Geology of the Mount McCusker-Robb Lake Area, Northeastern British Columbia (94G/4W)

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KEYWORDS: *Regional Geology, Paleozoic, , Sidenius thrust, Skoki Formation, Beaverfoot Formation, Nonda Formation, Muncho-McConnell Formation, Mississippi Valley type (MVT) deposits, Robb Lake deposit, lead and zinc mineralisation ,stratiform breccia, Ospika embayment, stratiform sedex potential.*

INTRODUCTION

The Mount McCusker-Robb Lake area of mapping lies near the western margin of the MacDonald platform. This tropical platform extended over much of northeastern B.C. in late Silurian to Devonian time. The western, ocean facing margin of the platform is host to numerous showings and prospects of Mississippi Valley type (MVT) lead-zinc mineralisation. The largest of these is the Robb Lake deposit which has measured geological reserves of six and a half million tonnes at 7.1 per cent combined lead-zinc. Fieldwork in 1999 extended the 1998 mapping southward to the vicinity of the Robb Lake deposit, as well as to the northwest and east. The mapping project is a component of the multidisciplinary National Mapping (NATMAP) Central Forelands Project of the Geological Survey of Canada.

One of the more interesting results of the mapping is indications of sharp breaks in the older Upper Ordovician to Lower Sillurian platform margin. There is some potential for stratiform sedex deposits in the Lower Silurian and Upper Ordovician marine beds of a basinal embayment in the area. A few base metal geochemical highs in host terrain appear to have been ignored, perhaps because the emphasis was to explore using the MVT model.

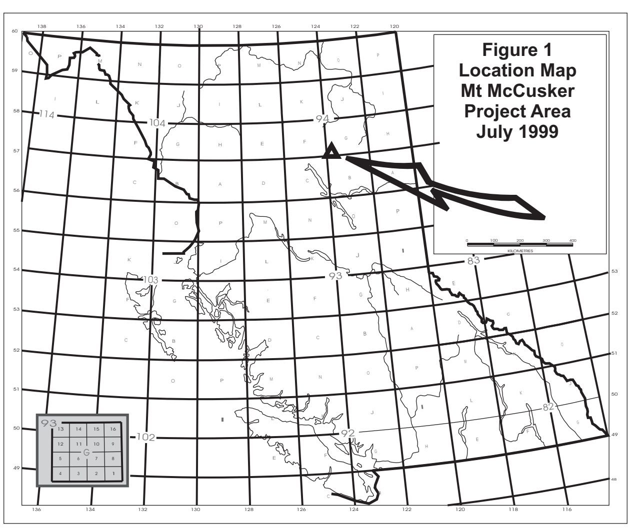

Figure 1. Location of study area.

LOCATION AND ACCESS

The map area lies 80 km due west of the small settlement of Pink Mountain on Highway 97 and 151 km north of Fort St. John. The area is within the eastern Muskwa Ranges, but close to the edge of the Rocky Mountain foothills to the east. The surveyed area lies at an altitude varying from 1250 to 2500 m. It is only accessible by air, but a few trails and seismic lines approach it from the east. The map area is bordered on the north by Colledge Lake and to the east by Mt. Bertha. To the south it extends to the vicinity of the Robb Lake deposit and Mississippi Creek. The main streams within the map area are the upper Sikanni Chief River and Sidenius Creek. Secondary drainages include Bartle, Embree, Gautschi and Colledge Creeks. In the following geological description of the area, major ridges are referenced by using the name of a nearby drainage (Figures 3, 4). For example, the ridge extending south from Sikanni Chief River, drained by Bartle and Embree Creeks, is called Bartle Ridge. Sidenius Ridge is the east-west trending ridge on the north side of the Creek of the same name.

Fieldwork in 1999 involved twenty-one traverses, to cover an area of about 600 square km. with helicopter support provided by the Geological Survey of Canada. The writer was ably assisted by University of Victoria geography co-op student, Panos Skrivanos. Due to foul weather, some areas were not mapped with the desired definition. The work was conducted from two fly camps, one in the northern Gautschi River valley, the second from a tributary on the south side of Sidenius Creek bordering the Robb Lake mapsheet (94B/13), informally named as Flycamp Creek.

PREVIOUS GEOLOGIC MAPPING

Early work in the area dates from the 1960's and focused on the regional stratigraphic and structural framework of the Paleozoic rocks for assessment of oil and gas potential. Mineral exploration received its impetus from active sampling and drilling of the Robb Lake prospect 20 km to the south in the early 1970's. This led to spin-off exploration for Mississippi Valley type deposits along the entire eastern border of the Northern Rockies. In the study area a number of showings were found and several, such as Lad (Williams, 1974a) and Toll (Williams, 1974b) have been drilled.

The area has not been mapped in detail, except for the immediate vicinity of the Lad (Mt. McCusker) prospect at a scale of 1:12000 (McHale and Pearson, 1974). The region is generally covered by a 1:250,000 scale compilation by the GSC (Taylor, 1979). Bob Thompson mapped and compiled the Halfway sheet south of the study area (Thompson, 1989), publishing both 1:50,000 and 1:250,000 scale maps.

GEOLOGIC SETTING

The stratigraphic succession ranges from Ordovician to Devonian. The succession in stratigraphic order (oldest to youngest), comprises the Ordovician Kechika, Skoki and Beaverfoot Formations, an unnamed early Silurian facies, the early Silurian Nonda Formation, a Silurian quartzite marker unit, the Siluro-Devonian Muncho-McConnell Formation, the Devonian Wokkpash, Stone and Dunedin Formations. Dolostones dominate, but there are significant intervals of shale (Figure 2). The lithologies can be ascribed to shelf and slope to basin environments. Biostromal dolostone, algal laminites, reef boundstone, and cross bedded quartzite correspond to the shelf. The offshelf is characterised by calcareous shales with biohermal and bioclastic lenses. The slope to basin facies includes graptolitic shales, quartz turbidites, graded beds with rip-ups and pyritic shale.

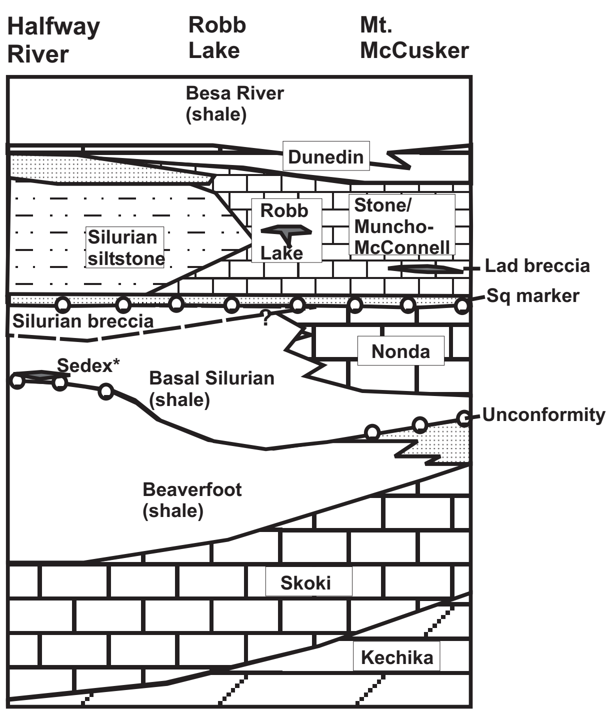

Figure 2. Postulated relationship of stratigraphic units in a general northeast (Mount McCusker) to southeast (Halfway River) transect of map area. * Stratigraphic position of CT, ERN stratiform mineral occurrences in Ware sheet to west (NTS 94F).

Structurally, the area of study lies at the edge of the northern Rocky Mountains at a transformation between a fold and thrust belt characterised by tight overturned folds and ramping thrusts, as at Mt. McCusker or Bartle Ridge, and a belt of more open folds to the east, with fewer and more shallow dipping thrusts such as at Mt. Bertha.

West of the map area in the Ware sheet (NTS 94F) Paleozoic shales dominate from the Ordovician Kechika Group to Devonian Earn Formation in the basin of the Kechika trough. These are described in several reports, including Cecile and Norford (1979), MacIntyre (1998).

The succession at Mt. McCusker preserves deposits of a basinal embayment into the platform in the Ordovician and Silurian called the Ospika embayment (Thompson, 1989). The facies boundary between the Skoki and overlying shales outlines the embayment. The position of the shelf edge in the Trutch and Halfway sheet is illustrated by Thompson (1989, Photo 3). In the study area the basin to shelf transition can be followed via a series of stratigraphic sections from Robb Lake to the Sikanni Chief River.

The stratigraphic succession is broken by two principal unconformities. The oldest lies at the top of the late Ordovician Beaverfoot. The younger unconformity is marked by the base of "Silurian Siltstone" in the basin and the base of the Muncho-McConnell on the platform. Recently the "Silurian Siltsone" has been formally named as the Kwadacha Formation (Pyle and Barnes, in press).

There are other unconformities of more local extent noted by workers, for example, the top of the Stone Formation below the Dunedin (Morrow, 1978).

MT. MCCUSKER AREA STRATIGRAPHY

Kechika Group

The Kechika is an extensive offshelf facies consisting of well recrystallised, thin to medium bedded calcareous shale, limestone and dolostone. Flaggy cleavage plates typically have a slight phyllitic sheen. The Kechika varies little throughout the map area. In some areas (*e.g.* a ridge above Sikanni Chief River east of Gautschi Creek) the uppermost beds below the Skoki are thick bedded. Barnes *et al.* (1998) noted trilobite debris in the Kechika. Work in 1999 delineated the contact of Kechika with Skoki Formation in the cirques northwest of Gautschi valley and in the core of a box-like anticline at Sikanni Chief River.

Skoki Formation

A complete section of Skoki, approximately 500 metres thick, was noted on Sidenius ridge in 1998 (Legun,1999).

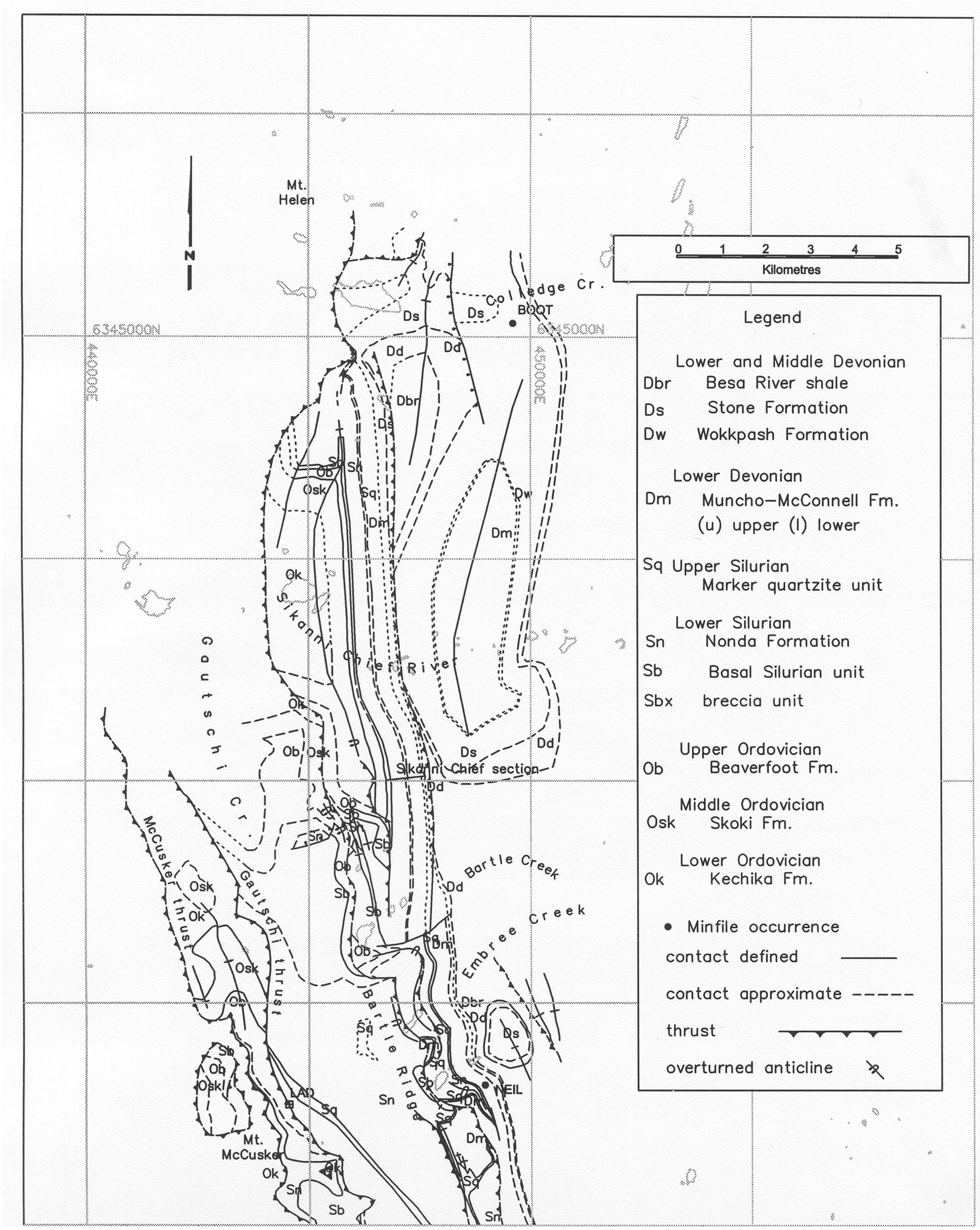

Figure 3. Geology of northern portion of map.

In 1999 the Formation was mapped south of Sidenius Creek. The common oncolitic facies was noted, but the chert facies was not evident. Uppermost beds (100 m or so) show indications of current activity. Bedding surfaces show patches of bioclastic crinoid debris and some beds are rippled and crossbedded. Also evident on bedding surfaces are drapes of reddish mudstone. In several locales near the top of the Formation there are beds with a dense distribution of oncolites cored by brachiopod valves. Macluritid planispiral gastropods are also found in these beds and have been documented elsewhere in the Skoki (Rohr *et al.* 1995).

The interpretation of these upper beds is uncertain, but on the whole, the Skoki does not appreciably change platformal character within the area of study. West of Mt. Kenny in the Halfway sheet it becomes more argillaceous (Thompson, 1989, p. 26). Closer to the Kechika Trough a

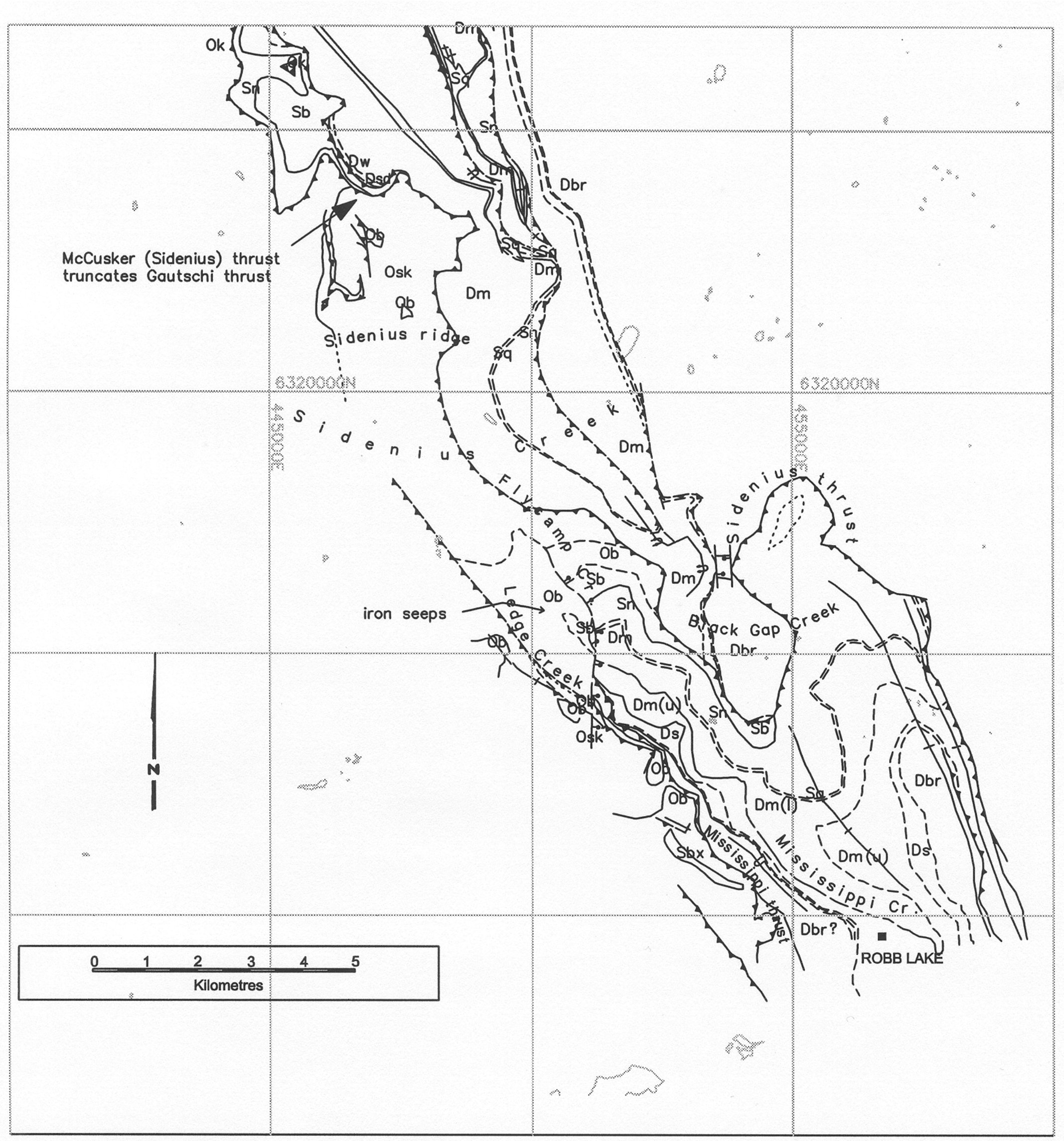

Figure 4. Geology of southern portion of map.

collapsing shelf edge has been described by Cecile and Norford (1979).

Beaverfoot Formation

The Beaverfoot Formation shows a transition from platform to basin depositional setting in the map area. Basically the quartz-dolomite unit of the platform (*ibid.*) was followed into the basin where it corresponds to the brown shale and quartzite unit (Thompson, 1989) near Robb Lake. The writer describes lateral facies within the single nomenclature of Beaverfoot. The quartz dolomite unit, brown shale and quartzite facies of Thompson (1989) are similarly overlain by basal Silurian facies both on the platform and in the basin and are underlain by the Skoki.

The platformal part of the Beaverfoot is well exposed near the Sikanni Chief section of Norford *et al.* (1966) on Bartle Ridge. Here a sequence of reddish (bioturbated) dolomitic siltstones passes upward to laminated and cross-bedded quartz arenite, arenaceous dolostone and orange dolostone. Mudcracks and breccias with ferricrete? nodules are present in the highest beds (Legun, 1999). The sequence, about 200 m thick, indicates an upward shallowing depositional environment.

In the hangingwall of the Gautschi thrust to the west, graded beds and erosional features in arenites together with interbeds of shell coquina suggest a subtidal slope facies. Lithologies include horizontal laminated sandstones, graded dolomitic sandstones with mudstone rip-ups and erosional bases; dolomitic shale (some beds rich in single valve shells); thin (5cm) pyritic beds, fine dolostones, nodular and lensoid breccia, rusty dolomite and sandy dolomite with scattered black chert. The thickness here is on the order of 250 to 300 m. Steep terrain and scree precludes a good section but brownish dolomitic shales are abundant.

Further to the south a nautiloid found in basal beds of the Beaverfoot south on Sidenius ridge (Legun, 1999) confirms open marine conditions at the time of the Ospika Embayment. Dark sandy and shaly calcareous beds lie abruptly on the Skoki. Only about 15m of Beaverfoot is preserved.

On the south side of Sidenius Creek there are several sections of a basinal facies of the marine embayment. In each case there is a sharp contact of very pale dolostones of the Skoki with brownish recessive beds of the Beaverfoot Formation. The lower Beaverfoot at Flycamp Creek (Photo 1) consists of sooty calcareous siltstone and dark shale, brown dolomitic siltstones with intraclasts of chert, and mud rip-ups from underlying beds. At least one thick quartz turbidite with a fluted base is found in the black shale, associated with rusty pyritic shales.

The black shale facies grades upward into a thicker bedded sequence of dolomitic siltstone, variably calcareous dolostone, chert and cherty siltstone. This may correspond to the shallowing up cycle on the platform. There appear to be lateral facies changes with banded cherty siltstones being replaced by calcareous shale, or yellow dolomitic mudstone within a kilometre of each other.

On airphotos and from a distant viewpoint, the transition from Beaverfoot to basal Silurian facies is evident as a change from brownish or paler beds to grey beds. In traverse the brownish or paler beds are a rhythmically banded facies of alternating calcareous dolostone and yellow dolomitic mudstone which develops lenses of limestone and calcareous shale up section. On close examination the calcareous units are bioclastic, either shallow channel bodies of reef detritus or perhaps eroding biohermal mounds. The presence of calcareous beds is a principal feature of the transition zone. This may reflect deepening conditions and other environmental changes.

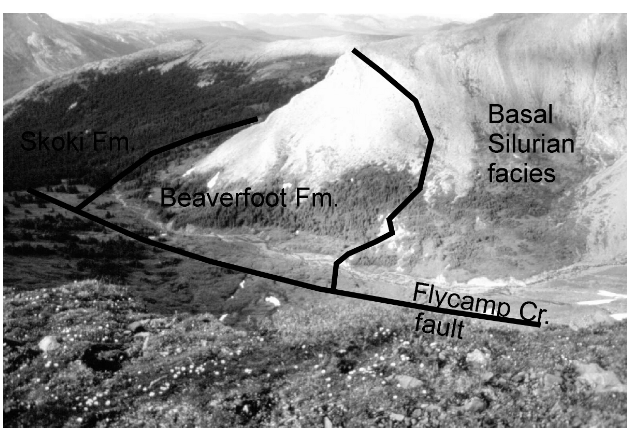

Photo 1. Looking northeast across Flycamp Creek. Ridge section of dipping beds of Beaverfoot Formation (light) to darker basal Silurian facies. Section continues to Nonda shale-out outside of picture to right.

The thickness from bedding dips and elevations at contacts indicates the Beaverfoot is approximately 300 m thick at Flycamp creek.

few kilometres to the south a ridge section exposes strata from the Skoki Formation to a Silurian breccia unit. A resistant bed of quartzite, lieing about 150 m above the base of the Skoki, may be the same bed as mapped to the north. Black shales above it are reported by Pyle (personal communication, 1999) to yield graptolites of the clingani Zone which is Late Ordovician (Caradoc) in age. Lithologically the upper contact of these beds with Lower Silurian shale beds is not clear here. There is minor folding and a fault before the section ends at exposures of Silurian breccia which form a near flat-lying cap to the high part of the ridge.

It is not clear whether in the area south of Sidenius Creek sedimentation was continuous from the Upper Ordovician to Lower Silurian. Ongoing biostratigraphic evaluation by Barnes *et al.* (1999) should provide some answers. In many basinal areas of the northern Cordillera a disconformity is reported (Lenz and McCracken, 1982). In the Halfway River sheet, Thompson (1989) distinguished basinal Lower Silurian beds from Upper Ordovician marine shales (Beaverfoot of this writer).

The disconformity in the basin apparently corresponds to a regionally downcutting unconformity on the platform. Norford (1966) noted that the unconformity cuts down northward such that at 58 latitude the Nonda sits on the Kechika.

Basal Silurian Facies

Basal Silurian beds suggest a transgression occurred at the end of the Ordovician. Basal Silurian calcareous shales, albeit thin, and somewhat oxidised, rest on the quartz dolomite facies of the Beaverfoot and underlie the Nonda Formation. The basal Silurian facies is unnamed on the platform but basinward corresponds to the Carbonaceous limestone unit (Scl) of Thompson (1989) in the Halfway River map sheet.

Norford *et al.* (1966) first recognised a recessive basal Silurian facies. The writer examined Norford's Sikanni Chief section in 1998 and found the recessive beds to be a mappable unit within the area of study.

In the Sikanni Chief section the basal Silurian beds are thin (about 80 m), and comprise yellowish, rubbly, nodular, shaly and calcareous dolostone, grey calcareous shale and dolomitic siltstone. Immediately to the west in the Gautschi valley the section thickens to *circa* 200 m, (see Gautschi Creek section in Barnes *et al.* 1999), and is comprised of a darker flaggy calcareous shale which weathers similar to the Kechika. Further to the west, basal Silurian facies outcrop in the hangingwall of the Gautschi thrust. Exposures are accessible via a cirque at the head of a tributary to Sidenius Creek. The upper contact against the Nonda is sharp, and the base not exposed in the bottom of the cirque. A calculated thickness of 160 m of low dipping beds are present.

The basal Silurian shows an increasing argillaceous character both west and south from the Sikanni Chief section.

Nonda Formation and Basal Silurian Facies

The Nonda is a platformal dolostone, often cherty, with distinct biostromal beds. It is uniform in thickness (about 320 m) and character across the McCusker map area. The westernmost exposures in the Mt. McCusker area are still platformal in character.

South of Sidenius Creek, Riddell (1972) first documented the basal Silurian facies thickening diachronously at the expense of the Nonda. Thompson (1989, Figure 8) described cliff exposures showing tongues of the Nonda pinching into shaly basal Silurian facies. At the shale-out the writer estimates the Lower Silurian to be at least 500 m thick, comprising 200 m of thinning Nonda and 300 m of shale.

South of the shelf break, basal Silurian beds (unit Scl of Thompson, 1989) are overlain by bedded breccias, which have been described as debris flows from a Nonda reef (ibid). Exposures of breccia forming the ridge top west of Mississippi Creek were briefly examined (Photo 4). The breccia consists of medium to dark grey, angular to subangular and subrounded tabular dolostone and “cobbles” of black chert in a grey dolomite cement. The coherence of the fragments suggest a good degree of induration in the host sediment. A discrete bed of breccia is sharply outlined against thin beds of cherty laminated dolostones and brown dolomitic siltstone above and below. Similar brown siltstones occur as clasts. The chert “cobbles” include some elongate pinch and swell shapes suggesting they may be disaggregated nodular beds. The writer noted dark reddish shale clasts, an uncommon lithotype in the Nonda. Nelson *et al.* (1999) noted well preserved fossil fragments of *Halysites*, *Favosites*.

Barnes *et al.* (1999) report that distinctive platform conodonts from the breccias appear to belong to the *Pterospathodus amorphognathoides* Zone, close to the base of the Wenlock. This conodont age is a little younger than the known age of the Nonda (Llandovery). The equivalence of these bedded breccias to the Nonda may need to be re-examined.

The total thickness of the Lower Silurian is reduced in the area where breccia overlies the basal Silurian shales (Thompson 1989, Figure 20). The reason for this is unclear. However the top of the breccia is overlain by Silurian Siltstone facies and the contact is an unconformity. This is further discussed below.

Marker Quartzite

The Silurian marker quartzite marks the top of the Nonda and base of the Muncho-McConnell Formation. Mapping in 1999 confirmed that it extends into the Robb Lake area. It was recognised below Mississippi ridge and in valleys on the south side of Sidenius Creek. At one location it appeared to be missing, represented by a dolomitic breccia with a sandy matrix.

This is the same unit mentioned by other workers in the Robb Lake area. It corresponds to the 60 foot thick quartzite band northeast of Mt. Kenny noted by Riddell (1972, section C-1-72). Thompson (1989, section 3, p. 117) shows a thick orthoquartzite (81 m) at the base of the Muncho-McConnell in the same area. Unit D of Mann (1981) is clearly the same unit.

The quartzite marker may be equivalent to sandstone beds at the base of the brown siltstone unit of Thompson (1989). The brown siltstone facies overlies the breccia facies mentioned above. The quartzite marker and the Silurian breccias may be related. Norford (1990) suggested the Nonda Formation was attenuated by erosion prior to the unconformity. The Silurian breccias may thus represent material that was eroded from subaerially exposed Nonda and carried into the basin, rather than representing debris flows from a reef front.

Thompson (1989) correlates his brown siltstone unit with the Silurian Siltstone facies (SD unit of Cecile and Norford 1979, p.224), also underlain by an unconformity. The base of the SD, brown siltstone, Silurian marker quartzite may represent the same unconformity or fall within a comparable interval of time (?Wenlock sea level low stand of Lenz, 1982). The base of the Muncho-McConnell is reported to be an erosional surface by Norford *et al.* (1966) downcutting eastward. MacIntyre (1998) has suggested the Middle Silurian siltstone facies in the Kechika Trough has its source in the erosion of the eastern portion of the MacDonald platform at this time.

Muncho-McConnell Formation

The Muncho-McConnell Formation consists of pale, fossil-poor, thick to medium bedded dololutites occasionally with discontinuous sand laminae and scattered quartz grains. It includes crinkly beds ascribed to algal mats and scattered quartz ascribed to aeolian sand. MacQueen and Thompson (1978) interpret the Muncho-McConnell as representing dolomitised, high salinity, lagoonal, intertidal, and supratidal carbonates with surfaces of dessication. The Muncho-McConnell thickens towards Robb Lake. It is on the order of 250 m thick near Mt. Helen and over 450 m at Robb Lake.

The Formation has been described in detail by others (*e.g.* Mann, 1981, Nelson *et al.,* 1999). In the Mt. McCusker area it is devoid of fossils. In the Robb Lake area large brachiopods are present which Taylor (1977) linked to the proximity of the Siluro-Devonian facies front. The Muncho-McConnell is replaced by the brown siltstone facies to the south between Robb Lake and Laurier Lake. This is postulated to represent an embayment (MacQueen and Thompson, 1978, p. 1741).

Breccia units within the Muncho-McConnell Formation are described separately under Economic Aspects.

Wokkpash Formation

The Wokkpash was recognised last year in western exposures in the footwall of the Gautschi thrust as a crossbedded dolomitic sandstone unit with scattered gastropods,. It was traceable for a km or so, 10 to 15 m thick, in apparent conformable contact with Muncho-McConnell beds underneath.

The Wokkpash is not a mappable unit on Bartle Ridge but reappears further to the east in a broad anticline in the Sikanni Chief River valley. Here several significant areas of massive quartzite outcrop. They are well jointed but bedding is difficult to discern. They are estimated to be at least thirty m thick. East of that structure Taylor and Mackenzie (1970, table II) measured 63 m (186 feet) in the Mt. Bertha structure.

The Wokkpash is locally mappable in the McCusker area. It represents at least two separate sand bodies.

Stone Formation

The Stone Formation consists of alternations of pale crystalline dolostone and tan dolostones similar to the Muncho-McConnell. The presence of paler (in some cases almost light blue-grey) crystalline dolomites is one of the few features that distinguish it from the more uniform Muncho-McConnell. Where the intervening Wokkpash sandstone is missing, the map contact between Muncho-McConnell and Stone Formations has a low confidence. The upper contact with the Dunedin is fairly sharp.

The Stone is relatively thick (100-150 m) in the broad arch at Sikanni Chief mapped this year. Further to the east at Mt. Bertha, Taylor and Mackenzie (1970) measured 140 m (459 feet). The Stone Formation thickens appreciably northward according to their regional isopach map (ibid.).

To the south Mann (1981) did not recognise the Stone as a mappable unit in the Robb Lake area and incorporated it with the upper member of the Muncho-McConnell. Nelson *et al.* (1999) recognised the facies locally. Thompson (1989, p.117, sections 3,4) noted the sand content of the Stone Formation increases toward the Halfway River. South of Robb Lake he mapped a dolomitic quartz sandstone unit (DqS) which is more or less equivalent to the Stone Formation..

Dunedin Formation

The Dunedin ranges from a few tens of metres to over 100m at Mt. Bertha; but averages 50 to 60 m in the area of study. The Dunedin tends to be poorly exposed and its contact with Besa River shale is often covered. Its continuity is uncertain; for example Thompson (1989) suggests the Dunedin is discontinuous along the edge of the Robb Lake anticline. It is clearly thicker and more continuous in the north part of the map area where new exposures were located in 1999.

The Dunedin is a complex facies spanning reef, shelf and offshelf environments. It includes reef boundstone facies with dark red argillaceous fill (well exposed at Mt. Helen), deeper water crinoid hash facies and sandy zones of uncertain origin. Throughout the area, the lower half of the Dunedin is often a grey, slightly fetid, fossiliferous dolomite with zebra texture and its contact with the Stone Formation is sharp. Its upper facies comprises dark biostromal limestone with abundant fossil debris including *Amphipora*, crinoids and bryozoa. Its contact with Besa River shale can be quite gradational over 10 m or more of dark calcareous shale. The gradational interval locally includes finely laminated, pyritic shale. Areas north of the map area have been subject to detailed study by Morrow (1978).

Tebbut (1970) first described sections from Mt. Helen, Mt. Bertha and Sheep Creek east of Robb Lake. A north to south trending reef front was postulated to lie near Mt. Helen and a thick shelf sequence further to the east at Mt. Bertha (ibid*.)*. Exposures mapped in 1999 around the periphery of an anticlinal arch between Mt. Helen and Mt. Bertha should assist in relating reef facies near Mt. Helen to the shelf at Mt. Bertha.

At Embree Creek the Dunedin is thinner and its fossil content is reduced. A basin re-entrant, postulated by Tebbut (1970), may be present south of Embree Creek. A deep shelf facies of argillaceous crinoidal deposits at Sheep Creek (Tebbut 1970; Thompson 1989), east of Robb Lake, is part of the postulated re-entrant.

Dunedin exposures were found by the writer at the northwest end of the Robb Lake anticline, in stratigraphic continuity with underlying Stone and Muncho-McConnell beds of the anticlinal limb and in the footwall of the Mississippi thrust.

To the south along strike there is a considerable thickness of shale in the footwall of the Mississippi thrust. Is this mostly basal Silurian (Road River) facies as postulated by Nelson *et al.* (1999) or Besa River shale as mapped by Thompson (1989)? Conodont samples at two levels collected by the writer may help clarify the age of calcareous shales and associated crinoid rich bioherms (Dunedin Formation?). Additional thrusts may be present in the tightly folded zone of shale and similar looking shales of varyimg age could easily be juxtaposed. The writer did not cross the stratigraphy further south at Webb ridge.

STRUCTURE

Thrusts

The trace of the McCusker thrust was followed in detail southward and its trace confirmed to coincide at the south end with the Sidenius thrust at Robb Lake. The thrust surface steepens to the west, both at Mt. McCusker and at Robb Lake. At Mt. McCusker the thrust flattens to the east, while at Robb Lake it undulates as a “folded” thrust. The footwall geology has two segments. The thrust appears to truncate the underlying Gautschi thrust at Sidenius ridge, the footwall to the Gautschi thrust then becomes the footwall to the McCusker (Sidenius) thrust. The probable explanation of these relationships is step faulting or ramping. Such step faulting is expected in a sequence of competent and incompetent units such as platformal dolomites with significant intervals of shale. A number of areas of fault rampin have been identified, one is well exposed below the arch of the Sidenius fault arch on the south side of Sidenius Creek (Photo 2).

Normal Faults

A few normal faults of minor displacement were noted in the northern part of the area (Legun, 1999).

The most significant normal fault lies in the south and it truncates the west limb of the Robb Lake anticline. It was mapped as a north-trending, normal fault by Thompson (1989) and the writer has extended its trace north and south via ground observations. The fault has more than one component as a fault wedge of Nonda is preserved against it. Displacement on the fault increases to the south and Dunedin is juxtaposed against Beaverfoot at one point. It appears to truncate the hangingwall Skoki beds of the Mississippi thrust in an area of incomplete exposure. On this basis the fault is mapped as displacing the thrust.

ECONOMIC ASPECTS

The McCusker map area lies along a trend of Mississippi Valley-type (MVT) showings and prospects at the platform edge of Siluro-Devonian rocks. The largest example is the Robb Lake deposit hosted in breccias of the Muncho-McConnell Formation near its shale-out to Silurian Siltstone facies. At Robb Lake the main breccia unit is near the junction of upper and lower members of the Muncho-McConnell, At least 200 m above the base of the Formation.

The Lad (Mt. McCusker) showing is associated with a stratiform breccia situated only about 70 m above the base (top of Silurian marker quartzite). The host Muncho-McConnell is not near any facies front at this location. The breccia is also not related to a nearby thrust as the breccia zone crudely maintains its position relative to the quartzite marker rather than the thrust. A second less well documented breccia near the Neil showing may represent the same stratiform zone as at Lad but on a separate thrust plate.

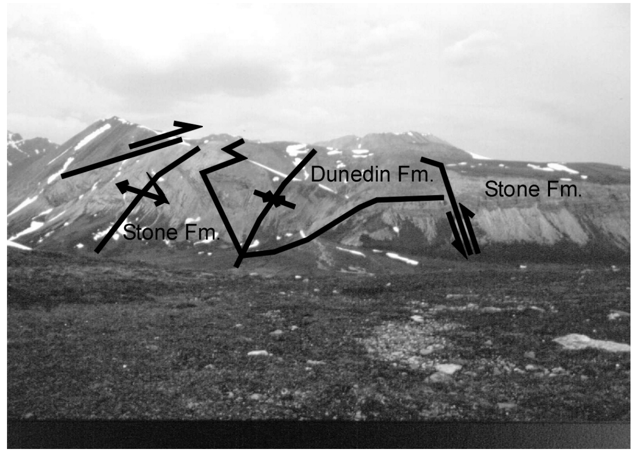

Photo 3. View north across Colledge Creek showing anticline syncline pair exposing Dunedin (dark) and Stone (light) Formations. To the right a normal fault cuts out the Dunedin Formation.


Photo 4. Bed of breccia sharply outlined against evenly bedded cherty dolostones. Photo taken at south end of ridge of Silurian breccia unit (Sbx) in figure 4.

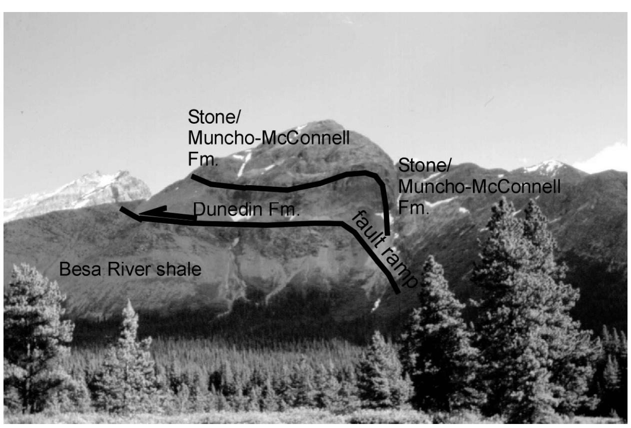

Photo 2. Looking north from Sikanni River along trace of fault ramp below overturned succession of Besa River shale, Dunedin Formation and undivided Stone/Muncho-McConnell Formations.

The Lad breccia has some general similarities to Robb Lake breccia (such as irregular vein-like masses with sub-rounded fragments in a crudely stratiform body), but the comminuted "trash breccias" are not apparent.

At Robb Lake no breccia is noted at the Lad and McNeil stratigraphic level. Mann (1981) described a local disconformity known as the ASM or angular sand marker, but at first assessment it appears to lie too high in the stratigraphic section to correlate with the Lad breccia.

A small area of "trash" breccia (after Nelson *et al.,* 1999) occurs within Stone and Dunedin Formations adjacent to the normal fault described in the Structure section. The breccia appears confined to the Stone and Dunedin and is probably cut by the fault. The outcrop may be worth a visit as it does not seem to have been noted previously.

East of the mapped area the Dunedin Formation is prospective for MVT deposits. Minor sphalerite bearing bands are described in Dunedin Formation at Mt. Bertha (Toll showing, Minfile 094G 015). To the north along the same anticlinal structure pods of calcite and barite with minor galena and sphalerite are found (Rb showing, Minfile 094G 004).

The writer suggests the basinal Siluro-Ordovician shales warrant some attention in the area. For that perspective it is necessary to jump west of the map area into the Ware sheet. In the Ware sheet within the Akie River area MacIntyre (1998) notes a few stratiform sedex prospects within basal Silurian units near the shelf margin. The Ern (Minfile 94F 001) is a stratabound sulphide zone in the basal Silurian section, immediately above Ordovician graptolitic black shales. It includes a sulphide bearing quartz breccia, stratiform zone of fine grained pyrite with a silica-barite matrix and minor sphalerite. The CT showing (Minfile 94F 010) is also found in basal Silurian beds interpreted to lie closer to the platform edge. It is essentially a bedded barite layer with zones of pyrite-sphalerite-barite.

Rocks of similar age and character extend to the Robb Lake area by way of marine embayments and re-entrants. A stratabound pyritic zone, associated with a quartzite, and marked by iron oxide seeps along the valley wall, occurs northwest of Robb Lake within the Beaverfoot (Figure 4). One prominent seep is at about UTM easting 450 000, UTM northing 6315700. The valley has not been sampled except at one corner. Four silt samples indicate raised lead (over 500 ppm) and zinc (over 1000 ppm) but disappointing trace metals. There has been no testing for barium. Reconnaissance geochemical sampling is warranted in these valleys.

In the same general area, some high values (4000 ppm zinc, 4000 ppm lead, up to 9 ppm silver and 175 ppm cadmium) are reported from rock and float in the general vicinity of the Nonda shale-out and the normal fault described above (Westoll and Sullivan, 1972). These results were apparently ignored in pursuing younger platformal dolostones. Conceivably the Nonda shale-out marks an old growth fault or is near a basin edge structure.

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