Summary Report
for the

DV Property

Fort Steele Mining Division,

82 G/11W and 82 G/12E

Latitude: 49° 36' N, Longitude: 115° 28' W

RECEIVED
GOVERNMENT AGENT
CRANBROOK

NOV 4 1997

NOT AN OFFICIAL RECEIPT
TRANS #

for

Big B Resources
3977 Woodlands Drive
Trail, B.C.
V1R 2V6

by

Richard T. Walker
Dynamic Exploration Ltd.
656 Brookview Cresecent
Cranbrook, B.C.
V1C 4R5

Date: July 30, 1997

1 OF 2

25,109

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SUMMARY

The strata comprising the Aldridge Formation in the western Rocky Mountains differ from those exposed to the west in the Purcell Mountains in that they have facies and thickness changes, diverse lithologies and a unusual carbonate facies near the base not identified farther west. Deposition of the Aldridge Formation in the Hughes Range of the Rocky Mountains was interpreted to have been proximal to the northeastern margin of the (Belt-) Purcell Basin, a huge rift basin extending south into the United States. This basin was gradually filled with sediments over time, from the deep water lithologies of the Aldridge Formation to the shallow water facies of the Creston and Kitchener Formations. Renewed rift activity is documented by the Sheppard and Nicol Creek formations.

Two regionally prominent faults have been episodically active since the Proterozoic and have had significant influence on the stratigraphic and structural history of the Canadian portion of the Purcell Basin. The Moyie - Dibble Creek and St. Mary - Boulder Creek faults both have a northern trend immediately north of the U.S. border and undergo a change to an essentially eastward trend near Cranbrook. These faults were interpreted to define a failed rift arm (an aulocogen). The Moyie - Dibble Creek fault has been subsequently interpreted as a flexure or monocline at the northern margin of a topographic high on the eastern margin of the Purcell Basin. This high standing block is known as Montania. Facies and thickness changes described from the Aldridge Formation in the Hughes Range may reflect proximity to Montania as well as movements on the (St. Mary-) Boulder Creek and (Moyie-) Dibble Creek faults. These faults may have localized a sub-basin within the Purcell Basin, similar to the Sullivan sub-basin (the "North Star Corridor"). A stratiform Pb-Zn occurrence (the Kootenay King deposit) was identified and mined in this sub-basin, however the source of mineralization for the deposit was not identified.

The entire stratigraphic package was transported to the northeast during the Laramide Orogeny in the hanging wall of the Hosmer Thrust. Based on detailed mapping in the southern Hughes Range, the rock mass was interpreted to have been initially transported to the southwest up and over the Dibble Creek monocline where it subsequently underwent extension due to gravitational settling. Igneous intrusions having granitoid compositions (composite syenitic to monzonitic dykes, stocks and plutons) were emplaced into the stratigraphic package in the Late Cretaceous (115 Ma), constraining the latest movement on some faults (i.e. the Moyie (-Boulder Creek fault). In addition, at least one of the intrusions appears to have played a role in localizing economic mineralization (i.e. the syenite stock at the Estella mine).

Finally, there is abundant evidence of mineralized fluids which pervaded the strata comprising the southern Hughes Range, resulting in alteration and mineralization of the host rocks. The Bull River Mine is comprised of two open pits located on at least seven zones of steeply dipping sheared and fractured rock, perhaps related to the Bull Canyon Fault. In addition, minor production was documented from the Dibble Crown Grants and the Victor Vein, both interpreted by the author to be related to hydrothermal activity along and/or proximal to fault planes.

Structural mapping of the DV property supports a very strong association between areas of mineralization and major faults or fault zones. Furthermore, the association of mineralization identified to date with either variable zones of alteration and/or quartz veins along planar discontinuities such as fractures and faults, has been interpreted by the author as a result of hydrothermal activity.

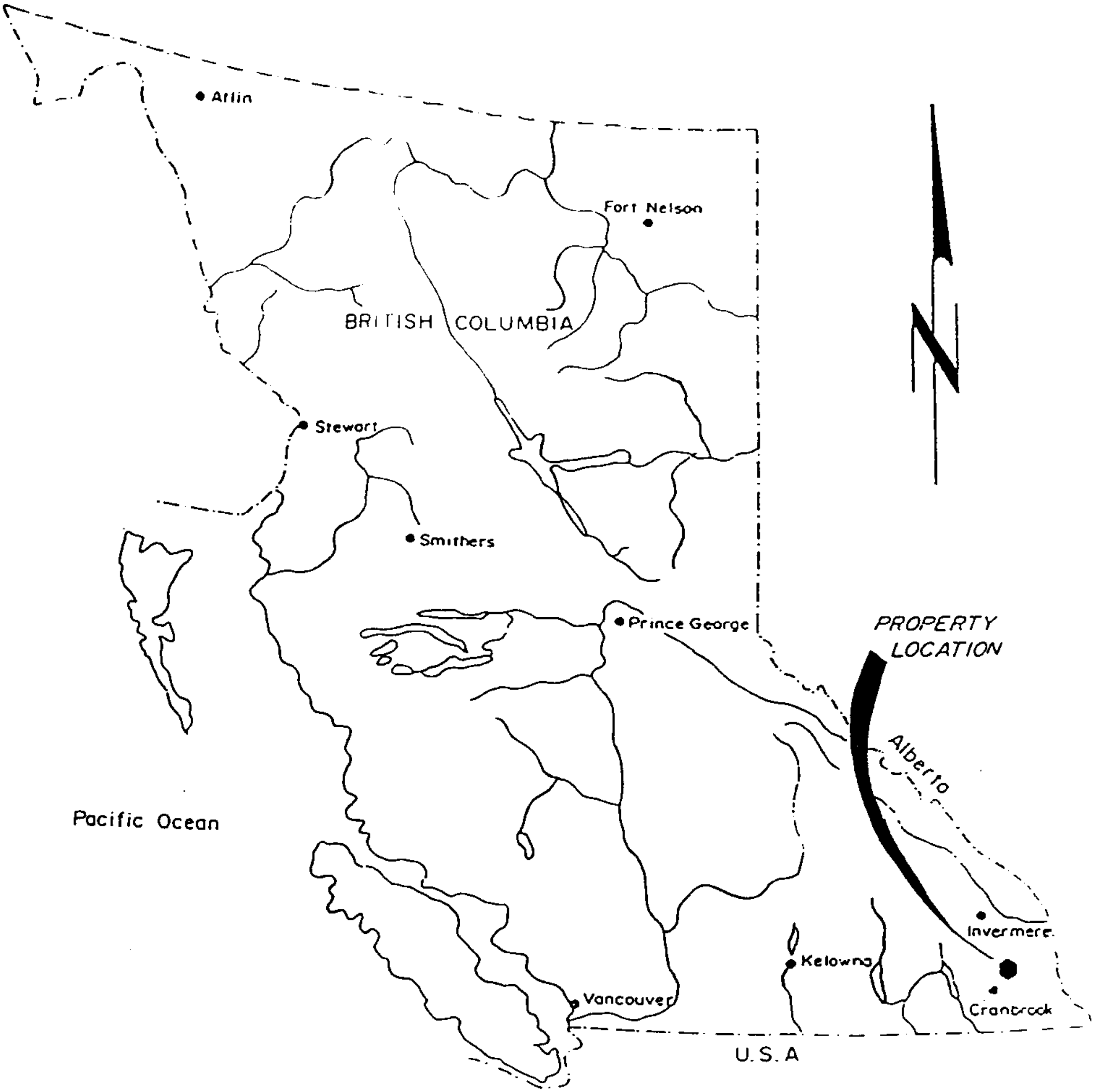
A linear geophysical anomaly was identified on the G.S.C. 8465G (Fernie) mapsheet, which is actually comprised of three magnetic highs. In general, the aeromagnetic data for the region defines a rather uniform gradient from east to west which is deflected by strong magnetic closures (anomalies) coincident with granitoid intrusions (i.e. the Reade Lake, Kiakho and Wild Horse stocks). Therefore, the magnetic anomalies underlying the DV property are inferred to reflect a granitoid intrusion, probably a dyke, at depth. Numerous, smaller granitoid dykes, sills and small plugs have been reported throughout the Hughes Range.

A Dighem airborne geophysical program was completed as part of the 1996 field program, covering the entire property. The purpose was to attempt better resolution of the three anomalies covered by the FOX claims as well as identifying any other additional anomalies which might be present. The Dighem survey was completed with an accompanying report (included, in part, in Appendix D) and the data subsequently sent to Frontier Geophysics Inc. for interpretation and recommendations (included, in part, in Appendix E).

INTRODUCTION

The following synopsis of the geology of the Hughes Range (Fig. 1) in the western Rocky Mountains has been taken from Höy (1993):

> "... Middle Proterozoic strata of the Purcell Supergroup exposed in the Fisher Peak area (Fig. 2) consist of a turbidite sequence gradationally overlain by shallow water, dominantly intertidal deposits that periodically grade into subtidal or subaerial deposits ... Thickness variations in the lower two units (of the Purcell Supergroup) outline a north-trending basin margin that is deflected more than 200 km westward near 49°N latitude. The rectilinear shape can be ascribed to deeply rooted block faulting associated with the development of a Proterozoic continental rift ... Thickness and facies relationships in Purcell strata indicate that the St. Mary - Boulder Creek and Moyie - Dibble Creek fault systems follow a northeast-trending Proterozoic aulocogen-type structure that has been outlined further east by geophysical methods.
>
> Three distinct episodes of regional metamorphism affected Purcell strata exposed in the Mt. Fisher area and the southern Purcell Mountains. The oldest metamorphic episode (1300-1350 Ma) approximately coincides with the termination of Belt - Purcell sedimentation. It was associated with east-west compression that resulted in the formation of north-trending folds, and at lower stratigraphic levels, a north-trending cleavage. A Late Proterozoic (800-900 Ma) metamorphic episode accompanied the regional uplift and block faulting (rifting?) that initiated Windermere sedimentation in the southern Purcell Mountains. Mesozoic metamorphism completely overprinted the earlier metamorphic assemblages along the Kootenay arc, in the region of intense Cretaceous-Paleocene deformation along the Dibble Creek fault, and in the upper Purcell strata north of the St. Mary - Boulder Creek fault.
>
> The overall structural geometry of the Mt. Fisher area is controlled by the position and orientation of ramps connecting bedding-glide zones in the underlying Hosmer thrust. The thrust formed across a pre-Devonian, northwest-facing structure of crustal dimensions, the Dibble Creek monocline, that is now the locus of the Moyie - Dibble Creek fault ...
>
> The evolution of anomalous northeast-trending structures in the region north of the Dibble Creek fault can be attributed to the southeastward displacement of the rock mass up and over the Dibble Creek monocline. Gravitational resistance to displacement up the monocline resulted in compression and the formation of northeast-trending thrust faults, folds and cleavage. After crossing the top of the monocline, the rock mass was then extended by lateral gravitational spreading, and normal displacement was induced along the pre-existing thrust faults" (McMechan 1980).



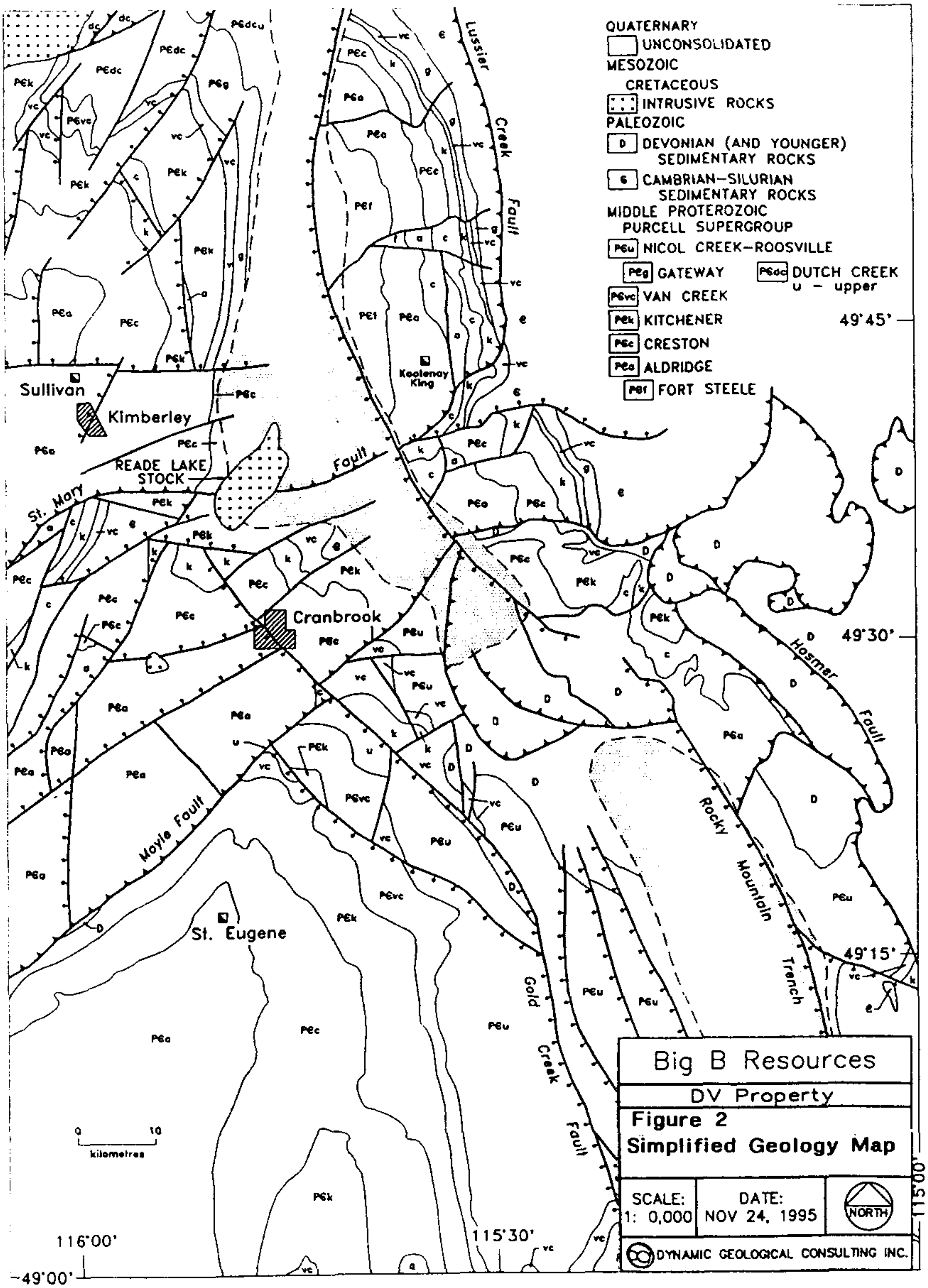
0 40 80 120 km

BIG B RESOURCES

DV CLAIM GROUP

Location Map

Gemquest Geological		NTS 82
Date **Nov., 1995**	Scale 1:8,000,000	Fig No 1



Big B Resources

DV Property

Figure 2
Simplified Geology Map

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DYNAMIC GEOLOGICAL CONSULTING INC.

The DV property lies in the Hughes Range of the western Rocky Mountains and comprises a portion of the stratigraphic and structural package described above. The area, including the DV property, has been previously mapped at a regional scale by Leech (1958) and McMechan (1980). In addition, detailed mapping on small grids within the DV property have been reported in previous programs (Ditson 1987, Rodgers 1988, Olfert 1986, 1984).

The purpose of the 1996 program was to utilize Dighem airborne geophysical data to:

1. achieve better resolution of the three separate anomalies identified on the FOX claims,

2. identify any other geophysical anomalies present on the property, and

3. determine a probable source and depth for any anomalies identified.

The Dighem data was sent to Frontier Geophysics Inc. for further processing, filtering and subsequent data interpretation. Both reports are included (as partial inclusions) in the Appendices following the main body of the report. In addition, a partial selection of maps has been included for reference to the report by Frontier Geophysics Inc.

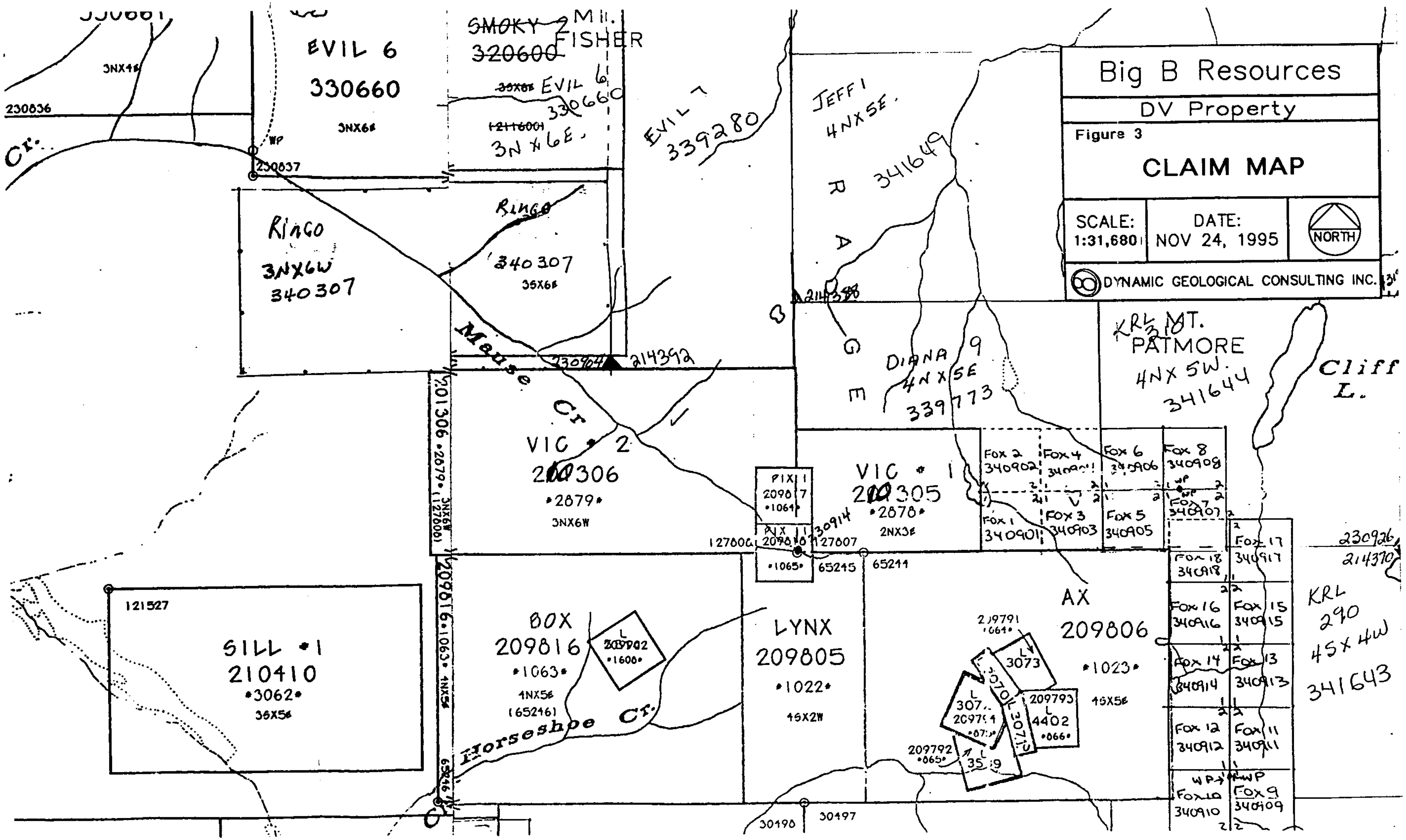
LOCATION AND ACCESS

The property can be accessed by two wheel drive vehicle from Cranbrook (Fig. 2 and 3) by approximately 36 kilometres of paved and rough gravel roads to the northern claim boundary along Maus Creek, or approximately 30 kilometres of paved and dirt roads / trails to Sunken Creek and/or Horseshoe Creek on the western claim boundary. There are reasonably good trails to the headwaters of Maus Creek and over into both Sunken Creek and the unnamed valley to the northeast. In addition, there are good trails along Sunken Creek and Horseshoe Creek. Finally, access is apparently possible from the northern end of Cliff Lake, from the Tanglefoot Creek area, into the northeast portion of the claims. Helicopter access was utilized for the more remote portions of the property from Cranbrook to maximize time spent on the property.

PHYSIOGRAPHY AND CLIMATE

The DV property is located on the eastern margin of the Rocky Mountain Trench (Fig. 2) in the Western Ranges of the Rocky Mountains. The property is characterized by moderate to high relief with elevation ranging between 915 metres (3000 feet) on the western margin of the property to 2523 metres (8280 feet) on an unnamed peak almost due north of Hungary Peak (immediately south of the property's southeast boundary). The area gets higher snowfall than the Rocky Mountain Trench and is available for exploration from early May (at lower elevations) to late October. Snow persists at higher elevations into late June.

Vegetation in the area consists of predominantly coniferous trees (Larch and Balsam) with lesser deciduous and sparse undergrowth consisting of slide alder and bushes. However, slide chutes and creeks have thicker undergrowth. The headwaters of Maus Creek and the unnamed valley to the north are sub-alpine and are comprised of larch and balsam. The south facing slopes at the headwaters of Horseshoe Creek are dry and therefore have relatively sparse tree cover and little undergrowth.


Big B Resources

DV Property

Figure 3

CLAIM MAP

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CLAIM STATUS

The DV property is located approximately 24 kilometres northeast of Cranbrook (see Fig. 2). The property consists of 108 claim units and 7 full or partial Reverted Crown Grants (Fig. 3). All claim information has been checked at the Gold Commissioners office in Cranbrook, B.C. and was current as of July 28, 1997. Pertinent claim data is tabulated below:

MODIFIED GRID CLAIMS

CLAIM	TENURE NO.	UNITS	RECORD DATE	EXPIRY DATE
AX	209806	20	July 30, 1980	July 30, 2000
LYNX	209805	8	July 30, 1980	July 30, 2000
BOX	209816	20	Sept. 15, 1980	Sept. 15, 2000
VIC 1	210305	6	Apr. 29, 1987	Apr. 29, 2000
VIC 2	210306	18	Apr. 29, 1987	Apr. 29, 2000
RINGO	340307	18	Sept. 22, 1995	Sept. 22, 2001
	Total:	90		

TWO-POST CLAIMS

CLAIM	TENURE NO.	UNITS	RECORD DATE	EXPIRY DATE
FOX 1	340901	1	Oct. 7, 1995	Oct. 7, 2002
FOX 2	340902	1	Oct. 7, 1995	Oct. 7, 2002
FOX 3	340903	1	Oct. 7, 1995	Oct. 7, 2002
FOX 4	340904	1	Oct. 7, 1995	Oct. 7, 2002
FOX 5	340905	1	Oct. 7, 1995	Oct. 7, 2002
FOX 6	340906	1	Oct. 7, 1995	Oct. 7, 2002
FOX 7	340907	1	Oct. 7, 1995	Oct. 7, 2002
FOX 8	340908	1	Oct. 7, 1995	Oct. 7, 2002
FOX 9	340909	1	Oct. 8, 1995	Oct. 8, 2002
FOX 10	340910	1	Oct. 8, 1995	Oct. 8, 2002
FOX 11	340911	1	Oct. 8, 1995	Oct. 8, 2002
FOX 12	340912	1	Oct. 8, 1995	Oct. 8, 2002
FOX 13	340913	1	Oct. 8, 1995	Oct. 8, 2002
FOX 14	340914	1	Oct. 8, 1995	Oct. 8, 2002
FOX 15	340915	1	Oct. 8, 1995	Oct. 8, 2002
FOX 16	340916	1	Oct. 8, 1995	Oct. 8, 2002
FOX 17	340917	1	Oct. 8, 1995	Oct. 8, 2002
FOX 18	340918	1	Oct. 8, 1995	Oct. 8, 2002
	Total:	18		

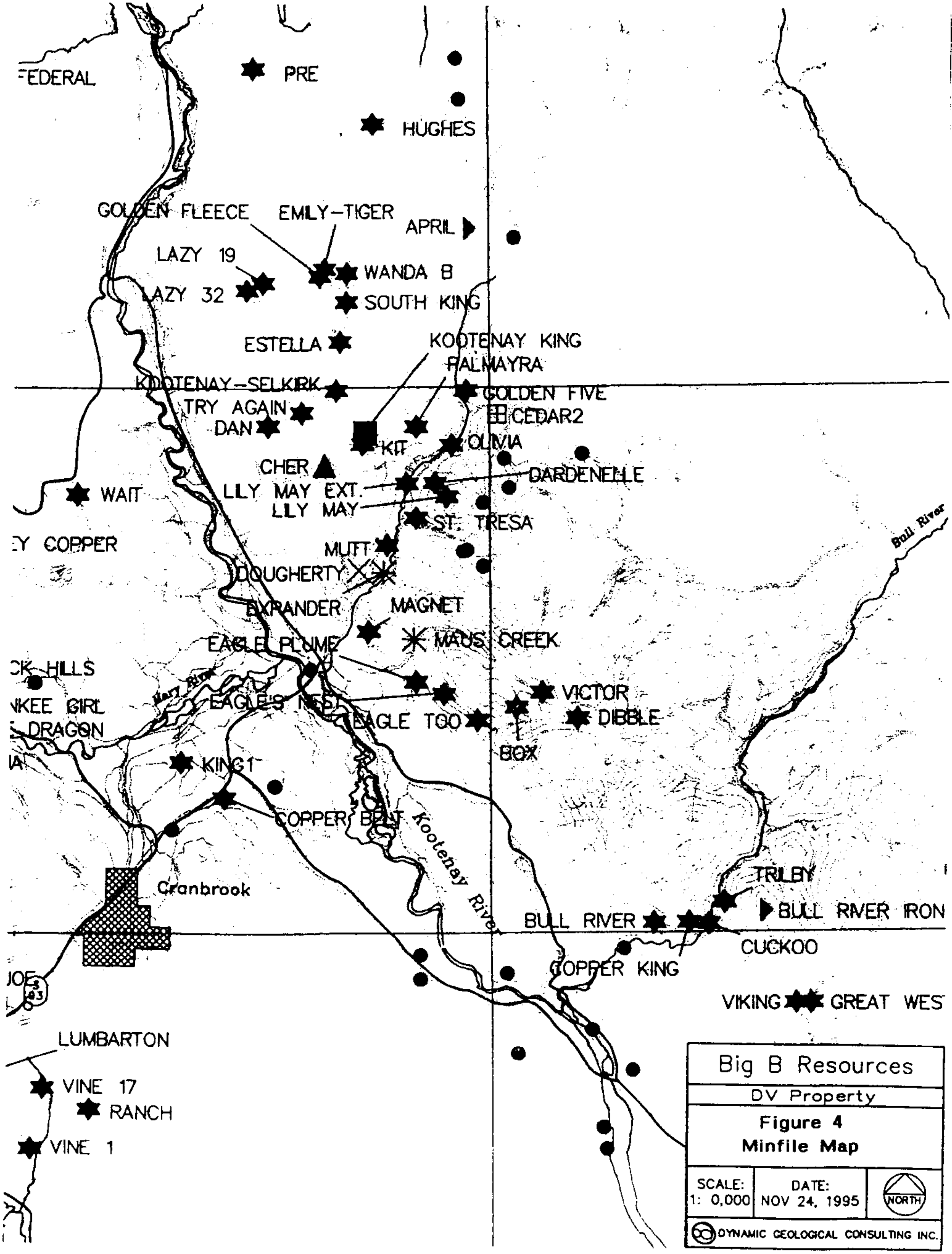
REVERTED CROWN GRANTS

CLAIM	RECORD NO.	LOT	RECORD DATE	EXPIRY DATE
LAST CHANCE FR.	864	3070	Jan. 15, 1980	Jan. 15, 1999
BEAVER FR.	864	3073	Jan. 15, 1980	Jan. 15, 1999
FIRST EXTENSION OF LAST CHANCE	865	3071	Jan. 15, 1980	Jan. 15, 1999
FOSTER	865	3539	Jan. 15, 1980	Jan. 15, 1999
RICHMOND HILL	875	3072	Feb. 4, 1980	Feb. 4, 1999
EMERALD	866	3070	Jan. 15, 1980	Jan. 15, 1999
BIG THREE	1608	5814	Feb. 15, 1980	Feb. 15, 1999
Total:	7 Full or partial claims			

HISTORY

The following summary of the history of the DV Property has been taken from Babcock and Babcock (1983). The occurrences are indicated on the accompanying Minfile occurrence map (Fig. 4 - modified from Geoscience Map 1995 - 2).

> The first public record of the Dibble Property on Lost Creek (now Sunken Creek), "a new mineral district", was in 1890. A highgrade sample yielded approximately 4.8 oz Au/T, 500 oz Ag/T, and 12% Cu. In 1895, four tons of handpicked ore were shipped to the smelter at Everett, Washington, returning 0.09 oz Au/T, 132 oz Ag/T, and 3% Cu. Work apparently was conducted annually until 1902, and it was in this period that more than 400 m of tunneling in six portals, plus numerous open cuts were completed. In 1969, Imperial Oil staked 40 claims and conducted geological mapping and geochemical sampling on the property. In 1972, TVI Mining and Athabasca Columbia Resources of Calgary carried out additional rock and dump sampling (65 samples of which 23 were analyzed for Cu and Ag), plus 5.4 km of flagged line, and 4.8 km of VLF-EM surveying. During 1980 and 1981 consulting geologist, C.M. Armstrong, conducted a modest field program on the property involving prospecting, stream sediment sampling, and rock geochemical sampling for F&B Silver.
>
> The first mention of the Victor Property, located at the headwaters of Maus Creek, was in 1904. The existence of Ag, Pb & Zn was recorded. A major portion of the existing tunneling was completed in the following years. In the period 1919 to 1921, a 50 TPD mill was erected, and a 7 Ton "mixed carload of ore and concentrates was shipped in the fall" of 1921. No additional tunneling has been driven since that time. Three adit drifts at about 32 m vertical intervals, aggregating more than 400m, follow a very steep dipping quartz vein normal to a precipitous mountain slope. In 1951, R. Sostad of Vancouver staked the 12 claim Victor group, and F.J. Hemsworth cut several samples of mineralized vein material in the upper and middle tunnels. The values ranged from 0.3 m with 0.02 oz Au/T, 2.0 oz Ag/T, 1.7% Pb, and 14.3% Zn, to 0.15m with 0.48 oz Au/T, 10.8 oz Ag/T, 3.9% Pb, and 23.6% Zn. In 1969, 1970, and 1971, the Victor Mining Corporation (R. Sostad, President) excavated five trenches totalling 64 m, and carried out a limited program of surveying, mapping, sampling and diamond drilling (two shallow holes totalling 64m) in the immediate mine area. G. Blaney cut 19 samples, and F.J. Hemsworth cut 40 samples in the middle and upper tunnels. No history of the Box Claim or Crown Grant L5814 prior to 1980 has been found. During 1980 and 1981 consulting geologist, C.M. Armstrong, P.Eng., conducted a modest field program at the Victor adits and a fairly detailed geochemical soil, silt and rock sampling program on the Box Claim. In 1980, nine representative chip-channel samples taken by C.M. Armstrong in the three tunnels on the Victor vein verified that some ore grade/width combinations were present. A flat-lying quartz lens, the F vein, with spotty, high grade galena



Big B Resources

DV Property

Figure 4
Minfile Map

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> mineralization was located on the Box Claim near the south strike extension of the Victor vein. During the 1981 investigation of anomalous silt values from the 1980 exploration program on the Box Claim, C.M. Armstrong discovered an "occurrence of a substantial body of brecciated and healed quartzite". Local patches of massive pyrite and chalcopyrite occur in the breccia. The breccia location coincides with a major east-west fault ... During 1981 94 B zone soil samples were collected on the "Breccia Zone" and analyzed for Cu, Pb, Zn, Ag and some Cd. Analysis indicated anomalous results for all elements (sic)."

The property has been subject to considerable exploration on behalf of the present owners (Big B Resources) which includes prospecting, mapping, sampling (at least 1580 soil, 183 rock and 15 silt samples), trenching, geophysics (VLF-EM and one conductivity survey) and limited small diameter drilling.

Geochemical sampling has identified numerous geochemical anomalies, probably associated with veins, with highly anomalous gold, silver, lead, zinc and copper values (Sample E35 - 4.10% Cu, 111.5 oz/ton Ag and 3.758 oz/ton Au; 2,710 ppm lead and 1,710 ppm zinc). In addition, several geophysical anomalies (both VLF-EM and conductivity) have been identified, some broadly coincident with geochemical anomalies, pervasive alteration and concordant with local bedding. Others have no identifiable surface expression and are interpreted to be a result of lenses of mineralization at depth (which the small diameter drill program attempted to test but was aborted significantly short of target depth).

The DV property consists of at least three separate areas of interest, the Dibble, Victor and Box showings. The Dibble claims are underlain by upper Aldridge sediments, structurally overlain by siltstones and quartzites of the Creston Formation. The area of the showings lies between two splays of the east-trending Dibble Creek Fault. The strata consist of grey, green and red siltstones with interbedded quartzite horizons. The lithology hosting mineralization are quartz veins, of which two distinct types have been interpreted. Limited historical production took place from narrow, high grade veins (Type I), which appear to have limited lateral continuity. Recent exploration and trenching has concentrated on the wider quartz-pyrite veins (Type II) which may have greater lateral continuity, both on surface and at depth, and therefore have greater economic potential. Geophysics (VLF-EM) has failed to identify any sulfide conductors and the resulting anomalies were interpreted to represent fault zones or water-saturated shears.

The Victor area is hosted entirely by the Creston Formation on the overturned limb of a northeasterly trending anticline. The Victor vein was also the site of limited historical mining activity. Recent exploration of the Victor area has identified several geochemical anomalies (Upper Pond and Flat Veins), which have been tentatively correlated as continuations of the Victor vein, offset by faults. In his report, Armstrong (1980) stated " It is probable that the Victor structure persists to substantial depth ... In addition to sampling and mapping, both diamond drilling and tunnelling are justified to further explore the Victor vein ..."

The Box area is underlain by middle and upper Aldridge strata in fault contact with Creston

Formation to the north. Considerable prospecting and geochemical soil sampling has outlined an anomalous area extending south west from the Pic adits in a belt 1,200 m in length and 300 m wide. Two main areas have been identified having anomalous Pb and Zn values (up to 1000 ppm and 900 ppm respectively). Recent mapping and prospecting outlined an alteration zone 1,000 m by 200 m, coincident with the geochemical anomaly and concordant to the regional strike of predominantly quartzitic Aldridge strata. Alteration includes albitization, pyritization and quartz stringers with sericitic haloes and minor galena. A geophysical survey conducted in 1988 identified a south-southwest trending sub-surface conductivity anomaly at an interpreted depth of 75 m, possibly "... generated from a concentration of small, conductive lenses focussed about a larger lineation and is considered the best electromagnetic target mapped" (Pezzot 1988). Attempts to test this anomaly by drilling (three holes) were hindered by broken ground and the small size of the drill utilized. Core recovery was less than 25% and the maximum depth achieved was 28.65 m, less than half the depth required to test the anomaly. This anomaly remains untested.

A more detailed summary of recent work undertaken on the DV Property can be found in the report by Price (1989).

REGIONAL GEOLOGY

The Mount Fisher area of the Hughes Range in the Western Ranges of the Rocky Mountains was mapped by McMechan and published at a scale of 1:50,000 (McMechan, 1979 - Fig. 5). Recently, a map of the Fernie west-half map sheet was published by Höy and Carter (1988) and subsequently a geological compilation of Ministry of Energy, Mines and Petroleum Resources field work (Höy 1993). The following synopsis for the area has been derived from the above sources.

The stratigraphy of the DV property is comprised predominantly of the middle(?) and upper Aldridge Formation and the Creston Formation of the Purcell Supergroup (Fig. 6). Subordinate exposures of the Kitchener Formation of the Purcell Supergroup are present along the eastern margin of the property across the Mt. Patmore Fault and to the southeast in the footwall of the Dibble Fault, stratigraphically underlying the basal Devonian unit. This stratigraphic succession has been transported northeast in the hanging wall of the Hosmer Thrust, the structurally highest and westmost thrust fault in the southern Rocky Mountains. The stratigraphic succession has been structurally complicated by faulting

Stratigraphy

Proterozoic

Fort Steele Formation

The lowest strata of the Purcell Supergroup exposed is the Fort Steele Formation, exposed along the western slopes of the northern Hughes Range in the Rocky Mountains (Fig. 2). The Fort Steele Formation is comprised predominantly of massive quartz arenite, quartz and feldspathic wacke and siltstone. There are no known exposures of the Fort Steele Formation in or adjacent to the DV property.

Aldridge Formation

The Aldridge Formation has been sub-divided into three informal units, the lower, middle and upper Aldridge Formations (Fig. 5). Regionally, the lower Aldridge Formation is comprised of grey weathering quartz wacke and siltstone interbedded with silty argillite. In the northern Hughes Range, lower Aldridge strata (Unit A1) is distinctive with respect to lower Aldridge strata of the Purcell Mountains in that "... it is characterized by diverse lithologies, pronounced facies and thickness variations and a conspicuous carbonate unit near its base" (Höy 1993). Furthermore, the lower-middle Aldridge transition at "Sullivan time" is not recognized and regional correlations in the lower portion of the section remain uncertain. However, regional markers indicate that the upper portion of the lowest division of the Aldridge Formation exposed in the Northern Hughes Range (Unit A1) correlates with the middle part of the middle Aldridge Formation of the Purcell Mountains. Unit A1 has been subdivided into six subdivisions (A1a

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DV Property

Figure 5

Local Geology Map

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NORTH

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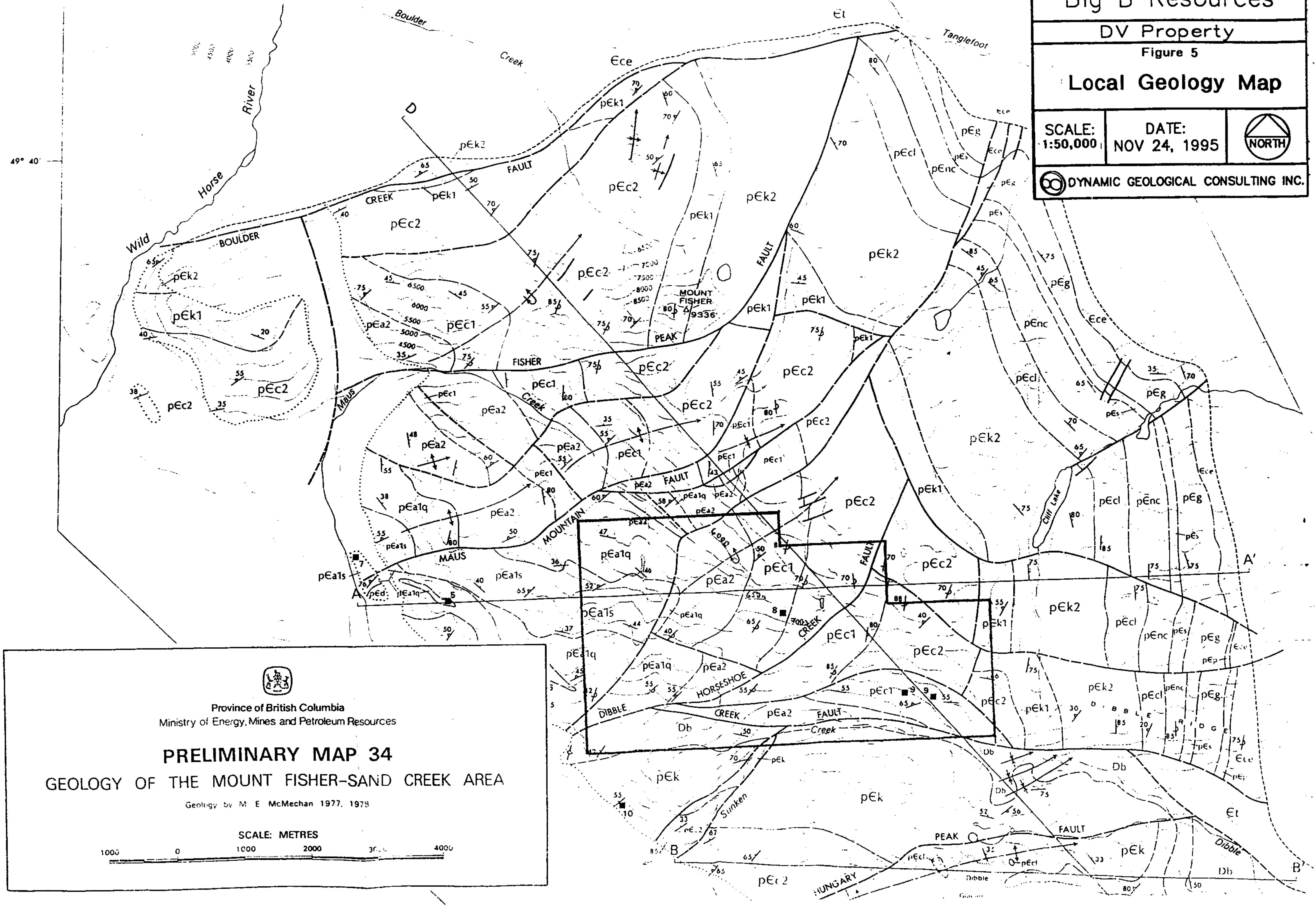


Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

PRELIMINARY MAP 34

GEOLOGY OF THE MOUNT FISHER–SAND CREEK AREA

Geology by M. E. McMechan 1977, 1978

SCALE: METRES

1000 0 1000 2000 3000 4000

Skookumchuck Creek

Pdc1 LOWER DUTCH CREEK
Coarse quartz wacke; stromatolitic, oolitic dolomite; green siltstone-argillite couplets

Pks KITCHENER, NICOL CREEK AND VAN CREEK FORMATIONS

Pnc NICOL CREEK FORMATION
Massive to amygdaloidal basaltic to andesitic lava flows, volcanic and feldspathic sandstone, siltite

  Pnc1 Green, locally purple volcaniclastic siltite, fine wacke and tuffaceous siltstone

Pvc VAN CREEK FORMATION
Green, mauve laminated siltstone and quartz wacke; minor tuffaceous siltstone at top

Pk KITCHENER FORMATION
Grey, black dolomite, limestone; green argillite, dolomitic siltstone

  Pk2 UPPER KITCHENER
  Grey, black dolomite, limestone, molar tooth texture; siltstone, thin quartz arenite beds

  Pk1 LOWER KITCHENER
  Green, beige siltstone, argillite; dolomitic siltstone

Pc CRESTON FORMATION
Green, grey and mauve siltstone, argillite; white, green quartz arenite

  Pc3 UPPER CRESTON
  Siltstone, quartz arenite, argillite

  Pc2 MIDDLE CRESTON
  White, green and mauve quartz arenite and siltstone

  Pc1 LOWER CRESTON
  Grey, black argillite-siltstone couplets, siltstone and siliceous argillite, green siltstone

Pa ALDRIDGE FORMATION
Quartzite, quartz wacke, siltstone, argillite, silty dolomite

  Pa3 UPPER ALDRIDGE
  Rusty weathering argillite and siltstone, thinly laminated

  Pa2 MIDDLE ALDRIDGE
  Grey quartzite, quartz wacke, siltstone; argillite, rusty weathering

  Pa1 LOWER ALDRIDGE
  Rusty weathering siltstone and quartzite with interbeds of silty argillite; quartz wacke

Pf FORT STEELE FORMATION
White quartzite, grey argillaceous quartzite, argillite, grey, black dolomitic and calcareous argillite

Pg GATEWAY FORMATION
Dolomite, quartz wacke, siltstone, argillite

  Pg2 UPPER GATEWAY
  Green siltstone, argillite, dolomite

  Pg1 LOWER GATEWAY
  Quartz wacke, dolomitic sandstone, stromatolitic dolomite, oolitic dolomite, green siltstone

Psh SHEPPARD FORMATION
Sandstone and conglomerate locally at base; dolomitic quartzite, sandstone, oolitic dolomite, stromatolitic dolomite at top

Dibble Property

Legend Figure 5

(EAST OF TRENCH)

Pa2a	Quartzite
Pa2s	Siltstone, argillite
Pa1a	Quartzite
Pa1s	Siltstone, argillite
Pa1ds	Silty dolomite

SYMBOLS

Limit of Mapping or Exposure ....

Geological boundary (defined, approximate, assumed) ....

Unconformity ....

Bedding (tops known, top unknown, vertical, overturned) ....

Cleavage, schistosity ....

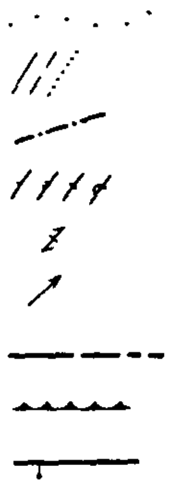
Mineral lineation ....

Fault (defined, approximate, assumed) ....

  Thrust (teeth in direction of dip) ....

  Normal (circle indicates downthrow side) ....

Fold:



through A1f), none of which have been identified in the area of the DV property.

Middle and upper Aldridge strata exposed in the Hughes Range differ from strata exposed in the Purcell Mountains in that the succession is thinner, although lithologically similar, than equivalent strata in the Purcell Mountains. Regionally, the middle Aldridge Formation is comprised of "... thick-bedded, massive to graded quartz arenite and wacke beds, thin-bedded siltstone and, minor argillite. ... The middle Aldridge in the Mount Fisher area ... comprises interbedded "quartzite", siltite and argillite. Although its base is not exposed, it is estimated to be of comparable thickness to the succession in the Moyie Lake area ", in excess of 2800 metres thick (Höy 1993). The upper part of the middle Aldridge "... comprises a number of distinct cycles of massive, grey quartz arenite beds that grade upward into an interlayered sequence of quartz wacke, siltstone and argillite, and are capped by siltstone and argillite" (Höy 1993).

There are two sub-divisions of the middle Aldridge Formation exposed on or immediately adjacent to the DV property, namely units Pa_2 (rusty weathering grey quartzite, quartz wacke and siltstone with subordinate argillite) and Pa_2q (quartzite) (Höy 1993). This differs slightly from the interpretation of McMechan (1980, 1979) in that Höy (1993) utilizes three informal subdivisions for the Aldridge Formation as opposed to two. "The contact with the upper Aldridge is placed above the last bed of massive grey quartz arenite" (Höy 1993).

The upper part of the Aldridge Formation consists mainly of rusty weathering, thin-bedded, dark to medium grey argillite, and thinly parallel-laminated light and dark grey siltite laminae (unit Pa_3 of Höy 1993). Strata of the Aldridge Formation "... grade into those of the overlying Creston Formation over a few hundred metres ... characterized by the increasing abundance of a very thin-bedded, medium-grained siltite ... The top of the Aldridge Formation was defined at the top of the last thick (greater than 10 metres) interval of grey argillite and thinly parallel-laminated siltite" (McMechan 1979). Alternatively, Höy (1993) described the contact between the upper Aldridge and Creston Formations as usually gradational and placed the contact where either green-tinted lenticular bedding or syneresis cracks become noticeable.

Creston Formation

The Creston Formation comprises dominantly green, mauve and grey siltstone, argillite and quartzite which conformably overlies upper Aldridge argillite and siltstone. McMechan (1980) sub-divided the Creston into five lithostratigraphic units (C1 - C5), described from bottom to top:

C1 - the basal unit is comprised predominantly of siltite-argillite couplets composed of light grey or green-grey siltite laminae which are gradationally or sharply overlain by dark grey argillite laminae. Syneresis (desiccation) cracks, load casts, scour-and-fill structures, ripple cross-laminations are locally abundant. This unit is approximately 150 metres in thickness.

C2 - is characterized by dark to light green siltite-argillite couplets and the general absence of quartzite lenses. The unit is also characterized by common scour-and-fill structures and rip-up debris beds with local mudcracks and ripple marks. This unit is 226 metres thick in the Maus

Creek area.

C3 - is characterized by purple-purple, green-green or green-purple siltite-argillite couplets. As with unit C2, mudcracks, ripple marks, scour-and-fill structures and rip-up debris beds are locally abundant, however interbedded quartzite lenses (locally having herringbone-crossbeds) are abundant. This unit is also 226 metres thick in Maus Creek.

C4 - is comprised predominantly of coarse-grained, purple-grey, grey or green siltite, with interbedded purple and green siltite-argillite couplets with locally abundant purple colour-mottling and rippled tops. Interbedded quartzite lenses comprise approximately half of the section and are an important constituent of unit C4. Unit C4 is approximately 610 metres thick in Maus Creek.

C5 - consists of green or purple siltite-argillite couplets and green dolomitic siltite-argillite couplets with locally abundant interbedded quartzite lenses. Minor coarse-grained siltite occurs near the near of the unit. Mudcracks and ripple marks are locally abundant in the lower part of the unit but are less common in the upper part whereas ripple cross-laminated lenses of dolomite-cemented, very fine-grained quartzite are locally abundant in green siltite-argillite couplets in the upper part of the unit. This unit is also approximately 600 metres thick at Maus Creek.

Unit C5 grades upward into dolomitic siltstones and argillites of the overlying Kitchener Formation across a transition zone a few hundred metres thick. The contact between the Creston and Kitchener Formations was defined as the top of the last 10 metre thick non-dolomitic siltite and argillite interval within the transition zone. The total thickness of the Creston Formation in the DV property area is approximately 1800 metres.

In subsequent work, Höy (1993) described three main subdivisions: "... a basal silty succession of thin-bedded grey to green siltstone and argillite, a middle quartzite succession of coarser grained mauve siltstone and quartz arenite, and an upper succession of intermixed green argillaceous siltstone and minor quartz arenite. ... The basal two (C1 and C2) comprise dominantly grey and green siltite-argillite couplets, C3 and C4 include the middle, generally mauve-tinged units, and C5, the upper, dominantly green siltite unit".

The following has been paraphrased from Höy (1993):

> "The basal Creston Formation comprises several hundred metres of interlayered argillites, argillaceous siltstone and minor quartz wacke. It is generally grey to dark grey and rusty weathering near the base, but becomes green tinged upsection with increasing siltite component. Thinly laminated argillite or siltite, graded siltite-argillite couplets and lenticular-bedded siltstone are the most abundant bedforms; more massive medium-bedded quartz wacke is less common and brown-weathering silty dolomite layers are occasionally recognized. Syneresis cracks are common in the thin-bedded argillite and argillaceous siltite units.

The thick, middle part of the Creston Formation comprises mauve or green argillite and siltstone with variable amounts of more massive quartz wacke or arenite. Siltstone-argillite couplets, up to several centimetres thick, dominate the basal section of the middle Creston and differ from units in the basal section as they are commonly purple in colour, thicker bedded and contain abundant mud cracks. Lenses of massive to graded, green, purple, or white quartzite that may contain large tangential crossbeds or wavy, irregular laminations are inter-bedded with the purple siltstone. The quartzites commonly scour the underlying siltstone and may contain numerous rip-up clasts. Coarsening-upward cycles, with massive to laminated purple and green siltstone at the base and interlayered purple siltstone and white quartzite with crossbeds, rip-up clasts, scour-and-fill structures and graded beds at the top have been described at Premier Lake.

A prominent, thick, white orthoquartzite unit occurs near the middle of the middle Creston. It is medium to thick bedded and contains broad trough and tangential crossbeds and numerous rip-up clasts. The upper part of the quartzite unit comprises a number of coarsening-upward cycles, 3 to 10 metres thick, with purple and green siltstones at the base grading up through ripple cross-laminated siltstones and quartzites to massive thick-bedded quartzite at the top. Smaller fining-upward sequences are also common in the middle quartzite interval and overlying siltstone units.

Interbedded mauve siltstone and argillaceous siltstone, white quartz arenite and minor green siltstone overlie the white quartzite unit. Small fining-upward cycles are common, with massive to cross-bedded quartzites at the base and thin-bedded, mud-cracked and rippled argillite or siltstone at the top. Rip-up clasts, mud-chip breccias and some load casts occur throughout these units.

Higher in the succession, laminated green siltstone and graded siltstone-argillite couplets become prominent. Surfaces may be mud-cracked or rippled, but these structures are less prominent than in underlying units. Small fining-upward cycles are common, with thick-bedded, white or green quartzite or more massive siltstone at the base grading up into thin-bedded siltite.

The top generally comprises pale green laminated to massive argillaceous siltstone, commonly with a dolomitic cement. Contact with the overlying Kitchener Formation is gradational and consists of a transitional zone of thin, regularly bedded siltstone-argillite that contains beds of dolomitic, buff weathering argillite. The Kitchener contact is placed at the base of the first appearance of relatively pure, thick dolomite".

Kitchener Formation

The following description has been paraphrased from Höy (1993), with minor additions from McMechan (1980):

> "The Kitchener Formation is readily divisible into lower and upper members, with the upper member further subdivisible into a lower, grey dolomitic unit and an upper interlayered dolomite, silty dolomite and siltstone unit.
>
> The lower member comprises dominantly pale green or locally grey siltstone and dolomitic siltstone interbedded with rusty to buff-weathering silty or argillaceous dolomitic layers typically 1 to 2 metres thick. The siltstone is commonly thinly laminated to thinly-bedded or consists of graded siltstone-argillite couplets. Mudcracks, lenticular beds, crossbeds, ripple marks and basal scours are common structures. Lenses of ripple cross-laminated, dolomite-cemented, very fine-grained quartzite that resemble lenticular bedded, scour-and-fill structures are locally abundant. Grey micritic limestone pods occur locally in some siltstone beds. "Dolomite" layers vary from a dark grey, argillaceous or silty dolomite to tan dolomitic siltstone. They are commonly lenticular bedded or contain discontinuous silt lenses. The thickness of the lower member is between 350 and 500 metres thick
>
> The upper member comprises dominantly dark grey, very thin- to thin-bedded argillaceous or silty limestone and dolomite overlain by a succession of calcareous or dolomitic siltstones. Graded beds, with thin dolomite layers capped by either siltstone or dark grey argillite, are common throughout the upper member. Carbonate layers are commonly finely or irregularly laminated, massive, and locally crossbedded. Molar-tooth structures are locally abundant in silty dolomite layers. Calcareous, dolomitic or non-dolomitic siltstone layers occur throughout the basal part of the upper member but predominate in the upper part. Non-dolomitic siltite and argillite layers become common in the upper 300 metres, are commonly graded with argillite cappings, locally crossbedded, and may have rippled surfaces. Syneresis cracks occur locally, particularly in the upper, more silty section, and mud cracks are uncommon. Thin oolitic layers occur near the base and top of the middle member and occasional layers of stromatolites are present throughout.
>
> In the Steeples block, dolomite occurs as massive beds with or without locally cross-laminated silty dolomitic laminae and is the dominant lithology throughout except in the upper 180 metres where dolomitic and non-dolomitic siltite and argillite predominate. Thick beds of sandy and oolitic dolomite are common between 300 and 400 metres below the top of the member. The upper member is 1175 metres thick in the Steeples block and approximately 1420 metres thick near Cliff Lake in the Fisher block".

Devonian

Basal Devonian

The basal Devonian is characterized by dolomites, sandy dolomites and dolomitic shales that weather buff, yellow, brown, or less commonly red or purple (Leech 1958). The lower portions of the basal Devonian consists of interbedded feldspathic, dolomitic sandstone, dolomite and red mudstone which rests unconformably upon Purcell Supergroup strata (Kitchener Formation) south of the Dibble Creek Fault. The unconformity cuts gently down section as it is traced west. In detail the surface is irregular and the lithology of the lowermost beds varies greatly from place to place. Conglomerate and breccia of local provenance are commonly developed at the base of this unit.

Intrusives

Moyie Intrusives

The following has been paraphrased from Höy (1993):

> "Moyie sills are restricted to the lower Aldridge, the lower part of the middle Aldridge, and to correlative rocks in the northern Hughes Range. Moyie Intrusions generally form laterally extensive sills ... (and) commonly comprise up to 30 per cent of lower and middle Aldridge successions. Their abundance decreases up-section in the middle Aldridge, as the abundance of thick-bedded A-E turbidites decreases.
>
> Moyie sills comprise dominantly gabbro and diorite ... (consisting of) dominantly hornblende and plagioclase phenocrysts, typically up to 5 millimetres in diameter, in a finer grained groundmass of plagioclase, quartz, hornblende, chlorite and epidote. Hornblende phenocrysts, commonly partially altered to chlorite and epidote, are generally subhedral to anhedral with irregular ragged terminations. Plagioclase ... is generally clouded by a fine mixture of epidote and albite (?), particularly in the more calcic cores of zoned crystals. Accessory minerals include leucoxene, commonly intergrown with magnetite, as well as tourmaline, apatite, calcite and zircon.
>
> Zircons from a fresh, massive sample ... were analyzed to determine the intrusive age of the ... Lumberton sill in the middle Aldridge. ... The upper intercept age of 1445 ± 11 Ma is interpreted to be a minimum age for emplacement of the sill. It is close to the 1433 Ma uranium-lead age of the Crossport C sill (Idaho) and a 1436 Ma potassium-argon date from a biotite in the alteration associated with the Sullivan deposit. As the Moyie sills are interpreted to have intruded during Aldridge sedimentation, the date indicates that the Sullivan deposit formed at approximately 1445 Ma and that lower and basal middle Aldridge rocks were deposited prior to 1445 Ma".

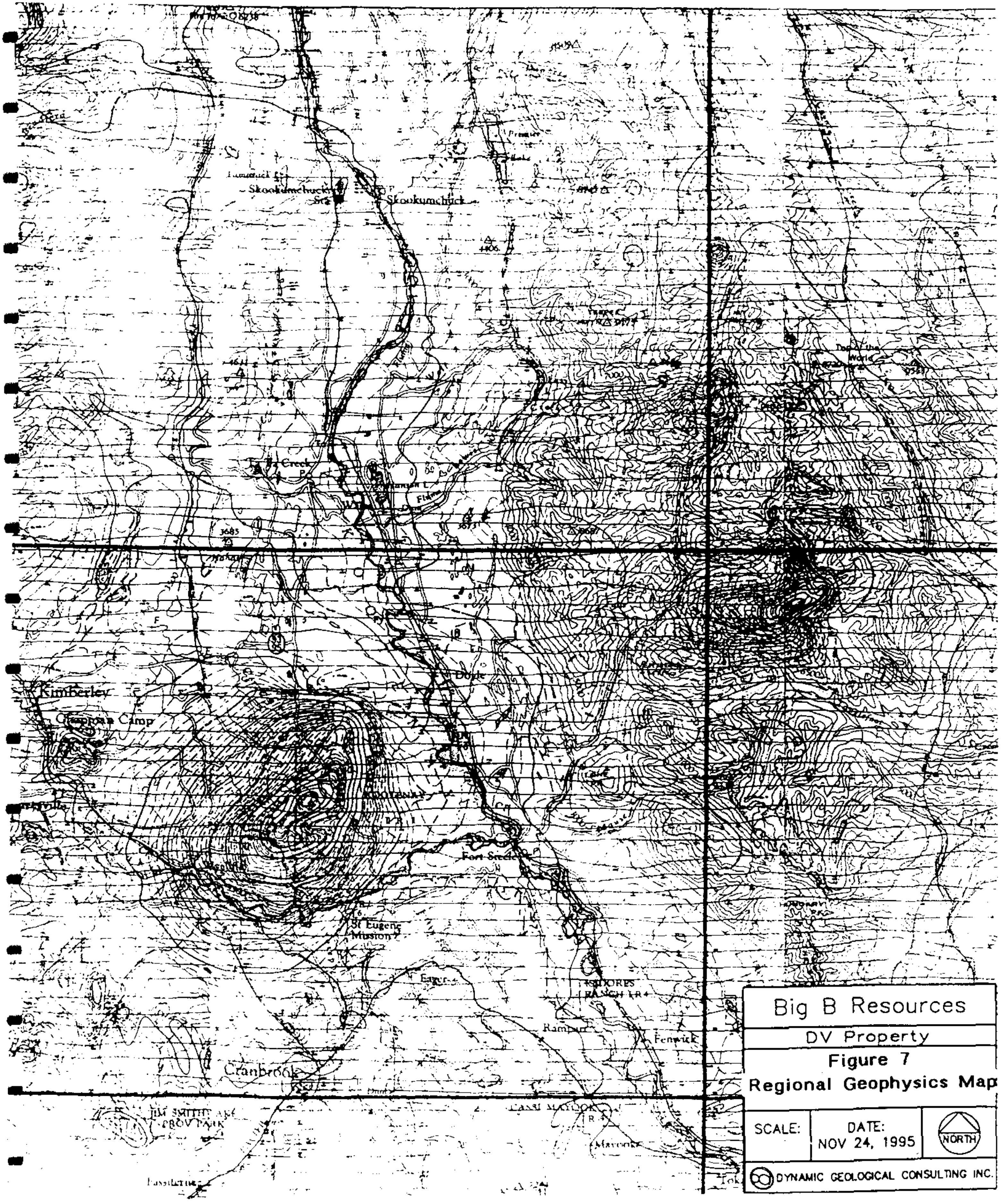
Meta -Gabbros to Meta-Diorites

Fine- to coarse-grained, hornblende-plagioclase metagabbro to metadiorite 'sills' have intruded strata of the Aldridge, Creston and Kitchener formations in the Mount Fisher area. These 'sills' are texturally similar to the Moyie sills in textural appearance, however they are chemically and mineralogically distinct from the Moyie sills and appear to represent a later magmatic event, perhaps related to the Nicol Creek lavas (Höy 1993). Magnetostratigraphic studies suggest that the Nicol Creek lavas were extruded between 1350 and 1400 Ma (Höy 1993).

Granitic Intrusions

No granitic intrusions have been identified on or adjacent to the DV property. However, due to the strong magnetic character of these alkali granitoid bodies (Fig. 7), they are included here for their possible correlation to a distinct magnetic linear identified on regional aeromagnetic data. The following has been paraphrased from Höy (1993):

> "A small, irregular crosscutting stock is exposed in the cirque near the headwaters of Tracy Creek 10 kilometres east of Wasa Lake ... informally referred to as the Estella stock because the worked-out Estella silver-lead-zinc vein occurs near its margin. The stock is in sharp intrusive contact with middle Aldridge Formation siltstone, argillite and minor quartz wacke. The country rock is hornfelsed and locally contains abundant disseminated pyrite; it may be brecciated and cut by quartz-carbonate-sulphide veins.
>
> ... Its composition is highly variable and includes quartz monzonite, quartz monzodiorite and syenogranite. Its dominant phase is a porphyry with euhedral potassic feldspar phenocrysts (to 1-2 cm in length) and albite (generally 1 cm) in a fine-grained to aphanitic groundmass of quartz, feldspar and amphibole (?). Disseminated pyrite and quartz veinlets with bleached margins are common. A fine-grained equigranular phase is mineralogically similar to the groundmass of the porphyry phase.
>
> The Estella stock is interpreted to be an epizonal, volatile-rich composite intrusion that was forcibly intruded into middle Aldridge metasedimentary rocks. ... A biotite concentrate from a coarse-grained porphyritic syenite phase of the Estella stock has yielded a 115 Ma date, ... similar to the Reade Lake and Kiakho stocks; however, it should be considered the maximum age of intrusion ... Vein mineralization at the Estella mine may be related to the stock. However, lead-lead dating of galena from these veins yielded a Middle Proterozoic age. It is possible, therefore, that the Estella deposits records Proterozoic mineralization, remobilized by the Middle Cretaceous Estella stock.



Big B Resources

DV Property

Figure 7

Regional Geophysics Map

SCALE:

DATE: NOV 24, 1995

NORTH

DYNAMIC GEOLOGICAL CONSULTING INC.

> A large L-shaped stock intrudes limestone and shale of the McKay Group ... near the divide between Tanglefoot Creek and the east fork of Horsethief Creek (sic. - probably meant Wild Horse Creek). ... The southern part of the stock is a pink porphyritic monzonite and quartz monzonite with medium to coarse subhedral grains of perthitic orthoclase and minor hornblende in a fine-grained groundmass of plagioclase, orthoclase and quartz. The northern part is more varied, with compositions ... ranging from almost equigranular to markedly porphyritic. Two zones of granitic rocks intrude the Gateway and Jubilee formations and the McKay Group just east of the headwaters of Wildhorse Creek. They range in composition from quartz monzonite to monzonite and minor syenite and vary from medium-grained equigranular phases to porphyritic phases. The porphyritic phases are most common, with phenocrysts of potassic feldspar, plagioclase, and less commonly hornblende in a fine to very fine grained groundmass ...
>
> A number of small outcrops of layered monzonite or granodiorite are exposed on the east side of the trench near the mouth of the Bull River. ... Many dikes and small irregular granitic intrusions are also exposed on the east side of the trench between Lewis Creek and Wild Horse River. ... Here, weathered, rounded outcrops of pink to grey intrusive rock occur within hornfelsed siltstone and quartzite of the Fort Steele Formation. ... (The) intrusion is a quartz monzonite to monzogranite. It is porphyritic with subhedral phenocrysts of perthite, commonly overgrown by plagioclase, in a groundmass of anhedral perthite, microcline, plagioclase and quartz. Accessory minerals include apatite, biotite, sphene and opaques; minor secondary minerals include chlorite, epidote and carbonate, and probably replacements of hornblende. Porphyritic dikes of similar compositions, 1 to 2 metres thick, cut orthoquartzites of the Fort Steele Formation up to 1 kilometre south of the main intrusive zone."

Structure

Rocks of the Purcell Supergroup have been affected by several separate phases of deformation, ranging from Middle Proterozoic through to Paleocene. The North American craton underwent two phases of extension, a compressional orogeny and subsequently continental rifting followed by development of a miogeocline. Thrusting and folding associated with development of the Foreland Fold and Thrust belt took place from Cretaceous to Paleocene time and was followed by Eocene extension.

The earliest deformation was associated with extension in the Middle Proterozoic which resulted in block faulting along the margin of the Purcell Basin, coincident with deposition of the Fort Steele and Aldridge formations. Distinct changes in the character of lower Purcell strata of the Hughes Range indicate that the Boulder Creek Fault and the segment of the Rocky Mountain Trench fault north of Boulder Creek represent the eastern and northern edges of the local Purcell Basin, respectively. Dramatic southward increases in coarse-grained sediments in the Northern Hughes Range suggest proximity to growth faults near the margin of the basin. Movement along growth faults is interpreted to have ceased by upper middle to upper Aldridge time.

Voluminous extrusion of basaltic lava (Nicol Creek Formation) in the upper Purcell Supergroup has been interpreted to indicate renewed extension in the Purcell Basin. In addition, dramatic changes in the thickness of the Sheppard and Gateway formations were interpreted to reflect growth faults active during deposition of these strata. A tectonic high has been proposed in the Larchwood Lake area north of Skookumchuck. Variations in the thickness and character of the strata document facies changes which resulted "... from block faulting ..., with erosion and deposition of coarse conglomerates on and at margins of tectonic highs and shallow-water, turbulent carbonate facies deposited in adjacent small basins (Höy 1993).

A late Middle to early Upper Proterozoic (1300 to 1350 Ma) compressional event, the East Kootenay orogeny, has been interpreted based upon evidence for deformation and metamorphism prior to deposition of lower Paleozoic miogeoclinal strata. This event was associated with folding, development of a regional cleavage and granitic intrusions (i.e. 1305±52 Ma Hellroaring Creek stock). Localized high grade metamorphic areas (i.e. Mathew Creek) are related to this tectonic event which is interpreted to have terminated Belt Purcell sedimentation.

The extensional Goat River orogeny occurred during deposition of the Windermere Supergroup (800 to 900 Ma) and is characterized by large-scale block faulting during and perhaps immediately prior to deposition of strata. The Windermere Supergroup is comprised of a basal conglomerate (Toby Formation) overlain by immature clastic and carbonate sediments of the Horsethief Creek Group. The Toby Formation consists of "... predominantly conglomerates and breccias, interpreted to have been deposited in fan sequences adjacent to active fault scarps in large structural basins. Locally, up to 2000 metres of underlying Belt-Purcell rocks have been eroded from uplifted blocks, providing a sediment source ... in adjacent basins" (Höy 1993).

The earlier tectonic events may record incipient rifting, with development of block-faulted, intracratonic structural basins, whereas by early Paleozoic time continental separation had occurred as platformal and miogeoclinal sediments were deposited on a western continental margin. The Laramide orogeny (Late Jurassic to Paleocene) resulted in the horizontal, northeast directed compression of Proterozoic strata and the overlying Paleozoic miogeoclinal prism onto the North American craton. Easterly verging thrust faults and folds developed with normal faults and westerly verging back thrusts and normal faults, resulting in a complex structural pattern. Two major faults, the Boulder Creek - St. Mary and Dibble Creek - Moyie faults (Fig. 2 and 5), have had a significant role in the structural history and fabric of the region, controlling facies and thickness changes in Proterozoic and Paleozoic strata.

"The Boulder Creek fault, one of the more prominent structural features that crosses the generally north-trending structural grain, coincides approximately with a pronounced change in Purcell rocks. The St. Mary fault, the southwestern extension of the Boulder Creek fault, follows the southern edge of a late Proterozoic (Windermere) structural basin. To the south, the northeast-trending Moyie - Dibble Creek fault system coincides with the northwestern flank of Montania, a lower Paleozoic tectonic high. These prominent northeast-trending faults segment the Hosmer thrust sheet into a number of fault-bounded blocks, ... (which include the) Boulder block and Hosmer nappe on the east side. Differential movements occurred on these blocks as the Hosmer nappe first moved northeastward approximately 8 kilometres and then southeastward 12 kilometres " (Höy 1993).

A final episode of north-trending, west-dipping normal faulting took place in the Late Tertiary. The Rocky Mountain Trench is the most prominent and is a listric normal fault having dip-slip separation of at least 5 to 10 kilometres. However, strike slip separation is interpreted to be minimal based on stratigraphic correlations across the trench.

Mineralization

There are two main deposit types hosted by Purcell Supergroup strata in southern British Columbia, namely:

1) stratabound clastic-hosted deposits such as the Sullivan and Kootenay King (Fig. 2), which are syngenetic or formed immediately following deposition of the host sediments, or

2) vein deposits, which have been sub-divided by Höy (1993) into three separate types:
    a) copper veins (i.e. Bull River and Dibble)
    b) lead - zinc veins (i.e. Estella and St. Eugene), and
    c) gold veins (Perry Creek and Midway).

Stratabound Clastic-Hosted Deposits

Stratabound clastic-hosted deposits are "... concordant bodies of massive or laminated lead, zinc and iron sulphides in fine to, less commonly, medium-grained sedimentary rocks" (Höy 1993). Some deposits may have cross-cutting footwall stockworks, disseminated or vein mineralization interpreted as conduits for mineralized solutions which were subsequently deposited as the overlying stratiform deposit.

Many stratiform lead-zinc deposits have associated zoning, either vertically (commonly copper-lead-zinc-(barium)) or laterally (commonly copper-lead-zinc). Stratiform lead-zinc deposits in the Purcell Supergroup are restricted to deep water facies of the lower and middle Aldridge Formation.

Details of stratiform clastic-hosted deposits are discussed in Höy (1993) and summarized in a past property report by Price (1989).

Kootenay King (from Höy 1993)

The Kootenay King mine (Fig. 2 and 4) is a stratiform clastic-hosted deposit which produced approximately 13 260 tonnes of ore with documented recovery of 715 grams of gold, 882 kilograms of silver, 710 866 kilograms of lead and 881 383 kilograms of zinc. The deposit was a small orebody comprised of a massive lead-zinc sulphide layer hosted by strata correlated to the lower middle Aldridge Formation. The deposit was contained within the "Kootenay King" quartzite, a prominent thick-bedded quartzite interval within dominantly buff-coloured dolomitic siltstone, dolomitic argillite and dark grey argillite. The quartzite interval is up to 250 metres thick and consists of a sequence of interbedded wacke, arenite and minor argillite which becomes thicker and coarser grained to the south. An impure, fine-grained dolomitic facies near the top of the Kootenay King quartzite hosted the orebody. Mineralization included fine-grained, laminated pyrite, galena and an unusual pale grey to green sphalerite.

"The lack of either a footwall stringer zone or hangingwall alteration, and the finely laminated nature of the mineralization suggests either that the deposit is distal, well-removed from its vent source or that much of it is eroded, including evidence of a conduit in the footwall" (Höy 1993).

Vein Deposits and Occurrences

The Aldridge and Creston formations are important for vein type deposits in southern British Columbia. The Aldridge Formation is host to copper veins (adjacent to Moyie sills), lead-zinc veins (in late structures or adjacent to late felsic intrusions) and gold veins. Copper veins are most commonly hosted by the Creston Formation. Gold veins are also documented in sheared Creston Formation in Perry Creek. Metals recovered from vein deposits (primarily the Bull River, Estella, St. Eugene and Stemwinder mines) total approximately 219 400 grams gold, 198 418 kilograms silver, 7270 tonnes copper, 119 962 tonnes lead and 28 850 tonnes zinc. "Most veins carry pyrite, pyrrhotite, chalcopyrite, galena or sphalerite in a quartz-carbonate gangue. Veins hosted by Purcell Supergroup rocks are subdivided into three main types, those with copper, those with silver, lead and zinc, and those with gold as their primary commodities" (Höy 1993).

Copper Veins

Copper veins are those which carry copper as the principal commodity with variable amounts of lead, zinc, silver and gold as chalcopyrite, pyrite and pyrrhotite. Galena and sphalerite commonly occurs and tetrahedrite has been reported in a few instances. Quartz, commonly with calcite or siderite, is the principal gangue mineral and barite occurs in some veins hosted by upper Purcell Supergroup strata.

"Two groups of copper veins are recognized: those hosted by middle Aldridge or, less commonly, lower Aldridge or Fort Steele rocks and those hosted by clastic rocks of the upper Purcell Supergroup. Many of the veins in the Aldridge Formation occur in shear or fault zones that cut across lower Purcell stratigraphy. Others are associated with Moyie sills, either in metasediments immediately adjacent to a sill or in vertical fractures in sills. ...

Veins in overlying upper Purcell rocks may be largely derived from remobilization of metals originally deposited in shallow-water clastic or carbonate facies. A few of these veins are in wacke that contains finely disseminated chalcopyrite or pyrite. This disseminated mineralization may be similar to, but far less concentrated than stratabound copper occurrences ... A number of other copper vein occurrences are closely associated with small mafic or alkalic stocks or dikes" (Höy 1993).

Bull River (from Höy 1993)

The Bull River mine (Fig. 4) produced approximately 7 256 tonnes of copper, 126 000 grams of gold and 6.3 million grams of silver from approximately 450 000 tonnes of ore. The ore was produced from two open pits at an average grade of 1.46% copper, 0.232 gram per tonne gold and 11.7 grams per tonne silver. Mineralization was reported to occur in at least seven zones of steeply south dipping, sheared and fractured rock. These zones crosscut lower Aldridge siltstone and wacke at or near a contact with a Moyie Intrusive (dyke). The zones consist of one or more quartz-siderite veins with disseminated or massive pods of chalcopyrite, pyrite and pyrrhotite.

Dibble (from Minfile Number 082GNW003)

The Dibble occurrence (Fig. 4) is hosted by argillite, quartzite and argillaceous quartzite of the Lower Creston Formation in a horse within the Dibble Creek Fault. Two types of mineralized veins are present: 1) narrow quartz stringers, 1 to 8 centimetres thick with tetrahedrite, arsenopyrite, malachite, azurite and very minor chalcopyrite; and 2) wider quartz-pyrite veins from 30 to 200 centimetres thick, breccias and replacements, often in quartzite units. Alteration of wallrock from veins of the first type is slight, ranging from 10 to 30 centimetres thick whereas alteration associated with the second type is more intense, ranging from 30 to 150 centimetres thick. Production in the past occurred from veins of the first type, which strike approximately east-west and dip steeply north. Highest assays returned from samples from these veins were 4.1 per cent copper, 3822.2 grams per tonne silver, 0.01 per cent lead, 0.15 per cent zinc and 126.8 grams per tonne gold. Note: see Price (1989) for a more detailed summary of the Dibble Group showing.

Eagle Plume (from Minfile Number 082GNW025)

The Eagle Plume showing (Fig. 4) is located on the western slopes of the Hughes Range, immediately east of the Rocky Mountain Trench and is interpreted as quartz-filled hydrothermal veins. Mineralization occurs in parallel "fissure" veins hosting disseminated chalcopyrite which strike roughly east within altered limestone and schist of the Aldridge Formation.

Eagle's Nest (from Minfile Number 082GNW026)

The Eagle's Nest showing (Fig. 4) occurs south-southeast of the Eagle Plume occurrence on the western slopes of the Hughes Range, immediately east of the Rocky Mountain Trench. A 1 metre wide quartz vein within a Moyie sill carries small amounts of chalcopyrite and pyrite near the contact with host Aldridge Formation argillaceous quartzites.

Eagle Too (from Minfile Number 082GNW032)

The Eagle Too showing (Fig. 4) occurs south-southeast of the Eagle Plume and Eagle's Nest showings and north of Horseshoe Creek. Chalcopyrite and pyrite in a quartz vein are reported in argillites and quartzites of the Aldridge Formation near the contact with a Moyie sill. Copper and gold are reported to occur.

Lead-Zinc Veins

Lead-zinc veins carry lead and zinc with variable amounts of copper, silver and gold with galena, sphalerite, pyrite and pyrrhotite as the main sulphide minerals. Minor chalcopyrite, arsenopyrite and tetrahedrite may also be present. The gangue mineral is predominantly quartz, but may include quartz-calcite or less commonly quartz siderite.

"Nearly all lead-zinc vein occurrences are within the Aldridge Formation, most commonly in the middle Aldridge or in rocks correlative with the middle Aldridge rocks (Unit A1d) ... Middle Aldridge rocks are deep-water clastic facies with relatively high background metal values that provide a source for metals in the veins. They are commonly thick-bedded and competent, and hence fracture readily. In contrast with copper veins, only a few lead-zinc veins appear to be associated with the Moyie sills. ...

Despite the variety of lead-zinc deposits in Aldridge rocks, most have very similar lead isotopic ratios. These ratios are similar to those of stratiform deposits such as Sullivan and Kootenay King, indicating a common lead source, presumably the host Aldridge succession. Metals were initially deposited together with Aldridge sediments, remobilized during intrusive or later tectonic events and deposited as lead-zinc veins" (Höy 1993).

Estella (from Höy 1993)

The Estella mine (Fig. 4) is an example of a lead-zinc vein and produced a total of approximately 6393 kilograms of silver, 5181 tonnes of lead, 9834 tonnes of zinc and very minor gold from a total of 109 518 tonnes of ore. The mine is located in a lead-zinc-silver vein hosted by siltstone, argillite and wacke of the Aldridge Formation and is adjacent to a small porphyritic to equigranular composite stock. Two diorite bodies occur locally, a large, irregular body just west of the mine and another underground, interpreted to be Moyie Intrusives.

The orebody was located in a moderately to steeply southwest dipping (40° to 70°) zone of fracturing and light shearing which follows the general trend of the underground diorite contact. The ore zone ranges from 5 to 7 metres in thickness and was comprised of secondary (replacement) sphalerite, galena and pyrite accompanied by variable amounts of silica.

Victor (from Minfile Number 082GNW004)

The Victor vein (Fig. 4) is an occurrence from which limited production is documented. Lead, silver, zinc, gold and copper values have been reported from sporadic galena, sphalerite and pyrite mineralization, present as small lenticular shoots and thin streaks along the footwall.

Occasional disseminations are also reported in the quartz gangue. The Victor vein is hosted by quartzites and argillites of the Lower Creston Formation which strike north-northwest and dip 70° to 75° west. Two distinct rock types have been reported, a green-grey argillaceous quartzite with minor interbedded apple green quartzite, and a silver grey-black argillite/phyllite with local silty units.

The Victor vein strikes 020° with an eastern dip ranging from 70° to vertical and can be traced on surface for over 600 metres. Polyphase quartz is present along the exposed length of the vein with occasional siliceous zones up to 4 metres thick and an alteration envelope between 10 and 30 metres thick. Three adits are present along the Victor vein system. Assays of recent samples taken along the adits returned a high of 12.9 per cent lead, 7.69 per cent zinc, 198.9 grams per tonne silver, 7.0 grams per tone gold and 0.39 per cent copper. Note: see Price (1989) for a more detailed summary of the Victor vein showing.

Box (from Minfile Number 082GNW051)

The Box showing (Fig. 4) is underlain by sediments of the Aldridge Formation in fault contact with Lower Creston Formation sediments to the north and Devonian sediments to the south. Lead, copper, zinc, gold and silver values have been reported from galena, chalcopyrite and pyrite mineralization. Spotty patches of galena are associated with quartz veins ranging from 0.5 to 2.0 metres thick within Aldridge Formation quartzites (Unit Pa_2q). The veins may be a strike extension of the Victor vein or may be similar in character and stratigraphic location. In addition, a large occurrence of brecciated and healed quartzite with patchy pyrite and chalcopyrite coincides with an east trending fault associated with the Horseshoe Creek Fault. Grab samples from bedding parallel quartz veins have returned assay values of 0.27 per cent lead, 0.17 per cent zinc, 1.52 grams per tonne gold and 3.4 grams per tonne silver. Note: see Price (1989) for a more detailed summary of the Box showing.

Gold Veins

"Although many of the copper veins and some of the lead-zinc veins contain minor gold, a number ... contain gold as their primary commodity. They are gold-quartz veins controlled by northeast-trending faults that cut Creston Formation quartzite and siltstone. Shearing and fracturing are extensive, commonly occurring in a zone several hundred metres wide on either side of the faults. Many of the veins are also associated with mafic dikes. They vary in thickness from a few centimetres to greater than 10 metres. They comprise massive, white to occasionally pink quartz, minor calcite, disseminated pyrite, and occasionally trace chalcopyrite and galena. They are commonly severely fractured or sheared and locally cut and offset by crossfaults. Others cut the prominent schistosity ... (indicating) that they formed during and immediately following deformation" (Höy 1993).

Sedimentary Copper Deposits

Although no sedimentary copper deposits have been reported in the Hughes Range, potential exists in both the Creston Formation and the carbonate facies of the Van Creek Formation (equivalent to the Siyeh Formation). However, only the Creston Formation is present in the DV Property. Copper mineralization occurs either in quartzites or in many of the red and green beds that overlie the deeper water Aldridge Formation.

> "Stratabound copper deposits and occurrences in Belt-Purcell rocks have a number of features in common with other stratabound, clastic-hosted copper deposits ... They commonly formed in a tectonically active, intracratonic setting; there appears to be only an indirect association, if any, with volcanic rocks; and the hostrocks are usually fine-grained clastic sediments, commonly green, reduced beds that immediately overlie more oxidized red beds. At Spar Lake, however, the hostrocks are white to pinkish quartzites within grey siltites. Mineralization in these deposits is stratabound, localized in specific favourable units; it is usually not strataform as it cuts across both sedimentary units and structures. Metals include copper and silver, less commonly uranium, and occasionally lead and zinc. Mineral and metal zoning is common.
>
> The Spar Lake deposit ... is in white, crossbedded quartzite of the Revett Formation. Sulphides occur as disseminations, clots and fracture fillings, commonly closely related to bedding planes, crossbeds and scour-and-fill structures. The sulphides are zoned with essentially a lower chalcopyrite zone, overlain by chalcopyrite-bornite-chalcocite, bornite-chalcocite, chalcopyrite-bornite-galena, galena-pyrite, and pyrite zones. Silver values correlate with copper values, with better grades in the thicker parts of the deposit. Evidence for structural control of mineralization includes: the spatial association with an early growth fault, the East fault; zonation of minerals and elements away from the fault; and vertical stacking of mineralized lenses in the Revett Formation" (Höy 1993).

LOCAL GEOLOGY

A profound change in facies and thickness occurs at approximately 49° 30', interpreted to have resulted from rotation and displacement along northeast-trending faults during Proterozoic and early Paleozoic time. This profound change was interpreted as a reentrant along the generally northwest trending Proterozoic Purcell Basin (McMechan 1980). Anomalously thickened turbidite sequences in the Aldridge Formation with local occurrence of coarse-grained sand and northeast to southwest transport of some of these turbidites "... strongly suggest this reentrant developed before or during deposition of the Aldridge Formation" (McMechan 1980).

Evidence for this northeast-trending reentrant, located where the right-hand, reverse St. Mary - Boulder Creek and Moyie - Dibble Creek fault systems segment the eastern limb of the Purcell Anticlinorium (Fig. 2), is apparent in isopach maps of all Purcell Supergroup subunits. Thickness variations in the overlying Windermere Supergroup, suggest that movement on the block faults defining the reentrant had ceased by Late Proterozoic time. These pre-existing zones of crustal weakness were subsequently reactivated as right-hand reverse faults during Mesozoic compression.

The Moyie - Dibble Creek Fault (discussed in a later section) is a right-lateral reverse fault with an estimated displacement of 12 kilometres. West of the Rocky Mountain Trench, the Moyie Fault is represented as a steeply northwest dipping zone of intense shearing several hundred metre wide. The footwall of the Dibble Creek Fault, east of the Rocky Mountain Trench, follows a gypsum horizon in the basal Devonian succession (Fig. 6). The St. Mary Fault, west of the Rocky Mountain Trench, is also a right lateral reverse fault with an estimated displacement of 11 kilometres. The fault is intruded by the Reade Lake stock south of Kimberley. The quartz monzonite intrusion constrains the age of displacement on the fault to earlier than 94 Ma. East of the Rocky Mountain Trench, the Boulder Creek Fault accommodates right lateral displacement of the St. Mary Fault, juxtaposing strata of the Aldridge Formation in the hangingwall against Kitchener Formation strata in the footwall. North of these faults, a thick succession of Cambrian through Silurian strata are exposed. In contrast, Devonian rocks rest unconformably on upper Purcell strata to the south.

McMechan (1980) interpreted a northwest-dipping flexure, the Dibble Creek monocline, to coincide with the northern flank of Montania, which occurred south of the Dibble Creek - Moyie fault system in pre-Devonian time. This interpretation was based on reconstruction of sub-Devonian units across the northwestern flank of Montania. Contrasting stratigraphic relationships beneath the sub-Devonian unconformity on either side of the Moyie - Dibble Creek fault system show that this fault follows the locus of a pre - Middle Devonian transverse northeast-trending structure with more than 7 km of stratigraphic separation, across which the north side moved down as the lower Paleozoic strata were being deposited. North of the flexure, presently represented by the Dibble Creek - Moyie Fault (Fig. 5 and 6), was a basin filled with lower Paleozoic rocks. These two major, right lateral reverse faults, the St. Mary - Boulder and Moyie - Dibble Creek fault systems, have been interpreted to define a structural basin north of the Dibble Creek monocline. The DV property is located in the southern half of this structural basin, overlying and north of the Dibble Creek Fault.

McMechan (1980) structurally subdivided the southern Hughes Range into 5 separate domains, separated by faults, on the basis of bedding orientation and/or folds outlined by bedding.

"Domain 1, in the western part of the (Mt. Fisher) block, is characterized by a series of faulted northeast-plunging asymmetric anticlines in Aldridge to Kitchener strata. Domain 2, in the eastern part of the block, comprises an east-facing panel of north- to northwest-striking Kitchener to Cranbrook strata. Domain 3, at the southern end of the block, is a horse of Aldridge and Creston strata that occurs along the Dibble Creek fault ... Domain 4 lies between the Bull Canyon and Dibble Creek faults and is characterized by a series of low amplitude, open, northeast-plunging folds. Domain 5 lies south of the Bull Canyon fault and is dominated by the northwest-striking Lizard segment of the Hosmer nappe structure" (McMechan 1980). The DV property lies predominantly in Domains 1 and 3, with minor overlap into Domain 2 to the east and Domain 4 south of the Dibble Creek fault.

The structural geometry of Domain 1 is dominated by a series of asymmetric anticlines. The right-way-up limbs strike west to northwest and dip moderately north to northeast. Steeply dipping to overturned beds strike northeast or southwest and dip southeast (right-way-up) or northwest (overturned). The folds generally have northwest plunging (approximately 60°) axial planes and fold axes that plunge moderately (37°) to the north-northeast. Northwest-dipping faults having left-lateral normal separation replace synclines, juxtaposing the steep forelimb of one anticline against the backlimb of the adjacent anticline. On the outcrop scale, a moderate to well developed penetrative cleavage is developed in argillaceous strata and a spaced cleavage in argillaceous quartzite and siltites.

Domain 2 is comprised of an east-facing stratigraphic succession, from Kitchener Formation on the west upward to the Cranbrook Formation to the east. Strata is moderately to steeply northeast dipping with a predominant northwest strike. The Fisher Peak and Patmore faults separate Domain 1 on the west from Domain 2 on the east. "The Patmore fault is a steep north to northwest-trending fault that represents a zone of décollement near the base of the Kitchener Formation separating the homoclinal panel of Domain 2 from the complex faulted folds of Domain 1" (McMechan 1980).

Domain 3 is a horse of upright Aldridge and Creston strata lying between the Dibble Creek Fault to the south and a splay to the north. Both bedding and cleavage strike west and dip moderately (60°) to the north, sub-parallel to the orientation of the Dibble Creek Fault.

"Domain 4 is basically a northeast-plunging monocline. The northeast-dipping upper limb is broadly folded about open, shallow (23°), northeast (046°)-plunging folds that involve both Proterozoic and Devonian strata. The northwest-dipping middle limb dips under the Dibble Creek fault and occupies the northern part of Domain 4" (McMechan 1980).

Dibble Creek Fault

The hangingwall of the Dibble Creek Fault comprises a ramp which truncates structures and stratigraphic units of the Purcell Supergroup, ranging from the Aldridge Formation to the Kitchener Formation in an eastward direction. Proterozoic strata in the hangingwall show evidence of deformation, with bedding and cleavage partially rotated into the plane of the plane. The footwall lies in a flat, following a gypsum horizon in the basal Devonian unit, therefore, strata comprising the basal Devonian unit show little or no evidence of proximity to a major, regional scale fault. The fault also separates strata showing evidence of northwest-southeast directed compression and folding around northeast-trending fold axes during southeastward displacement of the hangingwall relative to the footwall. Benvenuto and Price (1979) estimated that there has been in the order of 12 kilometres of right-lateral reverse movement along the Dibble Creek Fault. The orientation of the fault, as determined near the headwaters of Sunken Creek, suggests the fault strikes west and dips north at approximately 55°. The surface trace of the fault swings from northeast (Moyie Fault) to almost due east (Dibble Creek Fault) in the region of the Rocky Mountain Trench.

The "... Moyie - Dibble Creek Fault probably initiated as the locus of vertical adjustment between thicker and thinner parts of the (Hosmer) thrust sheet. The ... fault propagated northeastward and southwestward along the flank of the Dibble Creek monocline as a right-hand reverse fault when the direction of displacement on the Hosmer thrust changes from northeast to southwest" (McMechan 1980). At this location the fault splayed into, and its locus was controlled by, a gypsum horizon in the basal Devonian unit. Subsequent southeastward displacement of the Hosmer thrust sheet was restricted to strata lying structurally above the Dibble Creek Fault.

The Fisher Peak, Maus Creek, Tanglefoot and Horseshoe Creek faults are northwest-dipping transverse faults that have had a complex history of reverse, strike-slip, and normal displacement. Asymmetric minor folds associated with these faults generally indicate reverse dip-slip displacement while stratigraphic offset and early faults (i.e. Patmore Fault) indicate left-lateral normal slip on the Fisher Peak, Maus Mountain and Horseshoe Creek faults.

Bedding in the southern portion of Domain 1 is overturned an additional 20° due to proximity to the right-lateral Dibble Creek reverse fault. The regional cleavage is also deformed in strata proximal to the Boulder Creek, Dibble Creek and Fisher Peak faults, as evidenced by partial rotation into the plane of the faults and local development of a west-northwest plunging, folded cleavage. In contrast, folds documented in bedding proximal to the Horseshoe Creek Fault have an undeformed northwest-dipping axial planar cleavage consistent with northwest-southeast directed compression. Reverse (north to northwest side up) displacement is recorded by the minor folds adjacent to all these faults.

The major zones of crustal weakness developed during aulocogen formation were reactivated as northwest-side down structures that controlled the pattern of erosion and deposition in the Late

Proterozoic and early Paleozoic and as right-hand reverse faults in the Mesozoic.

Geophysics

An airborne geophysical digital dataset was obtained for the area (western portion of Fernie mapsheet (8465G) and eastern portion of Cranbrook mapsheet (8469G)) and reviewed in the course of this study (Fig. 8 and 9). The geophysical data was acquired from Sept. 1969 to June 1970 along flight lines spaced between 500 metres and 2 kilometres apart. The flight lines were flown at an average elevation of 300 metres above ground level.

The contoured data (mapsheets 8465G and 8469G) data generally documents a fairly uniform regional gradient which decreases to the west. The regional gradient is greatly disturbed by at least two prominent localized highs, which correspond to the Reade Lake stock (underlying Cranbrook airport) and a monzonite - syenite intrusive body in the east fork of the Wild Horse River (Fig. 7). In addition, a northwest trending aeromagnetic high is also evident, which extends from the headwaters of the Dibble Creek valley northwestward to the northeast portion of the Maus Creek valley, where it passes into the core of a regional scale magnetic low (Fig. 7). However, in detail, the trend is segmented into three separate north to northwest trending bulls-eyes or linears (Fig. 8 and 9).

The eastern linear is spatially associated with a thick sequence of gabbros exposed in the ridge crest northeast of the Dibble Group Reverted Crown Grants (Fig. 6 and 8). However, the trend of the linear is oriented at an oblique angle to the strike of the gabbros. In addition, the geophysical trend extends both to the southeast along a ridge and to the northwest into an alpine cirque (Fig. 9) where little or no surface exposures of gabbro were noted. Furthermore, the gabbros are exposed at surface whereas the source of the geophysical anomalies are most likely located at depth. Finally, the gabbroic exposures are interpreted to be correlative to the Nicol Creek volcanics, a basaltic accumulation occurring at higher stratigraphic levels in the Purcell Supergroup. Mapped exposures of the Nicol Creek volcanics do not appear to disturb the geophysical gradient evident on the contoured geophysical map. It is unlikely that gabbroic dykes and/or sills in the sub-surface, having similar compositions to the Nicol Creek volcanics, would produce a stronger magnetic signature than the correlative basaltic lavas. Therefore, the anomalies are not believed to be sourced from gabbroic exposures at surface.

The trend of the individual segments of the geophysical anomalies is sub-parallel to slightly oblique to the average orientation of bedding and highly oblique to the average foliation. However, the magnetic lows which separate the three magnetic high segments appear to correspond reasonably well with the possible depth extension of the Horseshoe Creek Fault and a small (?) north-trending, unnamed fault mapped north of the Dibble Group (Fig. 6). Therefore, the linear orientation of the magnetic highs may represent a single magnetic body which was subsequently segmented by brittle faulting. Subsequent fluid movement along the fault planes may have destroyed the magnetic minerals (i.e. altering magnetite to hematite). The only strong magnetic features which readily stand out on the map sheet are the very pronounced magnetic highs associated with the Wild Horse monzonite intrusion to the north. Therefore, by analogy, it is proposed that the segmented magnetic linear may reflect an alkalic intrusive dyke at depth, underlying the DV property. Subsequent development of fault planes may have acted as conduits for fluid movement, resulting in alteration of primary magnetic minerals to non- or weakly magnetic secondary minerals.

PROPERTY GEOLOGY

Structure

Additional structural mapping of the DV property was undertaken as part of the 1995 field program, to improve and build upon McMechan's (1979) mapping (Fig. 5) and to evaluate previously proposed drill targets with respect to the structural data. The domains defined by McMechan (1980) were used to analyze the resulting structural data. The DV property lies primarily within Domains 1 and 3, with minor overlap into Domain 2 to the east and Domain 4, south of the Dibble Creek Fault. The results and interpretations arising from structural mapping were reported in the 1995 Assessment Report (Walker 1995).

1996 FIELD PROGRAM

As part of the 1996 field program on the DV property, a Dighem airborne geophysical survey was undertaken and completed on the entire property. A total of 338 line kilometres was flown at an average EM bird height of 30 metres, with collection of electromagnetic, magnetic and radiometric data at 100 line spacings (see Appendix D). The data was processed and plotted at a scale of 1:10,000 on the geological base map of Walker (1995). A number of low grade conductors were detected, interpreted to arise largely from overburden sources (McConnell 1996, Appendix D).

The raw data were subsequently submitted to Cliff Candy of Frontier Geophysics Inc. for additional processing and interpretation. A stacked profile map was produced from the Dighem data "... using the coplanar inphase data set ..." to facilitate correlation of electromagnetic responses. As a result of the additonal processing, a reasonable correlation of magnetic data from the Dighem survey with exposed gabbro occurences and projected sub-surface equivalent appears probable. A number of conductors were identified, particularly on the western portion of the property, north and west of the BOX claims. Two, designated C9 and C10, are proximal to sericite alteration identified at surface in previous mapping and broadly coincident with a south-southwest trending sub-surface conductivity anomaly at an interpreted depth of 75 metres, possibly "... generated from a concentration of small, conductive lenses focussed about a larger lineation ..." (Pezzot 1988).

The procedures utilized in collecting, processing and analyzing the airborne geophysical data is outlined in the Dighem and Frontier Geophysics Inc. reports included in the Appendices at the end of this report (Appendix D and E, respectively).

DISCUSSION AND INTERPRETATION

Three magnetic anomalies were identified on a regional magnetic data set obtained from the Geological Survey of Canada and discussed in the 1995 Assessment Report (Walker 1995). The DIGHEM airborne geophysical survey appears to have resolved these into smaller magnetic anomalies. A number of magnetic anomalies were identified on the FOX claims which had been staked specifically to cover the apparently large magnetic anomalies. As a result of the Dighem survey, these anomalies now appear to be best explained as sub-surface equivalents of gabbro sills and shallowly cross-cutting dykes mapped previously on the property. Such an interpretation is apparently supported by the partial coincidence of mapped gabbroic exposures and magnetic airborne anomalies. However, there exists the possibilty that mineralization might be associated with gabbroic exposures as reported at the nearby Minfile occurrences to the west (Eagle's Nest and Eagle Too) and samples RW95-1a and 1b (Walker 1995).

A large number of conductors, together with magnetic anomalies were identified on the western portion of the property, north and west of the BOX claims. The magnetic anomalies identified are similarly interpreted as probable sub-surface gabbroic occurrences due to partial coincidence with surface exposures previously mapped. The conductors identified, however, are considered significant: 1) as they are associated with the quartzites of the middle Aldridge Formation (possible Kootenay King equivalents), 2) they are broadly, spatially associated with sericitic alteration mapped at surface on the BOX claims, 3) two (C9 and C10) appear to be coincident with a sub-surface geophysical conductor identified by Pezzot (1988) and 4) anomalous soil and rock geochemistry has been previously documented on the BOX claims . The BOX claim area has been previously identified as a high priority drill target and remains so subsequent to the DIGHEM airborne geophysical survey.

In contrast, the DIBBLE and VICTOR areas did not return appreciable airborne geophysical responses. This may reflect the lack of an orebody or orebodies of any appreciable size near surface. However, the relative depth penetration of airborne geophysics (i.e. the depth to which the airbore EM bird can effectively "see") may be as little as 100 metres. Therefore, an orebody or orebodies may still be present, albeit at somewhat deeper levels. (Note: a large orebody at deeper levels would still be expected to manifest itself in the form of a low amplitude, broad anomaly and therefore would be at much deeper levels than one or more smaller orebodies in order to remain undetected. Such an orebody, if present, may be at depths of 250 metres or more (sub-surface) and not be evident on the airborne survey).

The author is of the **opinion** that the mineralization previously identified on the DIBBLE and VICTOR claims is still significant despite the apparently negative DIGHEM results. The Victor vein, possibly together with the Flat and Pond veins, may represent potential for a low tonnage, high grade deposit worthy of a small mining operation with further evaluation. Similarly, gold-bearing quartz veins documented on the DIBBLE claims may also represent potential for a low tonnage, high grade operation, a open pittable resource or, if the veins are shear-hosted and merge at depth, a higher grade underground resource. It is important to realize, however, that the above possibilities are nothing more than speculative, based on information available at present.

CONCLUSIONS

There is evidence that the DV property may be located in a sub-basin on the margin of the Proterozoic Purcell Basin. The sub-basin coincides with a reentrant that was controlled by two major tranverse faults episodically active from the Proterozoic (during deposition of the Aldridge Formation) to the Mesozoic (deformation associated with the Laramide orogeny). The St. Mary - Boulder Creek Fault is present to the north and the Moyie - Dibble Creek Fault comprises the southern margin of the DV property. The Dibble Creek Fault is coincident with a Proterozoic monocline, the Dibble Creek monocline, on the northern flank of a basement high-standing area referred to as Montania. Sediments that thicken and coarsen to the south, coupled with northward directed paleo-currents suggests that the DV property may have been located in a sub-basin controlled by growth faults.

There are three past producers in the immediate vicinity of the DV property, the Estella, Kootenay King and Bull River mines. The Kootenay King mine was a stratabound orebody located in a quartzite, the Kootenay King Quartzite, in a separate sub-basin. Of particular significance is the fact that the source vent for the deposit was not located and was interpreted as either eroded or distal from the resulting orebody. The Estella mine was a lead-zinc vein, located proximal to both a composite monzonite - syenite stock and two Moyie sills, one exposed in outcrop immediately west and the other in the sub-surface mine workings. The Bull River mine consists of a series of seven separate sheared and fractured zones within the host lower Aldridge argillites. With the exception of the host strata, mineralization identified to date on the Dibble Group appears to be broadly similar to that described in the Bull River mine. Quartz veins (with siderite) in sheared and fractured rock proximal to a major fault (Bull Canyon Fault) host disseminated or massive pods of chalcopyrite, pyrite and pyrrhotite. In the Dibble Creek area, sheared and fractured Creston strata proximal to a major fault (the Dibble Creek Fault) host disseminated or massive pods of chalcopyrite and pyrite.

The Victor vein is a vein infill of a rather minor fault which is sub-parallel to bedding. It hosts predominantly lead-zinc mineralization with significant values in gold and silver and minor copper. It has been, and is interpreted, as vein style mineralization. The source for the mineralization is presently unknown, but is interpreted to have a composite source, locally from the Creston Formation (silver and copper, probably gold) and the Aldridge Formation (lead and zinc). The Box showing has previously been interpreted as a lead-zinc vein showing (Höy 1993, Minfile) but the author believes it may have stratiform potential. There are a number of quartzite beds which comprise a significant proportion of the local stratigraphy (upper middle Aldridge), there is a relatively wide lead anomaly, the area is interpreted to be in a sub-basin of the Purcell Basin characterized by deep water clastics and is south of the Kootenay King stratiform deposit. The Kootenay King Quartzite hosted the mine and is the highest of a number of quartzites in the lower middle Aldridge Formation. Harris (1990) proposed that the suite of samples obtained from the Box showing may represent a tuffaceous or exhalative environment.

> "They (the petrographic suite examined) are comprised of unusually albite-rich meta-sediments (feldspathic argillitic siltstones and arkosic quartzites); albitites (of unknown, but possibly keratophyric meta-igneous or meta-tuffaceous origin); chlorite-quartz rocks, possibly representing ferro-magnesian cherts; and a

> cryptofragmental amphibole-chlorite rock which could be a mafic meta-tuff. Several of the albitic samples contain traces of barite, associated with metamorphically remobilized (?) hairline veinlets of quartz and albite. One (Sample 9 from DDH-3) contains siderite and sphalerite, and most contain disseminated pyrite or derived limonite.
>
> This mineralogy suggests a distinctive depositional environment which may have included a tuffaceous or exhalative component. The albitites are texturally distinct from the feldspathic quartzites, and no evidence was found to indicate that they have developed from "alteration" of the latter ..." (Harris 1990).

Finally, an airborne geophysical program completed during the 1996 field season resolved the magnetic anomalies covered by the FOX claims as probable sub-surface equivalents of gabbroic exposures identified at surface as part of previous mapping programs. However, mineralization was identified on the ridge north of the Dibble Crown Grants associated with gabbro (RW95-1a and1b) and similar mineralization may be found with other gabbros.

Similar magnetic anomalies were identified north and west of the BOX claims and are also interpreted as sub-surface equivalents of gabbroic exposures identified at surface. However, in contrast to the FOX claims, geophysical conductors were also identified on the BOX claims. These may be significant with respect to quartzites of the middle Aldridge Formation, sericite alteration and anomalous levels of soil and rock geochemistry previously identified on the Box claims. Furthermore, a sub-surface conductor was identified and reported by Pezzot (1988) as a south-southwest trending sub-surface conductivity anomaly at an interpreted depth of 75 metres, possibly "... generated from a concentration of small, conductive lenses focussed about a larger lineation ...". The two most prominent conductors (designated C9 and C10) are located west of the sericite alteration zone mapped on the BOX claims, are sub-parallel to parallel to local stratigraphy and are associated with quartzites of the middle Aldridge Formation. These two conductors are considered to be among the best drill targets on the DV property.

RECOMMENDATIONS

1) Plot Barium values on a property map as a possible pathfinder for hydrothermal alteration associated with fractures, faults and/or as yet unknown quartz veins hosting mineralization,

2) Re-contour VLF data for the Victor geophysical grid (and possibly the Box grid),

3) Undertake a geographical positioning survey of the property to survey in adit, trench, shaft and mineral occurrences together with geographical features for future reference (i.e. trails, helipads, etc.),

4) Order complete black and white and/or colour airphoto coverage for the property to facilitate mapping and assist in future program decisions,

5) Collect soil samples along (a) contour(s) below the BOX Crown Grant and the EM conductors to identify any mineralized horizons associated with the conductors,

6) Collect soil on a grid in the FOX claims to determine the potential for mineralization associated with gabbros and/or host strata and identify anomalous levels of mineralization which may be associated with a magnetic source other than a gabbro,

7) Evaluate the economic potential of the gypsum horizon in the basal Devonian unit,

9) Undertake soil and rock sampling of Domain 3 to completely assess mineralization of the Aldridge and Creston block bounded by the Dibble Creek Fault and its splay,

10) Compile all geological, geochemical and geophysical data to develop and test drill targets.

Targets developed to date and considered worthy of drilling are:

a) the VLF anomaly underlying the Box claim at an interpreted depth of 90 and proximal EM conductors;
b) the Victor vein system, to test mineralization with depth;
c) the Horseshoe Creek and/or Dibble Creek fault systems to evaluate their down-dip extension(s) for mineralization;
d) the segmented geophysical anomalies identified on the airborne geophysical dataset (after additional soil sampling to better define the anomaly).

PROPOSED BUDGET

Drafting (plotting barium values / re-contour VLF data)	$ 2,000
Airphotos	$ 150
GPS Survey of property	$ 4,000
Geochemical Survey - collection of 500 soil samples (10 man-days)	$ 4,500
- Analyses	$ 6,000
Geological mapping - 1:2,000 or less - Box, Dibble, Fox and Victor grids	$ 4,000
Data compilation, plotting and analysis	$ 5,000
Drilling - Box Grid (depth 100 metres - 3 holes)	$ 20,000
- Dibble Grid (est. depth 300 metres - 2 holes)	$ 40,000
- Victor Grid (est. depth 100 metres - 2 holes)	$ 14,000
- Fox Grid (est. depth 300 metres - 1 hole)	$ 20,000
	$119,650
Contingency @ 10%	$ 12,000
Total	**$131,650**

** Note: The proposed program can be separated into four separate phases consisting of the Box, Dibble, Fox and Victor claims. Any or all of these claims can be evaluated to follow-up on any anomalies identified.

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Appendix A

Statement of Qualifications

STATEMENT OF QUALIFICATIONS

I, Richard T. Walker, of 656 Brookview Crescent, Cranbrook, B.C., hereby certify that:

1) I am a graduate of the University of Calgary of Calgary, Alberta, having obtained a Bachelors of Science in 1986;

2) I obtained a Masters of Geology at the University of Calgary of Calgary, Alberta in 1989;

3) I am a member in good standing with the Association of Professional Engineers and Geoscientists of the Province of British Columbia;

4) I am a member in good standing with the Association of Professional Engineers, Geologists and Geophysicists of Alberta;

5) I am a Fellow of the Geological Association of Canada;

6) I am a consulting geologist and Principle of Dynamic Exploration Ltd. with offices at 656 Brookview Crescent, Cranbrook, British Columbia;

7) I am the author of this report which is based on a DIGHEM airborne geophysical program conducted on the property between September 30 and October 5, 1996. The author contracted and supervised the program on behalf of Big B Resources,

8) I have no interest, direct or indirect, in Big B Resources; in any of their projects or properties nor do I expect to receive any such interest.

9) I hereby grant my permission to Big B Resources to use this report, or any portion of it, for any legal purposes normal to the business of the firm, provided the excerpts used do not materially deviate from the intent of this report as set out in the whole.

Dated at Cranbrook, British Columbia this 30th day of July, 1997.

R. T. WALKER

Richard T. Walker, P.Geo, P.Geol., F.G.A.C.

Appendix B

Statement of Expenditures

STATEMENT OF EXPENDITURES

The following expenses were incurred on the DIBBLE property for the purposes of geological exploration within the period September to October, 1997.

Personnel	
R. Walker, P.Geo., 4 days at $400/day	$ 1,600.00
G. Babcock, P.Eng., 3 days at $400 / day	$ 1,200.00
Disbursements	
DIGHEM airborne geophysical survey	$ 41,355.50
Frontier Geosciences Inc. - geophysical data evaluation	$ 2,704.96
Courier Charges	$ 50.00
Report Writing / Reproduction	
R. Walker, P.Geo., 2 days at $400 / day	$ 800.00
Reproduction	$ 100.00
Telephone Charges	$ 135.00
Total	**$ 47,945.46**

Appendix D

Partial Geophysics Report

DIGHEM

Report #1258

DIGHEM^{V} SURVEY
FOR
BIG B RESOURCES INC.
KOOTENAY RIVER AREA
BRITISH COLUMBIA

NTS 82G 11/12

Dighem, a division of CGG Canada Ltd.
Mississauga, Ontario
November 20, 1996

Doug McConnell, P.Eng.
Geophysicist

R1258NOV.96

SUMMARY

This report describes the logistics and results of a DIGHEM^V airborne geophysical survey carried out for Big B Resources Inc., over a property located near Kootenay River, British Columbia. Total coverage of the survey block amounted to 338 km. The survey was flown from September 30 to October 5, 1996.

The purpose of the survey was to detect zones of conductive mineralization and to provide information that could be used to map the geology and structure of the survey area. This was accomplished by using a DIGHEM^V multi-coil, multi-frequency electromagnetic system, supplemented by a high sensitivity cesium magnetometer and a gamma-ray spectrometer. The information from these sensors was processed to produce maps which display the magnetic, radioactive and conductive properties of the survey area. A GPS electronic navigation system, utilizing a UHF link, ensured accurate positioning of the geophysical data with respect to the base maps.

The survey property contains several anomalous features, which are considered to be of moderate to high priority as exploration targets. Most of the inferred bedrock conductors appear to warrant further investigation using appropriate surface exploration techniques. Areas of interest may be assigned priorities on the basis of supporting geophysical, geochemical and/or geological information. After initial investigations have been carried out, it may be necessary to re-evaluate the remaining anomalies based on information acquired from the follow-up program.

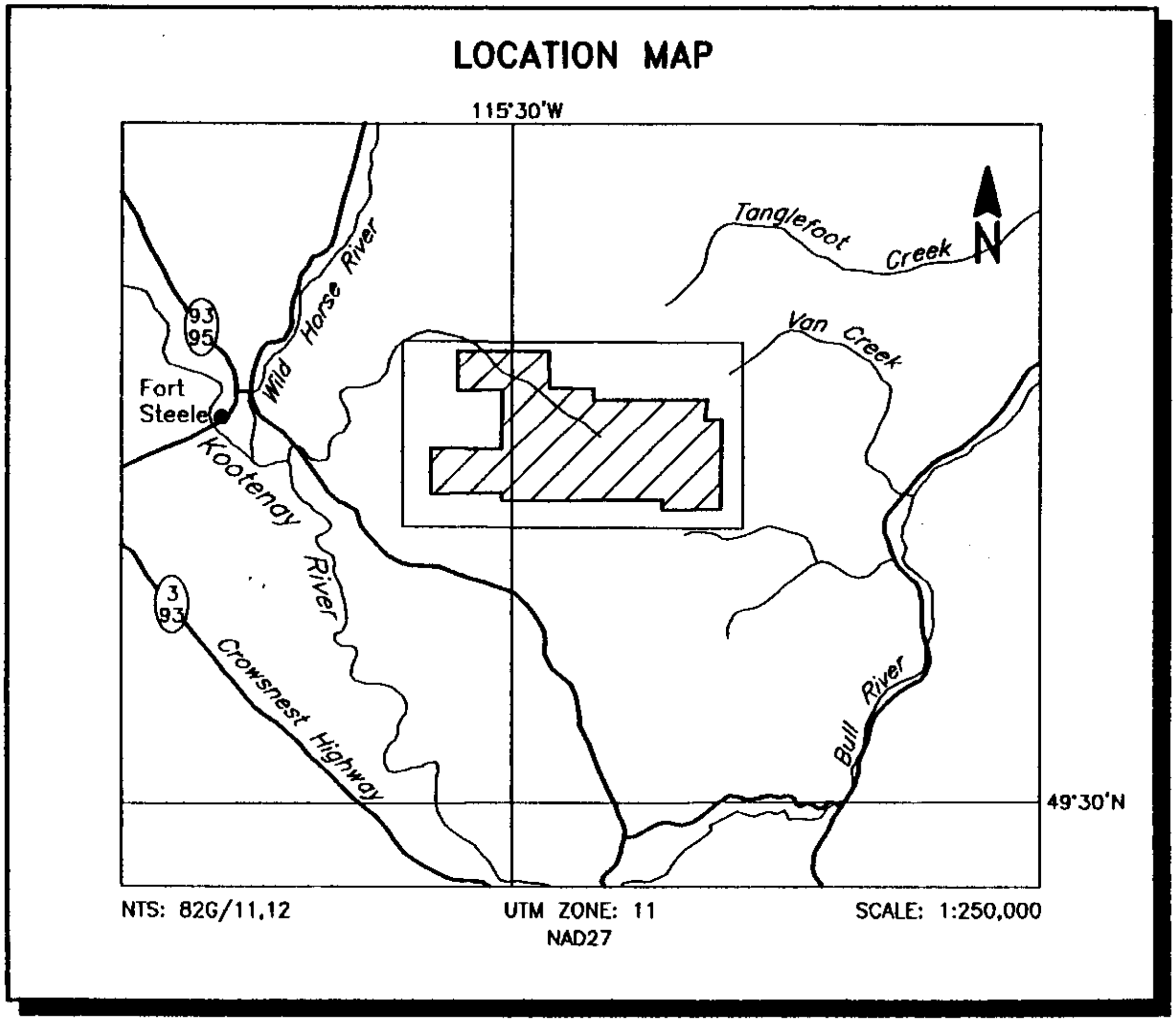

FIGURE 1
BIG B RESOURCES INC.
KOOTENAY RIVER AREA, B.C.
JOB #1258

CONTENTS

INTRODUCTION

A DIGHEM^V electromagnetic/resistivity/magneti/radiometricc survey was flown for Big B Resources Inc., from September 30 to Octrober 5, 1996, over a survey block located near Kootenay River, British Columbia. The survey area can be located on NTS map sheet 82G 11/12 (see Figure 1).

Survey coverage consisted of approximately 330 line-km of traverse lines and 8 line-km of tie lines. Flight lines were flown in an azimuthal direction of 90° with a line separation of 100 metres.

The survey employed the DIGHEM^V electromagnetic system. Ancillary equipment consisted of a magnetometer, radar altimeter, video camera, analog and digital recorders, a gamma-ray spectrometer and an electronic navigation system. Details on the survey equipment are given in Section 2. Section 2 also provides details on the data channels, their respective sensitivities, and the navigation/flight path recovery procedure.

SURVEY EQUIPMENT

The instrumentation was installed in an Aerospatiale AS350B turbine helicopter (Registration C-FUAM) which was provided by Questral Helicopters Ltd. The helicopter flew at an average airspeed of 70 km/h with an EM bird height of approximately 30 m.

Electromagnetic System

Model:	DIGHEM^V
Type:	Towed bird, symmetric dipole configuration operated at a nominal survey altitude of 30 metres. Coil separation is 8 metres for all frequencies except the 56,000 Hz coil-pair which has a separation of 6.3 metres.

Coil orientations/ frequencies:	coaxial/	900 Hz
	coplanar/	900 Hz
	coaxial/	5,500 Hz
	coplanar/	7,200 Hz
	coplanar/	56,000 Hz

Channels recorded:	5 inphase channels 5 quadrature channels 2 monitor channels

Sensitivity:	0.06 ppm at	900 Hz
	0.06 ppm at	900 Hz
	0.12 ppm at	5,500 Hz
	0.12 ppm at	7,200 Hz
	0.30 ppm at	56,000 Hz

Sample rate: 10 per second

The electromagnetic system utilizes a multi-coil coaxial/coplanar technique to energize conductors in different directions. The coaxial coils are vertical with their axes in the flight direction. The coplanar coils are horizontal. The secondary fields are sensed simultaneously by means of receiver coils which are maximum coupled to their respective transmitter coils. The system yields an inphase and a quadrature channel from each transmitter-receiver coil-pair.

The EM system was calibrated with an external coil at the start and end of the survey, and with an internal coil approximately three times per hour during survey flights. The EM system was phased with an external ferrite rod before each survey flight. The EM bird is flown out of ground effect (over 250 metres) approximately every half hour to provide zero levels for the EM channels.

Magnetometer

Model:	Picodas 3340
Type:	Optically pumped cesium vapour
Sensitivity:	0.01 nT
Sample rate:	10 per second

The magnetometer sensor is towed in a bird 20 m below the helicopter.

Magnetic Base Station

Model:	MEP710
Type:	Optically pumped cesium vapour
Sensitivity:	0.01 nT
Sample rate:	0.2 per second

A digital recorder is operated in conjunction with the base station magnetometer to record the diurnal variations of the earth's magnetic field. The clock of the base station is synchronized with that of the airborne system to permit subsequent removal of diurnal drift.

Analog Recorder

Manufacturer:	RMS Instruments
Type:	DGR33 dot-matrix graphics recorder
Resolution:	4x4 dots/mm
Speed:	1.5 mm/sec

The analog profiles are recorded on chart paper in the aircraft during the survey. Table 2-1 lists the geophysical data channels and the vertical scale of each profile.

Table 2-1. The Analog Profiles

Channel Name	Parameter	Scale units/mm	Designation on digital profile
1X9I	coaxial inphase 900 Hz	2.5 ppm	CXI (900 Hz)
1X9Q	coaxial quadrature 900 Hz	2.5 ppm	CXQ (900 Hz)
3P9I	coplanar inphase 900 Hz	2.5 ppm	CPI (900 Hz)
3P9Q	coaxial quadrature 900 Hz	2.5 ppm	CPQ (900 Hz)
2P7I	coplanar inphase 7,200 Hz	5.0 ppm	CPI (7200 Hz)
2P7Q	coplanar quadrature 7,200 Hz	5.0 ppm	CPQ (7200 Hz)
4X7I	coaxial inphase 5,500 Hz	5.0 ppm	CXI (5500 Hz)
4X7Q	coaxial Inphase 5,500 Hz	5.0 ppm	CXQ (5500 Hz)
5P5Q	coplanar inphase 56,000 Hz	10 ppm	CPI (56 kHz)
5P5I	coplanar quadrature 56,000 Hz	10 ppm	CPQ (56 kHz)
ALTR	altimeter	3 m	ALT
CMGC	cesium magnetics, coarse	20 nT	MAG
CMGF	cesium magnetics, fine	2.0 nT	
CXSP	coaxial spherics monitor		
4XSP	coaxial 5,500 Hz spherics monitor		
CPSP	coplanar spherics monitor		
CXPL	coaxial power line monitor		
CPPL	coplanar power line monitor		
TC	total count	200 cps	
K	potassium	20 cps	
U	uranium	20 cps	
TH	thorium	20 cps	

Radar Altimeter

Manufacturer:	Honeywell/Sperry
Type:	AA 220
Sensitivity:	1 ft

The radar altimeter measures the vertical distance between the helicopter and the ground. This information is used in the processing algorithm which determines conductor depth.

Digital Data Acquisition System

Manufacturer:	RMS Instruments
Type:	DGR 33
Tape Deck:	RMS TCR-12, 6400 bpi, tape cartridge recorder

The digital data are stored on tape cartridges which are downloaded to the field workstation for processing.

Tracking Camera

Type:	Panasonic Video
Model:	AG 2400/WVCD132

Fiducial numbers are recorded continuously and are displayed on the margin of each image. This procedure ensures accurate correlation of analog and digital data with respect to visible features on the ground.

Navigation System (RT-DGPS)

Model:	Sercel NR106, Real-time differential positioning
Type:	SPS (L1 band), 10-channel, C/A code, 1575.42 MHz.
Sensitivity:	-132 dBm, 0.5 second update
Accuracy:	< 5 metres in differential mode, ± 50 metres in S/A (non differential) mode

The Global Positioning System (GPS) is a line of sight, satellite navigation system which utilizes time-coded signals from at least four of the twenty-four NAVSTAR satellites. In the differential mode, two GPS receivers are used. The base station unit is used as a reference which transmits real-time corrections to the mobile unit in the aircraft, via a UHF radio datalink. The on-board system calculates the flight path of the helicopter while providing real-time guidance. The raw XYZ data are recorded for both receivers, thereby permitting post-survey processing for accuracies of approximately 2 metres.

Although the base station receiver is able to calculate its own latitude and longitude, a higher degree of accuracy can be obtained if the reference unit is established on a known benchmark or triangulation point. The GPS records data relative to the WGS84 ellipsoid, which is the basis of the revised North American Datum (NAD83). Conversion software is used to transform the WGS84 coordinates to the system displayed on the base maps.

Spectrometer

Manufacturer:	Exploranium
Model:	GR-820
Type:	256 Multichannel, Potassium stabilized
Accuracy:	1 count/sec.
Update:	1 integrated sample/sec.

The GR-820 Airborne Spectrometer employs four downward looking crystals (1024 cu. in.) and one upward looking crystal (256 cu. in.). The downward crystal records the radiometric spectrum from 410 KeV to 3 MeV over 256 discrete energy windows, as well as a cosmic ray channel which detects photons with energy levels above 3.0 MeV. From these 256 channels, the standard total count, potassium, uranium and thorium channels are extracted. The upward crystal is used to measure and correct for radon.

The shock-protected sodium iodide (thallium) crystal package is unheated, and is automatically stabilized with respect to the potassium peak. The GR-820 provides raw or Compton stripped data which has been automatically corrected for gain, base level, ADC offset and dead time.

Field Workstation

Manufacturer:	Dighem
Model:	FWS: V2.71
Type:	Pentium based P.C.

A portable PC-based field workstation is used at the survey base to verify data quality and completeness. Flight tapes are dumped to a hard drive to permit the creation of a database. This process allows the field operators to display both the positional (flight path) and geophysical data on a screen or printer.

PRODUCTS AND PROCESSING TECHNIQUES

Refer to Table 3-1 for a summary of the maps which accompany this report, some of which may be sent under separate cover.

Base Maps

Base maps of the survey area have been produced from published topographic maps. These provide a relatively accurate, distortion-free base which facilitates correlation of the navigation data to the UTM grid. Photomosaics are useful for visual reference and for subsequent flight path recovery, but usually contain scale distortions. Orthophotos are ideal, but their cost and the time required to produce them, usually precludes their use as base maps.

Flight Path

Visual flight path recovery techniques were used to confirm the location of the helicopter which was derived from the from the electronic navigation data where visible topographic features could be identified on the ground.

Electromagnetic Anomalies

Anomalous electromagnetic responses are selected and analysed by computer to provide a preliminary electromagnetic anomaly map. This preliminary map is used, by the geophysicist, in conjunction with the computer-generated digital profiles, to produce the final interpreted EM anomalies. These anomalies include bedrock, surficial and cultural conductors. A geophysical map containing only bedrock conductors can be generated, if desired. The selected anomalies and their attributes are listed in the EM anomaly list appended to this report.

Resistivity

The apparent resistivity in ohm-m may be generated from the inphase and quadrature EM components for any of the frequencies, using a pseudo-layer halfspace model. A resistivity map portrays all the EM information for that frequency over the entire survey area. The large dynamic range makes the resistivity parameter an excellent mapping tool.

Table 3-1 Survey Products

Final Transparencies and Colour Plots @ 1:20,000

Electromagnetic anomalies (black & white only)
Total field magnetic contours and colours
Calculated vertical gradient contours and colours
7,200 Hz resistivity contours and colours
56,000 Hz resistivity contours and colours
Total count contours and colours
Potassium contours and colours
Uranium contours and colours
Thorium contours and colours
Shadowed magnetic map

The final prints display the geophysical parameter combined with the flight path and EM anomalies on a screened topographic base. The colour maps display superimposed contours, screened topography, flight path, EM anomalies and UTM coordinates. Three prints of each black & white map and two sets of each colour map are supplied.

Other Products

Analog chart records
Flight path video cassettes
Digital XYZ archives with documentation
Digital grid archives on CD-ROM
Logistics report (3 copies)
Multi-channel 'stacked' geophysical profiles
Vision imaging software

Multi-channel Stacked Profiles

Distance-based profiles of the digitally recorded geophysical data are generated and plotted by computer. These profiles also contain the calculated parameters which are used in the interpretation process. These are produced as worksheets prior to interpretation, and can also be presented in the final corrected form after interpretation. The profiles display electromagnetic anomalies with their respective interpretive symbols. Table 3-2 lists the parameters which are displayed on the Multi-channel Stacked Profiles. In Table 3-2, the log resistivity scale of 0.06 decade/mm means that the resistivity changes by an order of magnitude in 16.6 mm. The resistivities at 0, 33 and 67 mm up from the bottom of the digital profile are respectively 1, 100 and 10,000 ohm-m.

Total Field Magnetics

The aeromagnetic data are corrected for diurnal variation using the magnetic base station data. The background magnetic level has been adjusted to match the International Geomagnetic Reference Field (IGRF) for the survey area.

Calculated Vertical Gradient

The calculated vertical gradient (also known as the first derivative) is one of several filters that can be applied to the data after transforming the data to frequency domain using the FFT technique. The vertical gradient improves the recognition of near surface magnetic bodies, and reduces long wavelength regional variations. A reverse FFT procedure restores the data to space domain.

Table 3-2. The Multi-channel Stacked Profiles

Channel Name (freq.)	Observed parameters	Scale units/mm
MAG	magnetics	10 nT
ALT	bird height	6 m
CXI (900 Hz)	vertical coaxial coil-pair inphase	2 ppm
CXQ (900 Hz)	vertical coaxial coil-pair quadrature	2 ppm
CPI (900 Hz)	horizontal coplanar coil-pair inphase	2 ppm
CPQ (900 Hz)	horizontal coplanar coil-pair quadrature	2 ppm
CXI (5500 Hz)	vertical coaxial coil-pair inphase	4 ppm
CXQ (5500 Hz)	vertical coaxial coil-pair quadrature	4 ppm
CPI (7200 Hz)	horizontal coplanar coil-pair inphase	4 ppm
CPQ (7200 Hz)	horizontal coplanar coil-pair quadrature	4 ppm
CPI (56 kHz)	horizontal coplanar coil-pair inphase	10 ppm
CPQ (56 kHz)	horizontal coplanar coil-pair quadrature	10 ppm
CXS	coaxial spherics monitor	
CXP	coaxial powerline monitor	
CPS	coplanar spherics monitor	
CPP	coplanar powerline monitor	
TC	total count	
K	potassium	
U	uranium	
Th	thorium	
	Calculated Parameters	
DFI (900 Hz)	difference function inphase from CXI and CPI	2 ppm
DFQ (900 Hz)	difference function quadrature from CXQ and CPQ	2 ppm
RES (900 Hz)	log resistivity	.06 decade
RES (7200 Hz)	log resistivity	.06 decade
RES (56 kHz)	log resistivity	.06 decade
DP (900 Hz)	apparent depth	6 m
DP (7200 Hz)	apparent depth	6 m
DP (56 kHz)	apparent depth	6 m
CDT	conductance	1 grade

Radiometric Data Processing

All radiometric data reductions performed by Dighem rigorously follow the procedures described in the IAEA Technical Report[1].

All processing of radiometric data was undertaken at the natural sampling rate of the spectrometer, i.e., one second. The data were not interpolated to match the fundamental 0.2 second interval of the database.

The following sections describe each step in the process.

Pre-filtering

The radar altimeter data were processed with a 49-point median filter to remove spikes.

Reduction to Standard Temperature and Pressure

The radar altimeter data were converted to effective height (h_e) in feet using the acquired temperature and pressure data, according to the following formula:

$$h_e = h * \frac{273.15}{T + 273.15} * \frac{P}{1013.25}$$

where: h is the observed radar altitude in feet
T is the measured air temperature in degrees Celsius
P is the barometric pressure in millibars

Live Time Correction

The spectrometer, an Exploranium GR-820, uses the notion of "live time" to express the relative period of time the instrument was able to register new pulses per sample interval. This is the opposite of the traditional "dead time", which is an expression of the relative period of time the system was unable to register new pulses per sample interval.

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[1] Exploranium, I.A.E.A. Report, Airborne Gamma-Ray Spectrometer Surveying, Technical Report No. 323, 1991.

The GR-820 measures the live time electronically, and outputs the value in milliseconds. The live time correction is applied to the total count, potassium, uranium, thorium, upward uranium and cosmic channels. The formula used to apply the correction is as follows:

$$C_{lt} = C_{raw} * \frac{1000.0}{L}$$

where: C_{lt} is the live time corrected channel in counts per second
C_{raw} is the raw channel data in counts per second
L is the live time in milliseconds

Intermediate Filtering

Two parameters were filtered, but not returned to the database:

- Radar altimeter was smoothed with a 5-point Hanning filter (h_{ef}).
- The Cosmic window was smoothed with a 29-point Hanning filter (Cos_f).

Aircraft and Cosmic Background

Aircraft background and cosmic stripping corrections were applied to the total count, potassium, uranium, thorium and upward uranium channels using the following formula:

$$C_{ac} = C_{lt} - (a_c + b_c * \mathrm{Cos}_f)$$

where: C_{ac} is the background and cosmic corrected channel
C_{lt} is the live time corrected channel
a_c is the aircraft background for this channel
b_c is the cosmic stripping coefficient for this channel
Cos_f is the filtered Cosmic channel

Radon Background

The determination of calibration constants that enable the stripping of the effects of atmospheric radon from the downward-looking detectors through the use of an upward-looking detector is divided into two parts:

1) Determine the relationship between the upward- and downward-looking detector count rates for radiation originating from the ground.

2) Determine the relationship between the upward- and downward-looking detector count rates for radiation due to atmospheric radon.

The procedures to determine these calibration factors are well-documented in IAEA Report #323 on airborne gamma-ray surveying. The calibrations for the first part were determined as outlined in the report.

The latter case normally requires many over-water measurements where there is no contribution from the ground. Where this is not possible, it is standard procedure to establish a test line over which a series of repeat measurements are acquired. From these repeat flights, any change in the downward uranium window due to variations in radon background would be directly related to variations in the upward window and the other downward windows.

The validity of this technique rests on the assumption that the radiation from the ground is essentially constant from flight to flight. Inhomogeneities in the ground, coupled with deviations in the flight path between test runs, add to the inaccuracy of the accumulated results. Variations in flying heights and other environmental factors also contribute to the uncertainty.

The use of test lines is a solution for a fixed-wing acquisition platform. The ability of rotary wing platforms to hover at a constant height over a fixed position would appear to eliminate a number of the variations which degrade the accuracy of the results required for this calibration.

Hover test sites were established in or near the survey area. The tests were carried out at the start and end of each day, and at the end of each flight. Data were acquired over a four minute period at the nominal survey altitude (60 m). The data were then corrected for livetime, aircraft background and cosmic activity.

Once the survey was completed, the relationships between the counts in the downward uranium window and in the other four windows due to atmospheric radon were determined using linear regression for each of the three hover sites. The equations solved for were:

$$u_r = a_u Ur + b_u$$

$$K_r = a_K U_r + b_K$$

$$T_r = a_T U_r + b_T$$

$$I_r = a_I U_r + b_I$$

where: u_r is the radon component in the upward uranium window
K_r, U_r, T_r and I_r are the radon components in the various windows of the downward detectors
the various "a" and "b" coefficients are the required calibration constants

In practice, only the "a" constants were used in the final processing. The "b" constants, which are normally near zero for over-water calibrations, were of no value as they reflected the local distribution of the ground concentrations measured in the five windows. The values of a_I, a_K, a_T and a_u are summarized in Table 3-1.

The thorium, uranium and upward uranium data for each line were copied into temporary arrays, then smoothed with 21, 21 and 51 point Hanning filters to product Th_f, U_f, and u_f respectively. The radon component in the downward uranium window was then determined using the following formula:

$$U_r = \frac{u_f - a_1 * U_f - a_2 * Th_f + a_2 * b_{Th} - b_u}{a_u - a_1 - a_2 * a_{Th}}$$

where: U_r is the radon component in the downward uranium window
u_f is the filtered upward uranium
U_f is the filtered uranium
Th_f is the filtered thorium
a_1, a_2, a_u and a_{Th} are proportionality factors and
b_u and b_{Th} are constants determined experimentally

The effects of radon in the downward uranium are removed by simply subtracting U_r from U_{ac}. The effects of radon in the total count, potassium, thorium and upward uranium are then removed based upon previously established relationships with U_r. The corrections are applied using the following formula:

$$C_{rc} = C_{ac} - (a_c * U_r + b_c)$$

where: C_{rc} is the radon corrected channel
C_{ac} is the background and cosmic corrected channel
U_r is the radon component in the downward uranium window
a_c is the proportionality factor and
b_c is the constant determined experimentally for this channel

Compton Stripping

Following the radon correction, the potassium, uranium and thorium are corrected for spectral overlap. First, α,β and γ the stripping ratios, are modified according to altitude. Then an adjustment factor based on a, the reversed stripping ratio, uranium into thorium, is calculated. (Note: the stripping ratio altitude correction constants are expressed in change per metre. A constant of 0.3048 is required to conform to the internal usage of height in feet):

$$\alpha_h = \alpha + h_{ef} * 0.00049$$

$$\beta_h = \beta + h_{ef} * 0.00065$$

$$\gamma_h = \gamma + h_{ef} * 0.00069$$

$$\alpha_r = \frac{1.0}{1.0 - a * \alpha_h}$$

where: α, β, γ are the Compton stripping coefficients
α_h,β_h,γ_h are the height corrected Compton stripping coefficients
h_{ef} is the height above ground in metres
α_r is the scaling factor correcting for back scatter
a is the reverse stripping ratio

The stripping corrections are then carried out using the following formulas:

$$Th_c = (Th_{rc} - a * U_{rc}) * \alpha_r$$

$$K_c = K_{rc} - \gamma_h * U_c - \beta_h * Th_c$$

$$U_c = (U_{rc} - \alpha_h * Th_{rc}) * \alpha_r$$

where: U_c, Th_c and K_c are corrected uranium, thorium and potassium
α_h,β_h,γ_h are the height corrected Compton stripping coefficients
U_{rc}, Th_{rc} and K_{rc} are radon-corrected uranium, thorium and potassium
α_r is the backscatter correction

Attenuation Corrections

The total count, potassium, uranium and thorium data are then corrected to a nominal survey altitude, in this case 200 feet. This is done according to the equation:

$$C_a = C * e^{\mu(h_{ef} - ho)}$$

where: C_a is the output altitude corrected channel
C is the input channel
μ is the attenuation correction for that channel
h_{ef} is the effective altitude
h_0 is the nominal survey altitude to correct to

Contour, Colour and Shadow Map Displays

The geophysical data are interpolated onto a regular grid using a modified Akima spline technique. The resulting grid is suitable for generating contour maps of excellent quality.

Colour maps are produced by interpolating the grid down to the pixel size. The parameter is then incremented with respect to specific amplitude ranges to provide colour "contour" maps. Colour maps of the total magnetic field are particularly useful in defining the lithology of the survey area.

SURVEY RESULTS

General Discussion

Geology[2]

The following information was taken from a report supplied by Big B. A summary of information which was considered relevant to the geophysics is presented here.

The property contains three separate showing areas called the Dibble, Box and Victor areas.

The Dibble showings comprise veins of high grade copper, silver and gold which were mined briefly from 1895 to 1905. Rocks in the vicinity of the showings consist of grey and red siltstone, metamorphosed to slates with interbedded quartzite horizons. Locally, structure and lithology are east-west.

The Dibble showings occur over a large oval-shaped area with sericitic alteration in argillaceous strata and silicification and brecciation in quartzite beds.

The Box showings are situated at the head of Horsehoe Creek. A reverted crown grant in the area of these showings is also shown on the topography which is presented on the maps from this survey.

Galena, pyrite and chalcopyrite have been found in quartz veins and altered quartzite float. Galena and tetrahedrite with gold and silver values and copper mineralization have been reported on the crown grant.

Outcrop near the Pic vein contained chalcopyrite, pyrite and possible arsenopyrite. Gossanous clay alteration (fault gouge) is also present.

Soil sampling has turned up anomalous lead, zinc and gold in the area of the Box showing.

The Victor showings are steeply dipping quartz veins situated at the head of Maus Creek. This area produced gold, silver, lead, zinc and copper in the 1919 to 1920 period.

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[2] Taken from Price, B.J., Rapitan Resources Inc. DV Project, Fort Steel Mining District 1989.

The Victor vein is quartz with sphalerite, galena, chalcopyrite and pyrite with anomalous gold and silver. It is exposed over a vertical distance of 300 m and varies from a few centimetres to over 1 metre in width. Several other veins which are described as erratic, including the Upper Pond, flat and related veins have been sampled and many exhibit high grades.

Electromagnetics

Table 4-1 summarizes the EM responses in the survey area, with respect to conductance grade and interpretation. The anomalies shown on the geophysical maps are based on a near-vertical, half plane model. This model best reflects "discrete" bedrock conductors. Wide bedrock conductors or flat-lying conductive units, whether from surficial or bedrock sources, may give rise to very broad anomalous responses on the EM profiles. These may not appear on the geophysical maps if they have a regional character rather than a locally anomalous character. These broad conductors, which more closely approximate a half space model, will be maximum coupled to the horizontal (coplanar) coil-pair and should be more evident on the resistivity parameter.

The EM anomalies resulting from this survey appear to fall within one of two general categories. The first type consists of discrete, well-defined anomalies which yield marked inflections on the difference channels. These anomalies are usually attributed to conductive sulphides or graphite and are generally given a "B", "T" or "D" interpretive symbol, denoting a bedrock source.

The second class of anomalies comprises moderately broad responses which exhibit the characteristics of a half space and do not yield well-defined inflections on the difference channels. Anomalies in this category are usually given an "S" or "H" interpretive symbol. The lack of a difference channel response usually implies a broad or flat-lying conductive source such as overburden. Some of these anomalies may reflect conductive rock units or zones of deep weathering.

Excellent resolution and discrimination of conductors was accomplished by using a fast sampling rate of 0.1 sec and by employing common frequencies (900 Hz) on orthogonal coil-pairs (coaxial and coplanar). The resulting "difference channel" parameters often permit differentiation of bedrock and surficial conductors, even though they may exhibit similar conductance values.

The effects of conductive overburden are evident over portions of the survey area. Although the difference channels (DFI and DFQ) are extremely valuable in detecting bedrock conductors which are partially masked by conductive overburden, sharp undulations in the bedrock/overburden interface can yield anomalies in the difference channels which may be

TABLE 4-1

EM ANOMALY STATISTICS

KOOTENAY RIVER AREA, B.C.

CONDUCTOR GRADE	CONDUCTANCE RANGE SIEMENS (MHOS)	NUMBER OF RESPONSES
7	>100	0
6	50 - 100	0
5	20 - 50	0
4	10 - 20	0
3	5 - 10	0
2	1 - 5	9
1	<1	3
*	INDETERMINATE	21
TOTAL		33

CONDUCTOR MODEL	MOST LIKELY SOURCE	NUMBER OF RESPONSES
B	DISCRETE BEDROCK CONDUCTOR	13
S	CONDUCTIVE COVER	20
TOTAL		33

(SEE EM MAP LEGEND FOR EXPLANATIONS)

interpreted as possible bedrock conductors. Such anomalies usually fall into the "S?" or "B?" classification but may also be given an "E" interpretive symbol, denoting a resistivity contrast at the edge of a conductive unit.

In areas where EM responses are evident primarily on the quadrature components, zones of poor conductivity are indicated. Where these responses are coincident with magnetic anomalies, it is possible that the inphase component amplitudes have been suppressed by the effects of magnetite. Most of these poorly-conductive magnetic features give rise to resistivity anomalies which are only slightly below background. If it is expected that poorly-conductive economic mineralization may be associated with magnetite-rich units, most of these weakly anomalous features will be of interest. In areas where magnetite causes the inphase components to become negative, the apparent conductance and depth of EM anomalies may be unreliable.

The geophysical maps show the anomaly locations with the interpreted conductor type, dip, conductance and depth being indicated by symbols. Direct magnetic correlation is also shown if it exists. When studying the map sheets, consult the anomaly listings appended to this report.

Noise levels of less than 2 ppm are generally maintained for wind speeds up to 35 km/h. Higher winds may cause the system to be grounded because excessive bird swinging produces difficulties in flying the helicopter. The swinging results from the 5 m^2 of area which is presented by the bird to broadside gusts.

Anomalies which occur near the ends of the survey lines (i.e., outside the survey area), should be viewed with caution. Some of the weaker anomalies could be due to aerodynamic noise, i.e., bird bending, which is created by abnormal stresses to which the bird is subjected during the climb and turn of the aircraft between lines. Such aerodynamic noise is usually manifested by an anomaly on the coaxial inphase channel only, although severe stresses can affect the coplanar inphase channels as well.

In some portions of the survey area, the steep topography forced the pilot to exceed normal terrain clearance for reasons of safety. It is possible that some weak conductors may have escaped detection in areas where the bird height exceeded 120 m. In difficult areas where near-vertical climbs were necessary, the forward speed of the helicopter was reduced to a level which permitted excessive bird swinging. This problem, combined with the severe stresses to which the bird was subjected, gave rise to aerodynamic noise levels which are slightly higher than normal. Where warranted, reflights were carried out to minimize these adverse effects.

Any interpreted conductors which occur in close proximity to cultural sources, should be confirmed as bedrock conductors prior to drilling.

As economic mineralization within the area may be associated with massive to weakly disseminated sulphides, which may or may not be hosted by magnetite-rich rocks, it is difficult to assess the relative merits of EM anomalies on the basis of conductance. It is recommended that an attempt be made to compile a suite of geophysical "signatures" over areas of interest. Anomaly characteristics are clearly defined on the computer-processed geophysical data profiles which are supplied as one of the survey products.

A complete assessment and evaluation of the survey data should be carried out by one or more qualified professionals who have access to, and can provide a meaningful compilation of, all available geophysical, geological and geochemical data.

Magnetics

There is some evidence on the magnetic maps which suggests that the survey area has been subjected to deformation and/or alteration. These structural complexities are evident on the contour maps as variations in magnetic intensity, irregular patterns, and as offsets or changes in strike direction. Some of the more prominent linear features are also evident on the topographic base maps.

If specific magnetic characteristics can be assigned to the rock type which is believed to host the target mineralization, it may be possible to select areas of higher priority on the basis of the total field magnetic data.

The magnetic results, in conjunction with the other geophysical parameters, should provide valuable information which can be used to effectively map the geology and structure in the survey areas.

Radiometrics

The radiometrics contours do not appear to have been overwhelmingly affected by the distribution of surficial material. As most of the measured radioactivity comes from the top few metres of the earth, water laden soil will subdue the total radioactivity. The contours appear to mostly reflect variations in radioelement concentrations within geological units. Some structures are also apparent as lineations.

Whether or not the radiometrics will be a useful exploration tool in this area must be determined by persons with local geological knowledge who can assess the radioactive characteristics of the various rock types.

Resistivity

Resistivity maps, which display the conductive properties of the survey area, were produced from the 7200 Hz and 56,000 Hz coplanar data. The maximum resistivity value, which is calculated for each frequency, is approximately 1.15 times the numerical value of the frequency. This cutoff eliminates the meaningless higher resistivities which would result from very small EM amplitudes. In general, the resistivity patterns appear to be strongly influenced by conductive surficial material. In some cases, the resistivity contours agree with trends in the magnetics. This probably indicates structural or lithological control of surficial material.

Interpretation

The rocks of mostly sedimentary origin in the Creston, Kitchener and Aldridge formations show relatively no internal magnetic variation. Many of the strong magnetic responses correlate with meta diorite/gabbro sills and dykes. One obvious exception to this generalization is the northeast trending, narrow magnetic high which crosses the crown grant that covers the Box showing. This magnetic response flanks the zone of silica pyrite alteration.

The magnetic source yields the highest intensity near the location of the Pic vein. It also appears to be truncated by a northwest structure at this point, which may be related to the Pic Fault. If this northwest structure is thought to have influenced mineralization in the area, then the vicinity of anomaly 10307A may be of interest. In this location, the northwest fault has distorted another magnetic body.

Low radiometric intensities in a northeast-southwest trend correlate well with the altered quartzite in the Box showing. The silica, pyrite alteration (also described as sericitic, limonitic and sideritic hydrothermal alteration) may have caused replacement of the radioactive minerals.

Resistivity lows on the 7200 Hz and 56,000 Hz parallel the radiometric and magnetic trends. They may reflect control of surficial material, such as stream sediments or clay by stratigraphy or the contact at the northwest edge of the alteration zone.

The Dibble showings are situated within a broad magnetic high, a semi-circular portion of which is in the survey area, which is most likely due to a very deep magnetic source. The magnetics is generally inactive in this zone indicating that there are not any significant near surface variations in magnetite content.

The meta diorite/Gabbro sills and dykes which have been mapped by geology on the ridge to the northeast of the Dibble showings are prominent on the magnetic maps.

The Dibble area geochemistry outlines an oval zone elongated in the east-west direction. Trends in this direction would not be well defined by the east-west survey line direction, so it is difficult to establish if a subtle geophysical signature exists.

The Dibble showings are contained within a roughly circular shaped zone of anomalous total radioactivity, with about the same dimensions as the area covered by the old crown claims. This zone does not appear to be related to topography or stratigraphic boundaries and may reflect some form of alteration on a large scale.

The Victor showing is in the general area of a west-northwest trending magnetic low. A likely cause for this low would be a fault parallel to the Saddle fault. This is supported by the shape of the resistivity contours, radiometrics contours and topography. Within this trend, there is a local magnetic low between line 10310, fiducial 1020 and 10300, fiducial 3540 which may reflect a zone of more intense alteration.

Based on the geophysics alone, there are several areas which may warrant further investigation. Anomaly 10270A reflects a possible bedrock conductor that is associated with a magnetic response. The corresponding magnetic and EM anomalies suggest sulphide mineralization as a source. This anomaly is on strike with the Pic Fault.

Anomalies 10330A to 10392A and 10400A to 10470B are situated in an overburden covered area dominated by surficial conductive responses. Anomalies 10400A to 10470B reflect conductive sources that appear to extend to depth. They may result from clay in a fault gouge. This is supported by the topography. Anomalies 10330A, 10342B, 103410A to 10470B have been interpreted as questionable bedrock anomalies due to their shapes. They may be due to sharp overburden/bedrock interfaces or bedrock conductors beneath the overburden.

There are several other low resistivity zones with "S?" and "B?" anomalies which may warrant further investigation if there is supporting geological, geochemical or other geophysical information. These anomalies may be due to surficial sources, however, the rugged terrain in this area may have caused less than ideal EM bird orientation. This would affect anomaly shapes but not the resistivity calculations from the coplanar coils. Therefore, the local resistivity lows should be given more significance than EM anomaly interpretations.

Similarly, any magnetic anomalies that cannot be correlated with known gabbro occurrences similar to the response at anomaly 10270A and the magnetic trend crossing the Box showings may warrant follow-up.

BACKGROUND INFORMATION

Electromagnetics

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

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

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

Geometric Interpretation

The geophysical interpreter attempts to determine the geometric shape and dip of the conductor. Figure 5-1 shows typical DIGHEM anomaly shapes which are used to guide the geometric interpretation.

Discrete Conductor Analysis

The EM anomalies appearing on the electromagnetic map are analyzed by computer to give the conductance (i.e., conductivity-thickness product) in siemens (mhos) of a vertical sheet model. This is done regardless of the interpreted geometric shape of the conductor. This is not an unreasonable procedure, because the computed conductance increases as the electrical quality of the conductor increases, regardless of its true shape. DIGHEM anomalies are divided into seven grades of conductance, as shown in Table 5-1. The conductance in siemens (mhos) is the reciprocal of resistance in ohms.

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

Table 5-1. EM Anomaly Grades

Anomaly Grade	Siemens
7	> 100
6	50 - 100
5	20 - 50
4	10 - 20
3	5 - 10
2	1 - 5
1	< 1

Conductive overburden generally produces broad EM responses which may not be shown as anomalies on the geophysical. However, patchy conductive overburden in otherwise resistive areas can yield discrete anomalies with a conductance grade (cf. Table 5-1) of 1, 2 or even 3 for conducting clays which have resistivities as low as 50 ohm-m. In areas where ground resistivities are below 10 ohm-m, anomalies caused by weathering variations and similar causes can have any conductance grade. The anomaly shapes from the multiple coils often allow such conductors to be recognized, and these are indicated by the letters S, H, and sometimes E on the geophysical maps (see EM legend on maps).

For bedrock conductors, the higher anomaly grades indicate increasingly higher conductances. Examples: DIGHEM's New Insco copper discovery (Noranda, Canada) yielded a grade 5 anomaly, as did the neighbouring copper-zinc Magusi River ore body; Mattabi (copper-zinc, Sturgeon Lake, Canada) and Whistle (nickel, Sudbury, Canada) gave grade 6; and DIGHEM's Montcalm nickel-copper discovery (Timmins, Canada) yielded a grade 7 anomaly. Graphite and sulfides can span all grades but, in any particular survey area, field work may show that the different grades indicate different types of conductors.

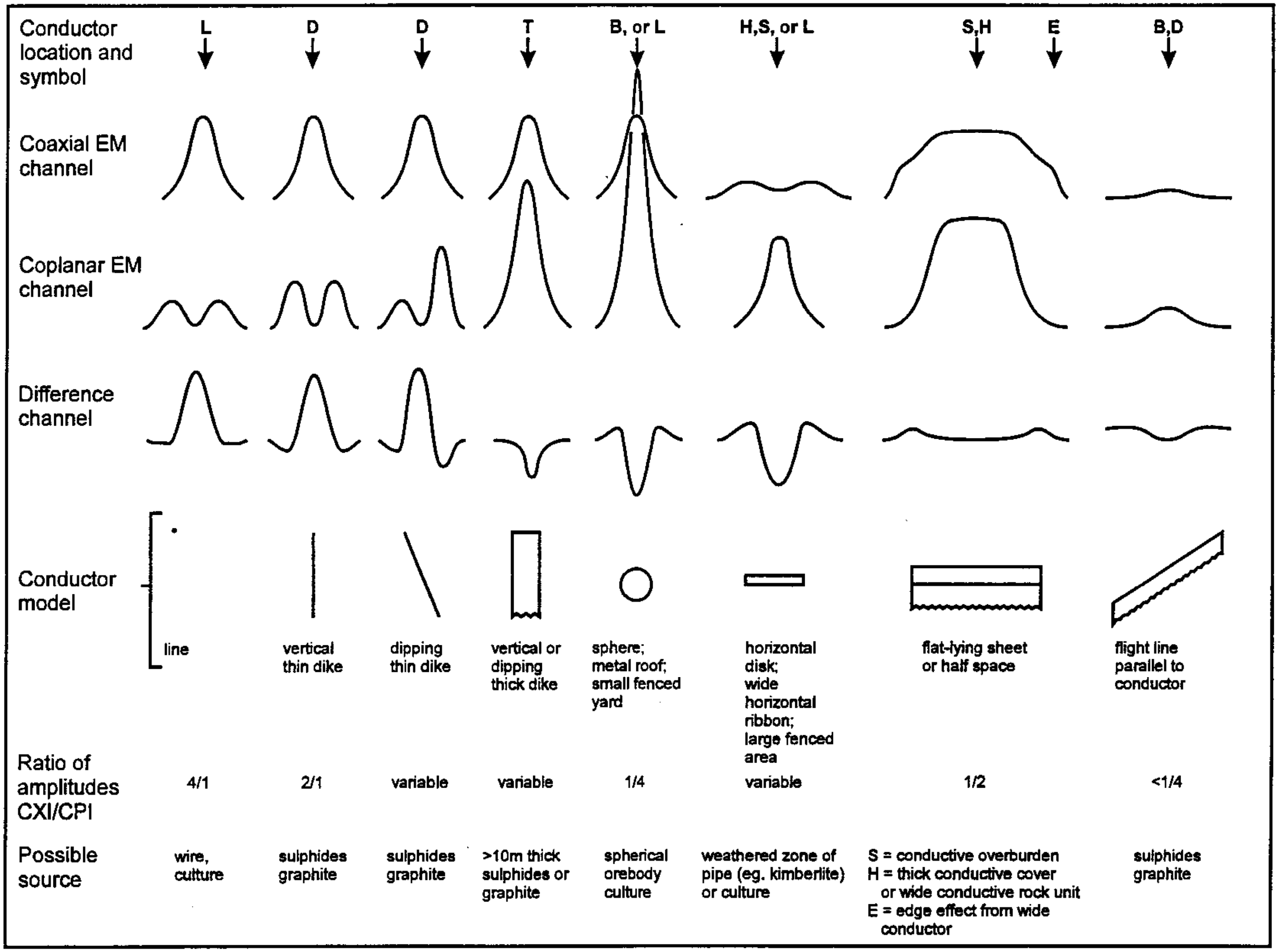
Strong conductors (i.e., grades 6 and 7) are characteristic of massive sulfides or graphite. Moderate conductors (grades 4 and 5) typically reflect graphite or sulfides of a less massive character, while weak bedrock conductors (grades 1 to 3) can signify poorly connected graphite or heavily disseminated sulfides. Grades 1 and 2 conductors may not respond to ground EM equipment using frequencies less than 2000 Hz.

The presence of sphalerite or gangue can result in ore deposits having weak to moderate conductances. As an example, the three million ton lead-zinc deposit of Restigouche Mining Corporation near Bathurst, Canada, yielded a well-defined grade 2 conductor. The 10 percent by volume of sphalerite occurs as a coating around the fine grained massive pyrite, thereby inhibiting electrical conduction. Faults, fractures and shear zones may produce anomalies which typically have low conductances (e.g., grades 1 to 3). Conductive rock formations can yield anomalies of any conductance grade. The conductive materials in such rock formations can be salt water, weathered products such as clays, original depositional clays, and carbonaceous material.

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

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

The conductance measurement is considered more reliable than the depth estimate. There are a number of factors which can produce an error in the depth estimate, including the averaging of topographic variations by the altimeter, overlying conductive overburden, and the location and attitude of the conductor relative to the flight line. Conductor location and attitude can provide an erroneous depth estimate because the stronger part of the conductor may be deeper or to one side of the flight line, or because it has a shallow dip. A heavy tree cover can also produce errors in depth estimates. This is because the depth estimate is computed as the distance of bird from conductor, minus the altimeter reading. The altimeter can lock onto the top of a dense forest canopy. This situation yields an erroneously large depth estimate but does not affect the conductance estimate.



Typical DIGHEM anomaly shapes

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

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

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

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

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

Questionable Anomalies

DIGHEM maps may contain EM responses which are displayed as asterisks (*). These responses denote weak anomalies of indeterminate conductance, which may reflect one of the following: a weak conductor near the surface, a strong conductor at depth (e.g., 100 to 120 m below surface) or to one side of the flight line, or aerodynamic noise. Those responses that have the appearance of valid bedrock anomalies on the flight profiles are indicated by appropriate interpretive symbols (see EM legend on maps). The others probably do not warrant further investigation unless their locations are of considerable geological interest.

The Thickness Parameter

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

Resistivity Mapping

Resistivity mapping is useful in areas where broad or flat lying conductive units are of interest. One example of this is the clay alteration that is associated with Carlin-type deposits in the south west United States. The Dighem system was able to identify the clay alteration zone over the Cove deposit. The alteration zone appeared as a strong resistivity low on the 900 Hz resistivity parameter. The 7,200 Hz and 56,000 Hz resistivities show more of the detail in the covering sediments, and delineate a range front fault. This is typical in many areas of the south west United States, where conductive near surface sediments, which may sometimes be alkalic, attenuate the higher frequencies.

Resistivity mapping has proven successful for locating diatremes in diamond exploration. Weathering products from relatively soft kimberlite pipes produce a resistivity contrast with the unaltered host rock. In many cases weathered kimberlite pipes were associated with thick conductive layers which contrasted with overlying or adjacent relatively thin layers of lake bottom sediments or overburden.

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

The apparent resistivity is calculated using the pseudo-layer (or buried) half space model defined by Fraser (1978)[3]. This model consists of a resistive layer overlying a conductive half space. The depth channels give the apparent depth below surface of the conductive material. The apparent depth is simply the apparent thickness of the overlying resistive layer. The apparent depth (or thickness) parameter will be positive when the upper layer is more resistive than the underlying material, in which case the apparent depth may be quite close to the true depth.

The apparent depth will be negative when the upper layer is more conductive than the underlying material, and will be zero when a homogeneous half space exists. The apparent depth parameter must be interpreted cautiously because it will contain any errors which may exist in the measured altitude of the EM bird (e.g., as caused by a dense tree cover). The inputs to the resistivity algorithm are the inphase and quadrature components of the coplanar coil-pair. The outputs are the apparent resistivity of the conductive half space (the source) and the sensor-source distance. The flying height is not an input variable, and the output resistivity and sensor-source distance are independent of the flying height when the conductivity of the measured material is sufficient to yield significant inphase as well as quadrature responses. The apparent depth, discussed above, is simply the sensor-source distance minus the measured altitude or flying height. Consequently, errors in the measured altitude will affect the apparent depth parameter but not the apparent resistivity parameter.

The apparent depth parameter is a useful indicator of simple layering in areas lacking a heavy tree cover. The DIGHEM system has been flown for purposes of permafrost mapping, where positive apparent depths were used as a measure of permafrost thickness. However, little quantitative use has been made of negative apparent depths because the absolute value of the negative depth is not a measure of the thickness of the conductive upper layer and, therefore, is not meaningful physically. Qualitatively, a negative apparent depth estimate

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

usually shows that the EM anomaly is caused by conductive overburden. Consequently, the apparent depth channel can be of significant help in distinguishing between overburden and bedrock conductors.

Interpretation in Conductive Environments

Environments having low background resistivities (e.g., below 30 ohm-m for a 900 Hz system) yield very large responses from the conductive ground. This usually prohibits the recognition of discrete bedrock conductors. However, DIGHEM data processing techniques produce three parameters which contribute significantly to the recognition of bedrock conductors in conductive environments. These are the inphase and quadrature difference channels (DFI and DFQ, which are available only on systems with common frequencies on orthogonal coil pairs), and the resistivity and depth channels (RES and DP) for each coplanar frequency.

The EM difference channels (DFI and DFQ) eliminate most of the responses from conductive ground, leaving responses from bedrock conductors, cultural features (e.g., telephone lines, fences, etc.) and edge effects. Edge effects often occur near the perimeter of broad conductive zones. This can be a source of geologic noise. While edge effects yield anomalies on the EM difference channels, they do not produce resistivity anomalies. Consequently, the resistivity channel aids in eliminating anomalies due to edge effects. On the other hand, resistivity anomalies will coincide with the most highly conductive sections of conductive ground, and this is another source of geologic noise. The recognition of a bedrock conductor in a conductive environment therefore is based on the anomalous responses of the two difference channels (DFI and DFQ) and the resistivity channels (RES). The most favourable situation is where anomalies coincide on all channels.

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

The conductance channel CDT identifies discrete conductors which have been selected by computer for appraisal by the geophysicist. Some of these automatically selected anomalies on channel CDT are discarded by the geophysicist. The automatic selection algorithm is intentionally oversensitive to assure that no meaningful responses are missed. The interpreter then classifies the anomalies according to their source and eliminates those that are not substantiated by the data, such as those arising from geologic or aerodynamic noise.

Reduction of Geologic Noise

Geologic noise refers to unwanted geophysical responses. For purposes of airborne EM surveying, geologic noise refers to EM responses caused by conductive overburden and magnetic permeability. It was mentioned previously that the EM difference channels (i.e., channel DFI for inphase and DFQ for quadrature) tend to eliminate the response of conductive overburden.

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

EM Magnetite Mapping

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

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

The EM magnetite mapping technique provides estimates of magnetite content which are usually correct within a factor of 2 when the magnetite is fairly uniformly distributed. EM magnetite maps can be generated when magnetic permeability is evident as negative inphase responses on the data profiles.

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

Recognition of Culture

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

1. Channels CXP and CPP monitor 60 Hz radiation. An anomaly on these channels shows that the conductor is radiating power. Such an indication is normally a guarantee that the conductor is cultural. However, care must be taken to ensure that the conductor is not a geologic body which strikes across a power line, carrying leakage currents.

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

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

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[4] See Figure 5-1 presented earlier.

small fenced yard.[5] Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

4. A flight which crosses a horizontal rectangular body or wide ribbon yields an m-shaped coaxial anomaly and a centre-peaked coplanar anomaly. In the absence of geologic bodies of this geometry, the most likely conductor is a large fenced area.[5] Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

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

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

Magnetics

Total field magnetics provides information on the magnetic properties of the earth materials in the survey area. The information can be used to locate magnetic bodies of direct interest for exploration, and for structural and lithological mapping.

The total field magnetic response reflects the abundance of magnetic material, in the source. Magnetite is the most common magnetic mineral. Other minerals such as ilmenite,

---

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

pyrrhotite, franklinite, chromite, hematite, arsenopyrite, limonite and pyrite are also magnetic, but to a lesser extent than magnetite on average.

In some geological environments, an EM anomaly with magnetic correlation has a greater likelihood of being produced by sulphides than one that is non-magnetic. However, sulphide ore bodies may be non-magnetic (e.g., the Kidd Creek deposit near Timmins, Canada) as well as magnetic (e.g., the Mattabi deposit near Sturgeon Lake, Canada).

Iron ore deposits will be anomalously magnetic in comparison to surrounding rock due to the concentration of iron minerals such as magnetite, ilmenite and hematite.

Changes in magnetic susceptibility often allow rock units to be differentiated based on the total field magnetic response. Geophysical classifications may differ from geological classifications if various magnetite levels exist within one general geological classification. Geometric considerations of the source such as shape, dip and depth, inclination of the earth's field and remanent magnetization will complicate such an analysis.

In general, mafic lithologies contain more magnetite and are therefore more magnetic than many sediments which tend to be weakly magnetic. Metamorphism and alteration can also increase or decrease the magnetization of a rock unit.

Textural differences on a total field magnetic contour, colour or shadow map due to the frequency of activity of the magnetic parameter resulting from inhomogeneities in the distribution of magnetite within the rock, may define certain lithologies. For example, near surface volcanics may display highly complex contour patterns with little line-to-line correlation.

Rock units may be differentiated based on the plan shapes of their total field magnetic responses. Mafic intrusive plugs can appear as isolated "bulls-eye" anomalies. Granitic intrusives appear as sub-circular zones, and may have contrasting rings due to contact metamorphism. Generally, granitic terrain will lack a pronounced strike direction, although granite gneiss may display strike.

Linear north-south units are theoretically not well-defined on total field magnetic maps in equatorial regions due to the low inclination of the earth's magnetic field. However, most stratigraphic units will have variations in composition along strike which will cause the units to appear as a series of alternating magnetic highs and lows.

Faults and shear zones may be characterized by alteration that causes destruction of magnetite (e.g., weathering) which produces a contrast with surrounding rock. Structural breaks may be filled by magnetite-rich, fracture filling material as is the case with diabase dikes, or by non-magnetic felsic material.

Faulting can also be identified by patterns in the magnetic total field contours or colours. Faults and dikes tend to appear as lineaments and often have strike lengths of several kilometres. Offsets in narrow, magnetic, stratigraphic trends also delineate structure. Sharp contrasts in magnetic lithologies may arise due to large displacements along strike-slip or dip-slip faults.

Radiometrics

Radioelement concentrations are measures of the abundance of radioactive elements in the rock. The original abundance of the radioelements in any rock can be altered by the subsequent processes of metamorphism and weathering.

Gamma radiation in the range that is measured in the thorium, potassium, uranium and total count windows is strongly attenuated by rock, overburden and water. Almost all of the total radiation measured from rock and overburden originates in the upper .5 metres. Moisture in soil and bodies of water will mask the radioactivity from underlying rock. Weathered rock materials that have been displaced by glacial, water or wind action will not reflect the general composition of the underlying bedrock. Where residual soils exist, they may reflect the composition of underlying rock except where equilibrium does not exist between the original radioelement and the products in its decay series.

Radioelement counts (expressed as counts per second) are the rates of detection of the gamma radiation from specific decaying particles corresponding to products in each radioelements decay series. The radiation source for uranium is bismuth (Bi-214), for thorium it is thallium (Tl-208) and for potassium it is potassium (K-40).

The uranium and thorium radioelement concentrations are dependent on a state of equilibrium between the parent and daughter products in the decay series. Some daughter products in the uranium decay are long lived and could be removed by processes such as leaching. One product in the series, radon (Rn-222), is a gas that can easily escape. Both of these factors can affect the degree to which the calculated uranium concentrations reflect the actual composition of the source rock. Because the daughter products of thorium are relatively short lived, there is more likelihood that the thorium decay series is in equilibrium.

Lithological discrimination can be based on the measured relative concentrations and total, combined, radioactivity of the radioelements. Feldspar and mica contain potassium. Zircon, sphene and apatite are accessory minerals in igneous rocks that are sources of uranium and thorium. Monazite, thorianite, thorite, uraninite and uranothorite are also sources of uranium and thorium that are found in granites and pegmatites.

In general, the abundance of uranium, thorium and potassium in igneous rock increases with acidity. Pegmatites commonly have elevated concentrations of uranium relative to thorium. Sedimentary rocks derived from igneous rocks may have characteristic signatures which are influenced by their parent rocks, but these will have been altered by subsequent weathering and alteration.

Metamorphism and alteration will cause variations in the abundance of certain radioelements relative to each other. For example, alterative processes may cause uranium enrichment to the extent that a rock will be of economic interest. Uranium anomalies are more likely to be economically significant if they consist of an increase in the uranium relative to thorium and potassium, rather than a sympathetic increase in all three radioelements.

Faults can exhibit radioactive highs due to increased permeability which allows radon migration, or as lows due to structural control of drainage and fluvial sediments which attenuate gamma radiation from the underlying rocks. Faults can also be recognized by sharp contrasts in radiometric lithologies due to large strike-slip or dip-slip displacements. Changes in relative radioelement concentrations due to alteration will also define faults.

Similar to magnetics, certain rock types can be identified by their plan shapes if they also produce a radiometric contrast with surrounding rock. For example, granite intrusions will appear as sub-circular bodies, and may display concentric zonations. They will tend to lack a prominent strike direction. Offsets of narrow, continuous, stratigraphic units with contrasting radiometric signatures can identify faulting, and folding of stratigraphic trends will also be apparent.

CONCLUSIONS AND RECOMMENDATIONS

This report provides a very brief description of the survey results and describes the equipment, procedures and logistics of the survey.

There are some anomalies in the survey block which may be typical of disseminated sulphide responses. The survey was also successful in locating a few moderately weak or broad conductors which may warrant additional work. The various maps included with this report display the magnetic and conductive properties of the survey area. It is recommended that the survey results be reviewed in detail, in conjunction with all available geophysical, geological and geochemical information. Particular reference should be made to the computer generated data profiles which clearly define the characteristics of the individual anomalies.

Most anomalies in the area are moderately weak and poorly-defined. Many have been attributed to conductive overburden or deep weathering, although a few appear to be associated with magnetite-rich rock units.

A group of EM anomalies in the southwest portion of the survey area (10330A to 10470B) have several possible explanations including buried bedrock conductors. Follow-up would be warranted based on supporting geological or geochemical evidence.

Anomaly 10370A may warrant follow-up based on its similar structural setting to the Pic Vein. Anomaly 10270A resembles a sulphide-type response and should be investigated further.

The interpreted bedrock conductors defined by the survey should be subjected to further investigation, using appropriate surface exploration techniques. Anomalies which are currently considered to be of moderately low priority may require upgrading if follow-up results are favourable.

It is also recommended that image processing of existing geophysical data be considered, in order to extract the maximum amount of information from the survey results. Current software and imaging techniques often provide valuable information on structure and lithology, which may not be clearly evident on the contour and colour maps. These techniques can yield images which define subtle, but significant, structural details.

Respectfully submitted,

DIGHEM

Doug McConnell, P.Eng.
Geophysicist Geophysicist

APPENDIX A

LIST OF PERSONNEL

The following personnel were involved in the acquisition, processing, interpretation and presentation of data, relating to a DIGHEM^{V} airborne geophysical survey carried out for Big B Resources Inc., near Kootenay River, B.C..

Felix Dolezel	Senior Geophysical Operator
Jeremy Weber	Field Data Processor
Roger Morrow	Pilot (Questral Helicopters Ltd.)
Theron Greenaway	Computer Processor
Doug McConnell	Interpretation Geophysicist
Lyn Vanderstarren	Drafting Supervisor
Mike Armstrong	Draftsperson (CAD)
Susan Pothiah	Word Processing Operator
Albina Tonello	Secretary/Expeditor

All personnel are employees of Dighem, A Division of CGG Canada Ltd., except for the pilot who is an employee of Questral Helicopters Ltd.

APPENDIX B

STATEMENT OF COST

IN ACCOUNT WITH
DIGHEM, A DIVISION OF CGG CANADA LTD.

To: Dighem flying of Agreement dated April 23, 1996, pertaining to an Airborne Geophysical Survey in the Kootenay River area, British Columbia.

Survey Charges

310 km of flying		$ 34,000.00
Radiometrics acquisition and processing		$ 4,650.00
	Total:	$ 38,650.00

Allocation of Costs

- Data Acquisition	(60%)
- Data Processing	(20%)
- Interpretation, Report and Maps	(20%)

APPENDIX C

EM ANOMALY LIST

```
1258 A KOOTENAY RIVER AREA , BC.

                COAXIAL  COPLANAR  COPLANAR .  VERTICAL   . HORIZONTAL CONDUCTIVE   MAG
                1056 HZ   876 HZ   7262 HZ .    DIKE     .   SHEET      EARTH      CORR
                                           .             .
  ANOMALY/ REAL QUAD REAL QUAD REAL QUAD . COND DEPTH*. COND DEPTH RESIS DEPTH
 FID/INTERP PPM  PPM  PPM  PPM  PPM  PPM .SIEMEN    M .SIEMEN    M OHM-M     M     NT
  ---------                                .             .
 LINE 10010    (FLIGHT  12)                .             .
  A  1259S?    0    2    0    2    2    4 .    -       - .   -     -     -     -      0
  ---------                                .             .
 LINE 10111    (FLIGHT   9)                .             .
  A  1759S?    0    1    0    1    1    4 .    -       - .   -     -     -     -      0
  ---------                                .             .
 LINE 10200    (FLIGHT   8)                .             .
  A  2320S?    0    2    1    2    2    4 .    -       - .   -     -     -     -      0
  ---------                                .             .
 LINE 10212    (FLIGHT   8)                .             .
  A  1912S?    0    3    0    3    9   13 .   0.6      0 .   1    35   684     2      0
  ---------                                .             .
 LINE 10251    (FLIGHT   5)                .             .
  A  4308S?    1    1    0    1    0    4 .    -       - .   -     -     -     -      0
  B  4330S?    1    2    0    2    2    4 .    -       - .   -     -     -     -      5
  ---------                                .             .
 LINE 10268    (FLIGHT   5)                .             .
  A  3737S     0    1    0    1    1    4 .    -       - .   -     -     -     -      0
  ---------                                .             .
 LINE 10270    (FLIGHT   5)                .             .
  A  3150B?    0    1    0    4    5   22 .   0.2      0 .   1    38  1089     5     70
  ---------                                .             .
 LINE 10307    (FLIGHT  12)                .             .
  A  3466S?    0    0    0    0    1    3 .    -       - .   -     -     -     -      0
  B  3520S?    0    1    0    2    0    4 .    -       - .   -     -     -     -      0
  ---------                                .             .
 LINE 10330    (FLIGHT   4)                .             .
  A  3977B     1    1    7    9   18    8 .   1.4     40 .   1    84    76    46     15   V
  ---------                                .             .
 LINE 10342    (FLIGHT   4)                .             .
  A  3837S?    1    2    1    2    2    4 .    -       - .   -     -     -     -     20
  B  3830B?    1    2    1    2    2    4 .    -       - .   -     -     -     -      0
  ---------                                .             .
 LINE 10350    (FLIGHT   4)                .             .
  A  2387S?    1    2    1    2    2    4 .    -       - .   -     -     -     -     20
  ---------                                .             .
 LINE 10361    (FLIGHT   4)                .             .
  A  2248S?    2    3    1    6   13   22 .   2.3     34 .   1    55   399     1     10   V
  ---------                                .             .
 LINE 10370    (FLIGHT   4)                .             .
  A   862S?    1    3    3    4    5   13 .   0.3      0 .   1    37   381     7      0   V
  ---------                                .             .
 LINE 10380    (FLIGHT   3)                .             .
  A  3969S?    2    3    3    6   12   18 .   3.3     46 .   1    77   304    23      8

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

1258 A KOOTENAY RIVER AREA , BC.

ANOMALY/ FID/INTERP	COAXIAL 1056 HZ REAL PPM	COAXIAL 1056 HZ QUAD PPM	COPLANAR 876 HZ REAL PPM	COPLANAR 876 HZ QUAD PPM	COPLANAR 7262 HZ REAL PPM	COPLANAR 7262 HZ QUAD PPM	VERTICAL DIKE COND SIEMEN	VERTICAL DIKE DEPTH* M	HORIZONTAL SHEET COND SIEMEN	HORIZONTAL SHEET DEPTH M	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH M	MAG CORR NT
LINE 10380	(FLIGHT 3)												
B 4093S?	1	1	1	2	2	4	-	-	-	-	-	-	0 ✓
LINE 10392	(FLIGHT 3)												
A 3800B?	1	1	1	2	2	4	-	-	-	-	-	-	0
LINE 10400	(FLIGHT 3)												
A 2587S?	2	4	1	5	11	30	1.8	41	1	77	628	6	0 ✓
B 2684S?	0	0	1	2	2	4	-	-	-	-	-	-	0 ✓
LINE 10410	(FLIGHT 12)												
A 2027B?	1	4	1	7	15	31	1.0	16	1	46	637	0	0
LINE 10420	(FLIGHT 12)												
A 3134S?	0	2	0	2	1	4	-	-	-	-	-	-	0
B 3111B?	2	6	3	12	25	42	1.4	18	1	47	208	6	0 ✓
C 2694S?	0	1	0	2	2	4	-	-	-	-	-	-	0
LINE 10430	(FLIGHT 2)												
A 3916B?	1	2	1	2	2	4	-	-	-	-	-	-	10
B 3919B?	3	5	4	11	15	20	2.1	20	1	46	166	5	13
LINE 10440	(FLIGHT 2)												
A 3802B?	3	5	7	14	25	31	2.7	31	1	50	133	12	15
LINE 10450	(FLIGHT 2)												
A 2963B?	1	2	1	2	1	4	-	-	-	-	-	-	0
LINE 10460	(FLIGHT 2)												
A 2845B?	1	4	2	6	11	12	1.2	12	1	39	250	0	0
B 2811S?	1	2	1	2	2	4	-	-	-	-	-	-	0
LINE 10470	(FLIGHT 2)												
A 1744B?	1	2	1	2	2	4	-	-	-	-	-	-	0
B 1749B?	1	2	1	2	2	4	-	-	-	-	-	-	0

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

BIG B RESOURCES INC.
INTERPRETATION REPORT ON
THE DIGHEM ^{V} SURVEY
KOOTENAY RIVER AREA, B.C.

by

Cliff Candy, P. Geo.

January, 1997

Project No. FGI-321

Appendix E

Partial Geophysical Report

Frontier Geophysics Inc.

CONTENTS

ILLUSTRATIONS

1.0 INTRODUCTION

An airborne geophysics survey was conducted on the D. V. Property on behalf of Big B Resources Ltd. during September and October of 1996. At the request of G.H. Babcock, Frontier Geosciences Inc. conducted an interpretation program on this data set, integrated with existing geophysical, geochemical, and geological data. The objective of this investigation was to identify possible targets for followup investigation.

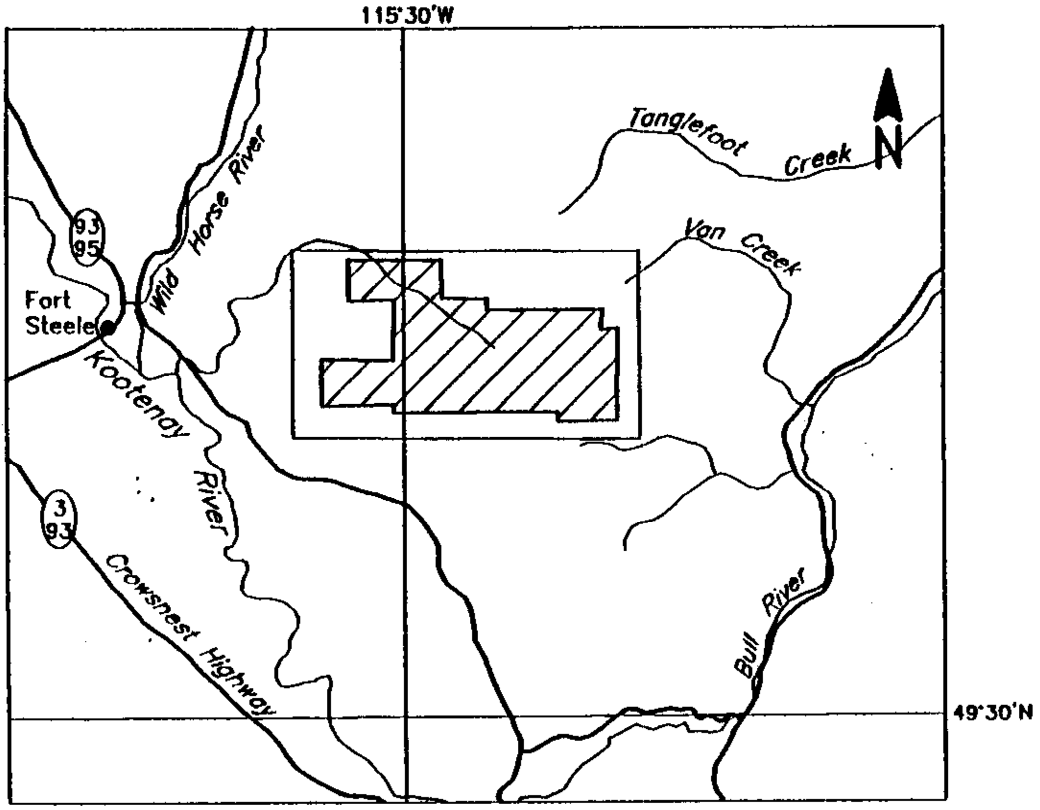
2.0 GEOPHYSICAL RESULTS

2.1 GENERAL

The airborne survey consists of 338 kilometres of electromagnetic, magnetic, radiometric data obtained at one hundred metre line spacings. From these data sets a number of products are reduced. The details of map production and processing, as well as a discussion of the various geophysical measurements and methodology, are set forward in the report for Big B Resources Ltd. by Dighem Surveys, by Doug McConnell P.Eng., dated November 1996, and located in Appendix I of this report.

The primary geologic information was provided by Richard Walker of Dynamic Exploration Ltd. in his geological report on the DV Property, dated November 30, 1995. In particular, the geological map at a scale of 1:10000 (Figure 10) was employed as the base upon which the results of the other surveys could be compiled. This map was scanned digitally and plotted at a scale of 1:10000 on acetate for convenient overlay with the 1:10000 maps prepared by Dighem. As well, a paper copy of Figure 3 is included in the appendix.

The findings of the Dighem report, with respect to the electromagnetic data, was that a number of low grade conductors were detected, the majority of which were interpreted to be related to overburden responses. As the electromagnetic responses are expected to be quite subtle, particularly in the zones where lead-zinc mineralisation is dominant in the western areas of the property, a stacked profile map was prepared using the coplanar inphase data set provided on CDROM (Figure 2). This stacked profile plot allows more detailed correlation of the electromagnetic responses. The interpreted conductors are detailed on Figure 3 of this report.



NTS: 82G/11,12 UTM ZONE: 11 NAD27 SCALE: 1:250,000

BIG B RESOURCES INC.

INTERPRETATION REPORT ON DIGHEM^V SURVEY
KOOTENAY RIVER AREA, B.C.

LOCATION MAP

FRONTIER GEOSCIENCES INC.

JANUARY 1997	SCALE 1:250000	FIG. 1

The most useful airborne geophysical measurements, in this geologic environment, were the electromagnetic survey which detects conductive trends, the magnetic survey which located intrusive bodies with higher magnetic susceptibility such as gabbros, and the potassium channel of the radiometric survey which provides information on the possible location of sericite alteration zones. The surface projection of small intrusive bodies such as gabbros is mapped for reference on the acetate overlay, Figure 3. In order to correlate the geologic information, electromagnetic conductors and magnetic sources with each of the geophysical measurements, Figure 3 may be overlaid on each of the Dighem maps in turn.

The zones of high potassium radiometric response are indicated in warm colors on this plot labelled 'Radiometric Potassium Counts'. An important caveat to be considered when reviewing the radiometrics data is that an increase in overburden thickness or water content may alter the response considerably by shielding the underlying rocks.

A northwest southeast trending magnetics high, apparently cross-cutting the primary geologic strike and structures, is present in the government coarse scale magnetics maps, that are referred to by Rick Walker in his report (Ref. 6). The closer examination allowed by the detailed airborne magnetics of the Dighem survey shows this overall trend to be composed of roughly aligned groups of magnetic highs of shallower origin, that in many cases are corellated with gabbros mapped in outcrop.

2.2 DISCUSSION

The airborne geophysics over the Box claims area shows the presence of a subtle electromagnetic conductor in good agreement with the main conductor observed in the 1988 ground transient electromagnetic survey (Ref. 3). As well, the magnetics data shows the presence of nearby intrusive bodies. The radiometric potassium channel response shows a high approximately associated with the mapped alteration zone. In addition, several short strike length weaker conductors are present labelled C14, C15, C16, C20 and C21 that are present in the same local geologic environment.

No clear electromagnetic responses are present in the vicinity of the Victor showing, likely due to the flight line directions been very nearly parallel to the strike of the geology in this area. A magnetic high exists one kilometre north east of the Victor showing that is very well correlated with a mapped north-south trending gabbro zone.

The most striking feature of the Dibble showing area is the well established circular, potassium radiometrics high. No airborne electromagnetics anomalies are detected in this area.

Several electromagnetic anomalies are present which are attributed to overburden responses. These include a series of conductors that are observed trending northwest along the edge of valley overburden in the southwest coverage. As well, a zone of increased conductivity follows the Maus Creek valley in the north western coverage.

A number of more subtle conductors are present which are not as readily attributed to valley filling sediments. The most prominent feature in this class of response is a north-north east striking pair of conductors labeled C9 and C10 on Figure 3 that occur within the favourable Middle Aldridge Formation rocks. This pair of conductors crosses a small creek valley at shallow angle. The conductors are situated in a very steep valley near mapped outcrop. This suggests that the valley is unlikely to contain a large thickness of sediments that would provide a conductive response. As well, the C9 trend is located on the potassium radiometrics high indicating a possible sericite alteration association.

A fault is mapped as passing parallel to the C9, C10 trends approximately 100 metres to the east. The presence of fault structures is seen to be an important association in other mineralised areas elsewhere on the property.

North of this area and northwest of the Box claims a number of lower order conductors are present, labelled C2 - C13 on Figure 3. These conductors are generally of short strike length and tend to cluster in the vicinity of the magnetics highs, particularly in the area of the northwest extension of the Pic Fault. One such zone, C5, is exactly coincident with a very local magnetics high.

A broad magnetics low is present coincident with the Middle and Upper Aldridge rocks that covers the northwest of the survey area. This zone extends to the C9-C10 zone on the south and is approximately is bounded by the northwest extent of the Creston rocks. The most pronounced centre of the zone is located approximately one km northwest of the Box Claims area. The most probable explanation of this zone is the effect of the lower magnetic mineral content of the Aldridge Formation rocks as compared to the Creston Formation rocks. However, It should be borne in mind that the Sullivan ore body is associated with a magnetics low, and further consideration based on the geologic model is warranted.

In the eastern area of the property, where the Creston Formation rocks are present, the electromagnetic data shows comparatively sparse responses. C23 and C24 are apparently associated with somewhat conductive segments of the Horseshoe Creek Fault. A weak anomaly, labelled C25, near the north end of the Saddle Fault is likely a result of conductive sediments associated with a small lake in this vicinity. Further south, in an area dominated by a strong complex of northwest trending magnetics highs, the C26 anomaly is associated with a compact zone that was tested by samples R95-5 and R95-6 (Ref. 6). The longer strike length C27 anomaly is associated with a zone sampled by R95-2, R95-3 and R95-4. The C26 and C27 zones show corelation with local highs in the radiometic potassium channel.

3.0 SUMMARY AND RECOMMENDATIONS

The airborne geophysics program carried out by Dighem provided comprehensive information on the conductivity, magnetic, and radiometic properties of the rocks and geologic structures on the DV Property. This was complemented by very good geologic mapping carried out previously by Rick Walker and others.

Unfortunately, the survey did not indicate the presence of strong conductive trends which might reveal the presence of large scale massive sulphide mineralization. There are, however, a number of weaker responses, which are located in favourable geologic conditions which warrant followup.

Prospecting followup of the C9 and C10 trends is recommended in order to determine the source of these responses, or if favourable alteration is present in outcrop in this area. As well, the presence or absence of outcrop may give important clues as to the extent of overburden in this area. In the course of this investigation time may be set aside to investigate to look at some of the lower quality conductors to the north of this area, particularly C11 - C13, which are located near a prominent, magnetic high. Based on the results of this investigation it may be appropriate to follow up with ground based geophysics to verify and further detail the zone. Additional prospecting targets include the C23 and C24 zones east of the Victor showings.

Diamond drill testing of the Box Claims electromagnetic anomaly, which was the subject of a failed previous drilling program is warranted, possibly timed to coincide with testing of other zones resulting from the C9 and C10 area study.

The electromagnetic survey of the eastern area of the property detected the weak expression of known mineralized zones in the southeastern area of coverage.

for Frontier Geosciences Inc.

Cliff Candy

Cliff Candy, P.Geo.

C. E. CANDY

4.0 REFERENCES

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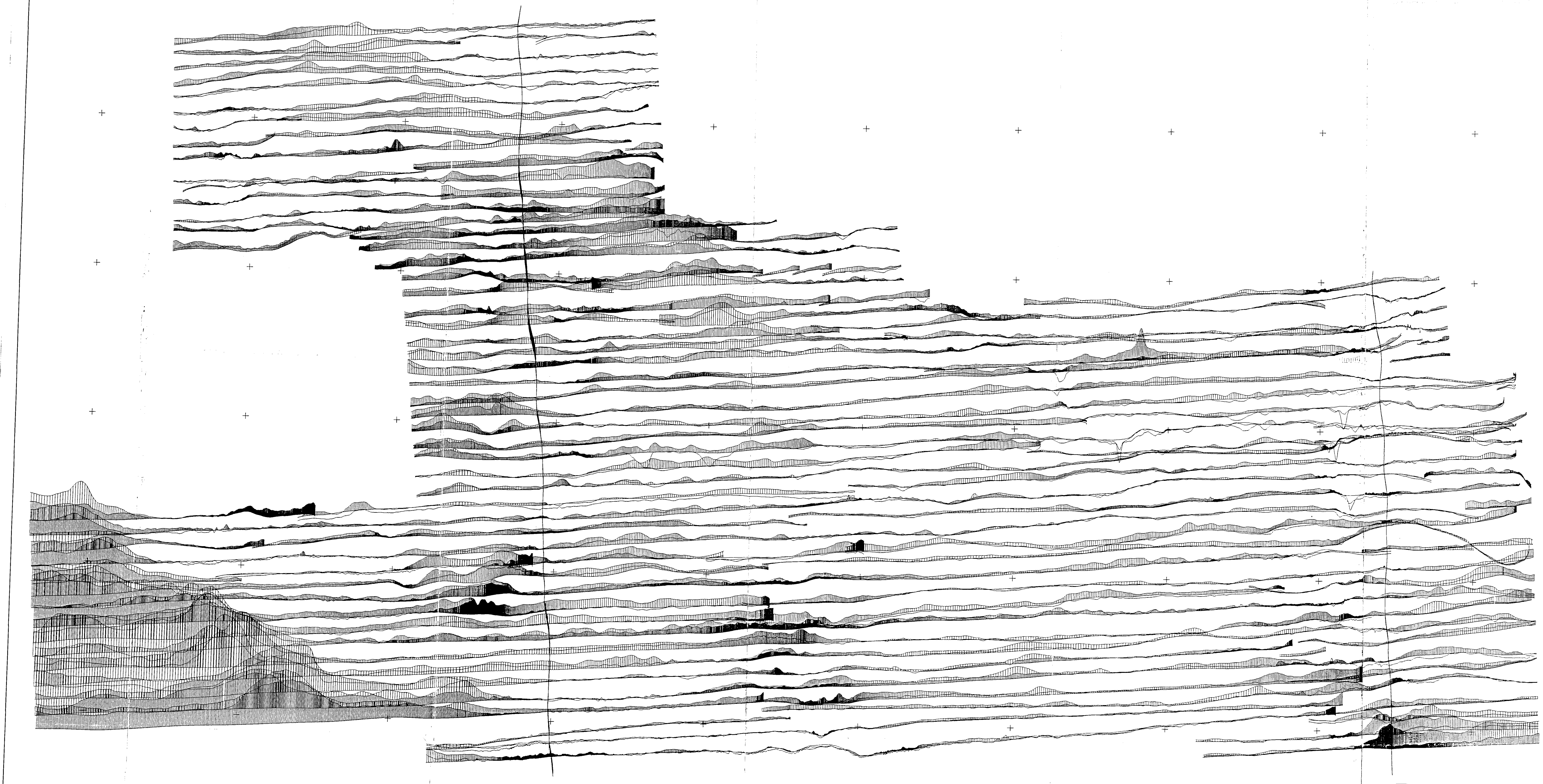
6) WALKER, R.T., 1995; Geological Report on the DV Property Fort Steele Mining Division, Report for Big B Resources Inc., dated Nov. 30, 1995.

①



NOTES:
SCALE: 1: 10000
INPHASE: SOLID LINE
QUADRATURE: DASHED LINE
INSTRUMENT: DIGEM V 56000 Hz COPLANAR
INSTRUMENT: DIGEM V 7200 Hz COPLANAR

BIG B RESOURCES INC.
DV PROPERTY

DIGHEM V AIRBORNE E.M. SURVEY

STACKED PROFILES PLOT

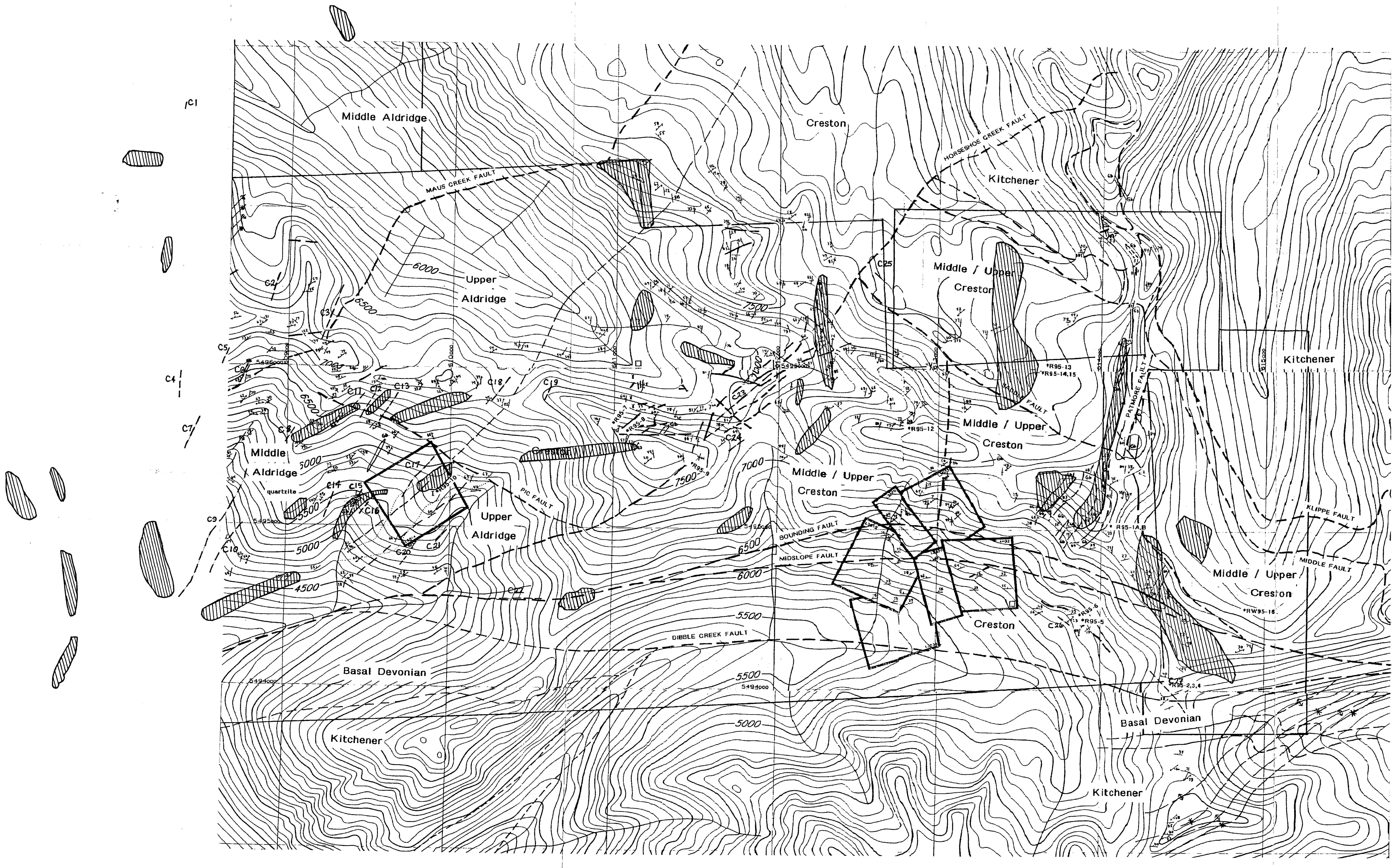
FRONTIER GEOSCIENCES INC.

DATE: JAN. 1997

FIG. 2

25,109①

②



GEOLOGICAL SURVEY BRANCH
ASSESSMENT REPORT

25,109 ②

NOTES:
GEOLOGICAL COMPILATION: DYNAMIC GEOLOGICAL CONSULTING LTD.
SCALE: 1:10,000
INTERPRETED AIRBORNE EM CONDUCTORS: — — —
INTERPRETED MAGNETIC SOURCE: ▨

BIGB RESOURCES INC.
DV PROPERTY

DIGHEM V AIRBORNE SURVEY

PROPERTY GEOLOGY AND COMPILATION MAP

FRONTIER GEOSCIENCES INC.

DATE: JAN. 1997

FIG. 3