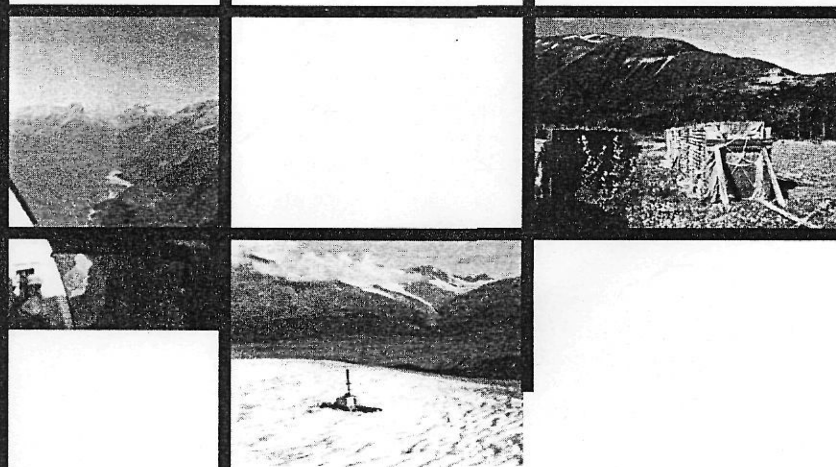
BRITISH COLUMBIA
**Ministry of Energy and Mines**
Energy and Minerals Division
Geological Survey Branch

# GEOLOGY OF THE FORREST KERR - MESS CREEK AREA, NORTHWESTERN BRITISH COLUMBIA (NTS 104B/10, 15 & 104G/2 & 7W)

**By James M. Logan, P.Geo,**
**John R. Drobe and William C. McClelland**

**With Contributions from:**
W.E. Bamber, Geological Survey of Canada
M.J. Orchard, Geological Survey of Canada
B.L. Mamet, University of Montreal
F. Cordey, University Claude Bernard Lyon 1



**BULLETIN 104**

granite and limestone and are probably related to mineralization. Small, highly fractured serpentinized peridotite bodies occur along northeast-trending fault zones.

Mineralization consists of disseminations, stringers and east-northeast-trending veinlets of tetrahedrite, with minor chalcopyrite, pyrite, sphalerite and galena. Secondary minerals include azurite and malachite. Alteration includes dolomitization of limestone, carbonitization of volcanic rocks, sandstone and conglomerate, and hydrothermal alteration and associated quartz veining in the granitic rocks (Gillan *et al.*, 1984). Alteration (limonitic orange cliffs) and mineralization are spatially related to north-trending regional faults and northeast-trending splays off them.

It was previously thought that granitic rocks on the property were responsible for the mineralization, as they were interpreted to intrude the mineralized carbonate rocks. However, subsequent age constraints on the granite (Early Mississippian) and the carbonate (mid Carboniferous) indicate that the contact must be a fault or a disconformity. Probable heat sources for the mineralization are the subvolcanic monzonite plugs associated with Au-Ag mineralization on the Run claim group, a stock of which crops out a few kilometres north of the property.

## STRATIFORM MASSIVE SULPHIDE DEPOSITS

## VOLCANOGENIC Cu-Zn-Pb (Kuroko) and CARBONATE-HOSTED Zn-Pb-Ag (Irish-Type)

### *FOREMORE (MINFILE 104G/148)*

The Foremore claims are located at the headwaters of the south tributary of More Creek, about 10 kilometres north of Forrest Kerr airstrip (Figure 5-2). The first claims were staked in 1987 by Cominco Ltd. in an area containing auriferous vein quartz boulders. Prospecting and mapping located quartz veins with gold values up to 9 g/t and copper skarn mineralization, but more importantly several hundred cobble to boulder sized clasts consisting of very fine grained pyrite, barite, sphalerite, with minor galena and tetrahedrite (Mawer, 1988). Additional staking was completed that year and the exploration target became the source of the massive sulphide boulders. Mapping, rock sampling and UTEM and Electromagnetic geophysical surveys were successful in locating laminated galena and sphalerite with coincident UTEM conductors in felsic volcanic rock (Barnes, 1989). Electromagnetic conductors located below 120 metres of glacier ice were drill tested in 1990 (Photo 5-6). Four holes were collared, three reached bedrock. Drilling intersected graphitic shear zones interpreted to represent the conductive horizons. A single hole was drilled in 1996 (664 m) from a nunatak located southwest of the 1990 drilling. The two electromagnetic conductors targeted in the 1996 drilling correspond to intersections of graphitic mudstone.

The property is underlain by Stikine assemblage rocks. These comprise a Lower and middle Devonian sequence of

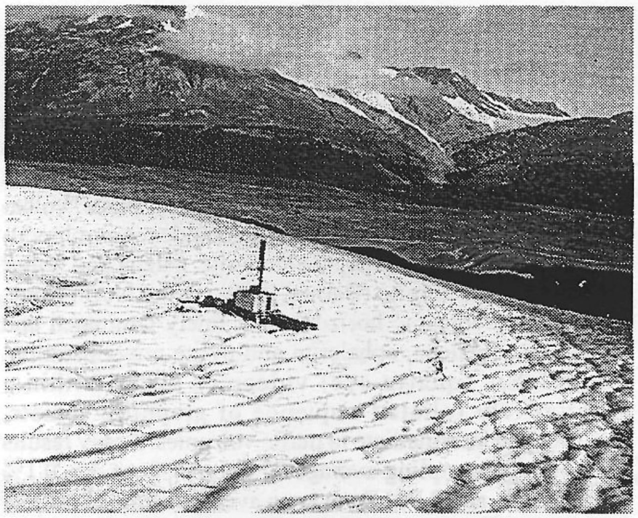


Photo 5-6. Diamond drilling on Cominco Ltd. - Foremore claims, 1990. The 1990 program targeted UTEM conductors located below 120 metres of glacier ice.

intermediate to felsic volcanic rocks, carbonate and graphitic and sericitic schistose sedimentary rocks and an Upper Devonian and Lower Mississippian sequence of primarily volcanic rocks. These sequences are intruded by the Early Mississippian More Creek Pluton and smaller satellite intrusions of quartz-porphyritic biotite granite.

Polyphase deformation has affected all rocks on the property. Strain partitioning led to formation of panels of more deformed rocks interleaved with largely undeformed rocks of the same age. Bedding and dominant foliation planes trend northeastward. Early recumbent folds in carbonate layers plunge shallowly to the northwest and southeast, deformed by later northeast-trending folds. East and northwest-trending crenulation cleavage overprints the dominant foliation. Several thousand mineralized boulders have been found on the Foremore claims. These occur in outwash plains at the eastern and northern lobes of the More glacier. The distribution of polymetallic massive sulphide float suggests the source is beneath the main ice sheet of More glacier. Boulders vary mineralogically, with pyrite-rich, zinc-rich, and copper-rich samples (Table 5-4) and texturally from massive to laminated.

(or on sides of covered by snow + recently (late 1990s, early 2000s) exposed)

note Pb-deficient (cf. Aug '02 discovery @ SG Zone)

**TABLE 5-4**
**ASSAY RESULTS FOR MINERALOGICALLY DISTINCT BOULDERS, FOREMORE PROPERTY**

| | Cu % | Pb % | Zn % | Ag g/t | Au g/t | Fe % |
|---|---|---|---|---|---|---|
| **North Zone** | | | | | | |
| chalcopyrite-rich (n=12)* | 2.3 | 0.5 | 6.2 | 186 | 1.5 | 16 |
| sphalerite-rich (n=29)* | 0.22 | 3.5 | 10.2 | 96 | 1 | 16 |
| **South Zone** | | | | | | |
| pyrite-rich (n=112)* | trace | 1 | 6.2 | 78 | nil | 23 |

*n= number of samples analysed
data from Barnes (1989)

The mineral and textural variation suggests the boulders from the north and south fields represent two or more distinct styles of mineralization, and those from the north, may indicate a single, zoned occurrence. Pb-isotope values also distinguish between the north and south boulder fields (Godwin, 1993). Boulders from the north field contain metal values comparable with those from 'in-place' volcanic hosted laminated sulphides. The boulders are mineralized with pyrite, sphalerite, chalcopyrite, galena and minor tetrahedrite and bornite (Barnes,1989). In the North Zone, pyritic felsic volcanic horizons host finely laminated and disseminated galena, sphalerite and pyrite mineralization. These felsic (quartz-eye) volcanics occur within a penetratively foliated sequence of graphitic schists, argillites and intermediate to mafic volcanics. Assay results from outcrop sampling average 87 ppb Au, 8 g/t Ag, 0.1% Cu, 0.3% Pb, and 2.7% Zn over an average sample width of 0.4 metres (Barnes, 1989). Boulders from the south field contain very fine grained pyrite and sphalerite with minor galena, chalcopyrite and tetrahedrite. Sulphide textures include massive, laminated, and blebby disseminations replacing carbonate and siliceous fragments. Limestone boulders host massive sulphide replacements. One such boulder contains probable algal laminations or stromatoporoid Favosites sp. of Late Ordovician to Middle Devonian age (B.S. Norford, personal communication, 1988; Logan *et al.*, 1990a).

Foremore mineralization includes: laminated galena and sphalerite in felsic volcanics that resemble samples of Kuroko volcanic massive sulphide deposit ore, and massive to laminated sulphide replacements in Early Devonian carbonates that are similar to Irish-type carbonate-hosted deposit ore. These data indicate that similar Devonian-Mississippian Stikine assemblage rocks elsewhere are potential VMS exploration targets.

### *ANTLER PROPERTY (MINFILE 104G/?)*

Pyrite veins, quartz veins and silicified stockwork zones are hosted in a mafic dominated, bimodal volcanic sequence of Devono-Mississippian age rocks north of the terminus of Alexander Glacier (Figure 5-2). This occurrence was first described by Gunning *et al.* (1994a) as a zone more than 100 metres long containing low base metal and variable precious and trace element abundances. It trends northwesterly, concordant with the volcanic host rocks. Follow-up mapping and rock, soil and stream sediment sampling indicated the zone is barren at surface (Gunning, 1995). The trace element association -elevated Cu, As and Sb- resembles some of the Mesozoic subvolcanic/intrusion-related veins and stockworks elsewhere in the area, but the potential for a Noranda/Kuroko-type base metal massive sulphide deposit in these rocks remains high.

### *NEW PROSPECTIVE HORIZONS*

Stratabound pyritic horizons associated with dacitic(?) pyroclastics or altered mafic hyaloclastite horizons crop out discontinuously within cherty siltstones and black carbonaceous argillites in a thick succession of basic pillow and breccia flows north of the Iskut River, 12 kilometres upstream from the mouth of Forrest Kerr Creek (Figure 5-2). Massive fine-grained pyrite and pyrrhotite form bedding parallel layers several centimetres thick and occur as disseminations. Rusty limonitic gossans and white weathering felsic rocks can be traced along the ridge for 1.5 kilometres. These horizons occupy a higher stratigraphic position than the ore horizon at Eskay Creek deposit, nevertheless follow-up is considered to be worthwhile.

## GALENA LEAD ISOTOPE RESULTS

Pb-isotope measurements of galena from selected stratabound massive sulphide boulders, skarn and subvolcanic vein deposits, together with feldspar-leads measured from a Late Devonian pluton, provide an exploration framework in which to define newly discovered mineral occurrences in the map area. The data also characterizes the basement and the metallogenic evolution of the Stikine terrane. The isotopic composition of Pb changes systematically over time because of the radiogenic decay of $^{238}U$, $^{235}U$ and $^{232}Th$ to $^{206}Pb$, $^{207}Pb$ and $^{208}Pb$, respectively. At the time galena is formed it freezes the ambient Pb-isotope composition, thus lead in younger deposits is more evolved and lies at progressively more radiogenic positions along the growth curves. The different sources of Pb (mantle, upper crust and lower crust), the heterogeneity of Pb-isotopes in these source areas and mixing of more than one source, make absolute dating of the deposits using Pb-isotopes impossible. Relative ages can be inferred using different growth curves which model the evolution of Pb in various reservoirs (Stacey and Kramers, 1975; Zartman and Doe, 1981; Godwin and Sinclair, 1982). Absolute constraints on the timing of mineralizing events is provided by U-Pb ages and sometimes by biostratigraphic ages in nearby rocks.

Jurassic and Tertiary clusters of galena lead isotope ratios in the Stewart area were first recognized by Godwin *et al.* (1980). Subsequent work by Alldrick *et al.* (1987; 1990) and Godwin *et al.* (1991) showed that these clusters define two separate, relatively short-lived metallogenic events. Stratigraphic information and other radiogenic dates are consistent with the interpretation that these were Early Jurassic and Tertiary Events. Radiogenic isotopic studies by Godwin (1993) and geochronological and radiogenic isotopic studies by Childe (1995, 1996) of selected VMS deposits within accreted terranes of the Canadian Cordillera provide a means of characterizing the metallogenic sources for this part of the Stikine terrane in Late Devonian time. The Stikine terrane is a product of primitive island arc magmatism, beginning in the Early Devonian and developed in a location removed from continental (evolved) detrital influences.

Pb-isotopes from 5 occurrences in the map area are presented in Figure 5-8, together with the Tertiary and Jurassic clusters of Godwin *et al.* (1991) and the Middle Jurassic - Eskay Creek, Triassic - Granduc, Mississippian - Tulsequah and the Late Devonian - Ecstall and Forrest Kerr Pluton clusters of Childe (1996). The Jurassic cluster represents synvolcanic gold-silver-copper-zinc-lead mineralization related to Hazelton Group magmatism. There is insufficient resolution to discriminate between Early and Middle Juras-

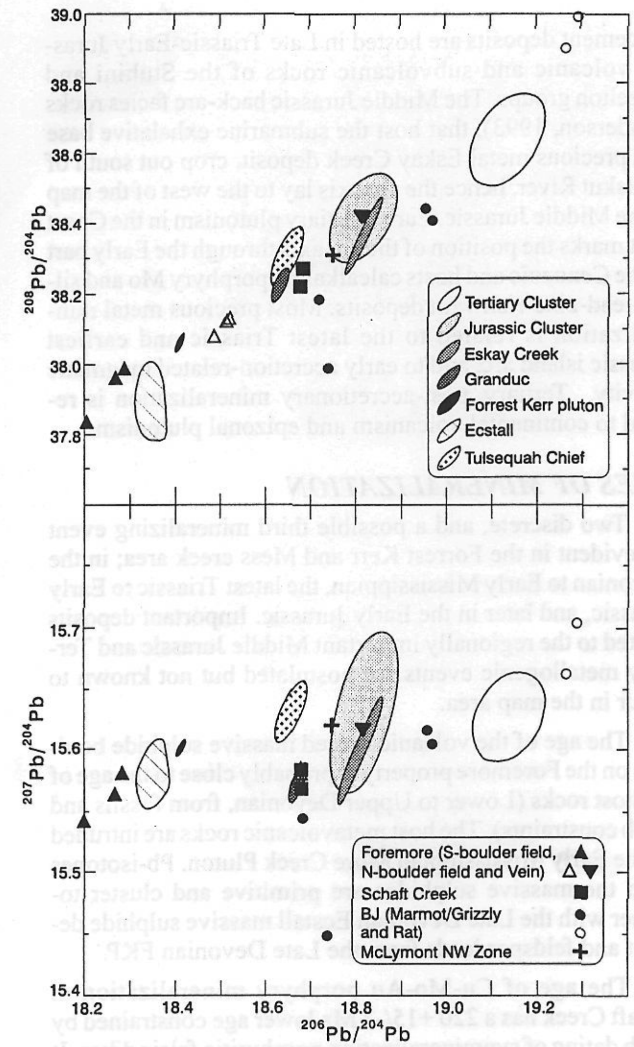



Figure 5-8. $^{206}Pb/^{204}Pb$ vs. $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ vs. $^{208}Pb/^{204}Pb$ for mineral occurrences in the study area. Data compiled from Godwin *et al.* (1988) and presented with Tertiary and Jurassic clusters of Godwin *et al.* (1991) and Middle Jurassic, Triassic, Mississippian and Devonian data of Childe (1996).

sic events. The second cluster is silver-zinc-lead±molybdenum occurrences related to Tertiary plutons.

Galena from the Foremore property (Godwin, 1993) posses some of the most primitive lead ratios found (Figure 5-8). There, the stratabound, volcanic hosted zinc-lead-silver±copper mineralization occurs in Devonian to Mississippian volcanic and volcaniclastic rocks. These underlie much of the Foremore property and have discontinuous interlayers of carbonate. A limestone boulder partially replaced by massive sulphide contains probable algal laminations or stromatoporoid Favosites sp. of Late Ordovician to Middle Devonian age (B.S. Norford, personal communication, 1988). The analyses from sulphide boulders, those with probable felsic volcanogenic affinities are more radiogenic and are from the north boulder field ('fn'). Less radiogenic samples are associated with Devonian carbonate from the south boulder field ('fs'). All the analyses plot in and around the cluster of values from the Ecstall VMS deposit and that for feldspars from the Forrest Kerr Pluton. At the Ecstall deposit, a 377 +9/-4 Ma diorite sill crosscuts strata hosting the massive sulphide lenses and constrains mineralization to the Late Devonian or earlier (Childe, 1996). The Forrest Kerr Pluton is Late Devonian (U-Pb zircon dates returned 369±5 Ma and 371±6.5 Ma respectively, Table I-1). The primitive Pb-isotopes, their similarity to those from the Ecstall VMS deposit and from the Late Devonian Forrest Kerr Pluton, and the stratabound nature of the mineralization suggests mineralization is Late Devonian, not Middle Jurassic as suggested by Godwin (1993). Pb-isotopes from a sample of auriferous quartz vein cutting granodiorite on the east side of the Foremore property plot in the Jurassic field of Godwin *et al.* (1980) and probably represent a younger mineralizing event than the stratabound mineralization.

Schaft Creek lead isotopes (Godwin *et al.*, 1991) plot between the Triassic Granduc cluster and the Jurassic cluster (Figure 5-8). The Granduc Cu-Zn besshi-type VMS deposit is hosted in well-dated Upper Triassic Stuhini Group basaltic andesites (223±5 Ma and 223±1 Ma; Childe, 1995). A previous interpretation, based on a Middle Jurassic age for Schaft Creek deposit, was problematic, but these isotopic ratios are explicable; if the crystallization age of the syn-mineralization felsic dikes (216.6±2 Ma) is close to the age of mineralization.

Galena from a sphalerite-galena vein in Drillhole 88-20, located at the north end of the McLymont Northwest zone was analyzed at The University of British Columbia for its isotope ratios (Ray *et al.*, 1991). The measured ratios plot within the Jurassic cluster, suggesting an Early Jurassic or older age for this mineralization.

Lead isotope ratios of galena samples from the GOZ/RDN property and a gold-bearing vein on the Foremore properties both plot in the Jurassic cluster (Godwin *et al.*, 1991).

Mineralization on the BJ property contains Pb-isotope ratios which lie outside both the Jurassic and Tertiary clusters (Godwin *et al.*, 1988). The least radiogenic samples, plotted as the average of two vein samples from the Marmot and Grizzly showings, lie between, but well below the Jurassic and Granduc clusters. The highly anomalous sample from the Rat vein plots right of the Tertiary cluster. It was muscovite-fuchsite from this quartz-carbonate sulphide vein that yielded an Early Jurassic potassium-argon date of 194±5 Ma (Holbek, 1988). The vein contains a mixed mineralogy of pyrite, sphalerite, chalcopyrite, tetrahedrite with trace amounts of galena, arsenopyrite and gold, which is characteristic of deposits within the Jurassic cluster. Tertiary age mineralization is widespread to the west in and adjacent to plutonic rocks of the Coast belt. Twenty kilometres west of the BJ property Tertiary mineralization is associated with felsic Eocene plugs at the Trophy property where it forms the Ptarmigan and Hummingbird zones. Galena lead from the Ptarmigan zone has isotopic ratios similar to Tertiary model ages (Logan and Koyanagi, 1994). Tertiary fluids can utilize older structures and may overprint earlier isotopic signatures.

## REGIONAL METALLOGENIC EVENTS

The general stratigraphic sequence, intrusive episodes and mineral deposit types are illustrated on Figure 5-9 for the Forrest Kerr - Mess Creek map area. Metallogenic activity occurred throughout the nearly continuous magmatic activity that spans an approximately 50 Ma period from the Late Triassic (228 Ma) to the Middle Jurassic (175 Ma). The intrusive activity has been divided into the distinctive: Late Triassic Stikine Plutonic Suite; the Late Triassic to Early Jurassic Copper Mountain Suite; the Early Jurassic Texas Creek Suite and the Middle Jurassic Three Sisters Plutonic Suite respectively (Woodsworth *et al.*, 1991; Anderson, 1993).

The potential for separate episodes of mineralization coincided with development of each of the volcano-plutonic arcs, beginning in Late Devonian to Early Mississippian, and including Pennsylvanian, Late Triassic to Early Jurassic, Middle Jurassic and Tertiary events. Mineral occurrences are known for all but the Pennsylvanian episode of volcanism and this maybe due to the fact that no intrusive rocks of this age are recognized in the map area. Early Devonian carbonate and volcanic rocks host conformable, massive polymetallic sulphide occurrences and copper skarns are developed adjacent to the Late Devonian Forrest Kerr and Early Mississippian More Creek plutons. High-level calcalkaline and alkaline synvolcanic porphyry, vein and replacement deposits are hosted in Late Triassic-Early Jurassic volcanic and subvolcanic rocks of the Stuhini and Hazelton groups. The Middle Jurassic back-arc facies rocks (Anderson, 1993), that host the submarine exhalative base and precious metal Eskay Creek deposit, crop out south of the Iskut River, hence the arc axis lay to the west of the map in the Middle Jurassic. Early Tertiary plutonism in the Coast Belt marks the position of the arc axis through the Early part of the Cenozoic and hosts calcalkaline porphyry Mo and silver-lead-zinc-rich vein deposits. Most precious metal mineralization is related to the latest Triassic and earliest Jurassic island arc, and to early accretion-related magmatic activity. Tertiary, post-accretionary mineralization is related to continental volcanism and epizonal plutonism.

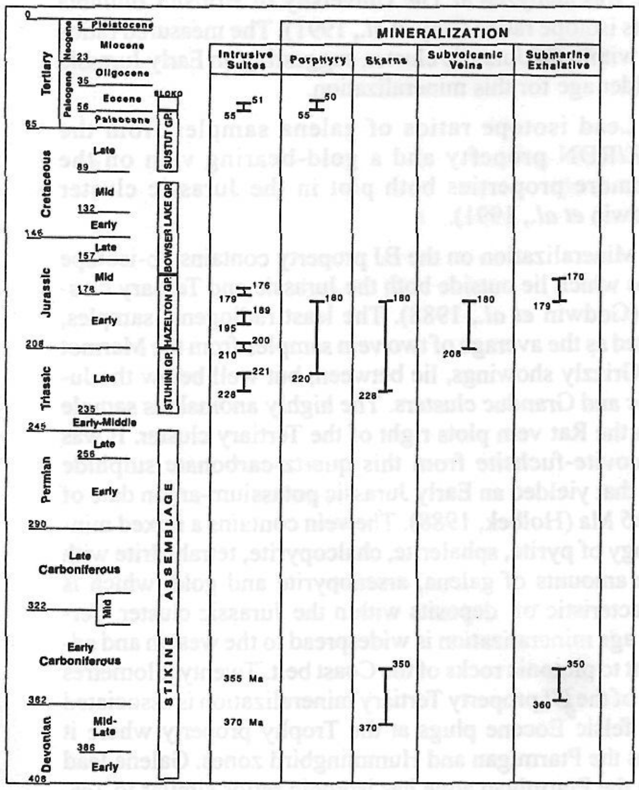



Figure 5-9. Summary of stratigraphy, intrusive events and mineralizing episodes by deposit type for the Forrest Kerr-Mess Creek area.

### *AGES OF MINERALIZATION*

Two discrete, and a possible third mineralizing event are evident in the Forrest Kerr and Mess creek area; in the Devonian to Early Mississippian, the latest Triassic to Early Jurassic, and later in the Early Jurassic. Important deposits related to the regionally important Middle Jurassic and Tertiary metallogenic events are postulated but not known to occur in the map area.

The age of the volcanic hosted massive sulphide boulders on the Foremore property is probably close to the age of the host rocks (Lower to Upper Devonian, from fossils and U-Pb constraints). The host metavolcanic rocks are intruded by the Early Mississippian More Creek Pluton. Pb-isotopes from the massive sulphides are primitive and cluster together with the Late Devonian Ecstall massive sulphide deposit and feldspar leads from the Late Devonian FKP.

The age of Cu-Mo-Au porphyry mineralization at Schaft Creek has a 220 +15/-2 Ma lower age constrained by U-Pb dating of synmineralization porphyritic felsic dikes. It also has Pb-isotope ratios which are similar to those of the Late Triassic Granduc copper-zinc deposit.

Metasomatic gold skarn mineralization at McLymont Creek is hosted in mid-Carboniferous to Upper Carboniferous sedimentary and volcaniclastic rocks, but related to Late Triassic or younger structures and intrusions. Alkaline to calcalkaline porphyry copper-gold mineralization south of Hankin Peak and east of Mess Creek are hosted by Upper Triassic volcanics and subvolcanic intrusives. Mineralization is generally believed to be latest Triassic to Early Jurassic in age for both these occurrences. Copper-silver mineralization at the Bam is hosted in Early Mississippian granite, Lower Permian carbonate and Lower Jurassic conglomerates. The epigenetic nature of the mineralization indicates it must postdate the youngest strata. A Late Triassic to earliest Early Jurassic age is also inferred for mineralization on the Run claim group. Vein mineralization appears to be marginally younger than the Triassic-Jurassic porphyry mineralizing event. Lead isotope studies of galena samples from the GOZ/RDN property and a gold-bearing vein on the Foremore properties both plot in the Jurassic cluster (Godwin *et al.*, 1991). An Early Jurassic (194+6 Ma; Holbek, 1988) age for auriferous mineralization is inferred from K-Ar dating of chrome-bearing muscovite from a carbonate-sulphide vein on the BJ property.

The Middle Jurassic Eskay Creek submarine exhalative base and precious metal sulphide deposit is located approximately 15 kilometers southeast of the map area. Correlative rocks are present in the Forrest Kerr - Mess Lake map area and the potential for exhalative deposits in this area has not been sufficiently tested.

Silver-rich base metal mineralization of Tertiary age is widespread to the east and elsewhere in northwestern British Columbia, but to date none has been recognized in the Forrest Kerr - Mess Creek map area.