



**THE FINDLAY INDUSTRIAL PARTNERSHIP PROJECT:
GEOLOGY AND MINERAL OCCURRENCES OF THE FINDLAY - DOCTOR
CREEK AREAS, SOUTHEASTERN BRITISH COLUMBIA
(parts of 82F/16, 82K/1)**

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KEYWORDS: Proterozoic, Purcell Supergroup, Aldridge Formation, Greenland Creek stock, White Creek batholith, Sedex deposits, fragmentals.

INTRODUCTION

This article is designed primarily to inform clients that new 1:50 000 scale maps are currently being completed for the Findlay-Doctor Creek area (Figure 10-1). A summary of preliminary results is presented for the Findlay Industrial Partnership Project after completion of three weeks of fieldwork in the Dewar and Findlay creeks map areas (82F/16, 82K/1) during 1997. The focus of the project is to provide updated 1:20 000 scale map compilations to be published at 1:50 000 scale, digital databases and prepare descriptions of mineral occurrences for the area underlain by the Aldridge Formation. In addition, a U-Pb dating and litho-geochemistry study of the Greenland Creek pluton and White Creek batholith were undertaken as part of a B.Sc. thesis (see Smith and Brown, this volume). Financial support was provided by Kennecott Canada Exploration Inc., Eagle Plains Resources Ltd. and Miner River Resources Ltd. Cominco Ltd. contributed their 1:20 000 scale geology maps. A summary of Purcell Supergroup stratigraphy can be found in Höy (1993) and Brown and Woodfill (this volume).

Access to the map area is provided by a network of gravel roads extending west from Highway 3 near Canal Flats. Several relatively new roads along Doctor Creek allow truck access to much of the project area. Partially overgrown roads/trails along Skookumchuck and Greenland creeks make it possible to get to the eastern part of Rusty Ridge on foot or by all terrain vehicle. The western and southern sections of the map area lie within the Purcell Wilderness Conservancy (Figure 10-2) and no new traverses were conducted in this region.

The physiography of the project area changes radically from northeast to southwest. The Findlay Creek valley east of Doctor Creek is a broad, open grassland area filled with glacio-fluvial outwash and silt to about 1100 m elevation. Farther west, topography is more rugged with ridges up to 2830 metres in elevation with abundant exposures in the alpine and subalpine (Doctor Peak; Figure 10-2) separated by deeply incised valleys. The largest drainages include Findlay, Skookumchuck and Doctor creeks

Previous Work

Initial reconnaissance scale mapping in the region established the general stratigraphic framework (Rice, 1941). More detailed mapping in the early 1950's by Reesor (1958) in the Dewar Creek area (82F/16) and later, in the Lardeau east map area (82K/east, Reesor, 1973) including a portion of the current study area (Figure 10-1, 10-2), permitted subdivision of the Aldridge Formation. For example, near Dewar Creek, the Aldridge Formation was divided into lower and upper divisions, and were estimated to be over 1370 and 3350 metres thick, respectively. A quarter of the lower division comprises Moyie sills (about 330 m). The upper division, including the uppermost Argillite member, is correlated with the middle and upper Aldridge Formation as currently defined. The overlying strata consisting of Creston, Kitchener, Siyeh and Dutch Creek formations were also described by Reesor (1958) and Höy (1993).

McLaren *et al.* (1990a and b) completed a mineral potential assessment across the region and produced a 1:50 000 scale geology map that incorporated Reesor's work. A federal-provincial multiparameter airborne geophysical survey of much of the map area was undertaken in 1996, digital data and hardcopy maps are available from the Geological Survey of Canada (includes total field aeromagnetism, conductivity, potassium, thorium/potassium, and ternary radioelement maps; B.C. Ministry of Employment and Investment Open File 1996-23). The digital data set is available from the National Geophysical Data Centre in Ottawa (613-995-5326). Exploration companies have concentrated their efforts in the Rusty Ridge area, the headwaters of Doctor Creek, and the Greenland Creek areas; some of their results are incorporated in this study.

GEOLOGICAL SETTING

The Findlay-Doctor Creek project area straddles in the central axis of the Purcell anticlinorium, a broad, gently north-plunging structural culmination cored by the Proterozoic Purcell Supergroup (Figure 10-1). The supergroup comprises a siliciclastic and lesser carbonate sequence at least 12 kilometres thick, that initially

accumulated in an intracratonic rift basin. The strata are preserved in an area 750 kilometres long and 550 kilometres wide, extending from southeastern British Columbia to eastern Washington, Idaho and western Montana. The original extent and geometry of the basin is poorly known in part because the western and northwestern margins are poorly exposed and in part due to Laramide contractional deformation.

Stratigraphy

Most of the project area is underlain by the Aldridge Formation, the lowermost Purcell Supergroup strata, although the base is not exposed. Excellent examples of the lower and middle parts of the Aldridge Formation occur in the Rusty Ridge area between Middle Findlay Creek and the headwaters of Greenland Creek (Figure 10-2). The lower Aldridge is thin bedded to laminated and rusty brown weathering, in contrast to the medium to thick bedded, grey weathering turbidites of the middle Aldridge Formation. Middle Aldridge turbidite beds display normal grading, flame structures, load casts and rare ripples.

The contact between lower and middle Aldridge rocks is gradational and includes an extensive fragmental unit, here called the LMC fragmental (see

below). An important change from the more evenly bedded lower energy units of the lower Aldridge to rapidly deposited turbiditic sedimentation characteristic of the middle Aldridge suggests a fundamental change of the Purcell Basin sedimentation/tectonics at this time.

Much of the lower Aldridge succession exposed in the area is muscovite-biotite schist (meta-wacke) adjacent to the White Creek Batholith, in the vicinity of the Silver Key occurrence (Minfile 082KSE053; Figure 10-2). Minor quartz pods and lenses with black tourmaline crystals occur within the most schistose zones of this area.

The upper Aldridge comprises less than 250 m of dark grey argillaceous phyllite that weathers dark rusty brown. Tight southeast-verging minor folds and coarse crenulations are evident in outcrops along the access trail to the Alpine occurrence (Minfile 082KSE081).

The Creston Formation consists of pale grey to green argillite with interlaminated greenish siltstone, and minor pale grey quartz arenite. Lenticular and wavy bedforms, argillaceous rip-up clasts, and tectonically flattened mudcracks distinguish the Creston from the Aldridge Formation. The medium to thin bedded quartz wacke and argillite commonly displays a sericitic phyllitic foliation. The formation was only examined around the Alpine showing and west of the Doc

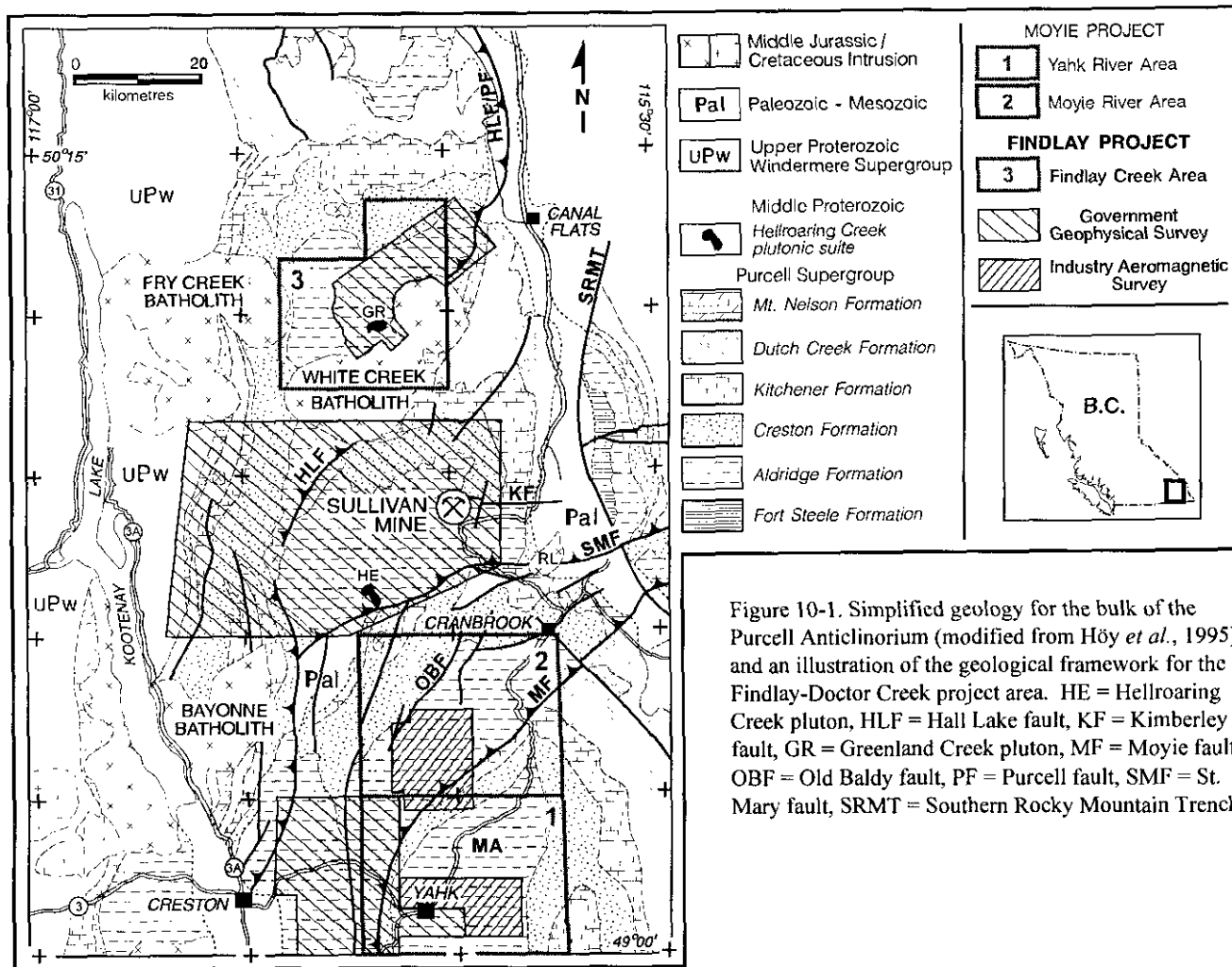


Figure 10-1. Simplified geology for the bulk of the Purcell Anticlinorium (modified from Höy *et al.*, 1995), and an illustration of the geological framework for the Findlay-Doctor Creek project area. HE = Hellroaring Creek pluton, HLF = Hall Lake fault, KF = Kimberley fault, GR = Greenland Creek pluton, MF = Moyie fault, OBF = Old Baldy fault, PF = Purcell fault, SMF = St. Mary fault, SRMT = Southern Rocky Mountain Trench.

occurrence (Minfile 082KSE060). In these areas discrete schistose shear zones and southeast-verging minor folds are common. Narrow (<10 m thick), dark green mafic sills and dikes locally intrude the Creston Formation.

Intrusive Rocks

Two contrasting Middle Proterozoic magmatic suites intrude the lower and middle Aldridge Formation: the laterally extensive gabbroic Moyie sills and small bodies of leucocratic pegmatite, and quartz monzonite that comprise the Greenland Creek stock. The middle Cretaceous White Creek Batholith dominates the southeastern quarter of the map area.

Middle Proterozoic Moyie Intrusives

Middle Proterozoic Moyie Intrusives are the oldest magmatic rocks in the area (*cf.* Brown and Woodfill, this volume). They are massive to locally well foliated meta-diorite and amphibolitic gabbro forming dark green to brown weathering sills. Amphibole has largely replaced primary pyroxene phenocrysts (Mackenzie, 1971). The sills provide good local markers that have been clearly offset in excellent exposures along Rusty Ridge. The majority of the sills in the study area are about 10 to 100 m thick and cumulatively comprise up to 25% of the lower Aldridge section. They rarely cut up or down section to form dikes. Albite alteration along sill contacts is well developed, especially at the headwaters of Greenland Creek. U-Pb isotopic dating of the Moyie sills have returned zircon ages of 1468 Ma (Anderson and Davis, 1995; see Brown and Woodfill, this volume).

Middle Proterozoic Greenland Creek intrusions

The Greenland Creek intrusions are a series of small, discordant irregularly-shaped stocks that cut Moyie sills and lower Aldridge Formation rocks (Figure 10-2; see Smith and Brown, this volume). The westernmost body displays a zoned contact; coarse-grained pegmatite grades sharply outward through a 3 m wide zone of tourmaline-quartz-rich material to aplite to a muscovite-rich selvage at the gabbro contact. Coarse-grained pegmatite contains sheets of muscovite and rare tourmaline crystals. Phyllitic to schistose fabrics developed in thin-bedded meta-wacke adjacent to the intrusive bodies suggest a narrow zone of contact metamorphism developed during emplacement of the bodies.

The geometry of scattered, isolated bodies of pegmatite and quartz monzonite hosted in Moyie sills and lower Aldridge rocks is analogous to that of the Hellroaring Creek stock and a series of smaller pegmatite bodies in the Matthew Creek area southwest of the Sullivan Mine (Figure 10-1). Compositionally, the Greenland Creek and Hellroaring Creek stocks are similar (Reesor, 1996). They also produce a similar airborne radiometric signature -- a very low Th/K ratio (see Lowe *et al.*, 1996). Therefore, they are considered part of the same Hellroaring Creek plutonic suite and are

presumed an equivalent in age, about 1370 Ma (see Smith and Brown, this volume).

Middle Cretaceous White Creek batholith

The Middle Cretaceous White Creek batholith is divided into four broadly concentric phases by Reesor (1958): biotite granodiorite, hornblende-biotite granodiorite, porphyritic quartz monzonite and leuc-quartz monzonite. A fifth phase, equigranular quartz monzonite, intrudes the western two phases of the batholith. The K-feldspar megacrystic (porphyritic) quartz monzonite phase underlying the Doctor Creek area produces a strong aeromagnetic anomaly (see B.C. Ministry of Employment and Investment Open File 1996-23).

A biotite lamprophyre (minette) dike cuts the Creston Formation and probably represents the youngest intrusive rocks in the study area. The recessive weathering, dark green dike is exposed along the access road to the Alpine showing.

STRUCTURE

The study area is dominated by broad, open folds in strata of the Aldridge and Creston formation. They plunge moderately to the west and north. However, adjacent to schistose shear zones bedding dips steepen, and tight to isoclinal minor folds with rare overturned limbs (Anderson, 1988) are present. Southeast- to east-verging minor folds are common in the Creston Formation near the Alpine showing. Local isoclinal minor folds occur near the MC showing (Minfile 82FNE107), however, it is unclear whether they are related to a discrete fault zone or a larger structural culmination. Early penetrative phyllosilicate foliation is overprinted locally by coarse crenulations or kink folds. The phyllitic to schistose shear zones locally host quartz veins and pods.

The **Hall Lake fault** is one of several right-lateral, reverse faults that cut obliquely across the northerly-trending structural grain of the Purcell anticlinorium (Figures 10-1 and 2). It puts Creston on Kitchener Formation and is truncated by the White Creek Batholith, in the Buhl Creek area (Reesor, 1996). Its northern continuation projects to where middle Aldridge Formation lies on Creston Formation (Reesor, 1973).

A reverse fault that parallels the Hall Lake fault and underlies the area near the intersection of Findlay and Doctor creeks has been mapped by Cominco Ltd., and is here called the Doctor Creek fault (Figure 10-2). It results in an apparent 6 kilometres of lateral offset of the upper Aldridge Formation. The western continuation of the fault is obscure.

A series of north-trending faults are evident between Middle Findlay and Doctor creeks, where they locally displace Moyie sills. These faults also displace the quartz vein at the Alpine showing as discussed above.

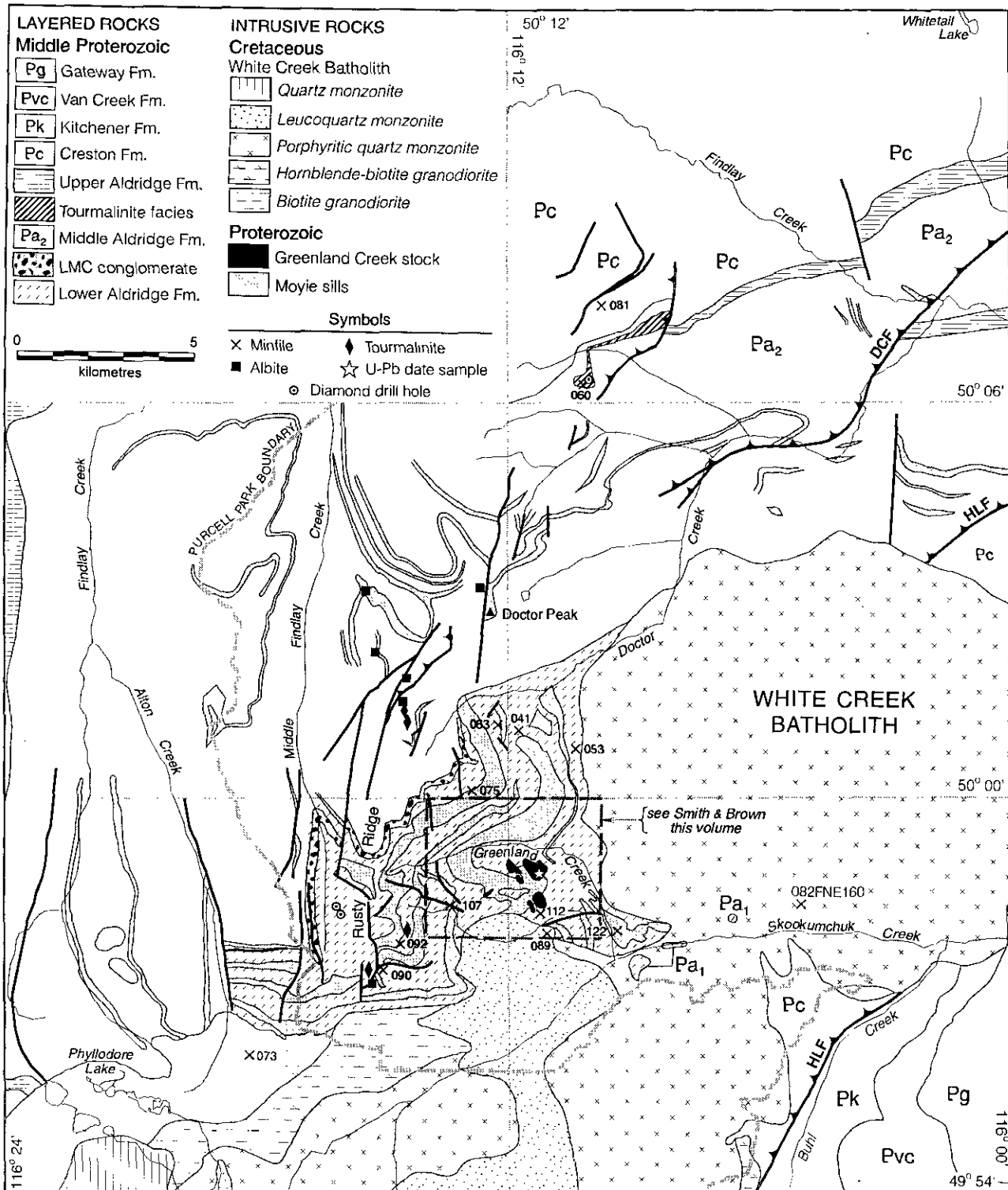


Figure 10-2. Simplified geology of the Findlay Project area modified from Reesor (1958, 1973) and Cominco Ltd. Minifile mineral occurrence locations are shown with numbers that are prefixed with 082KSE, north of 50° latitude and 082FNE to the south. DCF = Doctor Creek fault, HLF = Hall Lake fault, Purcell Wilderness Conservancy indicated as Purcell Park on this figure.

MINERALIZED FACIES

LMC fragmental

A stratabound fragmental unit (see Brown and Woodfill, this volume) occurs along the lower-middle Aldridge contact at the headwaters of Doctor Creek, a simplified depiction of its distribution, largely from Cominco Ltd. mapping, is shown on Figure 10-2. It extends over 6 km along strike and is up to 15 m thick. Matrix- to clast-supported units display diverse textures and rapid changes in clast size (Photo 10-1). Angular to rounded fragments include argillite, siltstone and quartz wacke; ranging in size up to about 25 cm long. Rare sulphide clasts are found within the fragmental at the headwaters of Greenland Creek (Leitch, 1997), and farther north, at the headwaters of Doctor Creek (Echo Lake area), pyrrhotite fragments are common and a boulder-size clast contains 1% Zn (Webber, 1977). Locally argillaceous siltstone fragments are aligned parallel bedding and rounded albitized wacke clasts occur locally in a fine silty matrix. A thin bedded, iron-sulphide rich meta-argillite horizon 3-4 m thick lies stratigraphically below the LMC fragmental (Webber,

1977). The fragmental body was not examined in detail but it warrants additional study and mapping. Similar stratabound fragmental units lie in the same stratigraphic position, along the lower-middle Aldridge contact, farther south at the Sullivan Mine, at the Vulcan showing (Minfile 082FNE093), and at the Clair showing (Doug Anderson, per. comm., 1996). These deposits are interpreted to herald an extensional episode within the Purcell basin by Höy *et al.* (in prep.).

Tourmalinite Ridge

A dark grey to black silty meta-argillite facies occurs 4 km northeast of Doctor Peak (Photo 10-2). In 1996, Craig Leitch identified abundant, fine, disseminated needles in the unit as tourmaline. The facies extends over 5 km along strike and is estimated to be up to 50 m thick (1996 drilling determined it to be >18m thick; Downie, 1997). The horizon dips moderately to the north-northwest and was traced into the unnamed creek to the north of the Doc showing. The same facies crops out along the ridge between the Doc and Alpine showings. The dark grey to black argillite is fissile, silty medium to thin bedded and recessive

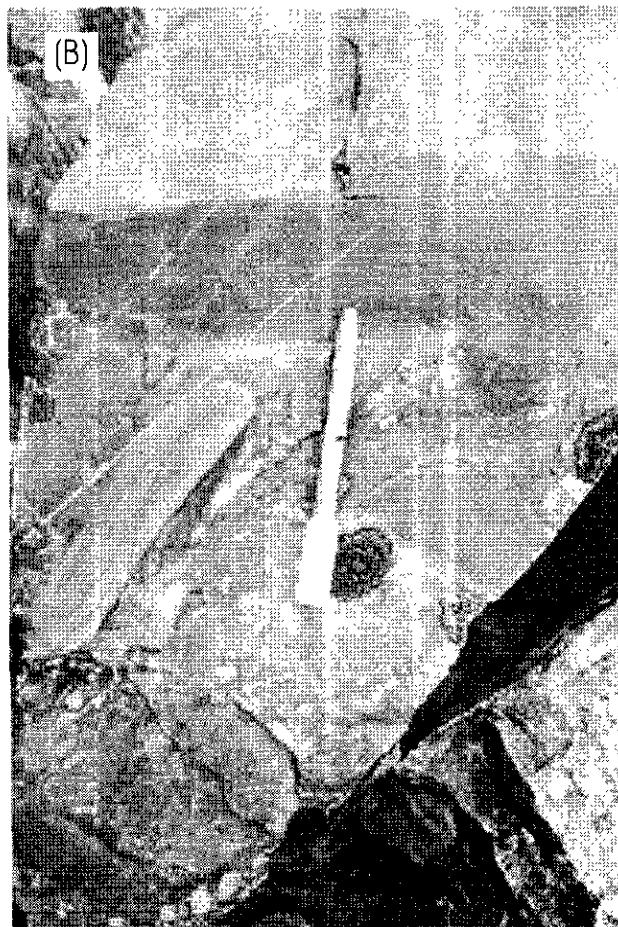


Photo 10-1. LMC fragmental, a stratabound conglomerate/fragmental unit that occurs along the lower-middle Aldridge contact at the headwaters of Doctor Creek. (a) Clast-supported, pebbly sandstone fragmental with bleached altered rims around numerous siltstone clasts; scale bar in centimetre divisions. (b) Subrounded siltstone clasts up to cobble size supported in a matrix of pebbly siltstone. The top dark grey layer immediately above the flare pen is well bedded, undisturbed siltstone.

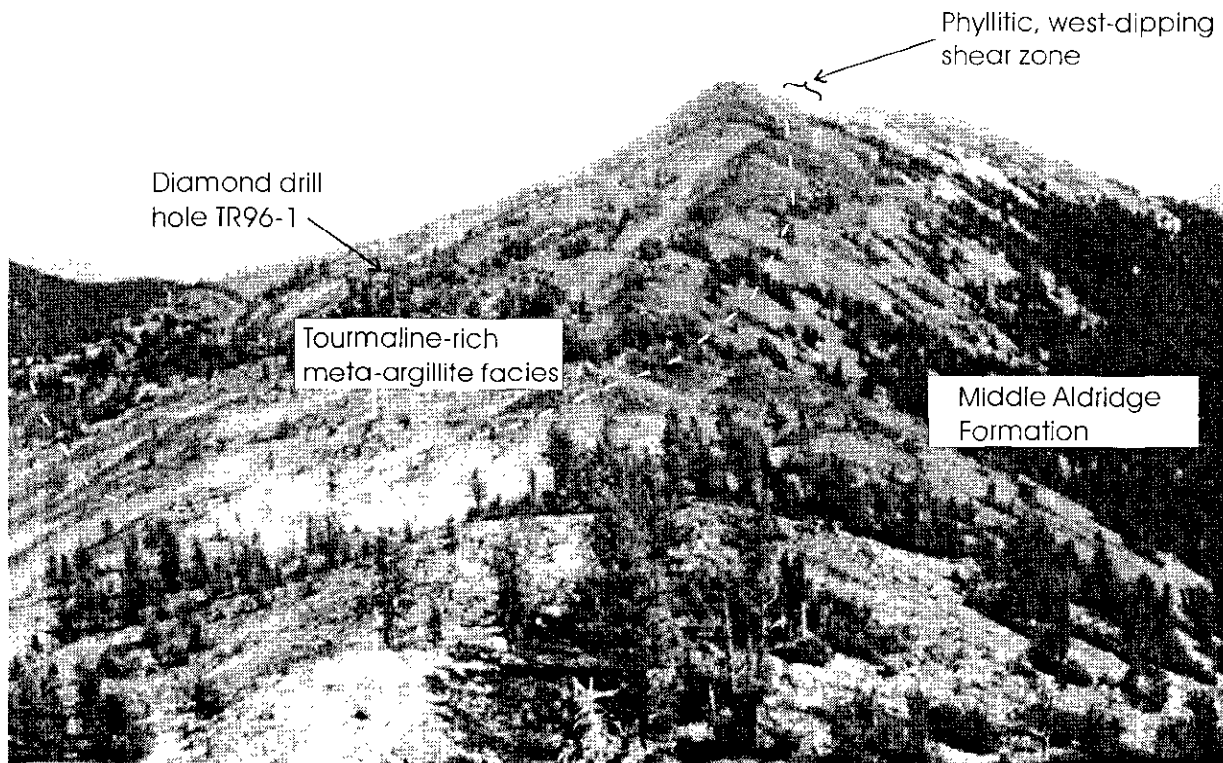


Photo 10-2. View to east of Tourmalinite Ridge, where the argillaceous siltstone facies contains abundant disseminated tourmaline-needles (up to 40%) and numerous galena-sphalerite-chalcopyrite veins.

weathering. Its stratigraphic position remains uncertain because of a shear zone (interpreted to be a reverse fault) between it and the upper Aldridge to the east (Figure 10-2). It is an important, mineralized argillaceous facies tentatively included in the upper part of the middle Aldridge Formation. This argillite unit may indicate a local, more restricted and anoxic facies of the upper middle Aldridge Formation. Alternatively, it could be a metamorphosed distal tourmaline-rich exhalative horizon. The facies is important because it is geochemically anomalous in Pb and Zn and it hosts a series of quartz veins that locally contain disseminated galena and/or tourmaline needles (see Doc Showing, Minfile 82KSE060 below).

MINERAL OCCURRENCES

There are 13 metallic mineral occurrences in the Minfile database for the Findlay-Doctor Creek map area (Table 10-1). The Silver Key and St. Anthony are past producers (Table 10-2).

St. Anthony past producer (Minfile 82KSE041)

The St. Anthony base metal occurrence is located in the Doctor Creek watershed. Five tonnes of material were reportedly extracted from a small pit in 1963

(Table 10-2). The occurrence consists of disseminated and veins of pyrite, pyrrhotite, magnetite, goethite, sphalerite and chalcopyrite (Mackenzie, 1971). These workings were not located in the field, however, numerous narrow, discontinuous quartz veins occur in the immediate area. The veins, containing minor pyrite, pyrrhotite and arsenopyrite, and rare galena and sphalerite, occur in sheared meta-wacke and meta-gabbro sills (Anderson, 1988).

Silver Key past producer (Minfile 82KSE053)

The Silver Key workings lie at the headwaters of the east fork of Doctor Creek. Several adits have been driven along bedding-parallel veins within quartz wacke and Moyie sills, west of the western contact of the northern porphyritic quartz monzonite phase of the White Creek Batholith. A total of 29 tonnes of ore were mined from Silver Key (Table 10-2). Narrow quartz veins (2-5 cm wide) containing disseminated galena and pyrite occur in tightly folded and sheared country rock. At least 6 veins dip about 45° to the west. The age of mineralization is unknown but its proximity to the margin of the White Creek Batholith suggests it could be Middle Cretaceous.

Doc Showing (Minfile 82KSE060)

The Doc showing comprises a series of white, galena-bearing quartz veins cutting the dark grey tourmalinite needle-rich meta-argillite facies of the middle Aldridge Formation, on a ridge 7 km north of Doctor Peak (Figure 10-2). It was originally explored by Kerr Addison Mines Ltd. in the 1970's when they outlined a large Pb soil geochemistry anomaly (Kerr Addison, 1972). Angular blocks of vein material occur within the argillite felsenmeer along the ridge. The northwest-and lesser northeast-trending veins are up to 100 cm wide (average 10 to 20 cm wide) and have been traced for about 100 m. Veins contain galena, lesser sphalerite and traces of chalcopyrite. Disseminated sulphides also occur in the host meta-argillite (Pautler, 1991).

Alpine/Rocky Top Property (Minfile 82KSE081)

The Alpine, also known as the Rocky Top property is hosted in rocks correlated with the Creston Formation, based on wavy bedforms, local abundant mudcracks, interbeds of argillite and faint green colour. It has been explored by Cominco Ltd. (Mawer, 1986) and Tech Exploration Ltd. (Pautler, 1991). A moderately, northwest-dipping sericitic phyllite shear zone hosts a shallow-dipping stratabound to slightly discordant zone of alteration comprising silicified, albitized and clay-altered rocks with disseminated pyrite and lesser sphalerite and galena. A semi-concordant boudinaged quartz-ankerite vein in the shear zone with disseminated pyrite and irregular blebs of sphalerite and minor galena ranges from 20 cm to 2 m thick.

The vein is cut by a series of younger, north-trending normal faults that offset portions of it by up to about 5 m. The zone is exposed in a bulldozer trench about 6 m high and 80 m long that has been mapped in

detail by Mawer (1986). The grade of the zone is 0.5% Pb and 0.6% Zn across a 3.5 m width and over the length, with a higher grade band containing 16 gm/T Ag, 2.2% Pb and 3.7% Zn (Mawer, 1986).

MC showing (Minfile 82FNE107)

Two old hand trenches at the MC showing have recently been re-investigated by Eagle Plains/Miner River Resources Ltd. A stratabound zone of banded and brecciated sulphides, locally with over 0.5 m of sphalerite, galena and pyrrhotite, is hosted in thin-bedded siltstone of the lower Aldridge Formation. Part of the occurrence displays "durchbewegung texture", where pyrrhotite-rich sulphide contains rounded quartz fragments. Samples of typical sulphide material returned up 130.0 g/t Ag, 9.17% Pb and 6.27% Zn over 25 cm (Miner River Resources data). Rare colourless vuggy quartz veins cut the zone and are interpreted to be younger, Mesozoic features.

The showing was drilled in late 1997 by Miner River/Eagle Plains Resources. Seven short drill holes totaling 580 metres intersected several stratabound massive sulphide intervals of variable thickness (less than 1 cm). Assay results were not available during preparation of this report.

Streams draining the showing area are in the 99th percentile for the Nelson RGS survey for the 82F map sheet (Matysek *et al.*, 1991) for the elements cesium, cobalt, copper, molybdenum, tin, tungsten, and zinc. The highest finite conductors detected for the entire Findlay Creek Area (Area 3; B.C. Ministry of Employment and Investment Open File 1996-23; 10-20 siemens; 7200 Hz, coplanar), interpreted to be narrow bedrock conductors, lie adjacent to the MC showing.

Table 10-1. Minfile mineral occurrences for the Findlay-Doctor Creek area, location are plotted on Figure 10-2.

MINFILE	NAME	Commodities	TYPE
082FNE073	MOLLY	W, Mo	W skarn
082FNE089	PICO	W, Sn, Pb, Zn	W skarn adjacent to Moyie sill
082FNE090	VAL	W, Sn	W skarn
082FNE092	PIMACO	Sn, W	Sn veins and greisens
082FNE107	MC	Pb, Zn	Veins Ag-Pb-Zn±Au
082FNE112	GREENLAND CREEK	Be	REE pegmatite
082FNE122	BURNT	Cu	Veins Ag-Pb-Zn
082KSE041	ST. ANTHONY	Ag, Pb, Zn, Cu	Veins Ag-Pb-Zn
082KSE053	SILVER KEY	Ag, Zn, Pb, Cu	Veins Ag-Pb-Zn
082KSE060	DOC	Ag, Pb, Zn, Cu	Veins Ag-Pb-Zn
082KSE063	ECHO LAKE	W, Zn, Pb	W veins
082KSE075	PICO	W	W veins
082KSE081	ALPINE/ROCKY TOP	Pb, Zn, Ag	Veins Ag-Pb-Zn±Au

Table 10-2. Past production data for the Findlay-Doctor Creek area.

MINFILE NO.	NAME	MINED (T)	Pb (kg)	Zn (kg)	Cu (kg)	Ag (gm)	Year
082KSE053	Silver Key	29	11,145	887	---	99,499	1926-1940
082KSE041	St. Anthony	5	82	25	25	12,006	1963
Total		34	11,227	912	25	111,505	

Greenland Creek Tungsten Showings

Three broad areas of scheelite-wolframite mineralization were evaluated by AMAX in the late 1970's; north and south of Greenland Creek, and at the confluence of Greenland and Skookumchuck creeks (Parry and Hodgson, 1980). Some of the showings north of Greenland Creek had been previously explored by Kerr Addison Ltd. Most showings comprise narrow quartz veins in Moyie sills, however, those near Skookumchuck Creek include quartz-garnet-diopside-scheelite skarn. A scheelite-bearing breccia dike consisting of angular fragments of phyllite, diorite, and porphyritic quartz monzonite clasts in a fine-grained pyritic matrix crops out in the latter area (*ibid.*).

Possible ages for tungsten mineralization were suggested by Parry and Hodgson (1980) as synchronous with Moyie sill intrusion, or during emplacement of the White Creek Batholith. The sill most highly mineralized with scheelite, tourmaline and cassiterite, lies near the LMC contact, which corresponds to the stratigraphic position of the Sullivan deposit, which contains those same minerals. This points to a Middle Proterozoic mineralization age. Alternatively, tungsten-bearing breccia dikes and skarns near the batholith contact support a Middle Cretaceous plutonic connection.

CONCLUSIONS

The Findlay-Doctor Creek area Open File map is the primary product that will be generated from this project. The map area hosts a number of provocative mineral occurrences that continue to receive exploration attention, for example, the Rusty Ridge area, and Doc and Alpine occurrences. The extensive LMC fragmental unit, zones of base-metal enrichment for stream sediments and rocks illustrate that the Findlay-Doctor Creek area is a favourable SEDEX environment. Updated 1:50 000 scale mapping conducted under the auspices of this project provides a new framework for exploration.

ACKNOWLEDGMENTS

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updated road maps for the project area. The Ministry of Employment and Investment's Cranbrook regional office provided office space for the field season. Verna Vilkos patiently produced the figures. Reviews by Bill McMillan and Mitch Mihalynuk improved the final manuscript.

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