



**LEAD-ZINC SHOWINGS IN CARBONATE ROCKS
SOUTHERN ROCKY MOUNTAINS
(82)**

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INTRODUCTION

Carbonate rocks of the southern Rocky Mountains are often overlooked as potential host rocks for economic base metal deposits. However, numerous lead-zinc deposits and showings have been discovered over the years, the most significant of which is the Monarch – Kicking Horse (MI 82N-19, 20) at Field. Among the more recently discovered are the Shag (MI 82J/NW-2) and SOAB (MI 82J/SW-13) prospects, both of which were found as a result of reconnaissance geochemical exploration programs in the 1970's. These, and a number of other prospects, were visited in August 1980, in order to gain a general understanding of the type, distribution, and characteristics of Paleozoic lead-zinc deposits and to assess the potential for further exploration and discoveries.

The showings are within the foreland fold-and-thrust belt of the Cordillera and occur not only in the Rocky Mountains but also in the Rocky Mountain Trench. Although the structural style varies within the study area, northeast-directed thrust faults and associated folds and overfolds with northwest-southeast axes dominate.

The deposits, with the exception of the Hawk Creek showing (MI 82N-21), are in Middle to Upper Cambrian and Devonian platformal carbonates. The Monarch – Kicking Horse deposits occur in a thick succession of massive to thin-bedded limestone and dolomite of the Middle Cambrian Cathedral Formation. The Shag group was reported to be in the Cathedral Formation (Bending, 1978); however, it now appears that the host carbonate is part of the overlying Pika and Eldon Formations (Bending, 1980, personal communication). Steamboat (MI 82K/NE-65) and Mitten occur in carbonate of the Middle to Upper Cambrian Jubilee Formation within and along the western margin of the Rocky Mountain Trench. Hawk Creek is a vein deposit in limestone and shale of the Cambro-Ordovician Goodsir Group, and the SOAB prospect is in dolomite of the Palliser Formation.

Characteristically the Middle Cambrian deposits are in close proximity to carbonate bank margins. They have many features characteristic of the so-called Mississippi Valley-type deposits (Sangster, 1970). Monarch – Kicking Horse and Shag are in Middle Cambrian platformal carbonates just east of a transition to basinal shale and limestone of the Chancellor Group (Cook, 1970; Aitken, 1971). Deposits in the platformal Jubilee Formation are on an ancestral high, the Windermere, that was periodically emergent in Early Paleozoic time (Reesor, 1973).

DESCRIPTIONS OF DEPOSITS

MONARCH – KICKING HORSE (MI 82N-19, 20)

The Monarch – Kicking Horse deposits that occur in the steep cliffs on either side of the Kicking Horse River just east of the town of Field (Fig. 34) were described by Ney (1957) and Westervelt (1979). Their regional stratigraphic and tectonic setting was outlined by Cook (1970). Production from both deposits, from 1888 until their final closure in 1952, totalled 0.82 million tonnes containing 5.63 per cent lead, 8.85 per cent zinc, and 31 grams per tonne silver.

The deposits comprise a number of separate and discrete mineralized zones within massive to brecciated dolomite that forms a 60-metre stratigraphic interval in the lower 125 metres of the Cathedral Formation (Fig. 35). The dolomite zone cuts sharply into underlying well-bedded limestone and dolomite and is overlain by well-bedded carbonate rock. The brecciated dolomite that hosts the orebodies consists either of a stockwork of white dolomite 'veins' in grey dolomite or of light grey dolomite fragments in dark grey dolomite. Dolomite alteration zones immediately underlying the orebodies have original bedding preserved. The dolomite zones and orebodies trend northerly, parallel to both late normal faults, and to the abrupt carbonate platform-basinal shale transition zone described earlier.

The orebodies occur as narrow elongate runs in brecciated dolomite. They die out gradually along trend into barren, unmineralized dolomite but have sharp lateral boundaries. Sulphides, consisting of amber-coloured sphalerite, galena, minor pyrite, and trace chalcopyrite, are disseminated in the dolomite matrix of breccias and form irregular veinlets cutting both matrix and fragments. Coarse sphalerite and galena commonly rim dark dolomite fragments; spar dolomite is interstitial.

Dolomitization and the development of breccia and associated cavities cannot be directly related to any late fault structures. Faults cutting the deposits are not conspicuous and one of the two supposed boundary 'faults,' the Stephen-Dennis fault (Allan, 1914), is dominantly a stratigraphic, not a structural break (Cook, 1970). The location of the Monarch – Kicking Horse deposits in dolomitized breccia adjacent to a platform bank margin suggests rather a regional stratigraphic control of mineralization.

SHAG (MI 82J/NW-2)

A number of small lead-zinc showings were discovered by C. Graf in 1977 in limestone and dolomite in the heavily wooded drainage of Shag Creek 35 kilometres east of Radium (Fig. 34). Work by Rio Tinto Canadian Exploration Limited has included geological mapping, prospecting, soil sampling, and diamond drilling.

The showings occur in a thick, massive to well-bedded limestone-dolostone unit originally correlated with the Middle Cambrian Cathedral Formation (Bending, 1978) but may be in the overlying Middle Cambrian Pika or Eldon Formations (Fig. 35; Bending, 1980, personal communication).

Most of the showings consist of concentrations of galena and pale yellow to orange-coloured sphalerite in granular or brecciated dolostone overlain by dark laminated limestone. The sulphide concentrations appear to be restricted to two horizons, although a number of megascopically similar horizons occur in the succession. The dolostone at the 'BM,' the largest of the showings, consists of a number of cyclical beds. Each is a few centimetres thick, and each consists of an erosional basal surface overlain by massive or irregularly laminated dark dolomite capped by a coarse fragmental breccia or fenestral dolomite. This succession of cyclical beds is capped by dark, well-layered limestone.

Coarse crystallized sphalerite, minor galena, and trace amounts of pyrite occur either within sparry dolomite or dark argillaceous limestone that is interstitial to breccia fragments or as disseminated grains through more massive dolomite.

A second, similar horizon hosts scattered sulphide occurrences over a wide area. The mode of mineralization is generally similar, although locally galena and minor sphalerite occur in crosscutting calcite veins and shears.

The finely disseminated nature of some of the sulphide minerals and their restriction to specific horizons suggests a syngenetic to early diagenetic origin. The host rock is an intertidal dolostone that was repeatedly

emergent and hence subjected to erosion, solution, and local brecciation. Dark argillaceous limestone between dolomite fragments probably represents concentrations of less soluble residue, and interstitial sparry dolomite represents early diagenetic cavity filling. The favourable horizons developed just prior to or during the marine transgression that caused deposition of the overlying subtidal laminated limestone. As at Monarch – Kicking Horse, the deposits are proximal to a platform-basin transition zone.

STEAMBOAT (MI 82K/NE-65)

The Steamboat property is on Steamboat Mountain, 12 kilometres northwest of Radium (Fig. 34). It is accessible by logging roads which branch off a secondary road on the west side of the Columbia River. Work by the owner, Cominco Ltd., includes drilling and geophysical and geochemical surveys in 1975 and 1976.

Host rocks are massive dolomites of the Jubilee Formation (Fig. 35) on the overturned eastern limb of a southwest-dipping syncline (Reesor, 1973). Sparse mineralization occurs along a strike length of approximately 300 metres and to a depth in excess of 100 metres (Webber, 1977). Galena, sphalerite, pyrite, and minor copper sulphides are associated with silicified dolomite and dolomite breccia with quartz and barite veins and pods. Dolomite breccia is generally of a coarse to fine chaotic or 'crackle' variety, but may also appear clastic (Webber, 1977). Fragments of light or dark-coloured dolomite lie in a matrix of fine to coarsely crystalline dolomite, barite, or quartz.

Galena and sphalerite occur as disseminations, irregular clusters, or stringers of generally fine crystals. They occur in dolomite fragments, in barite, in quartz, or in the breccia matrix. Malachite and azurite were observed locally.

Mineralization is considered to be of the vein-replacement type in 'late' fractures and fracture breccia.

MITTEN

The Mitten prospect is located on Lead Mountain, 17 kilometres northwest of Spillimacheen, and is reached by a 9-kilometre road north from the Silver Giant mine (Fig. 34). Discovery of the property dates to the turn of the century, but early work, that includes two adits and numerous surface cuts, did not prove up an economic orebody. Further drifting and diamond drilling were carried out in the mid-1950's. Work by Cominco in 1976 included surface and underground mapping and soil geochemistry.

The host rock was mapped as Middle Cambrian Jubilee Formation by Reesor (1973), but Cominco geologists believe it to be a dolomitized equivalent of the Cambro-Ordovician McKay Group (Fig. 35). Underlying Lower Cambrian quartzite, grit, and conglomerate of the Cranbrook Formation is also exposed on the property. Both units dip steeply (55 to 65 degrees) to the southwest.

Mineralization on surface occurs in an area of roughly 50 square metres. A 60-metre-wide mineralized zone was intersected in three drifts and in diamond-drill holes (*Minister of Mines, B.C., Ann. Rept., 1955*). Galena, sphalerite, and pyrite, in decreasing order of abundance, are associated with centimetre-scale sparry medium-grained dolomite pods and veinlets.

Galena is finely crystalline. It lines cavities that were later filled by spar dolomite, occurs as irregular patches and stringers in the sparry dolomite pods, and forms stringers, veinlets, and disseminated clusters in both dolomite host rock and spar dolomite. Sphalerite is fine to medium grained. It is mainly associated

with the spar dolomite as enclosed clusters or as cavity linings but also occurs as stringers in the dolomite. Minor pyrite is disseminated in the spar dolomite.

The shape of the spar dolomite pods and the rimming texture formed by galena and sphalerite suggests filling of open spaces. The origin of the cavities is not known; they may represent spaces in an original reefal limestone or they may be related to later dolomitization and brecciation. Remobilization of sulphides into stringers and veinlets is common.

Sampling of the deposit over a 5 by 35-metre zone yielded an average grade of 3.75 per cent lead (*Minister of Mines, B.C., Ann. Rept., 1954, p. 149*). Assays of five grab samples collected during this study are given below. Lead varies from approximately 2 to 5 per cent, zinc <1 per cent to 2 per cent; the silver and gold content are low.

| Sample No. | Au <i>ppm</i> | Ag <i>ppm</i> | Pb <i>per cent</i> | Zn <i>per cent</i> |
|------------------|------------------|------------------|-----------------------|-----------------------|
| Lead Mountain 1A | <1 | 5.8 | 5.52 | 0.58 |
| Lead Mountain 1B | <1 | 5.0 | 4.50 | 0.71 |
| Lead Mountain 3A | <1 | 2.6 | 4.48 | 0.29 |
| Lead Mountain 3B | <1 | 5.0 | 2.40 | 1.38 |
| Lead Mountain 3C | <1 | 4.6 | 2.21 | 1.94 |

HAWK CREEK (MI 82N-21)

The showing is located on the north side of Hawk Creek in Kootenay National Park, about 50 kilometres northeast of Radium (Fig. 34). Trenching and drilling in 1942 by Base Metals Mining Corporation Ltd. constitute the only major physical work done on the property. Host rocks are strongly cleaved, thin-bedded argillaceous limestones and argillites of the Cambro-Ordovician Goodsir Group. A prominent, steep, northwest-trending shear zone appears to control the distribution of the vein and replacement mineralization. The shear zone and associated mineralization cuts sharply across bedding in the sedimentary rocks.

Mineralization comprises an irregular cylindrical zone roughly 15 metres in width and 75 metres in length (Henderson, 1953). Amber-coloured sphalerite, the dominant sulphide, forms massive fine-grained pods, disseminations, and stringers. Coarser grained dark brown sphalerite occurs as disseminated clusters in sparry calcite veins and stringers. Galena, which is less abundant, occurs as fine-grained disseminations and stringers associated with both sphalerite, calcite, and minor pyrite.

A 2-metre-wide high-grade zone assayed 30.6 per cent zinc, 43 per cent lead, 50 grams per tonne silver, and 1.56 grams per tonne gold (Richmond, 1930).

SOAB (MI 82J/SW-13), BOIVIN, ALPINE

On the SOAB mineral claims stratabound lead-zinc showings occur in platform carbonates of the Devonian Palliser Formation. The claims are located near the headwaters of Bull River, 50 kilometres east of Canal Flats (Fig. 34). They were discovered in 1972 by Silver Standard Mines Limited during follow-up of a regional stream sediment anomaly. The Alpine and Boivin showings were discovered in 1977 and 1978. Limited drilling of the SOAB and Alpine and blasting and sampling of Boivin has evaluated these occurrences. The geology of the property has been described by Gibson (1979) and is the basis of his M.Sc. thesis in progress at the University of British Columbia.

Mineralization is restricted to a unit within the Lower Morro member of the Palliser Formation. The unit is in the lower, overturned limb of an eastward-verging asymmetrical anticlinal fold that is thrust against Mississippian carbonates to the east. Overlying Cambrian-Ordovician strata to the west are also assumed to be in thrust-faulted contact with the Devonian package (Gibson, 1979).

A distinctive carbonate rock termed 'zebra facies,' that is characterized by fenestral (and geopetal) spar dolomite crescents in a fine-grained granular dolomite matrix, hosts the mineralization. It is interpreted to be of supratidal algal origin (Gibson, 1979) and is underlain and overlain by massive, subtidal limestone. Pale yellow to almost clear sphalerite is disseminated through the granular dolomite and is concentrated along the periphery of spar dolomite patches and within the spar dolomite. The mineralization is confined to a number of discrete zones generally less than 1 metre thick and a few metres in length. The Boivin showing, for example, measures approximately 12 metres in length and 2 metres in width and contains up to 20 per cent zinc (Gibson, 1979).

SUMMARY

The location of Middle Cambrian deposits in platformal carbonates adjacent to a bank margin is considered an important stratigraphic control. Associated brecciation and dolomitization in the Monarch — Kicking Horse and Mitten deposits does not appear to be structurally controlled; rather, it may be related to early karsting or cave development. Mineralization at Shag also appears to be stratigraphically controlled, not related to late structures. Its local disseminated nature in dark intertidal dolomite suggests an early, perhaps diagenetic, emplacement. Mineralization at Hawk Creek, and perhaps at Steamboat, may be structurally controlled.

The disseminated nature of sphalerite in the SOAB and its restriction to a specific carbonate unit within a thick succession of carbonates suggest an early syngenetic to diagenetic origin. Zinc-lead mineralization in Devonian rocks in southeastern British Columbia are scarce by comparison with the northeast Cordillera. Perhaps this reflects levels of exposure. The bank margin environment and shale basin facies that hosts northeast sulphide accumulations is not exposed in southeastern British Columbia; only the platformal environment, which would presumably lie to the east of the shale basin, is exposed.

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