520455

1991 SUMMARY REPORT ON THE ROO 1-3 CLAIMS: A STRATABOUND COPPER-COBALT-SILVER EXPLORATION TARGET

Located in the East Kootenay District
Fort Steele Mining Division
NTS 82G/2W, 3E
49° 01′ North Latitude
115° 00′ West Longitude

-prepared by-
Henry J. Awmack, P.Eng.

June, 1991

1991 SUMMARY REPORT ON THE ROO 1-3 CLAIMS

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1.0 INTRODUCTION

The Roo 1-3 claims were staked in April 1989 over copper showings located on Phillipps Creek, five kilometres northeast of Roosville in the Fort Steele Mining Division of southeastern British Columbia (Figure 1). The Roo copper showings are hosted by Proterozoic sandstones and conglomerates immediately below a stromatolitic horizon, demonstrating several characteristics in common with Kupferschiefer-type copper deposits. Several Kupferschiefer-type copper-silver deposits have been discovered in the last few years, stratigraphically lower in the same Proterozoic basin in northwestern Montana. In 1989, Noranda announced its purchase of 55% of the Montanore deposit, near Libby Montana, for $63 million. This deposit has drill-indicated reserves of 130 million tonnes grading 0.78% copper and 78.5 grams silver per tonne (Noranda, 1989).

2.0 STRATABOUND, KUPFERSCHIEFER-TYPE COPPER DEPOSITS

Kupferschiefer-type copper deposits, although not important in Canada, account for 20-25% of world copper reserves, in large-tonnage, moderate-grade orebodies, with varying quantities of co-product silver and cobalt. Examples include: Kolwezi Klippe in Zaire with 880 million tonnes of ore grading 4.5% copper and 0.4% cobalt; Nkana in Zambia, with 260 million tonnes of ore grading 3.06% copper and 0.16% cobalt; and White Pine in Michigan, with 322 million tonnes grading 1.1% copper and 7.4 g/tonne silver (Kirkham, 1989). Spar Lake, hosted by Middle Proterozoic quartzites approximately 100 kilometres southwest of the Roo claims in Montana, contained 58 million tonnes of ore grading 0.76% copper and 58 g/tonne silver prior to commencement of mining (Hayes and Einaudi, 1986). These deposits are hosted by very distinctive lithological sequences within a restricted geological and tectonic environment. All major deposits are Middle to Upper Proterozoic or Permian in age.

Renfro (1974) recognized five general characteristics of Kupferschiefer-type copper deposits. Each deposit is:

> "(1) Contained within strata that accumulated along the shoreward fringe of a shallow, semirestricted marine lagoon or inland sea.
> (2) Hosted by reduced, grey to black sandstone, shale, or dolomite that generally is stromatolitic.
> (3) Underlain by red-bed or otherwise oxidized continental clastic sediment.
> (4) Overlain by strata that contain dolomite, gypsum, anhydrite, and/or halite.
> (5) Laterally and vertically zoned with respect to metal content."

Renfro (1974) also notes that all major deposits are associated with copper-enriched source rocks. "Terrigenous clastics underlying

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ROO 1-3 CLAIMS

PROPERTY LOCATION MAP

FORT STEELE MINING DIVISION, B.C.

0 100 200 MILES

0 100 200 300 KILOMETRES

EQUITY ENGINEERING LTD.

Drawn J. W.	N.T.S. 82 G/2W,3E	Date JUNE, 1991	FIG. No. 1.

metalliferous deposits in the Roan, the Dzhezkazgan, and the Kupferschiefer were derived from metal-enriched, igneous sources". Gustafson and Williams (1981) also show that all important deposits of this type are hosted within intracratonic basins, commonly associated with rifting.

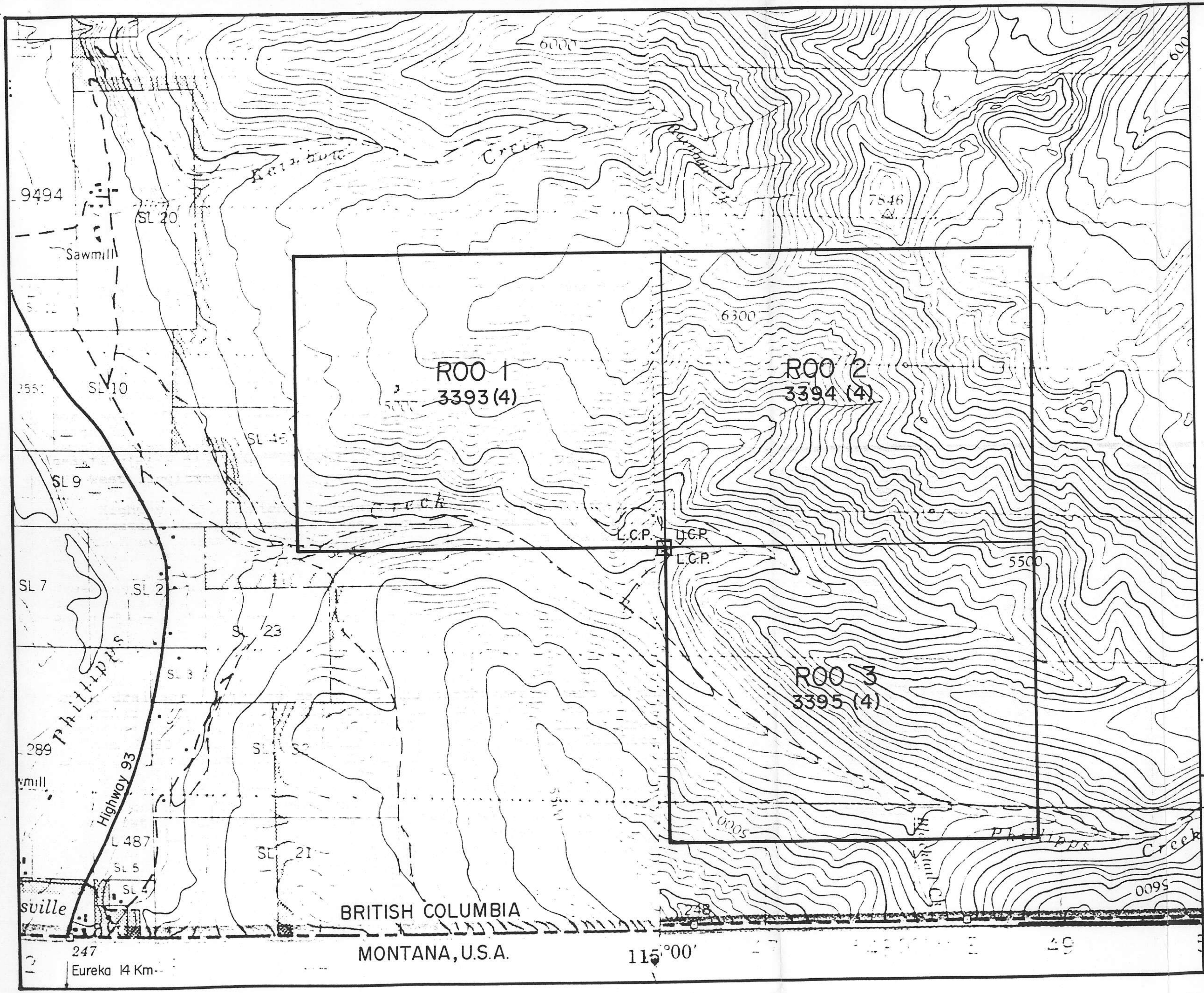
Renfro (1974) suggests a simple genetic model for Kupferschiefer-type copper deposits, based upon modern sabkha environments, such as occur along the Persian Gulf. Coastal sabkhas form along the supratidal margins of regressive shorelines in a hot, arid environment. They are underlain by saturated, porous and permeable coastal sediments, capable of transporting water to the surface for evaporation. Sabkhas are essentially flat, rising no more than a metre or two above high tide level. Below the high tide level, the mudflat is generally covered by a mat of blue-green algae, which may transgress laterally over the continental sediments. Lithification produces continental, oxidized sandstones (red-beds) overlain by stromatolitic dolomites, fine-grained organic-rich clastic sediments, evaporites and grey, reduced sandstones, commonly in several cycles of transgression and regression.

In Renfro's model, metal-enriched source rocks underlying the sabkha are leached by groundwater which is then transported by evaporation through the permeable redbeds towards the surface. Hydrogen sulphide, from decaying algae, reduces the dissolved metals to form metallic sulphides in proximity to the organic-rich sediments. The copper sulphides show a distinct zoning from chalcocite through bornite to chalcopyrite upwards and basinwards, related to their solubility in the presence of hydrogen sulphide. Other diagenetic models differ mainly in the mechanism for transporting the oxidised, metal-bearing groundwater to the reduced strata, invoking formation dewatering during compaction, paleotopographic hydraulic head in fluvial aquifers, release of pressurized formational fluids during tectonism, topographic inversion or thermal pumping (Kirkham, 1989). Different mechanisms may have predominated in producing different deposits.

Kupferschiefer-type copper deposits are roughly stratabound, although mineral zonation crosses bedding planes. They are generally restricted vertically, but very extensive laterally. The Spar Lake deposit, for instance, which is moderate in size, extends laterally for 2,225 metres by 450 metres, with a thickness of 15 to 24 metres (Hayes and Einaudi, 1986).

3.0 LIST OF CLAIMS

Records of the British Columbia Ministry of Energy, Mines and Petroleum Resources indicate that the claims listed in Table 3.0.1 (Figure 2), are owned by Henry Awmack, in trust for Equity Engineering Ltd..



H. J. Awmack

SCALE 1:25,000

m 0 500 1000 1500 m

N

ROO I-3 CLAIMS

CLAIM MAP

FORT STEELE MINING DIVISION, B.C.

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Drawn.	N.T.S.	Date.	FIG. No.
J.W.	82G/2W, 3E	JUNE, 1991	2

TABLE 3.0.1
CLAIM DATA

Claim Name	Record Number	No. of Units	Record Date	Expiry Date
Roo 1	3393	20	Apr. 26, 1989	Apr. 26, 2000
Roo 2	3394	20	Apr. 26, 1989	Apr. 26, 2000
Roo 3	3395	20	Apr. 26, 1989	Apr. 26, 2000
		60		

The location of the common legal corner post for the Roo 1-3 claims has been verified by the author.

4.0 LOCATION, ACCESS AND GEOGRAPHY

The Roo claim group is located on Phillipps Creek in the Galton Range of the Rocky Mountains, approximately five kilometres northeast of the Roosville border post and seventy kilometres southeast of Cranbrook, in the East Kootenay district of southeastern British Columbia (Figure 1). It lies within the Fort Steele Mining Division, centred at 49° 01′ north latitude and 115° 00′ west longitude.

Highway 93, which connects Cranbrook and Fernie to northwestern Montana, passes less than one kilometre to the west of the Roo 1 claim. A good logging road climbs from the highway up the drainage of Phillipps Creek, passing through the Roo 1 and Roo 3 claims. A new branch road has been built south of Phillipps Creek on the Roo 3 claim for clearcut logging and a second one climbs the western face of the ridge immediately southwest of the Roo 3 claim. Older spur roads and Cominco's trenching road provide access to most of the Roo 1 and 3 claims, including most of the known copper showings.

The Roo 1-3 claims lie almost entirely within the Phillipps Creek drainage, confined mainly to the northwestern part of the watershed (Figure 2). Topography is moderately steep, with elevations ranging from less than 1000 metres on Phillipps Creek to over 2280 metres on the ridge which separates the Phillipps Creek drainage from the Wigwam River drainage on the Roo 2 claim.

The property is covered by open forest composed of lodgepole pine, Douglas fir, ponderosa pine and alder, with little undergrowth. Summers are hot and dry, but winters are cold, with moderate snowfall. The copper-bearing horizon, located at approximately 1500 metres elevation, is snow-free on south-facing slopes by late April and on north-facing slopes by mid-May of each year.

5.0 PREVIOUS WORK

The first reported work on the Roo property dates from 1902, with four claims

> "on a lead which can be traced for miles along the mountain side. The ore is a rich sulphide of copper with much black oxide, and lies between syenite and porphyry walls. The work for this year consists of: Georgia, shaft continued 10 feet; Copper Giant, 12 feet of shaft; Montana, 50 feet of tunnel, and Belle Vue, shaft continued to a depth of 50 feet" (BCDM, 1902).

These workings were directed at quartz-chalcopyrite-chalcocite-barite veins. No further work is documented until 1967, but Wolfhard (1967) reports a total of four short shafts, four adits up to 30 metres in length and six open cuts completed before 1940, with shipment of one carload of barite in the 1920's or 1930's.

In 1967, Cominco re-evaluated the copper occurrences for their porphyry potential with geological mapping, soil sampling and five bulldozer trenches. They concluded that the veins were economically uninteresting, but recognized significant stratabound disseminated mineralization associated with the contact between sandstone and stromatolitic dolomite (Wolfhard, 1967). However, Cominco believed the mineralization to be due to syenitic dyking and allowed their claims to lapse.

The Roo 1-3 claims were staked in 1989 and optioned immediately to Teck Corporation Ltd., which carried out 18 days of geological mapping, sampling and backhoe trenching in September of that year. They excavated eight backhoe trenches totalling 250 metres within coarse sandstone and conglomerate near their contact with the overlying stromatolitic dolomite. All but one of these trenches intersected significant copper mineralization, with up to 1.93% copper and 579 ppm cobalt across 6.0 metres. Unfortunately, all trenching was carried out in an area of 80 metres by 100 metres, leaving over 7,000 metres of this contact untested. Soil samples were taken in the immediate area of the backhoe trenching, at ten-metre spacings along five lines spaced roughly 75 metres apart and cutting across stratigraphy (Thompson, 1990a).

In 1990, Teck carried out limited geological mapping and sampling and drilled 605.6 metres of NQ core in eight holes (Thompson, 1990b). The drilling was carried out from three drillsites, spaced approximately 570 metres apart on the Roo 1 claim. Holes from each drillsite intersected significant copper values, with the best intersection grading 0.81% copper over 11.05 metres. Soil samples taken immediately below the sandstone/stromatolite contact on the southwestern corner of the Roo 3 claim returned anomalous copper and cobalt values of a similar magnitude to those marking significant copper mineralization in the trenched area. Teck dropped the option upon completion of the drill program, although Thompson (1990b) recommended that "further exploration be carried out along the Lower-Upper Sheppard Formation interface to locate greater thicknesses or different styles of copper mineralization".

The unsampled drill core was briefly examined by the author in May 1991, and five more intervals were split, without returning more than traces of copper. Two float samples were taken from the vicinity of the anomalous soil samples in the southwestern corner of the Roo 3 claim, returning up to 2060 ~~ppb~~ copper.

ppm ?

6.0 REGIONAL GEOLOGY

The Belt/Purcell Supergroup comprises up to 15,000 metres of Middle Proterozoic clastic and carbonate sediments, which extend over the East Kootenay area of south-eastern British Columbia, northern Idaho and northwestern Montana. They were deposited in an intracratonic basin, which may have been related to rifting. In the Galton Range of the East Kootenays, on the eastern margin of the Rocky Mountain Trench, this sequence consists of Helikian sandstones, argillites and dolomites (Figure 3).

The Siyeh Formation (Unit 7) is composed predominantly of fine-crystalline dolomite and limestone, with thin upper and lower members of green argillite. Overlying the Siyeh Formation are up to 180 metres of basaltic flows (Unit 5b) termed the "Purcell Lavas" by Price (1961) and the "Nicol Creek Formation" by Hoy and Carter (1988). This unit includes pillowed, vesicular or amygdaloidal flows ranging from andesite to basalt in composition.

The Sheppard Formation (Unit 8), termed the "lower member of the Gateway Formation" by Leech (1960) and subdivided into the Snowslip and Shepard Formations by Whipple (1984), unconformably overlies the Nicol Creek Formation, with a total thickness of approximately 50 metres. It consists of a basal conglomerate overlain by "light-coloured, dolomitic and quartzitic, fine-or medium-grained quartz sandstone, dolomite and oolitic dolomite [Whipple's Snowslip Fm.]. The upper part [Whipple's Shepard Fm.] comprises light-coloured very fine crystalline dolomite, sandy and silty dolomite, and stromatolitic dolomite with minor amounts of dolomitic sandstone" (Price, 1961).

The Gateway Formation upper member (Unit 8) is composed of about 300 metres of greenish grey and grey argillaceous siltstones in thin beds with partings of red argillite. Salt casts, mud-cracks, ripple marks and intraformational conglomerates are common.

The Phillips Formation (Unit 9) consists of 200 metres of red and purplish red quartz sandstone and siltstone, with partings of argillite and micaceous argillite. These are gradational into the overlying Roosville Formation (Unit 10), which consists of over 1000 metres of green and grey argillite, siltstone and sandstone

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LEGEND

QUATERNARY
PLEISTOCENE AND RECENT

30 Till, gravel, sand, silt, alluvium

MISSISSIPPIAN

26 26 Undifferentiated Exshaw and Banff formations and Rundle group. 26a EXSHAW FORMATION: black shale, black limestone; BANFF FORMATION: dark cherty limestone and laminated silty limestone, grey limestone, limy siltstone, fetid in part; 26b RUNDLE GROUP: grey crystalline limestone, crinoidal in part, dark fine-grained limestone, cherty in part, all commonly fetid

DEVONIAN
UPPER DEVONIAN

25 PALLISER FORMATION: Lower (main) Member: massive mottled grey limestone, nodular limestone; Upper Member: thin-bedded nodular shaly limestone

24 Basal beds: buff-and orange-weathering dolomite, sandy dolomite, sandstone (may be older); FAIRHOLME GROUP: Lower Part: fine grained black and grey limestone, stromatolitic and coralline in part, dolomite; Upper Part: shale and limestone; ALEXO FORMATION: sandstone and sandy limestone, argillaceous limestone

ORDOVICIAN AND SILURIAN
UPPER ORDOVICIAN AND LOWER AND (?) MIDDLE SILURIAN

20 BEAVERFOOT-BRISCO FORMATION: dolomite, limestone, conglomerate locally at base, thin graptolitic shale near top

CAMBRIAN AND ORDOVICIAN
UPPER CAMBRIAN AND LOWER ORDOVICIAN

18 Mc KAY GROUP: limestone, shale, intraformational limestone conglomerate

CAMBRIAN
MIDDLE AND/OR UPPER CAMBRIAN

17 JUBILEE AND ELKO FORMATIONS: dolomite

MIDDLE CAMBRIAN

16 BURTON FORMATION: shale, limestone, sandstone, conglomerate at base

PURCELL

12 MOUNT NELSON FORMATION: argillite, dolomite, quartzite

10 ROOSVILLE FORMATION: laminated green argillite and siltstone, dolomitic in part, laminated black and grey argillite, grey quartzite, orange-weathering grey dolomite and grey-weathering limestone, both commonly stromatolitic and oolitic

9 PHILLIPS FORMATION: red quartzite, siltstone, and argillite

8 GATEWAY FORMATION: grey and green argillite and siltstone, partly dolomitic, grey quartzite; buff and orange weathering dolomite, commonly stromatolitic and in part oolitic; conglomerate; 8a, lower contact may be above base of rest of Gateway formation

11 DUTCH CREEK FORMATION: equivalent to units 8, 9, and 10

5 5a, green, grey, and purple siltstone, argillite, and quartzite, 5b, chiefly andesitic lava, breccia, and tuff except in Purcell Mountains south of latitude 49°30' where accompanied by green and grey argillite and siltstone, dolomitic in part, and quartzite

6 | 7 6 Comprises units 4 and 5 undivided
7. SIYEH FORMATION: red-weathering grey dolomite and argillaceous dolomite, grey dolomitic argillite and siltstone; quartzite, green argillite, grey-weathering grey limestone. Equivalent to 5a and part (most ?) of 4

4 KITCHENER FORMATION: grey and green argillite and dolomitic argillite, grey dolomite, sandy in part (dolomitic rocks weather buff to brown); quartzite; grey limestone

Rock outcrop
Geological boundary (defined, approximate, assumed)
Limit of geological mapping
Bedding (horizontal, inclined, vertical, overturned)
Bedding (dip known, top unknown)
Fault (defined, approximate, assumed)
Anticline (defined, approximate; showing direction of plunge of axis)
Anticline, overturned (showing dip of limbs, trace of crest plane, and approximate direction of plunge of crest line)
Syncline (defined, approximate; showing direction of plunge of axis)
Syncline, overturned (showing dip of limbs, trace of trough plane, and approximate direction of plunge of trough line)

Geology after Leech (1960) and Price (1961)
SCALE 1:126,720
Km 0 1 2 4 Km

ROO 1-3 CLAIMS
REGIONAL GEOLOGY
FORT STEELE MINING DIVISION, B.C.

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Drawn.	N.T.S.	Date.	FIG. No.
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with lesser argillaceous and stromatolitic dolomite.

7.0 PROPERTY GEOLOGY AND MINERALIZATION

7.1 Geology

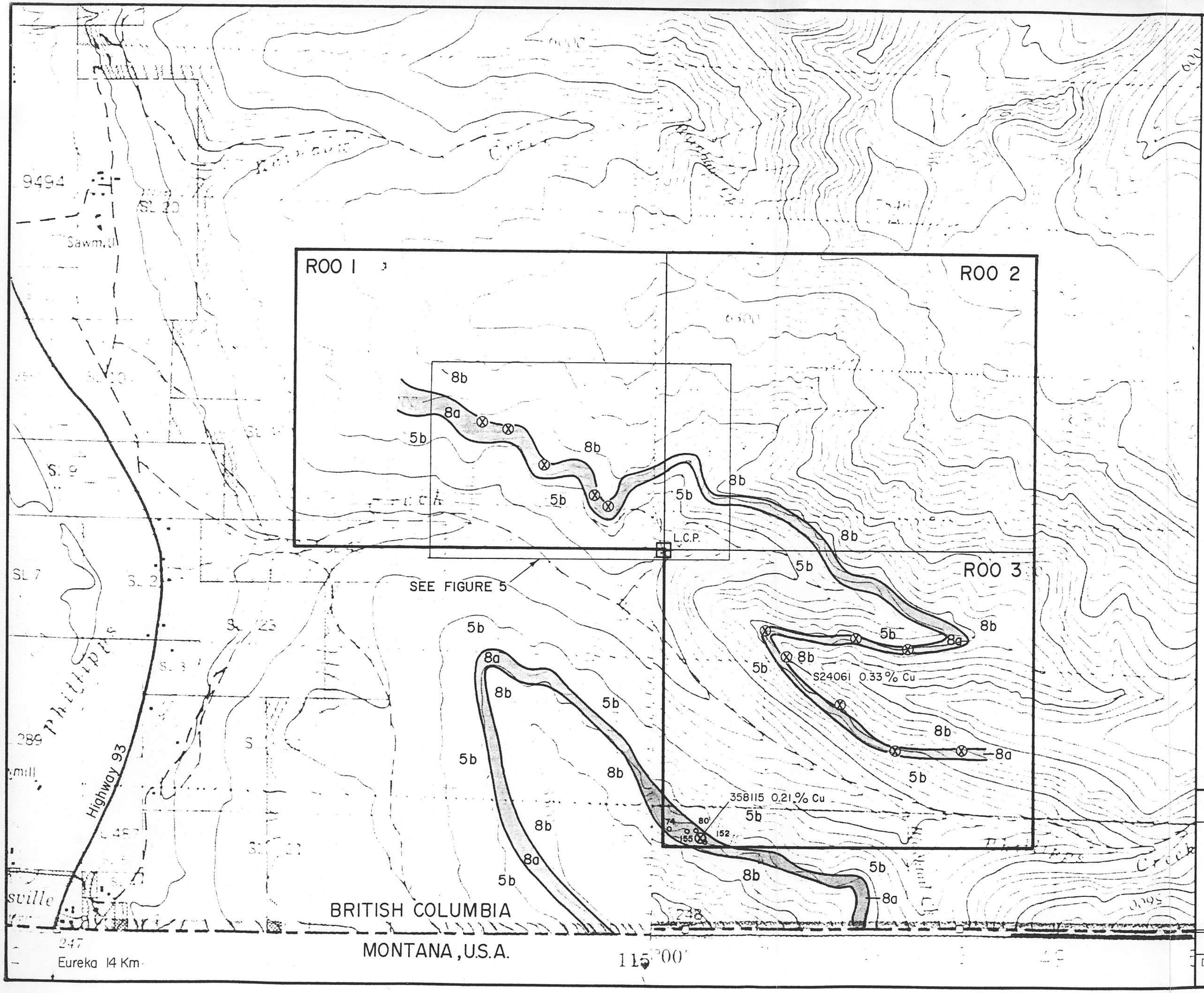
Wolfhard (1967) recognized three Proterozoic volcanic and sedimentary rock units on the Roo property (Figure 4). The oldest is the basaltic Nicol Creek Formation (Unit 5b), which is composed of

> "a lower pillowed unit 80 feet thick, overlain by green amygdaloidal volcanics and purple massive and amygdaloidal volcanics. The abundance of purple rocks increases up section. The upper 50 feet occasionally contains lenticular beds of angular to sub-rounded volcanic detritus of coarse sand size."

The Nicol Creek basalts are unconformably overlain by Sheppard Formation clastic sediments and dolomites, subdivided by Wolfhard (1967) into two units.

> "The lower unit [Unit 8a] varies from 15 feet to 300 feet in thickness. In the thicker parts, the section includes a basal conglomerate, overlain by purple siltstones and sandstones, probably composed mainly of volcanic detritus, weathered very little chemically before deposition. Higher up section, sediments grade to arkose, feldspathic sandstone, quartz sandstone, and sub greywacke. Medium to thick bedded, cross-bedded and current ripple marked, quartzitic and dolomitic sandstones usually complete the upper 10 to 30 feet of the section....
>
> The upper Sheppard [Unit 8b] begins at the base of the first stromatolitic dolomite above the top of the Purcell lavas. Above this 5 to 15 foot member, the unit includes 20 to 40 feet of medium bedded grey quartzite with minor argillite and siltstone. Cross bedding and ripple marks are fairly common. The quartzite is overlain by a second 5 to 15 foot stromatolitic dolomite, followed by 10+ feet of red siltstone and dolomitic sandstone. The top is not exposed."

Wolfhard (1967) interpreted a very shallow anticline in the Nicol Creek Formation, with an amplitude of 160 metres and wave length of approximately two kilometres. The Sheppard Formation is gently warped, with dips up to 15° to the east. Wolfhard (1967) noted a few northerly-trending normal faults with vertical displacement of one to six metres and a thrust fault dipping 10°-15° to the west with a maximum horizontal movement of 30 metres. Another flat-lying fault of unknown displacement is apparent in



LEGEND

PROTEROZOIC

8b	Sheppard Formation (Upper unit) Stromatolitic dolomite, quartz sandstone, siltstone
8a	Sheppard Formation (Lower unit) Conglomerate, sandstone, siltstone
5b	Nicol Creek Formation Massive and amygdaloidal basalt
⊗	Copper occurrence
○80	Soil sample (Cu in ppm)

Geology after Wolfhard (1967), as modified by Thompson (1990a, b)

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N

SCALE 1:25,000

m 0 500 1000 1500 m

ROO 1-3 CLAIMS

GEOLOGY AND MINERALIZATION

FORT STEELE MINING DIVISION, B.C.

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Drawn.	N.T.S.	Date.	FIG. No.
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Trench 5 and drill holes R90-01 to -05.

7.2 Mineralization

Disseminated chalcopyrite occurs in all lithologies on the Roo property with the exception of the massive Nicol Creek basalt and the basal conglomerate of the lower Sheppard unit (Figures 4 and 5). However, the most significant copper mineralization is hosted by sandstones and conglomerates near the upper contact of the lower Sheppard Formation. This style of mineralization consists of disseminated chalcocite (locally chalcopyrite), barite and ankerite filling interstitial pore space between rounded quartz, feldspar and volcanic clasts which are unaltered or weakly sericitized. The highest grade mineralization appears to be associated with coarser sediments and abundant intergranular ankerite. Some of the chalcocite coats chalcopyrite grains, but whether this is primary (diagemetic) or supergene is not yet clear. Chalcopyrite was noted within clasts in only one location, at 25.3 metres in hole R90-04, where it occurs disseminated along fractures but mainly between fragments. Below the chalcopyrite-chalcocite-ankerite mineralization, ankerite content diminishes and hematite becomes more common, with locally abundant pyrite. Chalcocite also forms dendritic blebs in thin, interbedded, dolomitic layers near the top of the clastic unit. In places, malachite staining and sparse disseminated chalcopyrite extend upwards into the lowermost metre of stromatolitic dolomite above the top of the lower Sheppard unit.

All significant trench and drill intersections are from sandstone- or conglomerate-hosted stratabound mineralization, with several multi-metre sections exceeding 1% copper. Sparse disseminated blebs of carrollite(?) or cobaltite(?) have been noted in drill core along with chalcopyrite, accounting for elevated cobalt values of up to 2000 ppm. Silver values generally range from two to seven ppm, with a maximum value of 33.8 ppm. Barium, nickel and chromium are geochemically anomalous with up to 5260 ppm, 846 ppm and 460 ppm, respectively. Although none of these elements show an exact correlation with copper, high copper values are generally accompanied by high values for the other elements. Three copper-bearing samples were analyzed in 1991 for gold, platinum and palladium without returning significant values. All values, including those from drilling, have been affected to some extent by oxidation and surface weathering. At this point, it is not known whether these values represent protore grades, or whether the protore has been enriched or depleted in individual elements.

Backhoe trenching was carried out in an area of 80 metres by 100 metres in 1989 (Figure 6). True widths of the stratabound mineralization cannot be determined from the available trench maps (Thompson, 1990a), but the intersections summarized in Table 7.2.1 provide an indication of the extent and grade of mineralization in that particular area. In several sections assaying greater than one percent copper, no copper mineralization whatsoever was observed (eg. TR89-04: sample 20405 with 2.44% Cu), or only weak malachite staining was noted. It seems likely that the copper values are due to unobserved chalcocite. More than half of the rock exposed by trenching was not sampled, including several sections with observed malachite, and the true extent of copper mineralization may have been greater than recognized.

TABLE 7.2.1
SIGNIFICANT TRENCH RESULTS

Trench	Length (m)	Copper (%)	Cobalt (ppm)	Silver (ppm)	Barium (ppm)
TR89-01	4.0	1.70 ($34)	338 ($10.50)	3.2 ($0.40)	1325 $44.50 US
TR89-02	1.0	0.30	129	<0.2	1410 ~$11.00
TR89-03		No significant intersections			
TR89-04	6.0	1.58 (31.60)	1310 (41.60)	4.6 (0.60)	2998 $73.80
TR89-05	2.0	0.71 (14.20)	1084 (32.00)	3.1 (0.50)	2530 $46.70
TR89-06	5.0	0.39	338	1.5	1010 $18.70
TR89-07	6.0	1.93	708	5.2	1170 $61.90
TR89-08*	3.0	0.62	44	4.7	2703

* Not entirely stratabound mineralization: cut by several 5-20 centimetre quartz-chalcopyrite-chalcocite-barite veins.

Wolfhard (1967) reported copper occurrences along 7,000 metres of the lower/upper Sheppard Formation contact on the north side of Phillipps Creek (Figure 4). Most of these occurrences have not been re-located or re-sampled. Essentially all the 1989 and 1990 work was confined to 1,200 metres strike length between the trenched area and the drillsite for holes R90-07 and -08. Between Phillipps Creek and the Montana border, this upper/lower Sheppard Formation contact is exposed along 4,500 metres. Only a small portion is currently covered by the Roo property and essentially no exploration has been carried out along it. A limited follow-up of anomalous soil samples by the author on the southwestern corner of the Roo 3 claim yielded a proximal float sample of coarse sandstone and conglomerate with intergranular ankerite, chalcopyrite and chalcocite. The float, which contained 0.21% copper, is very similar stratigraphically, mineralogically and texturally to that drilled north of Phillipps Creek.

The original work on the Roo property was directed at narrow quartz±barite veins containing scattered patches of chalcocite and chalcopyrite. Wolfhard (1967) noted an "apparent concentration of chalcopyrite in them near the upper contact of the lower Sheppard (2% Cu over 1′ for best material)". Within the hematitic alteration below the disseminated chalcocite-ankerite zone, these quartz veins contain abundant specular hematite rather than chalcocite or chalcopyrite. The intersection in Trench TR89-08 (Table 7.2.1 above) shows similar copper, silver and barium grades to the stratabound mineralization, but much lower cobalt and nickel values. A medium-grained pink trachyte dyke, composed mainly of orthoclase, ankerite and quartz, contains disseminated chalcopyrite and is associated with the quartz-barite-chalcopyrite-chalcocite veining near the drillsite for holes R90-07 and R90-08 (Figure 5). It graded 0.19% copper, 2.0 ppm silver and 314 ppm cobalt across 2.4 metres in 1989 grab sample 24098.

Wolfhard (1967) believed that the copper mineralization on the Roo property was genetically related to the syenite dykes which are associated with some of the quartz veining. In fact, this mode of vein mineralization is consistent with other red-bed deposits, where sulphides are remobilized from pre-existing stratabound mineralization. At the Spar Lake deposit in Montana, "veins of quartz, many with a little carbonate, also carry sulfides where they intersect mineralized beds. The sulfide in the vein is almost invariably the same sulfide as that which occurs in the adjacent wall rock" (Garlick, 1988). In this respect, it is interesting to note that the quartz veins on the Roo property are mineralized only where they cut the mineralized strata around the lowest stromatolite horizon, and that the chalcocite-chalcopyrite assemblage in the veins mirrors that of the disseminated stratabound mineralization. It appears that the syenite dyking is insufficient to account for the Roo copper occurrences, but may have generated the quartz veins which remobilized copper from the mineralized strata.

8.0 GEOCHEMISTRY

low Cu in soils

In 1989, five short soil lines were run across stratigraphy from the basalts upslope to the base of the stromatolitic dolomites in the area of the 1989 trenching (Thompson, 1990a). A total of 114 soil samples were taken at ten metre intervals along these lines, which covered a strike length of just 300 metres. These soil samples returned low copper values, generally in the range of 10 to 30 ppm. The presence of very significant copper mineralization in the trenches was marked by four soil samples exceeding 50 ppm copper, with the highest ones returning 87 and 93 ppm copper. Soil samples taken from areas underlain by basalt contained 20 to 40 ppm copper, discounting the hypothesis that anomalous copper values elsewhere on the property are due to a higher background level over the basalts. Cobalt and silver values for soil samples in the trenched area are low and randomly-distributed, ranging from 5 to 17 ppm cobalt and from below detection to 0.6 ppm silver.

In 1990, a further 29 soil samples were taken from the Roo property. Ten of these samples were taken from a line 50 metres west of the 1989 soil lines, and parallel to them. Copper and cobalt values were low. Nine were taken along the base of the stromatolitic horizon on the southwest corner of the Roo 2 claim, also returning low values. Ten were taken from the southwestern corner of the Roo 3 claim, from an area of quartzite and orthoclase, ankerite and quartz, contains disseminated chalcopyrite and is associated with the quartz-barite-chalcopyrite-chalcocite veining near the drillsite for holes R90-07 and R90-08 (Figure 5). It graded 0.19% copper, 2.0 ppm silver and 314 ppm cobalt across 2.4 metres in 1989 grab sample 24098.

Wolfhard (1967) believed that the copper mineralization on the Roo property was genetically related to the syenite dykes which are associated with some of the quartz veining. In fact, this mode of vein mineralization is consistent with other red-bed deposits, where sulphides are remobilized from pre-existing stratabound mineralization. At the Spar Lake deposit in Montana, "veins of quartz, many with a little carbonate, also carry sulfides where they intersect mineralized beds. The sulfide in the vein is almost invariably the same sulfide as that which occurs in the adjacent wall rock" (Garlick, 1988). In this respect, it is interesting to note that the quartz veins on the Roo property are mineralized only where they cut the mineralized strata around the lowest stromatolite horizon, and that the chalcocite-chalcopyrite assemblage in the veins mirrors that of the disseminated stratabound mineralization. It appears that the syenite dyking is insufficient to account for the Roo copper occurrences, but may have generated the quartz veins which remobilized copper from the mineralized strata.

8.0 GEOCHEMISTRY

In 1989, five short soil lines were run across stratigraphy from the basalts upslope to the base of the stromatolitic dolomites in the area of the 1989 trenching (Thompson, 1990a). A total of 114 soil samples were taken at ten metre intervals along these lines, which covered a strike length of just 300 metres. These soil samples returned low copper values, generally in the range of 10 to 30 ppm. The presence of very significant copper mineralization in the trenches was marked by four soil samples exceeding 50 ppm copper, with the highest ones returning 87 and 93 ppm copper. Soil samples taken from areas underlain by basalt contained 20 to 40 ppm copper, discounting the hypothesis that anomalous copper values elsewhere on the property are due to a higher background level over the basalts. Cobalt and silver values for soil samples in the trenched area are low and randomly-distributed, ranging from 5 to 17 ppm cobalt and from below detection to 0.6 ppm silver.

In 1990, a further 29 soil samples were taken from the Roo property. Ten of these samples were taken from a line 50 metres west of the 1989 soil lines, and parallel to them. Copper and cobalt values were low. Nine were taken along the base of the stromatolitic horizon on the southwest corner of the Roo 2 claim, also returning low values. Ten were taken from the southwestern corner of the Roo 3 claim, from an area of quartzite and conglomerate immediately downhill from the main stromatolitic horizon. Five of these returned copper values above 50 ppm, including 152 and 155 ppm. Cobalt values were also elevated, with up to 54 ppm. Rock fragments from one of these soil pits contained 0.21% copper with 147 ppm cobalt.

The low and erratic soil geochemical expression of the copper-bearing sandstones can be attributed to several factors. Soil is poorly developed on much of the property, with little red-brown B horizon noted in road cuts. In the area of trenching and drilling, topographic spurs (such as the drillsites for holes R90-01 to -05 and R90-07 to -08) are covered by residual soil with reasonably good B horizon development. Between these spurs, outcrop is masked by stabilized talus slopes whose soil samples reflect downslope dispersion from above the favourable strata, rather than from bedrock. However, even where the samples were taken from the B horizon of residual soil above copper-rich bedrock, anomalous copper levels are very low relative to the copper grade of the underlying mineralization. For instance, abundant mineralization exceeding 1% copper in the trenched area is indicated by just four soil samples in the range of 50 to 93 ppm copper . The low copper levels in soil samples may reflect abnormal weathering and chemical conditions in the area. In this respect, the scarcity or absence of malachite, even on heavily-weathered, well-mineralized, chalcopyrite- and chalcocite-bearing outcrops, may be significant. In evaluating future soil geochemistry on the property, samples exceeding 50 ppm copper should be carefully investigated.

Convenient fault?
but should be v. continuous
mineralization.

* Note cobalt values!

9.0 DIAMOND DRILLING

Eight holes were drilled from three drillsites (Figure 5) by Teck in 1990, totalling 605.6 metres of NQ core (Thompson, 1990b). Five holes (R90-01 to -05) were drilled in a fan from the first drillsite, located a few metres above the lowermost stromatolitic dolomite horizon in the area of Teck's 1989 trenching (Figure 6). Excellent intersections were cored in holes R90-04 (11.05 metres grading 0.81% copper) and R90-05 (4.11 metres grading 1.07% copper). As shown in Figure 7, this mineralization is separated from excellent trenching values (up to 6.0 metres grading 1.93% copper) by three blank holes (R90-01 to -03). A flat fault, exposed in a road cut at the site of Trench 5 and marked by fault gouge and poor core recovery in drilling, cuts the mineralized sandstones in each of the drill holes. This fault appears to have offset mineralization such that no significant copper was encountered in holes R90-01 to -03.

Hole R90-06 was collared 470 metres southeast of holes R90-01 to -05 (Figure 5). Although collared well below the lowermost stromatolitic dolomite in an area without much outcrop, this hole intersected 4.62 metres grading 0.89% copper and 1064 ppm cobalt. This intersection extends downwards from the bottom of the 3.0

832 w cobalt.

conglomerate immediately downhill from the main stromatolitic horizon. Five of these returned copper values above 50 ppm, including 152 and 155 ppm. Cobalt values were also elevated, with up to 54 ppm. Rock fragments from one of these soil pits contained 0.21% copper with 147 ppm cobalt.

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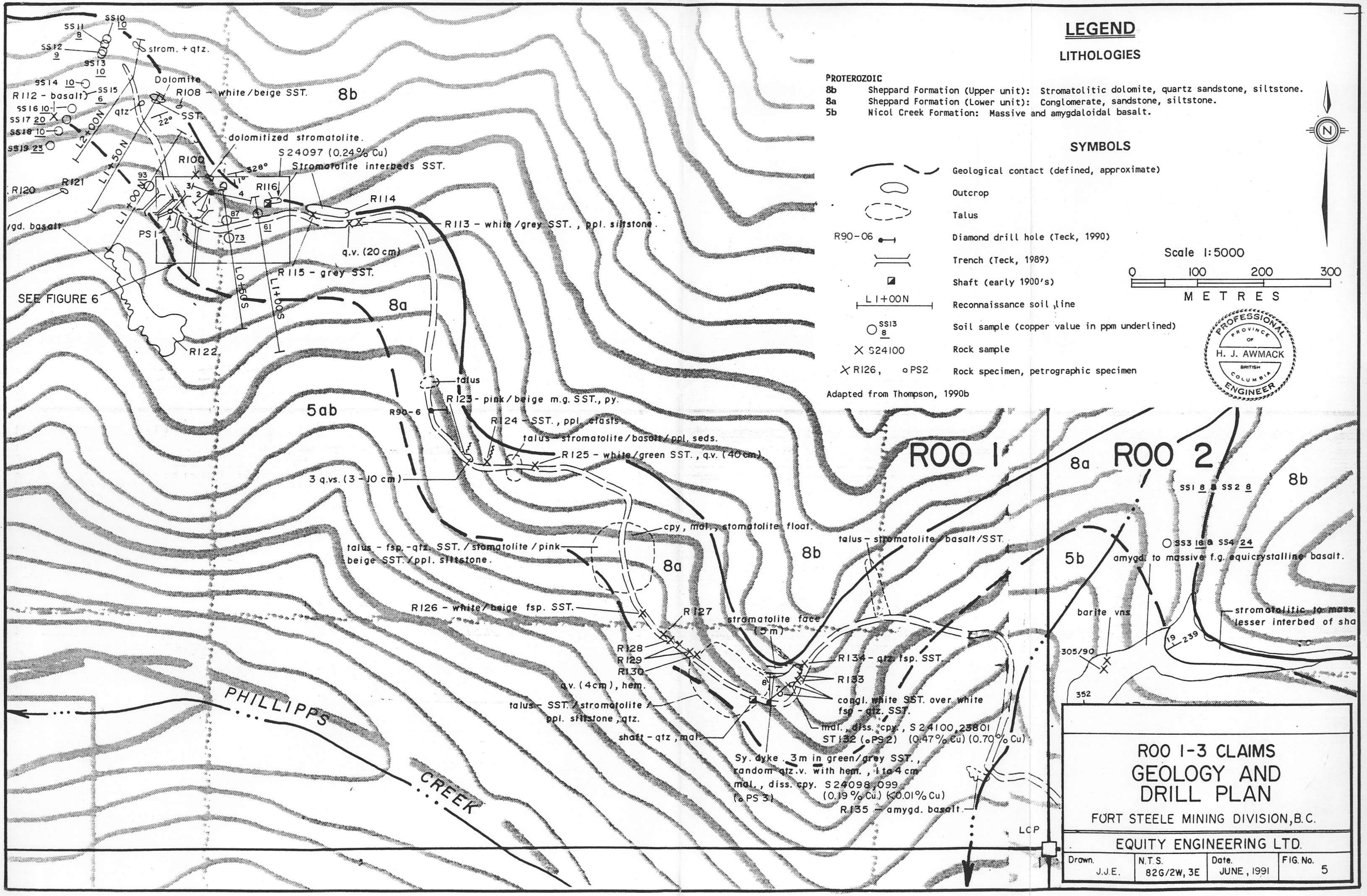
Hole R90-06 was collared 470 metres southeast of holes R90-01 to -05 (Figure 5). Although collared well below the lowermost stromatolitic dolomite in an area without much outcrop, this hole intersected 4.62 metres grading 0.89% copper and 1064 ppm cobalt. This intersection extends downwards from the bottom of the 3.0

[illegible]



LEGEND

LITHOLOGIES

PROTEROZOIC

8b	Sheppard Formation (Upper unit):	Stromatolitic dolomite, quartz sandstone, siltstone.
8a	Sheppard Formation (Lower unit):	Conglomerate, sandstone, siltstone.
5b	Nicol Creek Formation:	Massive and amygdaloidal basalt.

SYMBOLS

	Geological contact (defined, approximate)
	Outcrop
	Talus
R90-06	Diamond drill hole (Teck, 1990)
	Trench (Teck, 1989)
	Shaft (early 1900's)
L1+00N	Reconnaissance soil line
○ SS13 8	Soil sample (copper value in ppm underlined)
× S24100	Rock sample
× R126, ∘ PS2	Rock specimen, petrographic specimen

Adapted from Thompson, 1990b

N

Scale 1:5000

0 100 200 300

METRES

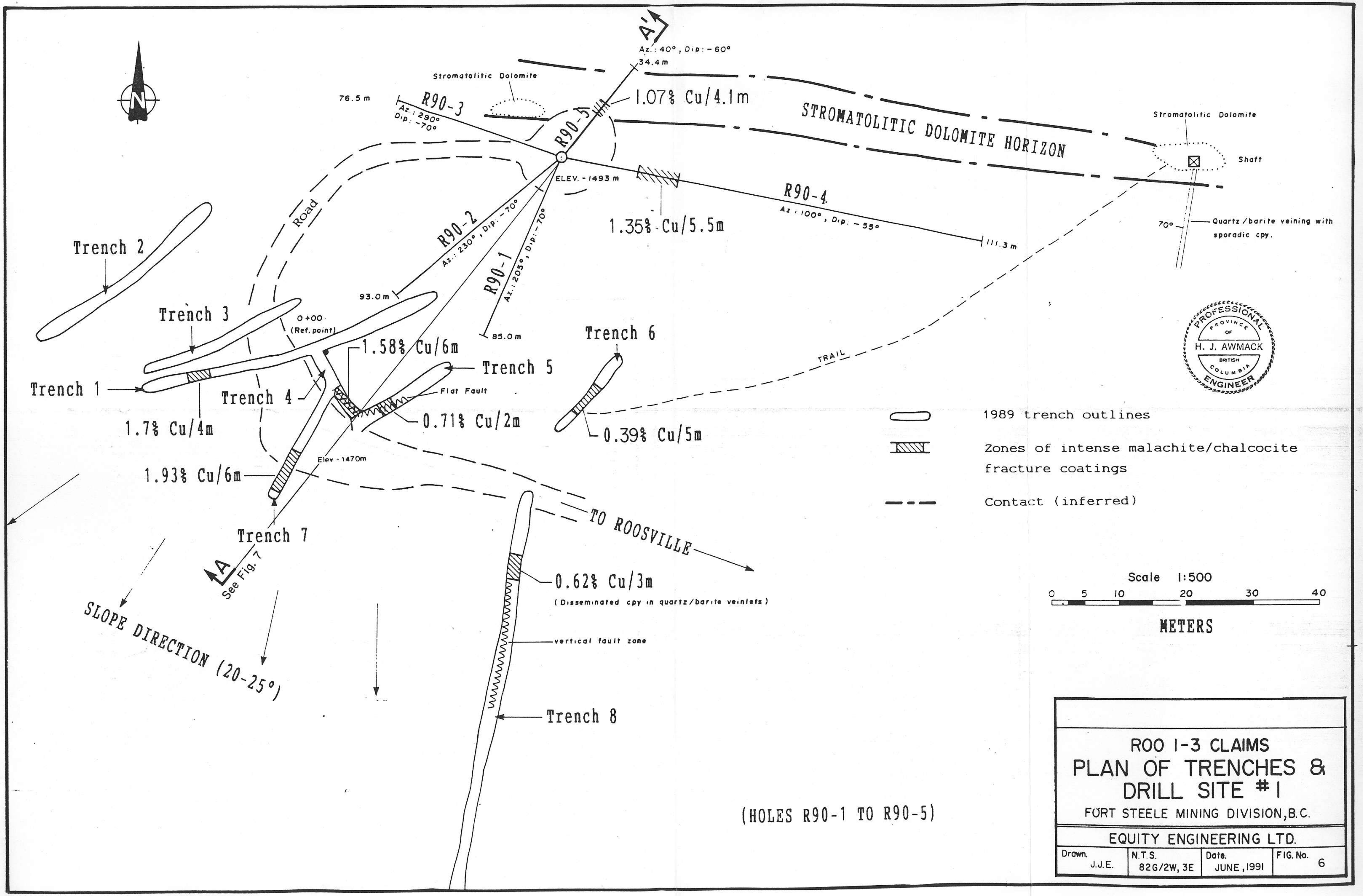
H. J. AWMACK

ROO 1-3 CLAIMS
GEOLOGY AND
DRILL PLAN

FORT STEELE MINING DIVISION, B.C.

EQUITY ENGINEERING LTD.

Drawn.	N.T.S.	Date.	FIG. No.
J.J.E.	82G/2W, 3E	JUNE, 1991	5

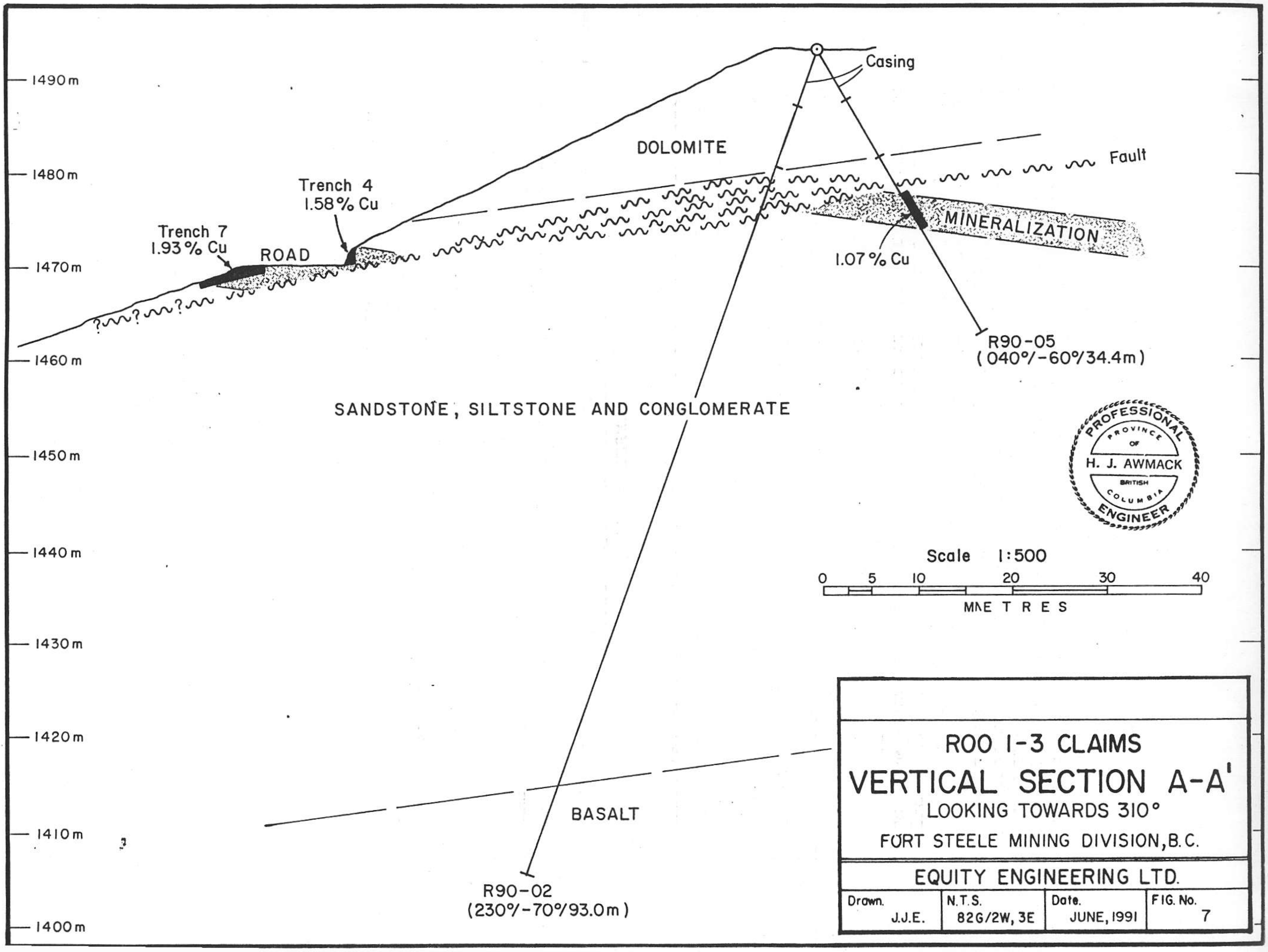


(HOLES R90-1 TO R90-5)

ROO 1-3 CLAIMS
PLAN OF TRENCHES & DRILL SITE #1
FORT STEELE MINING DIVISION, B.C.

EQUITY ENGINEERING LTD.

Drawn.	N.T.S.	Date.	FIG. No.
J.J.E.	82G/2W, 3E	JUNE, 1991	6



H. J. AWMACK

ROO 1-3 CLAIMS

VERTICAL SECTION A-A'

LOOKING TOWARDS 310°

FORT STEELE MINING DIVISION, B.C.

EQUITY ENGINEERING LTD.

Drawn.	N.T.S.	Date.	FIG. No.
J.J.E.	82G/2W, 3E	JUNE, 1991	7

metre drill casing and it is probable that the true vertical extent of mineralization at this site is greater.

Holes R90-07 and -08 were collared a further 670 metres to the southeast. Once again, the holes were collared well below the stromatolitic dolomite horizon. Thirty metres to the east of the drillsite, coarse sandstone and conglomerate with disseminated chalcocite and minor malachite extend upward from road level for at least four metres and possibly up to ten metres, where the base of the stromatolitic dolomite is exposed and malachite stained. The apparent trend of the base of this mineralization would roughly pass through the collar of the two drill holes. As they were cased to a depth of three metres, the core recovered from both holes is entirely in the footwall of the main mineralized horizon.

Significant diamond drill intersections are summarized in Table 8.0.1. True widths can not be accurately estimated, as the orientation of the mineralization is not precisely known. Wolfhard (1967) and Thompson (1990b) show dips of up to 22° (generally 10-15°) to the north, south and east, sometimes with contradictory orientations in the same locations. The true widths calculated in Table 8.0.1 are based on the assumption that the mineralization is horizontal. Data for all core samples are attached in Appendix B.

TABLE 9.0.1
SUMMARY OF DIAMOND DRILL RESULTS

Hole No.	Azimuth (°)	Dip (°)	Total Depth (m)	From (m)	To (m)	Length (m)	True Width (m)	Cu (%)	Co (ppm)	Ag (ppm)	
R90-01	205	-70	85.00	No significant mineralization							
R90-02	230	-70	93.00	No significant mineralization							
R90-03	290	-70	76.50	Not sampled; no apparent mineralization							
R90-04	100	-55	111.25	20.80	31.85	11.05	9.05	0.81	257	4.0	$24.72 US
	including			25.15	30.63	5.48	4.49	1.35	271	5.1	$35.67 US
R90-05	040	-60	34.44	17.68	21.79	4.11	3.56	1.07	974	12.6	$55.05 US
R90-06	090	-70	68.60	3.00	7.62	4.62	4.34	0.89	1064 !	2.6	$50.14
R90-07	050	-60	72.90	16.92	18.13	1.21	1.05	0.89	399	2.6	$30.94
R90-08	000	-45	64.00	No significant mineralization							
Average grades = (weighted)							4,50m	0.98%	536ppm	5.2ppm	$37.43US

10.0 GEOLOGIC AND ECONOMIC POTENTIAL

No reserves can be calculated for the Roo deposit at this early stage of exploration. However, the limited drilling returned encouraging copper and cobalt values over significant widths in three holes along the same well-defined mineralized horizon. Of the other holes, two (R90-07 and -08) were collared below the mineralized horizon and three intersected a flat fault which had displaced the mineralization. From the drilling to date, the Roo mineralization remains open in every direction.

As a very preliminary order-of-magnitude estimate of the potential size of the Roo copper deposit, the average grade and true width of holes R90-04, R90-05 and R90-06 was calculated (5.65 metres grading 0.89% Cu, 614 ppm Co and 5.4 ppm Ag). Mineralization was assumed to extend from 250 metres west of R90-04 to 250 metres east of R90-07 (a total of 1,640 metres) and the same distance into the hill. Assuming a specific gravity of 2.5, this block would contain 38 million tonnes at a grade well exceeding those being mined or developed south of the border at Troy, Rock Creek and Montanore. Given the size and continuity characteristics of Kupferschiefer-type deposits, this estimate, although highly speculative, is not unreasonable.

Table 9.0.1 details the unit metal values for the Spar Lake, Rock Creek and Montanore deposits as compared with the average Roo drill grades outlined above. These deposits, all in operation or under development, are located in a cluster 100 kilometres southwest of the Roo claims, near Libby Montana. They are all hosted within the Revett Formation of the Belt-Purcell Supergroup, stratigraphically below the Roo occurrences. ASARCO reached full production at the Spar Lake deposit in 1982 at a rate of 7,700 tonnes per day, using room-and-pillar methods (Hayes and Einaudi, 1986). Mining and milling costs at Spar Lake are estimated at about US$9/ton (Jackie Stevens, Montana Reserves, pers. comm., 1991). Asarco is permitting the Rock Creek deposit for production upon depletion of reserves at Spar Lake. Noranda is currently driving a five kilometre development adit at Montanore as part of a feasibility study. In Table 9.0.1, current metal prices for copper (US$1.07/lb), cobalt (US$14.15/lb) and silver (US$4.05/oz) have been taken from the May 27, 1991 Northern Miner.

TABLE 10.0.1
COMPARISON OF ROO DRILL GRADES WITH MONTANA DEPOSITS

Deposit	Size	Copper		Cobalt		Silver		Total
	tonnes	%	US$/ton	%	US$/ton	oz/ton	US$/ton	US$/ton
Spar Lake	58,000,000	0.76	$16.26	----	------	1.58	$6.40	$22.66
Rock Creek	131,000,000	0.68	$14.55	----	------	1.66	$6.73	$21.28
Montanore	130,000,000	0.78	$16.69	----	------	2.29	$9.27	$25.96
Roo	Unknown	0.89	$19.05	0.06	$16.98	0.16	$0.65	$36.68

Using the metal prices above to determine copper equivalence ratios for each of these deposits, the Roo property, with 1.71% Cu-equivalent, compares very favourably with those of Spar Lake (1.06% Cu-eq.), Rock Creek (0.99% Cu-eq.) and Montanore (1.21% Cu-eq.).

11. DISCUSSION

The Roo property demonstrates excellent potential to host a significant copper-cobalt±silver deposit of the Kupferschiefer type. These are large tonnage, moderate grade, stratabound deposits characterised by excellent continuity. They are also environmentally friendly, with very low sulphide tailings and negligible quantities of deleterious byproducts, such as arsenic, mercury or antimony. The Roo property exhibits all of the features of Kupferschiefer-type copper deposits:

a) **Age and Tectonic Setting:**
The sediments underlying the Roo claims were deposited in a Proterozoio, intracratonic basin associated with rifting. With few exceptions, all major Kupferschiefer-type deposits are hosted within Proterozoic, intracratonic basins, many of which are associated with rifting.

b) **Geological Setting:**
The Roo copper occurrences are:

1) contained within strata which show indications of shallow-water deposition, such as ripple marks.
2) hosted by reduced(?) quartz sandstone and conglomerate. The reduced nature of the original sediments is not entirely clear, due to surface oxidation and weathering.
3) underlain by a red bed sequence of oxidized, permeable clastic sediments.
4) immediately overlain by easily recognizable stromatolitic dolomite. This entire sedimentary sequence represents a classic sabkha environment, very similar to that present at most Kupferschiefer-type copper deposits.

c) **Metal Source:**
The Nicol Creek basalts are noted for their enrichment in copper. The overlying first-cycle red-bed sediments of the lower Sheppard Formation are largely composed of detritus from these basalts, providing an excellent metal source for subsequent leaching by groundwater in a sabkha environment.

d) **Geochemical Signature:**
No patterns of sulfide mineral zoning in the Roo copper occurrences can be determined from the work to date. However, the presence of hypogene copper and cobalt sulphide minerals in these showings supports the Kupferschiefer-type genetic model.

Initial diamond drilling grades on the Roo property have been excellent. The three holes which intersected the mineralized horizon averaged 0.89% copper, 0.06% cobalt and 5.4 ppm (0.016 oz/ton) silver across a true width of 5.65 metres. To date, diamond drilling has been limited to three drillsites, only one of which was located above the top of the mineralized horizon, allowing the entire width of the zone to be tested. All trenching and drilling have been confined to 1,140 metres strike length of the mineralized horizon. Copper occurrences had been previously noted by Cominco along a further 6,000 metres of this horizon on the Roo claims north of Phillipps Creek, but this potential remains essentially unexamined. South of Phillipps Creek, strong soil geochemistry, favourable lithology and an initial copper-bearing float sample provide strong incentive to enlarge the claim group to the south and explore a further 4,500 metres of the mineralized horizon to the border.

Of the base metals, cobalt has one of the brighter long-term outlooks. In 1989, Kupferschiefer-type copper-cobalt deposits in Zaire and Zambia produced approximately 69% (14,500 tonnes) of the Western world's cobalt, with the balance produced by Falconbridge, Inco, Sherritt Gordon and Outokompu as a byproduct from sulphide nickel ores. The Zaire and Zambia copper mines are fairly high cost operations, due to "inadequate maintenance and development during the period of low [copper] prices. The two countries are troubled by problems in their transportation and power infrastructure" (EMJ, March 1990). It could be expected that African cobalt production will drop as these high cost copper mines are phased out.

Kupferschiefer-type deposits in general, and the Roo property in particular, form very favourable exploration targets at current copper, cobalt and silver prices. Initial diamond drilling on the Roo property indicates that copper-cobalt(-silver) Kupferschiefer-type mineralization is present, with potential for a target size in the order of 30 to 40 million tonnes at a grade of 1.7% copper-equivalent. This compares well with the Kupferschiefer-type Spar Lake, Rock Creek and Montanore deposits which are presently being mined or developed further south in the Proterozoic Belt-Purcell basin of British Columbia and Montana.

Respectfully submitted,
EQUITY ENGINEERING LTD.

Henry J. Awmack, P.Eng.

Vancouver, British Columbia
June, 1991

H. J. AWMACK

APPENDIX A

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BIBLIOGRAPHY

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APPENDIX B

DRILL ASSAYS

DRILL ASSAYS

R90-01:

Sample Number	From (m)	To (m)	Length (m)	Cu (%)	Co (ppm)	Ag (ppm)	Ba (ppm)	Cr (ppm)	Ni (ppm)
358106	6.40	8.23	1.83	1*	2	<0.2	4570	25	<1
358107	16.31	19.20	2.89	51*	30	<0.2	2290	39	7

* ppm

R90-02:

Sample Number	From (m)	To (m)	Length (m)	Cu (%)	Co (ppm)	Ag (ppm)	Ba (ppm)	Cr (ppm)	Ni (ppm)
502285#	33.83	34.44	0.61	0.02	1	2.8	240	48	5

\# This interval was marked as sample 502297 in Thompson (1990b), but appears to be sample 502285.

R90-03:

No samples taken.

R90-04:

Sample Number	From (m)	To (m)	Length (m)	Cu (%)	Co (ppm)	Ag (ppm)	Ba (ppm)	Cr (ppm)	Ni (ppm)
358108	12.80	15.24	2.44	4*	7	<0.2	510	57	3
358109	15.24	16.76	1.52	11*	10	<0.2	330	67	5
358110	16.76	19.81	3.05	28*	91	<0.2	2990	35	15
502286	20.80	21.50	0.70	0.20	401	3.6	2820	127	69
502287	21.50	22.55	1.05	0.99	460	3.4	1340	123	72
502288	22.55	23.77	1.22	0.03	55	2.2	1610	27	15
502289	23.77	25.15	1.38	0.11	222	3.4	670	127	61
502291	25.15	25.90	0.75	0.93	299	5.2	380	120	120
502292	25.90	27.43	1.53	0.97	127	6.8	350	98	36
502293	27.43	28.96	1.53	1.73	376	4.6	280	150	84
502294	28.96	30.00	1.04	1.87	249	4.4	290	116	67
502295	30.00	30.63	0.63	1.02	371	3.2	620	32	62
502296	30.63	31.85	1.22	0.16	176	2.6	310	36	35
502297	31.85	32.60	0.75	0.01	18	2.0	250	20	6
502298	45.00	46.00	1.00	0.15	144	2.2	370	32	26

* ppm

R90-05:

Sample Number	From (m)	To (m)	Length (m)	Cu (%)	Co (ppm)	Ag (ppm)	Ba (ppm)	Cr (ppm)	Ni (ppm)
502051	17.68	19.50	1.82	1.23	871	3.2	5260	64	127
502052	19.50	20.73	1.23	1.19	1340	33.8	1640	101	209
505053	20.73	21.79	1.06	0.64	727	4.2	790	117	161
502054	21.79	22.86	1.07	0.02	158	1.8	840	26	36

R90-06:

Sample Number	From (m)	To (m)	Length (m)	Cu (%)	Co (ppm)	Ag (ppm)	Ba (ppm)	Cr (ppm)	Ni (ppm)
502055	3.00	4.57	1.57	0.77	1325	2.2	290	157	368
502056	4.57	6.10	1.53	1.04	1475	3.2	170	150	524
502057	6.10	7.62	1.52	0.87	382	2.4	410	196	119
502058	7.62	9.14	1.52	0.03	41	1.0	520	61	21
502059	32.00	32.60	0.60	<0.01	3	1.0	810	63	<1

R90-07:

Sample Number	From (m)	To (m)	Length (m)	Cu (%)	Co (ppm)	Ag (ppm)	Ba (ppm)	Cr (ppm)	Ni (ppm)
502060	16.92	18.13	1.21	0.89	399	2.6	270	43	78

R90-08:

No samples taken.

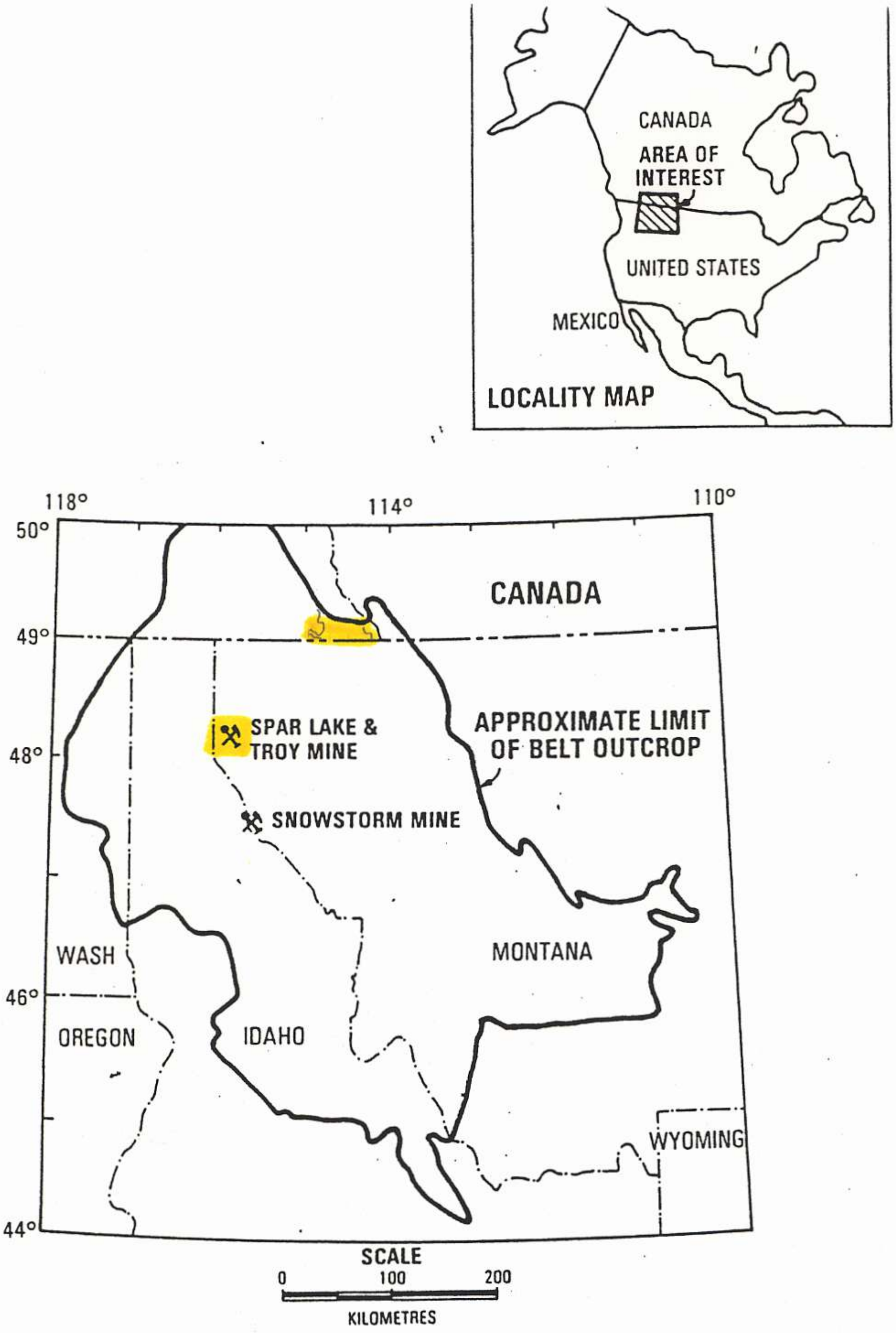

FIG. 1. Approximate limit of known Belt Supergroup outcrop, from Harrison (1972, fig. 3).