 1969 and has been under development by Brameda Resources Ltd. for the past two years. Of special interest is its close resemblance to Arizona porphyry copper deposits in an area of partial permafrost and unglaciated terrain which was not covered by continental Pleistocene glaciation.

HISTORY

Interest in the area from 1901 to 1933 was centered on the gold-tungsten placer occurrence on Canadian Creek. From 1933 to 1967 activity continued on the gold-tungsten placer showings but increasing interest was shown in the lead-zinc-silver veins, especially in Bomber Adit area (see General Geology map).

Geochemical soil surveys over Patton Hill area were conducted and led directly to the 1969 discovery. A more complete account of early history is contained in Archer and Main (1970).

LOCATION

The Casino property is situated 187 air miles northwest of Whitehorse, Yukon Territory, at $62^{\circ}43'N$ and $138^{\circ}49'W$ (see Location Map). It lies at a height of land between Canadian Creek, (a tributary of Britannia Creek, which flows north to Yukon River), and Casino Creek, (which flows south and west into Donjek River and White River, and eventually into Yukon River). The property is within claim sheets 115-J-10 and 115-J-15 (N.T.S.), while, physiographically, it lies within Dawson Range, a subdued mountainous portion of Yukon Plateau. The Alaska Highway passes within 75 air miles on the southwest, while Whitehorse-Keno road (Highway 2) passes within 65 air miles on the east. The Yukon River, which was the main transportation route in the Territory prior to World War Two, passes within 12 road miles on the north. Barge transportation for heavy equipment is available from Dawson.

In the winter of 1969 - 1970 a 140 mile winter road was constructed to the property from Burwash Landing on the Alaska Highway. During the summer, access is mainly to the airstrip which is suitable for wheeled aircraft up to a DC-3 in size.

FIELD MAPPING TECHNIQUES

True outcrop is rare in Casino area and is mainly confined to ridges. Mapping at a scale of one inch equals 1,000 feet was mainly of felsenmeer along ridges. The deposit area where detailed information was desired had less than one percent outcrop. Ground cover consists of a moss layer up to one foot thick below which is generally permafrost. The permafrost resulted in a tendency for blocks of ridge rocks to slide downhill on top of permafrost ice for several thousand feet, thus accumulating on the surface and obscuring underlying local rocks. Despite the degree of lateral transport the depth of overburden is often less than five feet. To help overcome these problems the following techniques were employed for one inch to 100 foot mapping:

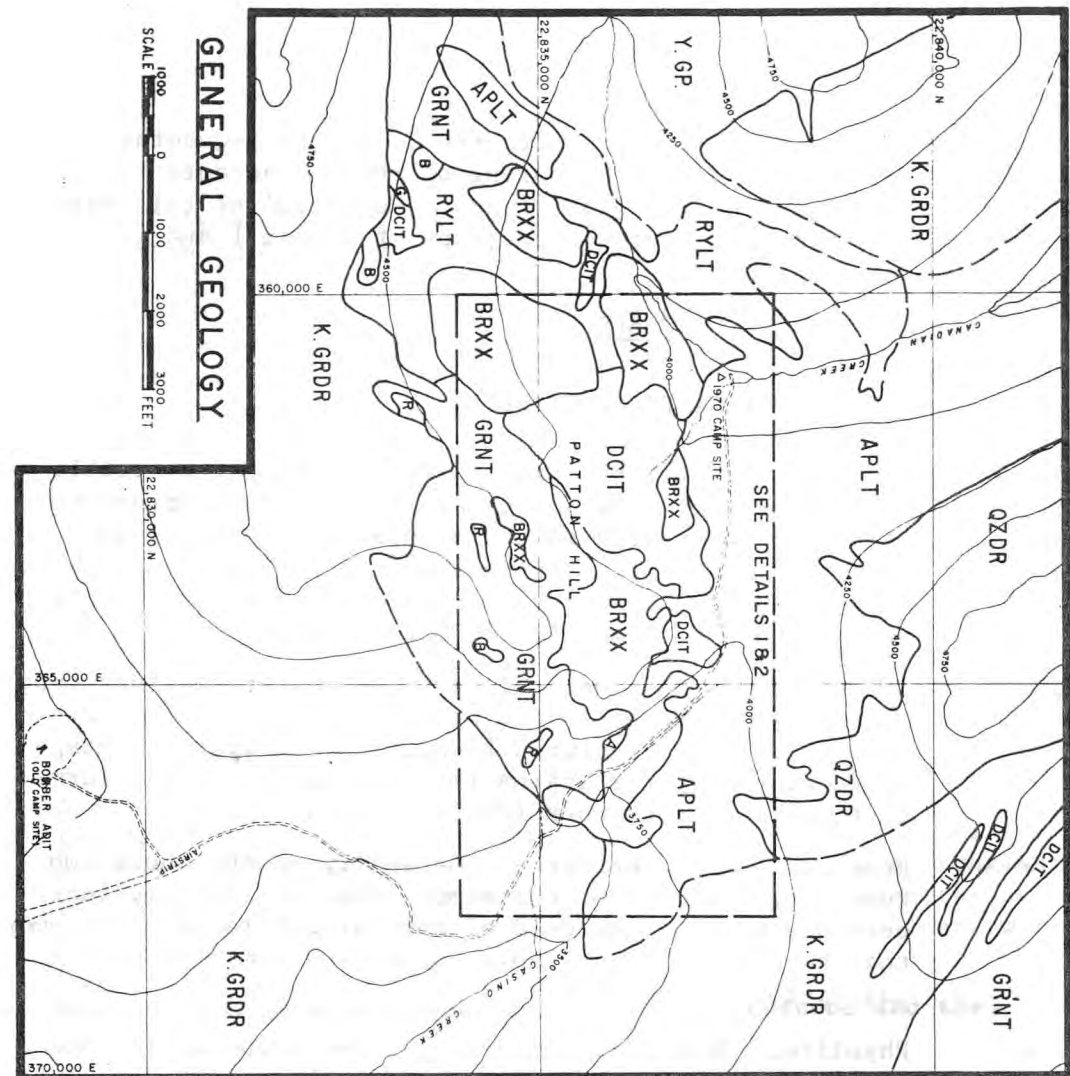
1. A continuous furrow was ripped by D-8 bulldozer to depths of up to 2 feet along lines spaced 400 feet apart; in areas of steep topography shallow trenches were cut. In this manner 240,000 line feet or 45 line miles were prepared. Where road cuts existed these were used in lieu of ripper furrows.
2. Approximately five specimens were collected each 100 feet by a geologist. An attempt was made in the field to differentiate between transported and residual float; small, angular fragments, for example, were thought to represent more accurately the bedrock than rounded, large boulders (especially if these boulders were representative of upslope ridge rocks).
3. Samples were examined under a binocular microscope and the following features were routinely observed:
 - (a) rock type of probable underlying rock.
 - (b) silicification intensity, alteration facies and intensity of underlying rock.
 - (c) limonite data where the intensity, and jarosite (yellow), goethite (brown), hematite (red) percentages were estimated by the colour of the limonite streak.
 - (d) associated minerals, especially hematite, magnetite, tourmaline, pyrite, chalcopryrite, chalcocite and molybdenite.
 - (e) structural relationships such as closely spaced parallel fractures, and cross-cutting quartz veins with quartz-sericite envelopes.
 - (f) transported float.
4. A rock chip specimen was taken from the collection of specimens for geochemical analysis of: Cu, Pb, Zn, Mo and W.

Geological data was displayed with the aid of four-quadrants of a one inch diameter circle. Colouring of these quadrants facilitated visual grouping of float types. Reduction of this data to 1 inch to 400 foot base produced the maps of Detail 1 and 2.

TABLE 1

ROCK DESCRIPTIONS

- C.BRRX = Cobble or boulder breccia. Fragments vary from cobble to boulder sizes and are generally well rounded and not welded to the matrix which is apparently clastic in character. Fragments include most rock types, notably: microbreccia, quartz, quartz-tourmaline, pyrite-quartz, dacite, aplite, granite, and Yukon group.
- M.BRAX = Microbreccia. A fine grained rock containing minor pebble sized fragments, a clastic matrix and up to 60% quartz as euhedral and fractured fragments. A high percentage of fractured quartz grains to grains with crystal forms distinguishes this rock from rhyolite.
- BRXX = Breccia, undifferentiated. Generally of the above two types, or mixtures of the same. However, locally there occurs a breccia composed of angular cobble-sized fragments that have only been slightly moved and cemented with a quartz-tourmaline matrix.
- RYLT = Rhyolite. Generally a light coloured porphyritic rock with pronounced doubly-truncated stubby quartz grains. This unit also includes several aphanitic types of varying colour.
- DCIT = Porphyritic dacite. A porphyritic rock with prominent plagioclase, biotite and/or hornblende phenocrysts and occasional quartz phenocrysts. In the deposit area, biotite but no hornblende occurs as phenocrysts. Distant from the deposit hornblende is dominant. K/Ar dating of this rock at University of British Columbia has yielded an age of 69 ± 3 my. A medium grained rock with an age of 71 ± 3 my. may be a variety of this unit, but is only observed in drill holes.
- APLT = Aplitite and fine-grained granodiorite. This unit is generally leucocratic and includes a variety of grain sizes up to medium grained alaskite.



LEGEND

BRXX	BRECCIA
RYLT	RHYOLITE
DCIT	PORPHYRITIC DACITE
APLT	APLITE & F. GRAINED GRANODIORITE
GRNT	MEDIUM GRAINED GRANITE
QZDR	QUARTZ DIORITE
K.GRDR	KLOTASSIN GRANODIORITE
Y.GP.	YUKON GROUP GNEISS, SCHIST & QUARTZITE

- GRNT = Medium grained biotite granite. This unit is generally porphyritic, distant from the deposit it is distinct by having only minor hornblende and large prominent quartz grains occupying up to 30% of the rock. In the deposit area where feldspars have been totally altered it is distinguished by its large quartz grains.

- QZDR = Quartz diorite. Several distinct rocks are involved including a leucocratic, medium grained, inequigranular, hornblende biotite quartz diorite that is locally sphene rich, and a porphyritic, mesocratic, medium grained, biotite-hornblende quartz diorite.

- K.GRDR = Klotassin granodiorite. A medium grained biotite hornblende granodiorite. Hornblende is subhedral and pronounced. K/Ar dating by the Geological Survey of Canada of a sample from near the Bomber Adit yielded ages of 95 and 99 my on biotite and hornblende respectively (Findlay, 1969).

- Y.GP = Yukon group gneiss, schist and quartzite. The age of this unit is unknown but is older than the Klotassin granodiorite.

GEOLOGICAL INTERPRETATION

The geology is described in maps of General Geology and Detail 1. Rock descriptions in Table 1 are mainly field descriptions; they are described in probable order of increasing age. A sequence of events that seems plausible is as follows:

1. The Yukon group - schists, gneisses and quartzites were intruded by Klotassin granodiorite that may be part of the Cretaceous Coast Intrusion sequence (Findlay, 1969).

2. The area was then intruded by a younger quartz diorite to granite complex.

3. Aplites intruded the above.

4. Feeders, possibly related to Carmacks Group volcanics (Bostock, 1936), of dacite and rhyolite occur concentrated in the vicinity of the deposit.

5. Rhyolites were strongly mobilized to form pipe-like micro-breccia bodies characterized by a high percentage of fractured quartz grains.

6. A second stage of brecciation results in cobble or boulder breccia where microbreccia fragments are commonly imbedded in microbreccia matrix. This breccia was apparently highly mobile because this type of breccia locally contains abundant foreign fragments including ones from Yukon Group.

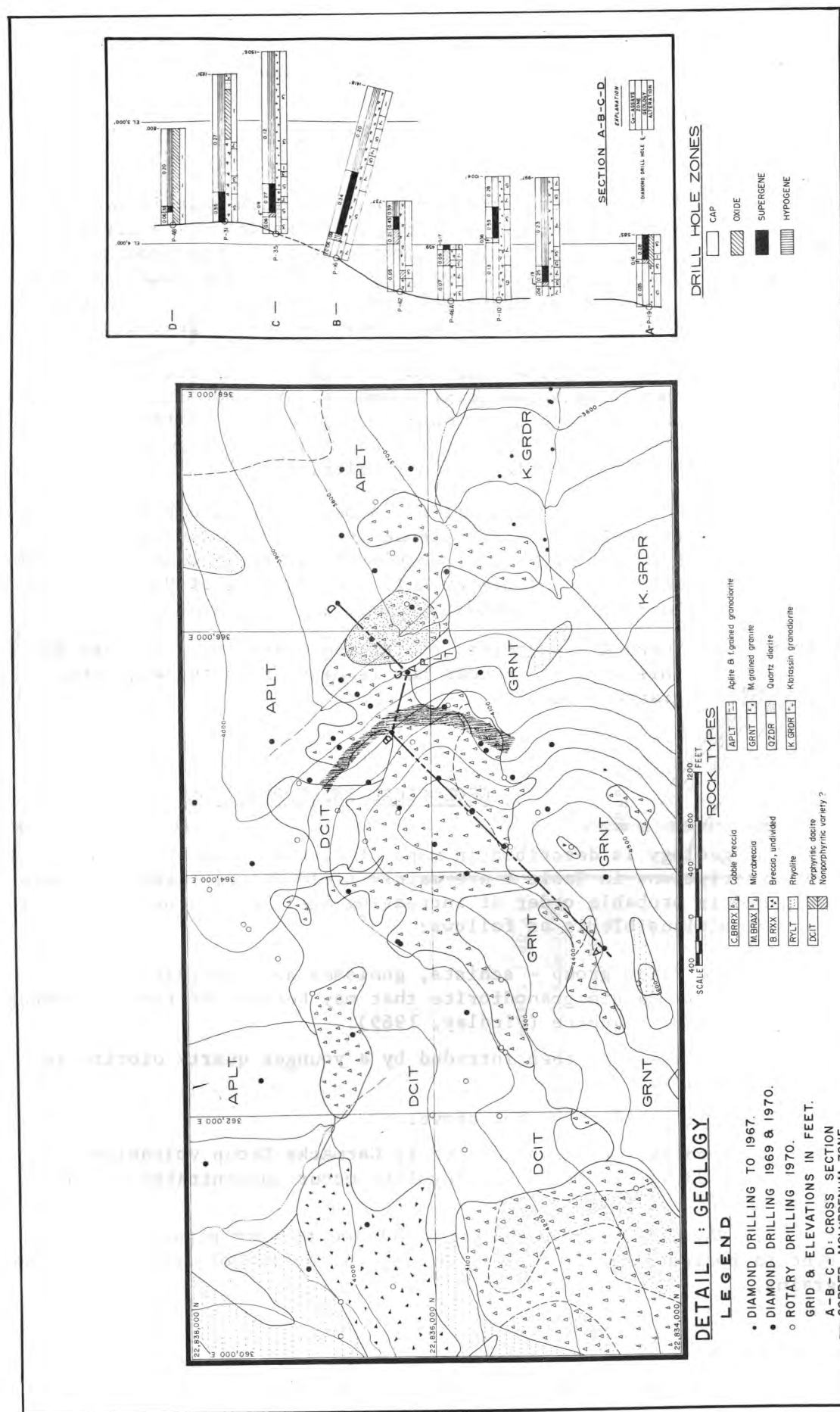
Abundant, strong alteration and lack of observed contacts, make the above age relationships somewhat speculative. Potassium-argon age determinations currently being undertaken at the University of British Columbia will hopefully aid in more refined future interpretations.

TABLE 2

ALTERATION FACIES DESCRIPTIONS

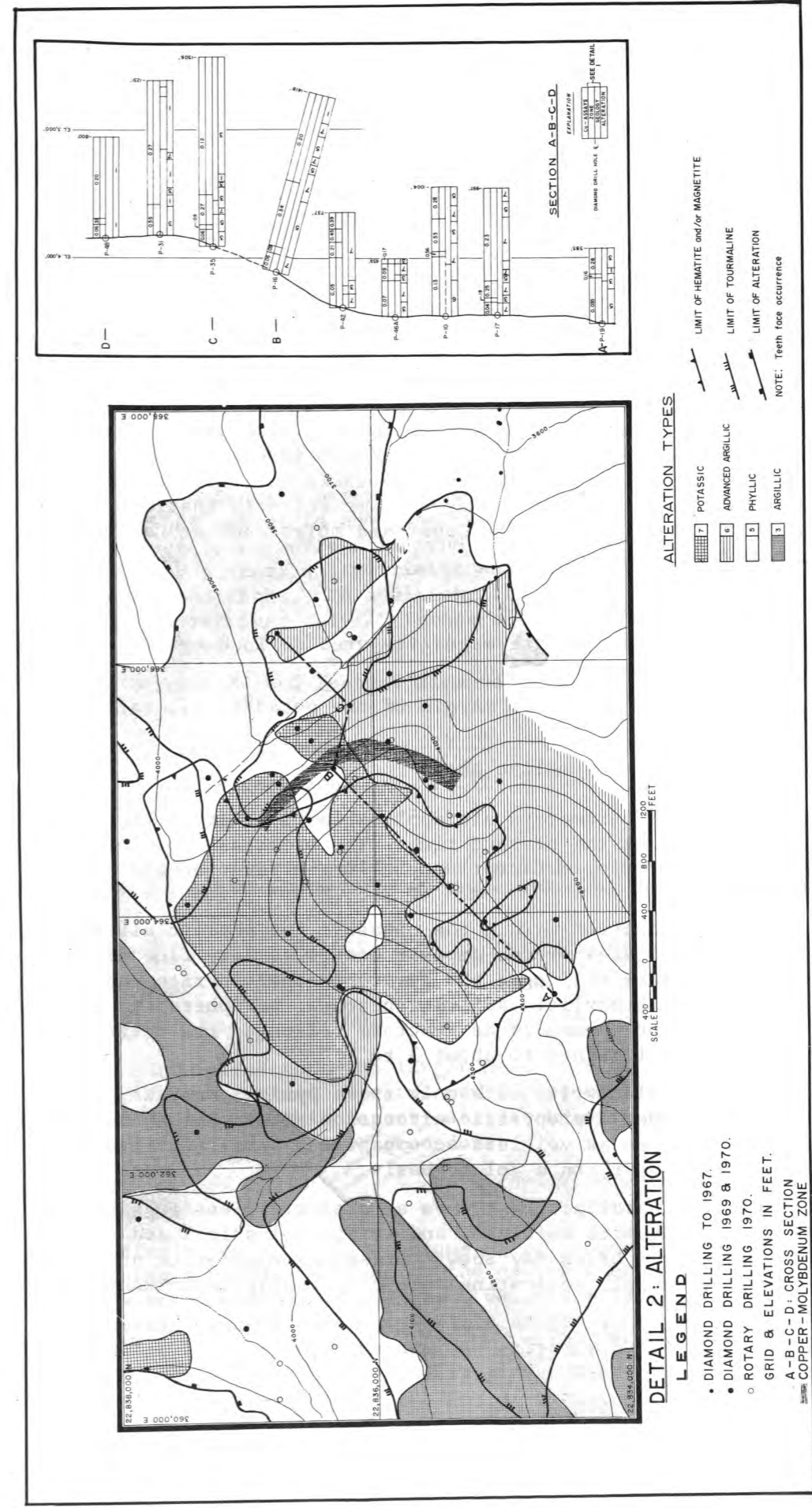
- POTASSIC (7) = potassium feldspar, biotite, hematite and/or magnetite, ankerite, tourmaline, some gypsum.
- ADVANCED ARGILLIC (6) = clay, muscovite-sericite (frequently distinctly coarse grained), abundant tourmaline and quartz, frequent quartz veins with quartz-sericite envelopes.
- PHYLIC (5) = strong sericite development, minor clay, moderate quartz.
- ARGILLIC (3) = strong clay, minor sericite, biotite, minor calcite and chlorite associated with montmorillonite.
- PROPYLITIC (1) = abundant chlorite and calcite, minor epidote, some gypsum.

(See Meyer and Hemley, 1967).



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TABLE 3

ZONE	MODE OR THICKNESS IN FT.		MINERALIZATION MINERALS IN APPROX. ORDER OF ABUNDANCE	OCCURRENCE
	MINIMUM	MAXIMUM		
SURFACE	PLACER		magnetite ferberite gold - fine wire and nuggets scheelite cassiterite molybdenite sphene	Canadian Creek Patton Gulch
	LODE		galena (argentiferous) anglesite pyrite chalcopryite	Barite gangene
CAP	0	500	jarosite (predominant) hematite (mainly after magnetite))minor goethite) ferrimolybdenite molybdenite (encapsulated in quartz)	Thickness related to topography.
OXIDE	0	100	magnetite and hematite tenorite and neotocite malachite azurite chalcantite brochantite chalcocite molybdenite pyrite native copper magnetite and hematite	
SUPERGENE	50	450	pyrite chalcocite covellite digenite (microscopically) molybdenite ferberite magnetite and hematite	
HYPOGENE			pyrite chalcopryite molybdenite sphalerite galena magnetite and hematite	



ALTERATION AND MINERALIZATION

Alteration and mineralization has been summarized in Tables 2 and 3. Generalized surface alteration facies and limits of the minerals tourmaline and hematite-magnetite are shown on Detail 2. An arcuate copper-molybdenum zone of better than average grade is shown on Details 1 and 2. Not all better grade copper-molybdenum zones are shown.

Apart from a small amount of polished section work (Tredger, 1970) all work has been based on field determinations aided by a binocular microscope. With all the limitations inherent in the fact that there is a severe supergene imprint on the surface rocks and that interpretations are field ones, Details 1 and 2 suggest some criteria that may be important to the localization of copper and molybdenum at Casino. The mineralization is:

1. mainly within breccia.
2. outside the hematite-magnetite area defined by the hematite-magnetite line
3. related to the outer margin of the potassic alteration zone.
4. inside the tourmaline area.

Whether or not these parameters are applicable to other parts of the property is unknown at the present time. The breccias, however, seem to be the most dominant single factor controlling alteration and mineralization.

Copper mineralization within the potassic and phyllic alteration zones in the central area of the deposit occurs as very fine disseminations and rarely as fracture fillings; the pyrite to chalcopyrite ratio is about 2 to 1. Within the propylitic alteration zones, peripheral to the deposit, mineralization is more commonly as fracture fillings; the pyrite to chalcopyrite ratios increase to about 3 to 1.

Significant chalcopyrite with only trace pyrite, however, locally occurs in the peripheral propylitic alteration zone. The chalcopyrite occurs along fractures as veinlets accompanied by potassic alteration which is minor, however, on a volume basis.

Molybdenite mineralization occurs as disseminations in strong pervasive silicification, in quartz veinlets, and as disseminations and fine quartz-free veinlets. Drill holes may show increasing molybdenite and decreasing copper values with depth indicating that copper-molybdenum zoning could be present.

ROTARY DRILLING

INTRODUCTION

During the past few years, rotary drilling has been used extensively in porphyry exploration programs in the United States, often as a supplement to diamond drilling. It has been used to a much lesser extent in Canada, mainly to penetrate thick glacial overburden. The relatively unweathered nature of Canadian porphyries, remoteness and absence of suitable sampling equipment to handle large quantities of water have hindered its use in Canada.

At the Casino deposit several drilling problems were encountered which are somewhat unique in the Canadian Cordillera. The water table is up to 700 feet below surface and the leached capping and supergene zone are, in many places, quite friable and soft, which resulted in serious caving conditions. In addition, its location at a height of land in an area which receives only 15 inches of precipitation created serious water supply problems.

In the initial 37,000 feet of diamond drilling, core recoveries averaged

leached zone	79.2%
supergene zone	79.3%
primary zone	92.7%

The poorest recovery was often obtained from the highest grade intervals. Diamond drilling costs for NQ and BQ size core were approximately:

	<u>direct</u>	<u>indirect</u>	<u>total</u>
summer	14.00	4.00	18.00
winter	24.00	6.00	30.00

It was anticipated that the larger hole size of the rotary method, and air circulation instead of water would produce a superior sample at a lower cost per foot. This report outlines briefly the equipment used, operating problems and sampling procedures.

DRILLING PROCESS

Big Indian's "Sure Core" technique, also known as centre hole return drilling process, is based on the use of a double wall drill stem pipe, rotary bit and a dual swivel head which provides a closed system and full recovery of the cuttings. Fluid or air is injected between the inner and outer wall of the pipe and the cuttings (rock fragments) are recovered through the inner tube. This prevents erosion of the hole walls. Cuttings return at about 600 f.p.m. when water is used as the drilling medium and about 5,000 f.p.m. with air. Only air injection was used at Casino.

Coring type bits are available with a special core breaker that allows core to be broken into 5 inch sections and pumped to surface. They were not used at Casino.

EQUIPMENT

The complete rig consists of:

- (a) a conventional 2,000 ft. jackknife mast drill mounted on a 5 ton gasoline operated truck with the addition of a dual swivel kelly and drill pipe system. The drill is powered by the truck motor. If difficult terrain is present, track mounted drills capable of drilling to 600 ft. are available.
- (b) a 315 cfm, 120 psi compressor, also mounted on the track.
- (c) a separate pipe rack on skids with a capacity of 1,000 ft. of drill pipe.
- (d) a skid mounted "dog house" with a 385 cfm, 250 psi compressor, generator, tools, bits, spare parts and geolograph (a device for graphing time and footage).
- (e) a 3 ton winch truck for transporting the "dog house" and rods.
- (f) a $\frac{1}{2}$ ton pickup truck for personnel.
- (g) a cyclone for separating dry cutting from the return air.

DRILLING PROCEDURE

Drill moves depend upon distance and topography and varied at Casino from one to eight hours for distances up to 5,000 ft.

The minimum size of a level drill site is 30 x 60 ft. Once on the site, the rig is levelled with hydraulic jacks located at the rear of the rig. The mast is also raised and held in a vertical position by hydraulic jacks.

A $6\frac{3}{4}$ inch diameter bit is used for the length of the 23ft. kelly. Then an 8 inch bit is used to ream out the kelly hole for the 7 inch casing. In the early holes at Casino which were collared in bedrock, only 4 feet of casing was installed, but broken ground at the top of the hole tended to fall into the hole behind the bit. Two holes near Canadian Creek were lost in running gravel overburden but could have been saved if casing of varying diameters had been available.

Drilling ahead of the casing is carried out with a $4\frac{7}{8}$ inch diameter bit attached to the $4\frac{1}{2}$ inch diameter drill pipe or drill collars.

Initially the rod rotation speed was 35 r.p.m. but it was found that better fragmentation of the bedrock and smoother walls to the hole could be obtained if this was increased to 50 r.p.m.

The initial drilling rate is slow due to lack of weight on the rotary bit so drill collars (weighted pipe) are added. They weigh 30 pounds per foot and are used to a depth of 300 feet. Drill pipe weighs 17 pounds per foot, comes in approximate 15 foot lengths and is worth about \$450.00 per length. It is stacked in the mast in 30 ft. lengths. The small truck mounted compressor is used to 600 ft. when cuttings are dry or until the water table is intersected. Operating air pressure is about 90 psi.

The drilling rate varies from 2 ft. per minute in soft ground to 8 minutes per ft. in the hardest ground. In the leached cap where supergene alteration has softened and leached the fractures, the rotary bit readily breaks the rock into large cuttings. In harder rock generally in the supergene and hypogene zones, the penetration rate is lower as the bit has to grind the rock and generally smaller fragments are obtained.

When the rock becomes moist, just above the water table, up to 10 gallons per minute of water is added to the injected air in order to stop the cuttings from plugging up the bit.

The maximum depth of the hole depends upon the competency of the wallrock and hardness of the rock. The deepest hole at Casino was 1,004 ft. and average hole depth was about 450 ft.

The standard oil field tricone bit, worth about \$65.00, averaged about 10 - 12 hours of drilling. One button bit worth about \$750.00 was used for experimental purposes and was found to have the same life as a tricone bit. A wide variety of tricone bits are available with varying combinations of button-tooth tricones for different ground conditions. Three holes were lost when faulty cones fell off the bit. Lost cones may be removed by a magnet or a new bit can be added to the drill pipe and the cone pushed into the wall of the hole.

In some instances caving conditions were encountered. If this condition was recognized by the driller the bit and pipe are pulled off the bottom and the hole is reamed out. If caving conditions are not quickly recognized, the loose material from the walls of the hole jams behind the bit. Only rarely can all the equipment be recovered. Two holes out of 35 were lost due to caving.

Small amounts of lime in solution can be added to injected air in order to stop corrosion by acid water on the inside of the inner double wall pipe.

During the winter when low temperatures are encountered methyl alcohol is added to the injected air in order to overcome freezing

condition in the air line between the compressor and the top of the hole.

PERSONNEL

The drilling crew consists of a tool-push (foreman) and a driller and two helpers on each eight hour shift, a total of 10 men. Crews work a continuous 20 days and then have 10 days off, a standard rotation procedure in oil field drilling. During the period June - August, 1970, the rotation period at Casino was extended to six weeks.

Initially, the drillers had some trouble drilling in broken ground as most of their experience had been in soft competent sedimentary rocks. After approximately a month's experience this problem was overcome.

SAMPLING PROCEDURE

Numerous inquiries were made regarding sampling procedures for wet cuttings, but little information was available and it was realized that special sampling techniques would have to be developed.

(a) DRY CUTTINGS

Dry cuttings were collected at the bottom of the cyclone in large canvas bags with the hole number and footages marked on the outside. Initially the samples were collected at five foot intervals and taken back to camp for splitting. Later, a Jones Splitter was set up at the drill site and the sample for a 15 ft. interval was split with the 1/8 sample used for assay and geological purposes and the 7/8 split discarded. This sample could be used for metallurgical purposes. A limited number of specific gravity determinations were carried out on diamond drill core in order to determine the theoretical sample weight. The average S.G. was 2.63 indicating a theoretical weight of 319 pounds for a 15 foot sample. All samples were weighed and indicate a recovery of between 95 and 100%.

The dry cuttings are separated from the air in a large cyclone. The exhaust from the cyclone contains extremely fine dust-like material. The placing of additional stacks over the top of the cyclone to catch the dust-like particle was only of limited value. A sample of dust collected with the aid of a damp cheese cloth assayed slightly higher in copper and double in molybdenite. The amount lost is small and it is not believed that appreciable copper or molybdenite was lost at Casino. Experience at a molybdenum prospect in Arizona which was rotary drilled and later investigated by underground workings,

indicated that significant molybdenite was probably lost in the dust (E. Eyde, personal communication). To overcome this problem, a vacuum filter device can be used and has recently become available.

(b) WET CUTTINGS

Initially, cuttings were directed from the bottom of the cyclone through a plastic hose to a series of upright 45 gallon drums but the large flow of water encountered (up to 50 gallons per minute) in winter conditions made this method impractical. An improvement in the previous system was the installation of a 1 inch outlet nipple halfway up the side of the 45 gallon drum. After testing various types of fabric, a nylon stocking was placed over the nipple to catch the fine material, while a screen on top of the drum caught the coarser fragments. This was satisfactory except that cuttings at the bottom of the drum were difficult to bag.

In order to improve sample collection a 45 gallon drum was cut in half lengthwise, pivots were welded at each end, so that the split drum could be rotated for cleaning, and mounted on a three foot high stand. A 1 inch outlet nipple was installed at the bottom end of the drum and a screen was placed over the drum to catch the coarser cuttings. Two sampling units were used to prevent interruption of drilling and installed in a skid mounted, heated shack which could be readily moved. A nylon stocking placed over the outlet removed the finest fraction as before.

Drilling was interrupted every five feet to clear the hole.

It was realized that molybdenite and copper in suspension might not be caught by the stocking, and it was estimated that up to 5 pounds of cuttings every 5 ft. could be lost. A flocculating agent, Separan NP 10, was added to the wet cuttings by a drip arrangement below the coarse screen. The amount could not be easily regulated and when an excess amount is added the wet cuttings turn to jelly. If problems with the recovery of molybdenite are suspected, special tanks for mixing and storing Separan in solution should be built and can be added to the air injected into the holes. Several holes drilled next to diamond drill holes for purposes of comparison in the early stages of drilling indicated that the copper-moly rotary assays were from 73 to 105% higher except in holes with very low moly assays.

Six out of seven holes which penetrated the water table in the early stages showed a consistent drop in recovery of about 30 percent below the water table. The water table varied from 100 feet in the lower areas to more than 700 feet on the top of Patton Hill. The reason for the lower recovery is not clear but several explanations are

suggested:

- (a) colloidal mineralization was not being recovered from the wet cuttings.
- (b) the hydrostatic pressure caused grouting of fractures at the bottom of the hole.
- (c) imperfect sampling technique.

In June 1970, an Elenburg Sampler was purchased from Monahans, Texas, at a cost of \$4,000 and used for the remainder of the program. The sampler is trailer mounted, and consists of:

1. SPLITTER - The wet cuttings enter a small cyclone and exit through a nozzle against the splitter, which rotates on a vertical axle. The splitter diverts 1/8 to a 20 mesh screen and rejects the remainder. It was found that the split on the total sample was between 1/8 and 1/9 due to surging of the wet cuttings. A minimum water flow of 10 gallons per minute is needed to operate the splitter. When normal air return contained less than 10 g.p.m., water was added to the air intake.

2. 20 MESH SCREEN - The split sample runs into the 20 mesh screen which catches the oversize cuttings ($\frac{1}{2}$ to $\frac{3}{4}$ of the sample). The fine cuttings drop through the screen and are pumped to a cyclone.

3. CYCLONE - The diesel-powered cyclone separates the fine cuttings from most of the water. The cyclones can handle up to 250 gallons of water with fines per minute and separates cuttings down to 340 mesh. A constant amount of water is regulated by the cyclone. At one end of the cyclone the moist fine cuttings are discharged into a small plastic bag. If poor recovery of the fine cuttings is suspected the discharge from the cyclone can be diverted back to the 20 mesh screen where it will return through the cyclone.

Sample interval was the length of the drill pipe - approximately 15 ft. The fine cuttings in the small plastic bag were tied and placed inside the larger plastic bag containing the coarser cuttings.

Tests were carried out to check the accuracy of the sampling techniques. Three reject samples were collected below the water table to determine recoveries. The average indicated recovery for the three samples tested was 87.6% on the basis of a 1/9 sample split. If the percent recovery for the sample had been determined on the basis of the weight of the 1/8 sample cut, it would have been reported as 69.3%.

All samples were weighed and examinations of the sample recoveries suggest that in highly fractured ground just below the water table, up to 50% of the sample is not recovered. In general, recoveries were

95% for dry cuttings and varied from 85 - 95% for wet cuttings.

Assay results on the 1/8 and 7/8 portions collected in these tests were not consistent. The discrepancy may be due to improper mixing and sampling the 7/8 portion which weighs as much as 256 pounds.

An overflow sample in excess of 600 gallons from the Elenburg cyclone was collected. Fines remaining proved to be semi-colloidal as only 3 lbs. settled out after several days. The overflow sample assayed higher in copper and lower in molybdenum than the 1/8 split. It is believed that the molybdenite remained in colloidal suspension and could not be collected. The amount of sample being lost is not sufficient to effect the assay results.

SAMPLE PROCESSING

Pre Elenburg Sampler

Samples were collected at 5 foot intervals, weighing about 100 lbs. in large canvas bags with the hole number and sample footages marked on the outside. At the end of each shift the samples were taken to a processing lab at the base camp. Dry samples were immediately put through the Jones Splitter and both the 1/8 and 7/8 splits were weighed. The wet samples were dried using a portable oil-fired blower and then split in a similar fashion. The 1/8 splits were assayed. About 3 lbs. of the 7/8 sample split was collected for geological purposes and the balance of the 7/8 sample split was stored in sealed 5 gallon metal pails. Hole numbers and footages were marked on the inside or the outside of the cans and stored. The lab was operated by a three man crew on a single daily shift.

Elenburg Sampler

The sample with its two size components were taken to the lab, dried and each split an equal number of times so that the combined weight of the sample would be about 4 lbs. The 4 lb. sample was thoroughly mixed, split equally into a 2 lb. sample for assaying and a 2 lb. sample for geological purposes.

DRILLING COSTS

The contractor was hired at an hourly rate of \$40 per hour during the period January - March, 1970, and \$47.50 during the period June - August, 1970. Standby rate was \$25 per hour with crew and \$100 per day without crew. Delays in repairs or maintenance and unavoidable delays

in supplies and equipment were charged at \$250 per 24 hour period.

The geograph was rented at \$120.00 per month. Mobilization, demobilization, bit charges, transportation of supplies, room and board and lost equipment were extra charges.

The following table gives the drilling costs:

PERIOD	FOOTAGE DRILLED	DIRECT COST/FT.	INDIRECT COST/FT. (EST.)	COST/FT. EQUIP. LOST (EST.)	TOTAL COST/FT. DIRECT & INDIRECT
Jan - Mar	5,808	13.50	2.00	*	15.50
June 2 - 30	4,119	10.98	3.50	2.27	14.48
July 1 - 31	5,838	5.85	3.50	nil	9.35
Aug. 1 - 9	2,007	7.61	3.50	2.28	11.11
June 1 - Aug. 9	11,964	7.91	3.50	1.16	12.57
Total	17,772			Average	13.53

* - included in direct cost

Direct - paid to contractor

Indirect - fuel, room and board, bits, crew rotation, preparation of drill sites, mobilization and demobilization.

The higher cost in January - March 1970, was due to stuck pipe, equipment failure, inexperienced crews, winter weather and shut down of the rig in order to modify sampling procedure. The drill costs from June to August 1970 reflect average operating conditions.

Comparison of rotary and diamond drilling costs shows that under summer operating conditions, the rotary drill is \$2 to \$6 per foot cheaper, and under winter conditions, when water supply is difficult, rotary drilling was from \$5 to \$15 per foot cheaper.

GEOLOGICAL SAMPLES

The sampler collected a small portion of the coarse and fine cuttings from the Elenburg Sampler at each sample interval. This was placed in a soil sample bag with the hole number and sample footage marked on the outside. The samples were examined by a geologist at the end of the shift for grade estimation and hole control. Grade

estimation was very difficult due to very fine grained chalcocite which coats chalcopyrite and pyrite.

The geological sample was sieved with a spaghetti strainer to obtain coarse and fine fractions. A portion of the fine fracture was panned to obtain a heavy mineral concentrate. To facilitate sulphide recognition and grade estimation, magnetite was removed with a magnet. The three fractions of the cuttings were glued with "Bond Fast" to sludge boards and displayed, together with footage, geology and assays, as a visual log at a scale of 1 inch to 10 feet.

Geological examinations of the 3 fractions of cuttings were carried out with the aid of a binocular microscope and variable intensity lamp. The host rock and alteration were determined from the coarse fraction. The fine fraction is useful in determining the bottom of the leached cap, where a discernable colour change is often evident. Mineralization is examined in the concentrate and coarse fraction.

Operational drill records and geological data was recorded on a computer coded form, (Chapman, Wood and Griswold Form 71 - 02). Under good conditions and after some initial experience a minimum of about 15 minutes was required for the examination and logging of each 15 foot sample.

Hindsight suggested that logging of rotary drill cuttings could have been aided by comparison with rock chip boards previously prepared from crushed diamond drill core.

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