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WILLISTON LAKE SHALE-HOSTED LEAD-ZINC RECONNAISSANCE

Northern Rocky Mountains

N.T.S. 94F 94B 94C 930

C. Graf October 1978

SUMMARY

A geological exploration proposal, to search for shale-hosted Pb-Zn deposits in the Northern Rocky Mountains, was brought to Riocanex by the writer in the fall of 1977. An exploration programme was subsequently organized and funded by Riocanex and carried out by the writer in the summer of 1978. The targets were the lower Silurian to middle Devonian Road River shales, and the upper Devonian to lower Mississippian black clastic "Gunsteel" unit. Road River shales host important stratiform Pb-Zn deposits at Howard's Pass in the Yukon Territory, while Devono-Mississippian shales host stratiform Ba-Pb-Zn deposits at the Tom-Jason zone in the Yukon Territory, as well as at Driftpile Creek in northern B.C. Field work consisted of regional mapping, stream silt sampling and prospecting of the Road River and Devono-Mississippian black shale formations. Ten claims (WIL) were subsequently staked on Devono-Mississippian shales on a tributary of the Kwadacha River to cover an area geochemically anomalous in Zn and Cu. Twelve claims (PIE) were staked on Devono-Mississippian shales and Devonian limestone immediately to the south of the Paul River. These claims cover one galena showing in shale, one sphalerite-chalcopyrite showing in shale, three sphalerite showings in limestone, many areas of massive and nodular bedded barite, and a dozen Pb-anomalous silt sample sites. Seven claims (DOG) were staked on Devono-Mississippian shales north of the Akie River to cover an area moderately anomalous in Pb geochemistry. No Pb-Zn mineralization was found in the Road River rocks, and as a whole the formation appeared to be too thin, and to contain too high a proportion of limestone interbeds to be a particularly favourable host for Pb-Zn deposits. Two very significant deposits of Ba-Pb-Zn minsralization in Devono-Mississippian

shales have been staked by Cyprus Anvil Mining Corporation in this same area. These two deposits are 80 km along strike from the Driftpile Creek Ba-Pb-Zn deposit, making the entire district one of the most important yet discovered in the search for shale-hosted deposits in Western Canada.

This report describes the regional geology, geochemistry, topography, accessibility and mineral occurrences of the area investigated.

1. INTRODUCTION

Selwyn Basin shales in the Yukon Territory have attracted much Pb-Zn exploration in the past five or six years because at least two very important stratiform Pb-Zn deposits occur within them. These orebodies are the Howard's Pass Pb-Zn deposit in lower Silurian to middle Devonian Road River shales, and the Tom-Jason zone of Ba-Pb-Zn mineralization in an upper Devonian to lower Mississippian black clastic unit, locally called the Canol Formation. Previously the Selwyn Basin was thought to lie exclusively within the Yukon Territory, but mapping by the Geological Survey of Canada in 1976 showed it to continue southward into B.C., to the headwaters of the Ospika River. In 1977 geological exploration carried out in the Gataga Lakes section of this new extension to the Selwyn Basin was successful in extending the size of a previously discovered Ba-Pb-Zn deposit in Devono-Mississippian shales at Driftpile Creek. During the same period of exploration, a second important Devono-Mississippian Ba-Pb-Zn deposit was discovered approximately 80 km further south, in rocks previously mapped by the Geological Survey of Canada as Road River Formation. It was this set of claims, on incorrectly mapped shales, that led the writer to recommend that the Road River rocks in the Ware map area also be investigated for stratiform Pb-Zn deposits. The mapping error was seen immediately once the field season commenced, and the deposit definitely lies in Devono-Mississippian shales.

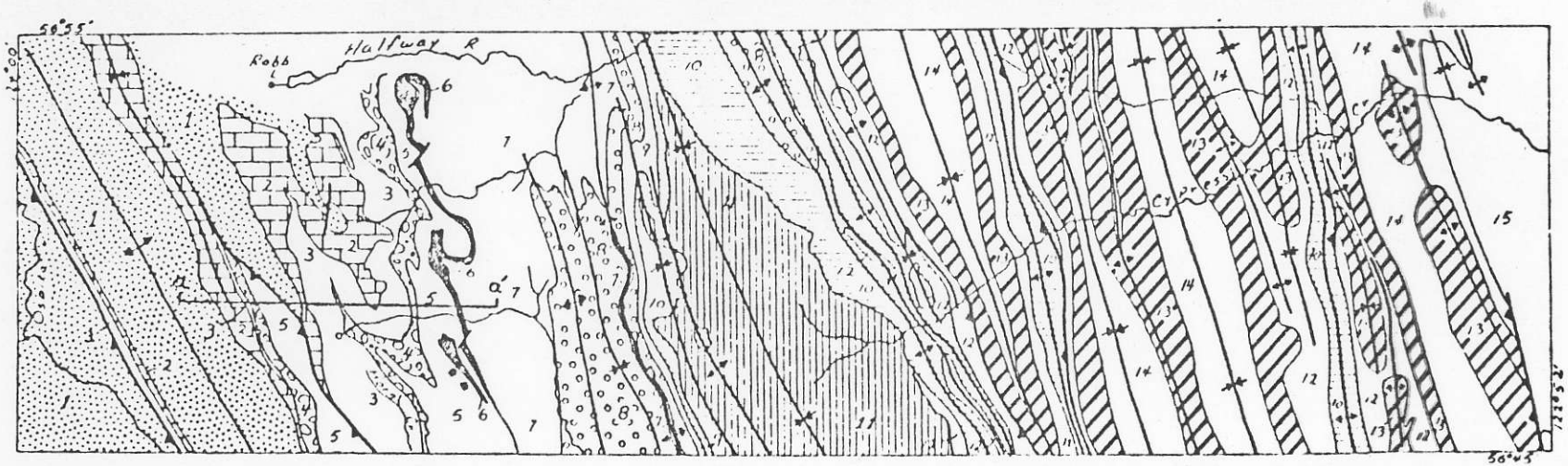
As far as could be determined, the 1977 flurry of exploration work on Devono-Mississippian shales, did not continue farther south than the Kwadacha River. The Ware east-half map area, immediately to the south, had not been mapped by the Geological Survey, but since the belt of Devono-Mississippian shales in Ware west-half continues as far as Kwadacha Park (DWG. L-8667) they were thought

likely to continue into and outcrop extensively within this unmapped area. If the Devono-Mississippian belt of shales did exist there, the chances of finding stratiform Ba-Pb-Zn deposits within them appeared to be very good. Road River shales outcrop quite extensively in Ware west-half and were thought to continue across Ware east half, to the upper reaches of the Ospika River in the Fort Grahame map area (DWG. L-6561).

Farther south, between Robb Lake and Lady Laurier Lake in the Halfway River area, a re-entrant of deeper water Silurian to middle Devonian shales and clastics into platformal carbonates has formed (Figure 1). The occurrence there of a variety of lithologies, including black shales, debris flow breccias and turbidites led the writer to propose that they be investigated for shale-hosted Pb-Zn deposits.

South of the Peace River, in the Pine Pass map area, a belt of Devono-Mississippian Besa River Formation shales over 100 km long has been mapped by the Geological Survey (Map 2). Because interbeds of chert pebble conglomerate and sandstone with descriptions similar to those in Ware west-half map area are mentioned the writer proposed that they also be investigated for shale hosted Pb-Zn deposits. The project was therefore divided into three separate sections or target areas, namely the Devono-Mississippian and Road River shales in the Ware map area, the clastic rocks within the re-entrant between Robb and Lady Laurier Lakes, and the belt of Besa River shales in the Pine Pass map area. By far, the Ware map sheet was found to be the most important of the three areas discussed above.

A project, proposed and supervised by the writer, was organized by Riocanex in 1978 to investigate the possibilities and ideas expressed above. The work, results and claims staked, within the Area of Interest shown in DWG. L-6561 are subject to an agreement between the writer (Graf) and Riocanex, dated 13 April 1978. Certain areas subsequently recommended also remain subject to the agreement.



10 Triassic Grayling and Toad Formations

9 Pennsylvanian-Permian Stoddart Group, Kindle Formation, Fantasque Formation

8 Mississippian Prophet Formation

7 Devonian Pinepoint and Besa River Formations

6 Devonian: massive dolomitic quartz sandstone

5 Silurian - Devonian: siltstone; calcareous siltstone, shale; quartzite, limestone

4 Silurian (? Ordovician): carbonaceous limestone, debris flow breccia; calcareous shale; shale

3 Ordovician (? Silurian): graptolitic shale, orthoquartzite, carbonaceous limestone

2 Ordovician (Skoki equivalent): medium crystalline dolomite with oncolite beds and bioturbated intervals

1 Ordovician Kechika Group

15 Cretaceous Fort St John Group

14 Cretaceous Bullhead Group

13 Jurassic Fernie Formation; Cretaceous Minnes Group

12 Triassic Liard, Charlie Lake, Baldonnel and Pardonet Formations

11 Triassic Ludditington Formation

0 5 10 miles

0 5 10 15 20 Kilometres

Figure 1. Northern part of Halfway River map-area (after Thompson, 1976).

Geological mapping defined two belts of Devono-Mississippian shales (DWG. G-8667). They were subsequently sampled for stream silts and prospected in moderate detail. The two belts of Devono-Mississippian shales converge northward until they become one belt in the vicinity of the Warneford River. The most westerly belt was missed by the Geological Survey in 1976, and was instead mapped as part of the Road River Formation. Road River Formation rocks outcrop immediately to the east and west of two belts of Devono-Mississippian shales, the whole being a broad belt of complex thrust faulting. In places Road River is thrust over Devono-Mississippian shales and vice-versa, and it often requires a trained eye to distinguish shale of one age from that of another. The western belt of Devono-Mississippian shales contains all of the known Ba-Pb-Zn mineralization discovered in Ware map area. Both of the important deposits discovered by Cyprus Anvil occur within it, as well as the showings and areas with anomalous lead in silts discovered and staked by Riocanex. The entire Road River Formation and the eastern belt of Devono-Mississippian shales are of a facies not likely to host stratiform Pb-Zn deposits. Both were probably deposited in a quiet environment close to or on the platform, and away from the zone of sub-basins, or hinge line, along which the deposits in the western belt were formed. No mineral showings nor anomalous Pb geochemical samples were found in the belts of shale occurring in the Halfway River or Pine Pass map areas to the south.

2. LOCATION AND ACCESS

The Area of Interest (DWG. L-6561) is a belt of the northern Rocky Mountains approximately 350 km long and 40 km wide, lying immediately south of Kwadacha Provincial Park, latitude 57°40'N. The N.T.S. divisions are 930, 94B, 94C and 94F. The Hart Highway cuts through the Besa River formation in the Pine Pass map area, but there are no branch roads to provide access up the side valleys, and consequently the area is almost inaccessible without helicopter support. The Halfway River and Ware map areas are in very remote sections of B.C., and all access is through float planes and helicopters. Northern Thunderbird Air has single Otter and Beaver float planes available for charter out of Mackenzie. Northern Mountain Helicopters have a Jet Ranger machine based in Mackenzie as well. All base camps in the remote areas must be located on lakes in order to ensure fixed wing support, unless a large quantity of fuel is flown in on skis during the early spring before the snow melts. The only two suitable lakes for float planes in the Ware map area are the Sikanni Chief Lake at the head of the Sikanni Chief and Akie Rivers, and Rainbow or Pretzel Lake, approximately 20 km southeast of Fort Ware. The ice will be suitably melted from these lakes by the end of the first week in June to allow float planes to land.

3. TOPOGRAPHY

The area is very mountainous, with elevations ranging between 2500 and 8000 ft. Generally the slopes are not overly steep, as much of the rock is moderately recessive shale. The valley bottoms are commonly covered with up to a hundred meters of glacial drift, and glacial lake deposits. Tree cover varies from very dense slide alder and scrub evergreen thickets on the slopes, to open, moss-covered mountain tops. In the valley bottoms the forest is usually quite open with randomly spaced spruce trees and moderate underbrush. Generally the bush is difficult owing to the slide alders and scrub evergreens on the slopes and in tight side valleys.

4. PREVIOUS WORK

a) The geology of Ware west-half map area was published as an Open File by the Geological Survey in 1976. Part of that mapping was incorrect, however, most belts of Road River and Devono-Mississippian shales have been accurately outlined.

b) A geological map of Ware east half map area has not been published at time of writing. However, a Geological Survey of Canada field crew was in the area during 1978 doing reconnaissance mapping, and an open file report is due during 1979.

c) The Halfway River map area has been remapped by Thompson 1977 (Figure 1), in which he shows that during Silurian and early Devonian time, a shale re-entrant into platform carbonates occurred between Robb and Lady Laurier Lakes. The entire map area has been extensively investigated for Mississippi-Valley type Pb-Zn deposits in Devonian carbonate rocks, and numerous have been discovered. The largest and best known of these is the Robb Lake deposit, which contains approximately 6 million tons of 6-8% combined Pb-Zn and is therefore subeconomic.

d) The Fort Grahame east half map area was geologically mapped by H. Gabrielse of the G.S.C. The results are contained in G.S.C. paper 75-33 and in G.S.C. map 2-1975 (Map 1). In the north-eastern corner of the map sheet he shows two belts of Road River age shale to occur. These rocks reportedly contain turbidites and submarine debris, flow breccias and were thought to be a good exploration bet. As far as is known, no previous exploration work has been carried out along these shale belts.

e) The Pine Pass area was mapped by the Geological Survey in 1961 (Map 2). Much of this map sheet, particularly the Devonian carbonates, has also been investigated for Mississippi-Valley type Pb-Zn deposits in the early 1970's but no economic occurrences were found. As far as is known, no previous investigations have been carried out in the Besa River shale.

f) Cyprus Anvil Mining Corporation and Aquitaine Company of Canada staked claims in the Ware map area in 1977. These claims cover ground likely underlain by Devono-Mississippian or Road River shales, but the amount of regional work they have done is thought to be minimal.

5. WORK BY RIOCANEX IN 1978

Three and a half months of field work was split into two separate parts, the first of which was an exploration of Devono-Mississippian-age Besa River shales in the Pine Pass area. The second part consisted of a similar investigation of Devono-Mississippian and Road River black shales in the Halfway River and Ware map areas. All of the work was done by helicopter. The Pine Pass and Halfway River areas had already been geologically mapped, so the work consisted simply of prospecting and stream silt sampling the desired belts of rocks. In the Ware area, it was necessary to map the units first, and then investigate them by prospecting and stream silt sampling.

The crew of eight persons consisted of one geologist, five geochemical samplers, one cook and one helicopter pilot supplied by Northern Mountain Helicopters. Work during the last half of May was conducted by helicopter from a motel base in Mackenzie. Two traverses were also made using a four wheel drive vehicle. From June 5th to August 30th, the base was moved to a tent camp on Sikanni Chief Lake in south-eastern Ware map area, from which transportation was solely by helicopter. Owing to success in the project, in that the area being investigated was found to contain highly prospective Devono-Mississippian shales, the entire project was re-budgeted and an extra month of field work and helicopter time was allotted. Work was finally completed on August 30th, 1978.

During the three and a half month long field programme, the Ware area was regionally mapped at 1:50,000 scale on topographic maps (DWG.'s GC-8668, 8670). A total of 3300 stream silt samples were taken, 2800 from Devono-Mississippian black clastic rocks, 150 from Besa River shales, and 350 from Road River shales. Three separate claim groups were staked on Devono-Mississippian stratigraphy te cover Pb-Zn-Cu showings and stream silt geochemistry. The WIL claims (136 units) were staked on the eastern belt of Devono-Mississippian shales (DWG. GC-8667) to cover an area of extremely anomalous Zn and moderately anomalous Cu stream silt samples. No sulphide showings were found on the property.

The PIE claims (135 units) were staked on the western belt of Devono-Mississippian shale and limestone, to cover a number of Ba-Pb-Zn-Cu showings and a number of Pb anomalous stream silt samples. No detailed work has been done on the property. The DOG claims (56 units) were staked to cover an area of moderate Pb geochemistry in stream silt samples. No showings have been found, and no detailed work has been done on the claims. Both the PIE and DOG claims lie in the same belt of Devono-Mississippian shales as the two important deposits staked by Cyprus Anvil. Cost of the project in 1978 was $230,000.

6. RESULTS OF 1978 FIELD PROGRAMME

6.1 Mapping

The most important part of the 1978 work, was recognizing, separating and mapping the Devono-Mississippian and Road River black shale units. The entire Ware area was regionally mapped, the results of which are shown in DWG. G-8667 at a scale of 1:500,000.

6.2 Geochemistry (DWG's GC-8668 - 8671)

None of the stream silt samples taken over Besa River shales was anomalous in Pb, Zn or Cu. Three stream silt samples taken over Road River-age shales were weakly anomalous in Pb. They have not been followed up by detailed work. Background values for Pb and Zn are 300 ppm and 35 ppm respectively in these Road River rocks. Devono-Mississippian shales contain many Zn anomalous silt samples, some which range as high as 40,000 ppm Zn. It has been concluded that the high zinc values in the silts are due to a high zinc background in the shale, and not to sphalerite mineralization, as none of the anomalies led to the discovery of sulphide mineralization upstream. Due to the erratic nature of the Zn geochemistry, it was deemed unreliable unless also accompanied by anomalous Pb values in the same area and preferably in the same sample. Background values for Pb were taken to be 35 ppm. The significance of Cu anomalies in these shales is yet to be determined; numerous anomalies do occur, but many are thought to be due to a nearby Silurian volcanic unit with a high Cu background. Background values for Cu were taken to be less than 50 ppm. To recapitulate: Pb geochemistry is the only reliable guide to locating sulphide deposits in these Devono-Mississippian black shales. Zinc geochemistry is misleading, unless used in conjunction with Pb geochemistry, and even then extreme caution must be exercised. The significance of Cu geochemistry is uncertain.

6.3 Mineral Showings

Two sulphide showings (now covered by the PIE claims) were discovered in the Devono-Mississippian shale. One of these is a vein or pod of coarse-grained, remobilized barite containing minor sphalerite and chalcopyrite. Boulders of this material, up to a half metre long, have been located as float in a small creek. A visual estimate of Zn and Cu content in the boulders is approximately 1%, however an assay of this material contained 11% Zn, 1.76% Pb and .19% Cu (Appendix II). The other showing occurs in the shale, but very close to the boundary with the underlying limestone. Mineralization consists of numereus pieces of fine grained galena scattered over a rusty gossanous area approximately 0.1 hectares in size. The galena appears to occur in a barite bed that on surface is extremely weathered, leaving only the galena recognizable. Bedded barite occurs extensively in the immediate vicinity. Although numerous trenches have been dug into the area containing the galena pieces, the source has not yet been definitely found. But as the showing occurs at the top of a rounded mountain, there is no doubt that the source for these galena fragments is local. Three assays made on these galena rich pieces averaged over 60% Pb, 0.5% Zn and only 2.09% oz Ag/ton (Appendix II).

Elsewhere, on the PIE claims, there are numerous outcroppings of massive and nodular bedded barite, in places up to three metres thick. None of these bedded barite occurrences has been found to contain sulphide mineralization.

Four showings of disseminated sphalerite, with no galena, occur in a middle Devonian limestone unit that directly underlies the Devono-Mississippian black shale sequence (DWG. G-8664). Three of these showings are within the boundaries of the PIE claims, while the fourth

lies just a few hundred meters outside. The largest of these mineralized areas is possibly a hundred meters long and up to three meters thick in one place. A visual estimate of zinc grade across the three meter interval is about 5%. All of the limestone-hosted showings are very similar in mode of mineralization, which is disseminated, in colour and grain size of the sphalerite crystals and in the total lack of galena or any evidence of open space development in the limestone.

Two claim groups staked by Cyprus Anvil cover significant deposits of bedded barite and pyrite which contain galena and sphalerite. Assay values from the CIRQUE claims range up to 26% combined Pb-Zn. Individual assays on the ELF claims reportedly run as high as 30% combined Pb-Zn (Roberts, pers. comm.), however an assay done by Riocanex reported only 5% Pb. Both properties are in an initial stage of exploration, with only a limited amount of trenching having been done, but as such, appear to be as promising pieces of ground as one could hope to find anywhere.

In addition, a deposit of bedded barite containing fine-grained galena and likely sphalerite, outcrops on the northeast side of Mt. Alcock, unfortunately within Kwadacha Provincial Park (DWG. G-8667). The barite bed is approximately 10 metres thick, and assays of up to 30% combined Pb-Zn have been reported from randomly picked hand-sized pieces of talus (Roberts, pers. comm.). Again, assays done by Riocanex contained only 5% Pb-Zn. Continuation of the barite horizon along strike has not been investigated because of its location within the Park.

7. GEOLOGY

7.1 Fort Ware Map Area (DWG. G-8667)

7.1.1 Cambrian and Hadrynian Geology

The oldest rocks in the map area are regionally metamorphosed Hadrynian age slates, schists and conglomerates of the Misinchinka Group. They outcrop in a continuous belt along the immediate east side of the Rocky Mountain Trench. These rocks are truncated northward by the Trench in the vicinity of Weissener Lake, but continue hundreds of kilometres southward, with few gaps, into Jasper Park. The next oldest rocks are quartzites, shales, conglomerates and limestones of the lower Cambrian Atan Group, which outcrop along the northern boundary of the Ware map area. A trend of unconnected middle Cambrian patch reefs stretches from the northwest corner of the map area, into its centre. These are essentially isolated knobs of limestone, roughly 500 metres long, 300 metres wide and 700 metres high, that are surrounded by younger Kechika Group shales. The above three groups of rocks were not studied in the field, and they have been mentioned here only to give a complete picture of the geology of the entire map area.

7.1.2 Ordovician Kechika Group

Kechika Group shales and shaly carbonates make up most of the Ordovician section in the Ware area. They underlie almost the entire eastern one third of the map area, and outcrop extensively in the remaining area to the east of the Trench as well. The Kechika Group facies in the eastern section are medium-bedded, shaly and silty, platformal-type carbonates, showing a well developed cleavage on a regional scale. West of the Ospika and Akie Rivers, these rocks have become thinly bedded, highly cleaved, whitish grey-weathering, limy, basinal shales, that have been described as muscovite schist. The transition from platformal to basinal facies takes place gradually over many kilometres. These rocks have no foreseeable economic potential.

7.1.3 Ordovician, Silurian, Devonian Road River Formation

Black graphitic Road River Formation shales and interbedded grey limestones outcrop in a 15 km wide belt from the northwestern to southeastern corners of the Ware west half map area. Their contact relations with the underlying Kechika Group rocks is uncertain, but is likely disconformable if not unconformable. Where observed, the rocks are composed of black graphitic shales and interbedded limestones roughly 150 metres thick. The limestone interbeds are over 3 metres thick near Chesterfield Lake in Kwadacha Park, but elsewhere are generally less than 1 metre thick. Thick beds of siliceous blue-grey-weathering quartzite and limy grey weathering quartzite up to 30 metres thick occur in the eastern part of the map area in the stratigraphic position normally occupied by black Road River shales. These rocks are interpreted as being eastern platformal time equivalent facies of the lower part of the Road River Formation. They may however, have formed prior to Road River deposition, and belong to an equivalent of the upper Ordovician Skoki Formation. All of the Road River rocks observed contained a significant proportion of limestone beds and appear to have been deposited in a transition zone between platformal and basinal environments. Sedimentary features such as turbidities, submarine debris flows and anomalous thickenings of the shales, which indicate favourable environments for deposition of stratiform Pb-Zn ore bodies, do not occur in these Road River rocks.

7.1.4 Silurian Siltstone Unit

Conformably overlying the Road River formation black shales, is a competent, siliceous, medium bedded, tan-weathering, pyritic siltstone unit between 25 and 100 metres thick. The distinctive light brown-weathering colour of these rocks and their uniform thickness and composition everywhere observed in the Ware map area, made it a very useful marker horizon. The importance of this unit as a marker bed is in the fact that it lies stratigraphically between the similar underlying black Road River shales and overlying black shales of Devono-Mississippian age. As such, it allows the two shales to be separated and accurately mapped in areas where they are intimately juxtaposed by thrust faulting, or where exposure is poor.

7.1.5 Devonian Limestone Unit

A highly fossiliferous, medium bedded, Devonian age limestone unit, over 300 metres thick, outcrops in a laterally restricted belt approximately 50 km long, between the Warneford and Akie Rivers. Its contact relations with the underlying Silurian siltstone unit and the overlying Devono-Mississippian shales are uncertain but possibly conformable. A notable feature of this unit is its complete absence elsewhere in the map area, where Devono-Mississippian shales lie directly on the Silurian siltstone. The occurrence of this isolated, shallow water, fossiliferous limestone unit is difficult to explain in a region dominated by deep water, basinal shale deposition since early Ordovician time. These rocks also lie tens of kilometres west of any time-equivalent platformal limestone rocks.

The interpretation made by the Geological Survey is that since none of the fossils are in growth position, the unit was deposited by submarine debris flows derived from a carbonate platform to the east. Yet there are no platformal limestones to the east which could have been the source for these debris flows. The Geological Survey solves this problem by assuming erosion to have removed all of the eastern limestone beds prior to deposition of the Devono-Mississippian shales. A strong counter argument against the theory or erosion lies in the fact that the Silurian siltstone unit exists to the east and shows no indication of having been eroded where observed. Both it and the underlying Road River Formation are of a consistent thickness for many kilometres to the east, precluding the possibility of significant erosion to have occurred there.

A more plausable theory for the origin of this limestone unit has been developed by the writer and is presented here. From DWG. G-8667 one can see that the limestone occurs only in the area between the two belts of Devono-Mississippian shales where they diverge from each other. It is proposed that during middle to late Devonian time, a zone of synsedimentary block-faulting developed within the shale basin forming a small elongate land area many kilometres west of the time-equivalent carbonate platform (DWG. G-7526). On this small land surface, an isolated "table" reef or series of table reefs grew, from which forereef or off-reef slump and debris-flow deposits formed during periods of renewed fault movement, or simply as a result of wave action. Deeper water prevailed both to the west and to the east, and two separate shale basins were formed. Abundant fossils show that the limestone is the same age as the lower part of the Devono-Mississippian shales. In Germany, a similar theory has been developed to explain the occurrence of the Devonian Meggen limestone reef at the edge of the Meggen shale trough, far removed from time equivalent platformal carbonate rocks (Figures 2 and 3).

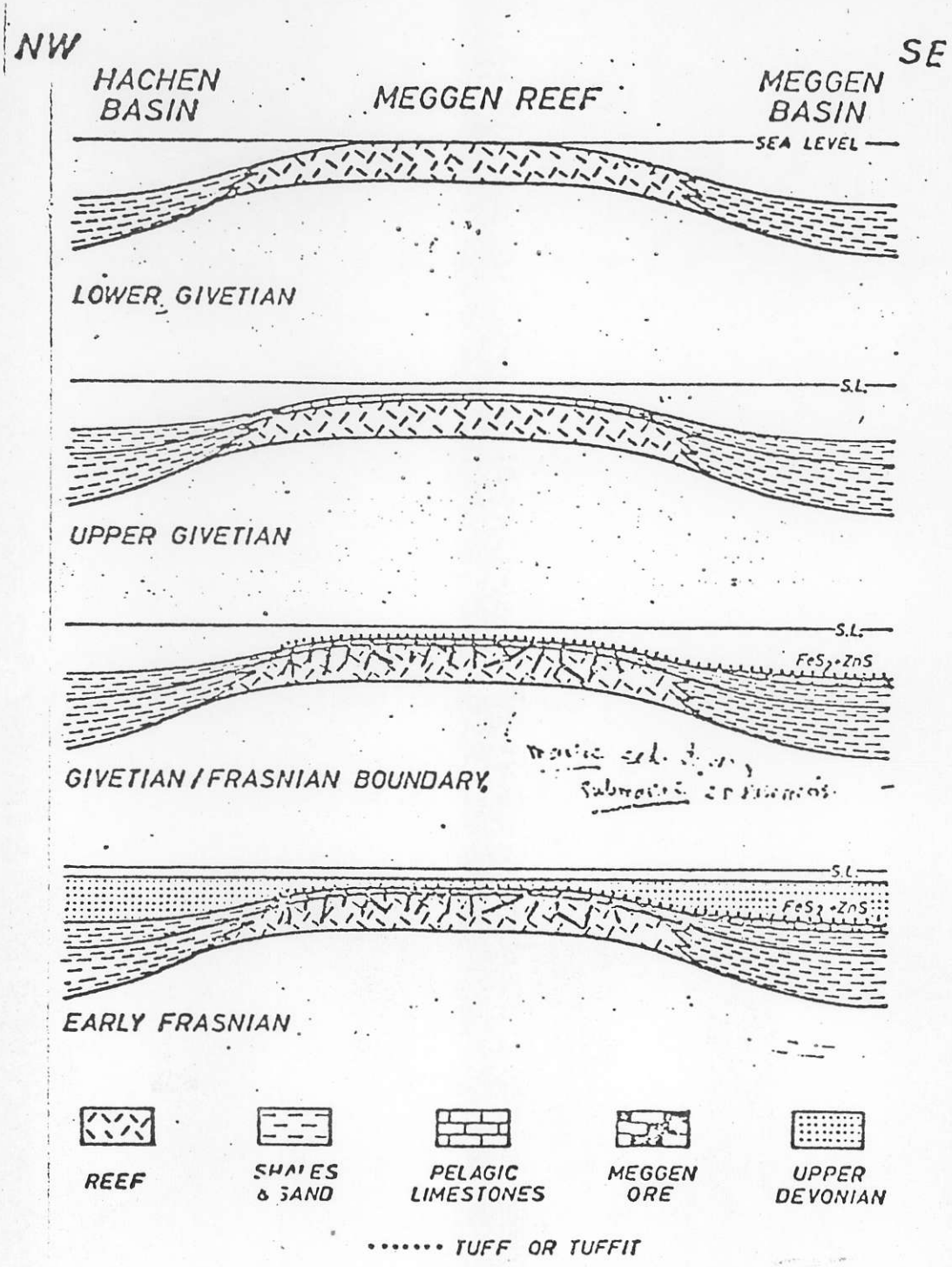


Figure 2. Paleogeographical development of the Meggen Reef from lower Givetian to early Frasnian (from Krebs, 1976).

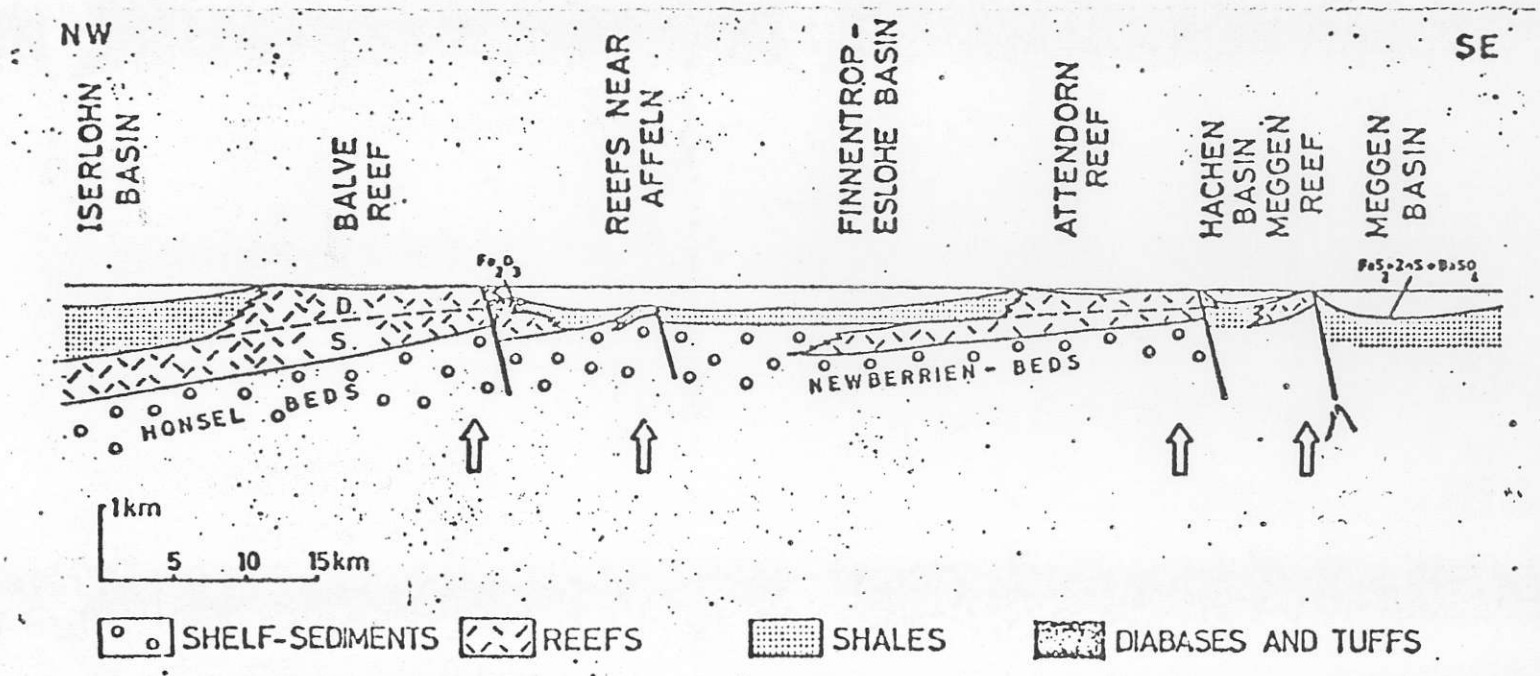


Figure 3. Vertically stretched cross section from the Iserlohn Basin to the Meggen Basin during the late Middle Devonian and early Upper Devonian showing synsedimentary block faulting (from Krebs, 1976).

7.1.6 Devono-Mississippian Black Clastic Belt

Rocks belonging to the Devono-Mississippian section outcrop as a continuous belt from the Ospika River valley, just north of latitude 57°00'N, to the head waters of Braid Creek, just north of latitude 58°15'N (DWG. G-7527). Total strike length of the belt is 385 km, and its maximum width is 25 km. Also shown in DWG. G-7527 are the locations of turbidite fans, mineral deposits, and the approximate edge of the original basin.

Rocks of this belt are composed of thinly laminated, silver-grey-weathering microturbidites, black pyritic shales, black pyritic cherty argillites, and siliceous chert arenites and chert pebble conglomerates. In addition, chemically-derived sediments such as thinly laminated black cherts and massive bedded and nodular barite commonly occur. In the Ware map area south of Kwadacha Park the most common facies are thin-bedded, rust-stained, black shales, while thick sections of chert arenites and chert pebble conglomerates occur as well in the belt north of the Park. At both the southern and northern ends of the belt the section thins and the rocks become silty and brownish weathering, and appear to have been deposited close to the north and south margins of the original basin. In addition there are very thin thrust slices of Devono-Mississsippian rock preserved approximately 3 km to the west of the western belt of shale. They, too, are of a brownish-weathering and silty facies, implying (assuming thrusting represents no significant eastward movement) that the original western boundary of the basin was only about 3 km west of the belt of Devono-Mississippian rock now exposed. We therefore have a fairly accurate picture of the positions of the original basin boundaries, and can show that they roughly fit the outline of the present outcrop belt (DWG. G-7527).

As a general statement, the entire Devono-Mississippian package can be separated into a lowermost division of flyschoid sedimentation and an upper division of thinly bedded black shales. The lower division varies from 75 m to 500 m thick and is composed of proximal and distal turbidite fan deposits. Two distinct facies can also be recognized within it, as the cores of the fans contain thick bedded chert arenites and chert pebble conglomerates, while the distal equivalents are thinly-bedded (5 mm) microturbidites of siliceous silt and shale. The turbidite fans were derived from an uplifted area to the west, and deposited as submarine landslides into apparently the deepest parts of a rapidly-subsiding, narrow fore-basin. The control to location of the fans is not clear. However they were possibly formed along deep, downdropped troughs that trended perpendicular to the basin. On the other hand, they could have been deposited directly offshore from the mouths of rivers which flowed on the uplifted source area to the west, and could have no relation to the internal structure of the basin itself. This implies that the source area was uplifted well above sea level, and is an implication that may be erroneous. Synsedimentary graben faults provided the mechanism by which the basin itself was downdropped. The eastern boundary roughly coincided with the margin of the earlier Road River basin, as did its southern and northern extremities. However the shallow water rock facies, preserved in the thin thrust slices further west, indicates that the Road River basin extended much further west than the narrow Devono-Mississippian basin. South of latitude 57°45'N the main basin divided into two narrower downdropped basins separated by an uplifted block which was partially subaerial and supported the growth of contemporaneous limestone reefs (DWG. G-7526).

The coarse material carried into the basin was quickly deposited as chert arenites and chert-pebble conglomerates, while the finer silt sized particles stayed in suspension much longer and were deposited often many tens of kilometres away. During the quiet intervals between successive submarine slides thin laminae of black shales were deposited on the silt layers resulting in the formation of thinly laminated siliceous microturbidites, which simply reflect the alternations between silt and shale deposition. Coincident, at least, with the later stages of this flyschoid sedimentation was the growth of table reefs on the uplifted block between the two parallel downdropped basins, south of latitude 57°45' (DWG. G-7526).

Extensive lateral deposition of nodular and massive bedded barite took place during the period immediately following the cessation of flyschoid sedimentation and, in at least four places, significant deposits of Pb and Zn sulphides were formed as well (DWG. G-7526). The Driftpile Creek deposit is located in a topographic low between the two submarine fans, likely near a syn-sedimentary graben fault zone. The Mount Alcock, CIRQUE and ELF deposits all occur in the narrow western basin, close to the limestone reef and to the fault zone upon which it grew. Much of the limestone unit is composed of debris flows, which implies that the fault was very active during the time the reef was growing, thereby constantly causing parts of it to break off and slide into deeper water to the west. This fault or fault zone could have provided a channelway for the mineralizing solutions which formed the sulphide deposits. Evidence that the sulphide deposits formed in topographic depressions on the sea floor adjacent to this fault zone has not been found, but is likely the case. A distinct analogy can be made between the geological setting of the CIRQUE deposit, and the Meggen deposit in Germany (Figure 2). Both occur along the outer flanks of limestone reefs, which formed away out in the shale basins along uplifted fault blocks (Figure 3). The shale basins in both cases occur in flanking depressions that were formed by similar processes of syn-sedimentary graben faulting.

Following the period of barite and sulphide deposition, the basin continued to slowly subside and eventually over 500 m of black pyritic shale was deposited. The limestone reef itself became buried under a thick section of black shale. No further flyschoid sedimentation or other mineralized horizons have been recorded. It was simply a long quiet period during which the basin became slowly filled with fine black material.

The most conspicuous and diagnostic features of this entire unit are the blood red iron springs and large areas of ferricrete and limonite gossans up to an acre in area and five metres thick, that commonly occur within it. Such gossans and iron rich springs are found only in Devono-Mississippian shales, and are a great aid to distinguishing them from otherwise similar-appearing black Road River shales. A second feature peculiar to this unit is the occurrence of sedimentary bedded barite and nodular baritic shales. The origin of the barite is poorly understood, but it is definitely a sedimentary rock that formed as a chemical sediment on the sea floor. A third feature, diagnostic of this unit is the silvery-weathering, gunsteel colour of the micro-turbidites on ridge tops above tree line. This is due to surface coatings of silica on small fragments of the lower microturbidite division, and gives the rock the informal name "Gunsteel" unit. The colour was as useful an aid to mapping as were the gossans.

7.2 Fort Grahame Map Area (DWG. GC-8674 and Map 1)

7.2.1 Road River Formation (Ordovician to Devonian)

The Fort Grahame area east of the Rocky Mountain Trench was mapped by Gabrielse in 1975 (map 2-1975) and described and published in G.S.C. paper 75-33 (Map 1). In the extreme northeast corner of the map area he shows three belts of Road River age rocks composed of shales, siltstones, argillaceous limestones, limestones and quartzite breccias. Gabrielse has divided the assemblage into three divisions as follows:

"1. A basal unit of platy, dark grey to grey, locally wine-mottled and cherty, limestone contains *Maclurites sp., in places interbedded with black, graptolitic shale.

2. A middle, tan weathering, very platy, thin bedded and laminated dark grey siltstone unit is of early to middle Silurian age. Within the siltstone sequence are rare lenses of breccia from 5 to 6 feet thick; where examined these contain fragments of light grey dolomite and sandy dolomite up to more than 6 inches long. Locally, overlying a breccia unit is about 2 feet of very fine grained pure quartzitic sandstone.

3. An upper dark weathering unit includes beds of Lower Devonian crinoidal limestone, argillaceous and cherty limestone, and black, graptolitic shale."

The predominance of black graptolitic shale in divisions 1 and 3 above, and the descriptions of debris flow deposits in division 2, formed the basis for the exploration of these rocks, as the environment of deposition is grossly similar to areas where shale hosted Pb-Zn deposits occur. Upon field examination however, the predominance of interbedded limestones indicates that the beds were deposited in a platformal environment. Black shale facies are not well developed and nowhere attain a

*Maclurites is a gastropod.

thickness greater than 150 metres. In places the shales are very pyritic, the only positive feature observed during field examination of these rocks.

The Silurian siltstone unit which comprises Division 2 is the same unit as the Silurian siltstone unit described in the Ware map area.

7.2.2 Devono-Mississippian Black Clastic Belt

In G.S.C. paper 75-33 and in Map 1 Gabrielse has mapped a narrow belt of lower Devonian strata along the northeast side of the Ospika River. He describes three lithologies in the belt; black graptolitic slate and shale, coarse-grained crinoidal limestone, and very pure, fine grained, dark grey, quartzitic sandstone. Graptolites in the shale indicate an early Devonian age.

Shales in this belt are slightly silvery-brown weathering, contain a number of weak gossans, and are directly on strike with the western belt of Devono-Mississippian shale in the Ware map area. It is therefore concluded that the bulk of the shale mapped as lower Devonian is in fact Devono-Mississippian in age. Where observed they did not attain a thickness greater than 150 metres, and are very faded and more brownish than silvery weathering. It is thought that they represent the southern extremity of the basin in which the Devono-Mississippian belt of rocks were deposited. The basin here was relatively shallow, and the shale deposited is of a more silty and dirty facies than in areas to the north where sulphide mineralization took place. The facies is similar to the eastern belt of Devono-Mississippian shale south of the Kwadacha River, which is also more silty and brownish-weathering.

7.3 Halfway River Map Area (DWG. GC-8674 and Figure 1)

A revision of the Halfway River map area has recently been completed by Thompson, but the information can only be obtained through personal communication at the present time. A small map and an accompanying brief report has been published in G.S.C. Paper 76-1A pp 471-477.

The most interesting aspect of Thompson's work is his recognition, mapping and description of a shale re-entrant into platformal carbonate rocks between Lady Laurier and Robb Lakes. He has mapped three units of Ordovician, Silurian and Devonian ages, that are of interest and will be described below.

1. Ordovician (and Silurian?) graptolitic shales interbedded with cross bedded orthoquartzites. These turbidites are underlain by carbonaceous limestones.
2. Silurian carbonaceous limestone, siltstone and shale interbedded with and overlain by debris flow breccias.
3. Silurian and Devonian siltstone, graptolitic siltstone and limestone and limestone with chert nodules and beds.

The predominance of graptolitic shales, siltstones, turbidites and debris flow breccias in the above rocks, led to their being an exploration target for shale-hosted Pb-Zn deposits. Unfortunately time did not allow the writer to observe these rocks in the field, but stream silts were sampled with no encouragement. It is likely that the Silurian or Devonian age crinoidal limestone is the same unit as the Silurian siltstone unit in Fort Grahame and Ware map areas, and that all three units belong to the Road River formation.

No other rocks were investigated in this map area.

7.4 Pine Pass Map Area (Map 2 and DWG.'s GC-8672,8673)

The Pine Pass area was mapped by the G.S.C. in 1961 and a belt of Devono-Mississippian calcareous shale and siltstone was shown to outcrop from approximately the centre of the map to its southeastern corner. Within this belt of shale, a clastic unit of Jurassic or possibly Cretaceous age was also mapped. The lithologies of this clastic unit included shale , greywacke, argillite, chert-pebble conglomerate and ironstone which are very similar to the lithologies found in the Devono-Mississippian belt of the Ware map area. Due to the above similarities, and the fact that these rocks occur in a very complicated thrust fault structure far to the west of any other outcrops of Cretaceous age rock, they were though to be possibly of Devono-Mississippian age. A discussion with J.E. Muller of the G.S.C. confirmed that the Cretaceous age assigned to these rocks was wrong, and that more recent fossil evidence indicates that they belong to the Devono-Mississippian package. The entire belt of rocks subsequently became an exploration target, based on the similarities in age and lithology with the productive belt in the Ware map area.

The writer's observations of this unit confirmed that the clastic rocks belong in the Devono-Mississippian shale, and that turbidites are common in most sections. Flute casts, sole markings and cross bedding indicate a source area to the northwest. Individual turbidite units average 30 cm thick, and often contain at least 3 of the 4 cycles described by Bouma in his descriptions of the internal structure of turbidites. The thickness of this unit is uncertain because of thrust faulting, but is over 700 metres thick. The coarse turbidite units often contain pyrite concretions the size of golf balls, but the shales are not pyritic.

Although these rocks contain similar lithologies to the Devono-Mississippian belt in the Ware map area, they differ when examined in detail. The main differences are that these shales are non-siliceous and therefore not silvery-grey weathering, they lack gossanous springs, and do not contain bedded barite, or sulphide deposits. The two environments of deposition were therefore quite different, and the Pine Pass shales belong to the Besa River Formation, and seem likely to be a more eastward time-equivalent facies of the Devono-Mississippian "Gunsteel" formation. Similar Besa River shales continue southward into Jasper Park, and northward into the Yukon Territory.

8. CLAIM GROUPS

8.1 PIE Claims (DWG. G-8664)

The PIE claims (13 claims, 135 units) were staked to cover a galena showing and a barite-chalcopyrite-sphalerite showing in Devono-Mississippian shale, three disseminated sphalerite showings in middle Devonian limestone, and a number of Pb anomalous stream silt sample locations. The claims adjoin Cyprus Anvil's CIRQUE group on the northwest and their FLUKE group to the southeast. The CIRQUE claims cover very interesting bedded Ba-Py-Pb-Zn mineralization. The FLUKE claims cover a weak to moderate stream silt Pb anomaly and some weak galena-pyrite mineralization.

The two shale hosted sulphide showings labelled P_4 and P_5 are considered the most important on the property (DWG. G-8664). The most encouraging is the P_4 showing, which consists of pieces of galena float lying on the surface in a gossanous area approximately 0.2 ha in size. Individual pieces vary up to 40 cm across by 10 cm thick, and grade up to 65% Pb and 0.75% Zn. Hand trenching was inconclusive due to extensive oxidation of the mineralized zone, however it is certain that the mineralization occurs in place within the gossan. The only recognizable mineral in the sulphide-bearing samples is galena, but much of the rock is composed of very fine-grained, soft, black material. The pieces are very sooty, due either to graphite or manganese oxides, and they smell strongly of sulphides. The maximum observed thickness of the mineralized zone in one hand trench was 50 cm.

An intriguing feature of this showing is that it occurs only a few metres above the shale-limestone contact and it was difficult to determine which unit was the host. Hand trenching indicated that the mineralization was in fact shale-hosted, as did its fine-grained and banded appearance. A thrust fault may be responsible for bringing the galena mineralization onto the limestone from its original position to the west. If this is true, then a possibility exists for a larger orebody to lie buried within the shale to the west. The shale units immediately to the west have a very steep westerly dip, which conforms to the above hypothesis.

The P_5 showing outcrops in a narrow gully approximately 250 metres west of the P_4 showing. It consists of coarse-grained remobilized barite, with minor sphalerite and chalcopyrite, in boulders up to 70 cm long. Little zinc or copper is visible yet an assay on a piece showed it to contain 11.2% Zn, 1.70% Pb and .19% Cu. The barite occurs as a pod or vein that is over 100 metres long, and of unknown thickness. The significance of this showing is that it may have been remobilized from a larger barite-sulphide body at depth. This is the only occurrence of shale-hosted barite-copper mineralization observed during the field season.

Limestene-hosted sphalerite showings labelled P_1, P_2 and P_3 are located on DWG. G-8664. All three showings are very similar in mode of mineralization, colour of sphalerite, and grade. The sphalerite is a rusty-brown colour and occurs as disseminated grains approximately 1 mm across in patches less than 3 metres long. The mineralized areas do not appear to be fracture controlled, and as a rule have longer horizontal than vertical dimensions. Due to the similar nature of the three showings it will only be necessary to discuss the largest (P_3) showing here. This showing was discovered after finding pieces of sphalerite-containing limestone talus approximately 30 to 50 cm across aleng the side of a creek valley. Many fist sized pieces are estimated to contain approximately 10% Zn, but no Pb. The mineralized source area was easily located upslope, and covers an area approximately 3 metres long by 2 metres thick. Outcrop is obscured on all four sides by overburden, moss and brush, so the mineralization is probably more extensive than observed. On strike, approximately 75 metres north, similar mineralization occurs on a small cliff face. The mineralized area is about 30 metres long, 1 metre thick, and contains roughly 3% to 10% Zn. Much coarse grained calcite influx occurs below the sphalerite mineralization

as well, and is definitely related although no sphalerite was observed in the calcite itself. It is thought that the two occurrences are actually continuations of the same zone of mineralization, which would make the showing over 100 metres long. The south part of the showing occurs approximately 25 metres east of the shale-limestone contact, which is likely a minor thrust fault. The mineralization does not appear to be fracture-controlled as its lateral dimension is much greather than its thickness and there is no evidence of veining. Controls of mineralization for these limestone-hosted showings are not understood, and the only possible affinity they have to the Mississippi Valley type model is the occurrence of calcite influx below the northern part of the P_3 showing. None of these showings is exciting in itself. Interest remains only because they indicate that sulphide mineralization is concentrated on the claims, whereas for many tens of kilometres along strike the limestone is barren. Other showings of this type are likely: the limestone was not thoroughly prospected because the target for exploration was the adjacent Devono-Mississippian shale. It is hoped that the limestone-hosted showings are genetically related to some yet undiscovered mineralization in the shale. Alternatively there is also a possibility of finding a significant zinc orebody within the limestone itself, as many more showings will be found during detailed property work in the ensuing years, and their controls will be better understood.

Many occurrences of massive and nodular bedded barite outcrop on the property, especially in the vicinity of the P_3, P_4 and P_5 showings. The main locations are shown on DWG. G-8664. A barite horizon connects the P_4 showing with a similar gossan (P_6) approximately 400 metres north. The only sulphide observed was pyrite, but a soil sample taken there was highly anomalous in Pb.

A number of Pb-anomalous stream silt samples occur on the property, but have not led to the discovery of any sulphide showings (DWG. G-8664). The most significant anomalies are located along the limestone-shale contact on the eastern fringe of the PIE 2 claim. The two main anomalies are located on springs, which made it impossible to locate their metal sources. As the anomalies occur in an area of overburden, close to the shale-limestone contact, it was not even possible to determine which rock is the host. There is little doubt however that galena mineralization is responsible for the high Pb values, as one of the streams is over 150 cm wide. No detailed prospecting or soil geochemistry has been done on the property.

8.2 DOG Claims

The DOG claims (7 claims, 56 units) were staked to cover an area of Devono-Mississippian shales, moderately anomalous in Pb silt geochemistry. The anomaly is approximately 2 km long, and as yet no sulphide showings have been found. The claims adjoin Cyprus Anvil's FLUKE group to the north, and their ELF group to the south, both of which have moderate Pb silt geochemical anomalies and contain galena mineralization. No detailed prospecting or soil geochemistry has been done on the property.

8.3 WIL Claims (DWG. GC-8663)

The WIL claims were staked on the eastern belt of Devono- Mississippian shales to cover an area anomalous in Zn and Cu silt geochemistry. No Pb anomalies were found in the silt sampling programme and similarly no Pb-Zn sulphide showings were discovered. A 10 km long baseline was laid out along the property and soil lines, spaced at 1 km intervals, were run perpendicular to it. Soil samples were taken along these lines at 100 metre intervals. The results of this survey were not encouraging as only one sample out of 173 collected was anomalous in Pb. No occurrences of bedded barite were found. The property does not appear to warrant further work.

9. STRUCTURAL GEOLOGY

Thrust faults are the dominant tectonic elements of the Ware map area. Much of the western Road River and Devono-Mississippian belt is cut into thin slices that have been stacked onto each other, and in some places the section is repeated six times within a horizontal distance of 3 km. Most of the faults appear to have small lateral displacements, in the order of 50 m to perhaps 1 km. The dip of the fault surfaces vary drastically along strike. For example in one exposure a thrust fault dips to the south-west at roughly 20°, while at a second exposure, less than 500 m north, it dips at 60° SW. Such variance in the dips of the faults will make the search for blind orebodies very difficult. Presumably the minor thrusts are splays off a sole thrust of much larger displacement, a possibility that was not investigated during the summer's work.

From the PIE claims southwards (DWG. G-8667) the western boundary of the western Devono-Mississippian belt is always a thrust fault. As was previously noted, the dip of this fault varies significantly along strike. As well, the hanging wall rocks vary from the Silurian siltstone unit between the Kwadacha and Akie Rivers, to the Kechika group shales south of the Akie River. It is likely that the fault displacement is much greater where the Kechika group rocks are involved.

North of the PIE claims (DWG. G-8667) Devono-Mississippian shales outcrop in two separate thrust-faulted belts approximately 700 m apart. Many small displacement thrusts (50 m) also occur and can be observed in the cirque above Cyprus Anvil's large gossan showing. These two thrust slices of Devono-Mississippian shale can be followed continuously from the CIRQUE claims to the Kwadacha River, however south of the CIRQUE claims only one belt occurs, and in 1978 the thrusts were not traced southwards (see DWG. G-8667). It seems that either a number of thrust faults converge along strike, or that some of the faults cut rapidly downward to lower strati-

graphic levels there, cutting out certain units and causing others to appear. The key to finding more orebodies within the western belt lies in a thorough understanding of the thrust faults, with particular regard to their dips, and apparent convergence or downcutting along strike.

The eastern belt of Devono-Mississippian rock lies in a thrust-faulted, north-plunging synclinorium - according to G.S.C. geologists. South of the Akie River (DWG. G-8667) a remnant of Road River shale caps a mountain in a small syncline. Immediately north of the river, but on strike, the same syncline occurs, also containing Road River shale. This north-plunging syncline can be traced right across the entire Ware map area. A few kilometres north of the Akie River, the first traces of Devono-Mississippian shales are found. Along strike, these rocks thicken from a few metres at the south end, to over 500 m at the Kwadacha River. Belts of Road River shales outcrop to the east and west of the Devono-Mississippian shale, in keeping with the synclinorium structure. Both contacts are thrust faults, and it is difficult to picture a synclinal fold. North of the Kwadacha River, upper Triassic black shales outcrop within the Devono-Mississippian belt, which is in keeping with the northerly plunge of the postulated synclinorium in that progressively younger rocks form its core along strike to the north. It is the writer's belief that the synclinal nature of the belt stems from a moderate amount of Laramide deformation being superimposed on a graben-like down-dropped basin filled with Devono-Mississippian shale. The belt presumably had the form of a trough before the Laramide Orogeny. This served to fold the belt and subjected its margins to thrust faulting. The writer therefore, does not agree with the concept of a synclinorium as proposed by the G.S.C.

The shale basin deepened to the north giving rise to progressively thicker sections of Devono-Mississippian in that direction (DWG. G-7526). Depressions which still remained were filled with upper Triassic shales at a much later time. Compression of this belt during the Laramide led to the development of thrust faults along previously formed lines of weakness and along the western boundary of the basin.

In summary, the writer does not believe that the belt is a remnant of a once much broader area of Devono-Mississippian shales that has been preserved from erosion as a down-folded syncline. Rather, it is thought that the present outcrop area of the eastern Devono-Mississippian belt is close to the boundaries of the original basin in which the shales were deposited, and that the apparent synclinal structure is a cursory effect of Laramide compression being superimposed on an already down-dropped narrow basin.

10. GEOCHEMISTRY

The geochemical results from the Pine Pass, Halfway River and Fort Grahame map areas were discouraging, and will not be discussed further here. Sample locations are shown on DWG.'s GC-8672, 8673, 8668, 8670.

10.1 Lead Geochemistry, Devono-Mississippian Shales

Lead geochemistry is by far the most reliable and accurate guide to locating sulphide deposits in the Devono-Mississippian shales: its background value is low, and it does not become concentrated during secondary dispersion. In general, where there is a high Pb stream silt anomaly, it is due to the presence of galena.

The background value was taken to be 35 ppm Pb. At this level only 100 samples were anomalous out of 2800 collected. Only 15 samples contained over 100 ppm Pb, with the highest being 20,500 ppm. In general anomalous values lay between 40 and 80 ppm.

Almost all of the anomalous values are located in the western shale belt, along a strike distance of 40 kilometres between the ELF deposit in the south to the CIRQUE deposit in the north (DWG.'s GC-8671). All of this belt is currently staked either by Cyprus Anvil or Riocanex.

A weakly anomalous area occurs just north of the CIRQUE deposit, on ground now staked as the YULE claims. Although the values are low, the area is considered highly favourable due to the fact that it is on strike with the CIRQUE deposit. A blind orebody could lie at depth here, hidden because of thrust faulting. Again the importance of unravelling the thrust fault picture is apparent. Further north at Mount Alcock an area of anomalous lead in silts is associated with galena-barite mineralization. However this falls within Kwadacha Park and is therefore not open ground.

The galena mineralization observed on the CIRQUE and ELF claim blocks is reflected well by the Pb values in stream silts. The Pb values range up to 300 or 400 ppm, which is much higher than values obtained in the area between them. Whether the anomalous belt in between is as significant or not, will be determined by detailed work in the next few years.

10.2 Copper in the Devonian-Mississippian Shales

Copper geochemistry was not found to be a reliable guide to locating mineralization within the Devonian-Missippian shales. Many anomalies that are likely to be related to a copper-anomalous Ordovician volcanic unit occur both in the eastern and western belts. Nevertheless, many samples taken on the CIRQUE claims that are highly anomalous in Pb, are also anomalous in Cu. The sulphide mineralization therefore contains copper, and as such could be used effectively in conjunction with detailed geologic maps, in order to screen out the possible effects of adjacent units with high background copper values.

The background value for Cu was taken to be 50 ppm. This led to 300 anomalous samples out of 2800 collected. Values ranged up to 400 ppm. So far no attempts have been made to separate the samples that are anomalous due to the high Cu background of the volcanic unit from those due to concentrations within the shale itself.

10.3 Zinc in Devono-Mississippian Shales

Zinc geochemistry was found to be a very unreliable guide to locating mineralization. The background zinc values vary from place to place, but are in general very high, especially in the eastern belt, and in the western belt south of the ELF claims, where the basins begin to disappear. To show the unreliability of Zn geochemistry, the Zn values of stream silts adjacent to 12% Zn ore on the CIRQUE claims are no higher than 6000 ppm, while numerous samples from creeks draining unmineralized shales contain over 10,000 ppm Zn, some have as much as 30,000 ppm Zn.

Accordingly, anomalous zinc values were not plotted. Zinc results may be obtained from the sample locations maps, and the laboratory reports in Appendix I.

11. CONCLUSIONS

The entire Devono-Mississippian belt of black clastic rocks can be described as one of the most exciting and productive areas yet investigated in the search for shale-hosted Pb-Zn deposits in western Canada. The CIRQUE and Driftpile Creek deposits are two of the most promising properties of this type recently discovered, and will quite likely become producers if their remote locations do not affect their economic aspects too adversely. The possibilities of locating blind orebodies along strike in the belt are good. Regional exploration should now focus on developing a detailed understanding of the stratigraphy and thrust faulting, particularly along strike from the known deposits.

11.1 PIE Claims

The PIE claims are promising because they contain some encouraging fine-grained and banded galena mineralization and much bedded barite and because they are roughly on strike with the CIRQUE deposit. The significance of the numerous limestone-hosted sphalerite showings is that they may be related to unrecognized sulphide mineralization in the adjacent shales. There is however, a slim possibility, which should be investigated in 1979, of the limestone becoming a target for Mississippi Valley type mineralization.

11.2 DOG Claims

The significance of the moderately anomalous lead values in stream silts on the DOG claims is not understood. Prospecting along the anomalous creeks failed to turn up any sulphide showings. The shales however, are cherty in places, and contain at least one barite-pyrite zone, and perhaps also a minor amount of disseminated galena. The only possibility of finding an orebody here is in the hope that the weakly mineralized zone or bed exposed at surface will turn to ore grade material at depth. It is directly on strike between the ELF and FLUKE groups, both of which contain interesting galena mineralization of as yet uncertain significance.

11.3 WIL Claims

No bedded barite or sulphide occurrences have been found on the WIL claims, and similarly none of the silt samples taken were anomalous in Pb geochemistry. A large number of Zn and Cu silt sample anomalies do occur. However they are due to high background values either in an adjacent Cu-rich volcanic unit or in the shale itself. The rocks themselves are of a facies which indicates they were deposited close to the shallowing margin of the basin, an area not favourable for the deposition of Pb-Zn sulphide bodies. It is therefore concluded that the WIL claims hold no potential to contain Ba-Pb-Zn deposits.

11.4 Ground North of the CIRQUE Deposit (Now Staked As The YULE Claims)

Between the CIRQUE and Mt. Alcock (Kwadacha Park) Ba-Pb-Zn occurrences, there are 25 km of unstaked ground which contain two continuous thrust faulted belts of Devono-Mississippian shale. A weak Pb geochemical anomaly occurs in this area, just north of the CIRQUE property, which may be as significant as the anomaly covered by the DOG claims. To the writer, there is a distinct possibility that a sulphide deposit not exposed at surface due to the geometry of the thrust faults could be located here. To study the possibility satisfactorily, one would have to walk out the stratigraphy and trace the thrust faults from the CIRQUE deposit into this area to the north. The thrust fault at the CIRQUE deposit narrowly misses the mineralized horizon, passing less than 50 m over top. The mineralization at Mt. Alcock (Kwadacha Park) lies only 10 m below what appears to be the same thrust fault. The thrust faults between the CIRQUE and Kwadacha Park deposits should be investigated in detail, for while the mineralized horizon has probably been cut off in many places, much of it may remain.

11.5 Ground South of the ELF Deposit (DWG. GC-8667)

There is roughly 35 km of unstaked Devono-Mississippian rock between the ELF and Aquitaine's AKI claims. The ELF claims contain interesting banded barite-galena mineralization, while the AKI claims contain one occurrence of pyritic bedded barite about 3 m thick. It has not been possible to follow the bedded barite along strike due to overburden and structural complexities. However, it is believed to lie on the west limb of an anticline, which continues almost to the ELF claims. Unfortunately the projection of the barite bed along strike places it down the centre of a large stream valley, and is therefore buried by glacial and river gravels for its entire length. Stream and soil geochemistry in the valley contained no anomalous Pb values, a result possibly due to the favourable horizon being unexposed. The occurrence of a reasonably thick bed of barite on the AKI claims, and good bedded barite-galena mineralization on the ELF claims, make it likely that the barite horizon is continuous between the two claim blocks. This ground should be mapped in detail, for if the barite horizon does continue between the two areas, then there is a possibility that it could also contain hidden Pb-Zn mineralization.

12. RECOMMENDATIONS

General: that the services of an expert structural geologist specialized in thrust faulting be acquired for at least part of the 1979 field season. His responsibility would be to interpret the structure especially between the CIRQUE and Kwadacha Park (Mt. Alcock) deposits, but also south of the CIRQUE claims, and between the AKI and ELF claims.

12.1 PIE Claims

1. A detailed (100 m spacing) soil sampling grid should be run over the entire property and the samples be analysed for Pb, Zn and Cu.
2. The property should be prospected and mapped in detail, particularly regarding the bedded barite outcrops.
3. The limestone unit should be prospected in detail as it is likely to contain more sphalerite showings, and may become a Mississippi Valley type target. Also, a pattern of mineralization may be found in the limestone that could lead to the discovery of sulphide deposits in the adjacent shale.
4. Silt samples (7811280 and 7811282) on the eastern side of the PIE claims are significantly high in Pb, and also Zn and Cu. The source of these anomalous concentrations should be investigated, as they undoubtedly represent galena and perhaps sphalerite and chalcopyrite mineralization. Both anomalies occur in large springs and as a result it was not possible to trace them upstream.

12.2 DOG Claims

1. These claims should be covered by a 100 metre spacing soil grid and the samples analysed for Pb, Zn, Cu.
2. The ground should also be mapped and prospected in detail.

12.3 WIL Claims

1. These claims should be dropped owing to lack of encouragement obtained from a reconnaissance soil survey conducted late in the 1978 field season.

12.4 Ground North of the CIRQUE Deposit

1. All or part of this ground should be staked immediately on commencement of the 1979 field season, particularly the area just north of the CIRQUE claims, where there is a weak Pb anomaly. (This ground was staked as the YULE claims in December 1978.)
2. A detailed soil sampling grid at 100 metre spacing should be conducted over the entire block of claims, and the samples analysed for Pb, Zn and Cu. The ground should be prospected.
3. The entire belt between Mt. Alcock (in Kwadacha Park) and the CIRQUE deposits should be mapped in detail, and the nature of the thrust faulting should be thoroughly understood with regard to the possibility of a blind orebody.

12.5 Ground South of the ELF Deposit

1. The area between the ELF and AKI claims should be mapped in detail, in order to trace the barite horizon along strike between the two areas. If the barite bed can be inferred to exist along the belt, then consideration should be given to sampling it at regular intervals.

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APPENDIX I

APPENDIX II

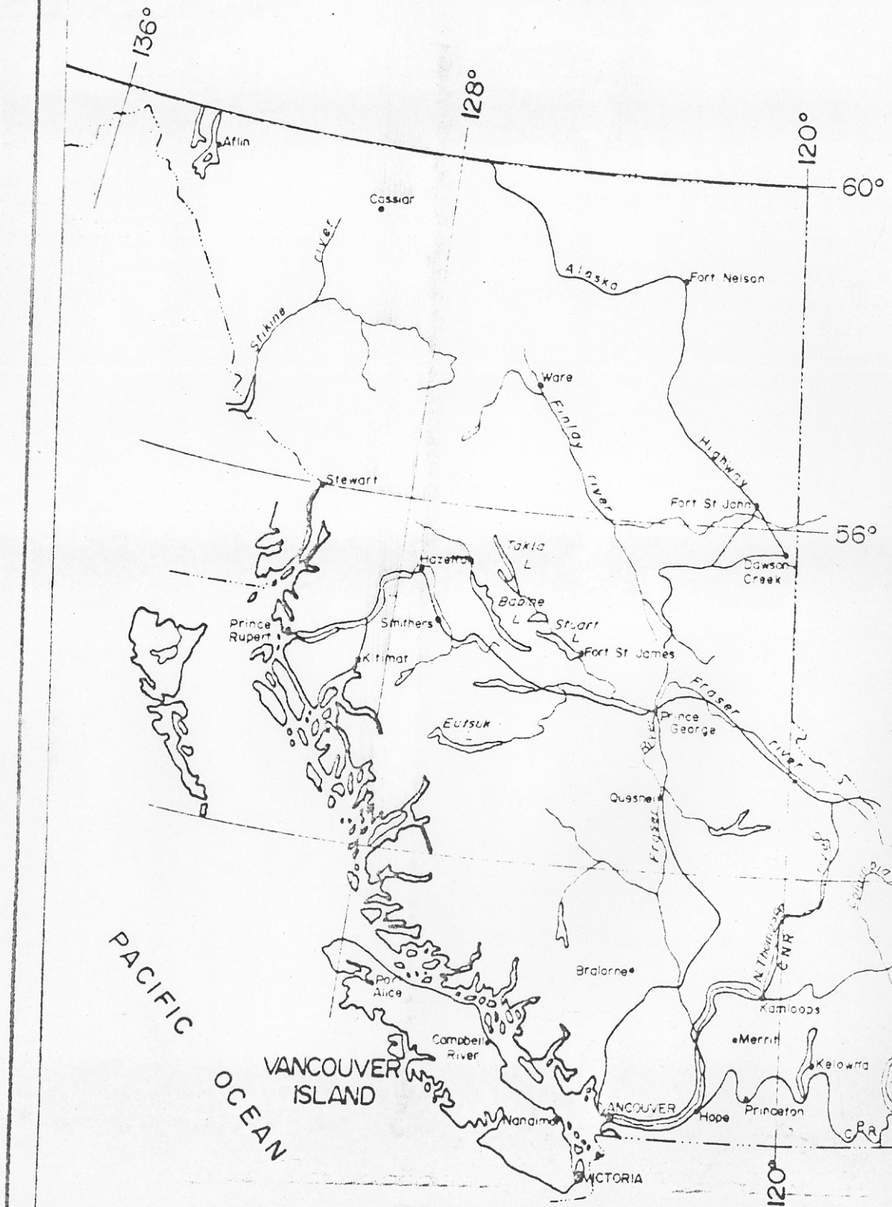
APPENDIX III

RECONNAISSANCE IN THE KECHIKA AND RABBIT RIVER MAP AREAS (DWG. L-6565)

INTRODUCTION

This small project developed as an extension of the Williston Lake Pb-Zn reconnaissance programme that was carried out during the 1978 field season by the writer. The highly prospective belt of Devono-Mississippian black clastic rocks of the Ware (94F) and Tuchodi Lakes (94K) map areas were thought to extend northward through the Kechika (94L) and Rabbit River (94M) map sheets and thence into the Yukon Territory. A 150 km long belt of shales, siltstone, sandstones and cherts, mapped as Cambrian and Ordovician in age by the G.S.C. (maps 42-1962 and 46-1962), trends along the east side of the Rocky Mountain Trench in these two map areas. This belt was now believed to be largely composed of Devono-Mississippian rocks, that had not been recognized in the original Geological Survey of Canada reconnaissance.

The recent discoveries of at least four separate and very significant deposits of barite-lead-zinc within Devono-Mississippian rocks in the Ware and Tuchodi Lakes map areas prompted a proposal by the writer to investigate the Kechika and Rabbit River map areas for similar mineralization. A two-phased investigation was proposed, consisting first of reconnaissance mapping the area, with the intention, given sufficient encouragement, to follow it up with prospecting and silt geochemistry. Two blocks of claims held by Amoco, and one block of claims held by Tesasgulf, cover ground thought to be underlain by Devono-Mississippian black clastic rocks. The reconnaissance work involved investigating these claims as well, to determine whether in fact they were staked on Devono-Mississippian rocks, and whether they contained any significant Ba-Pb-Zn deposits. All flying was done with a Jet Ranger helicopter owned by Frontier Helicopters in Watson Lake.



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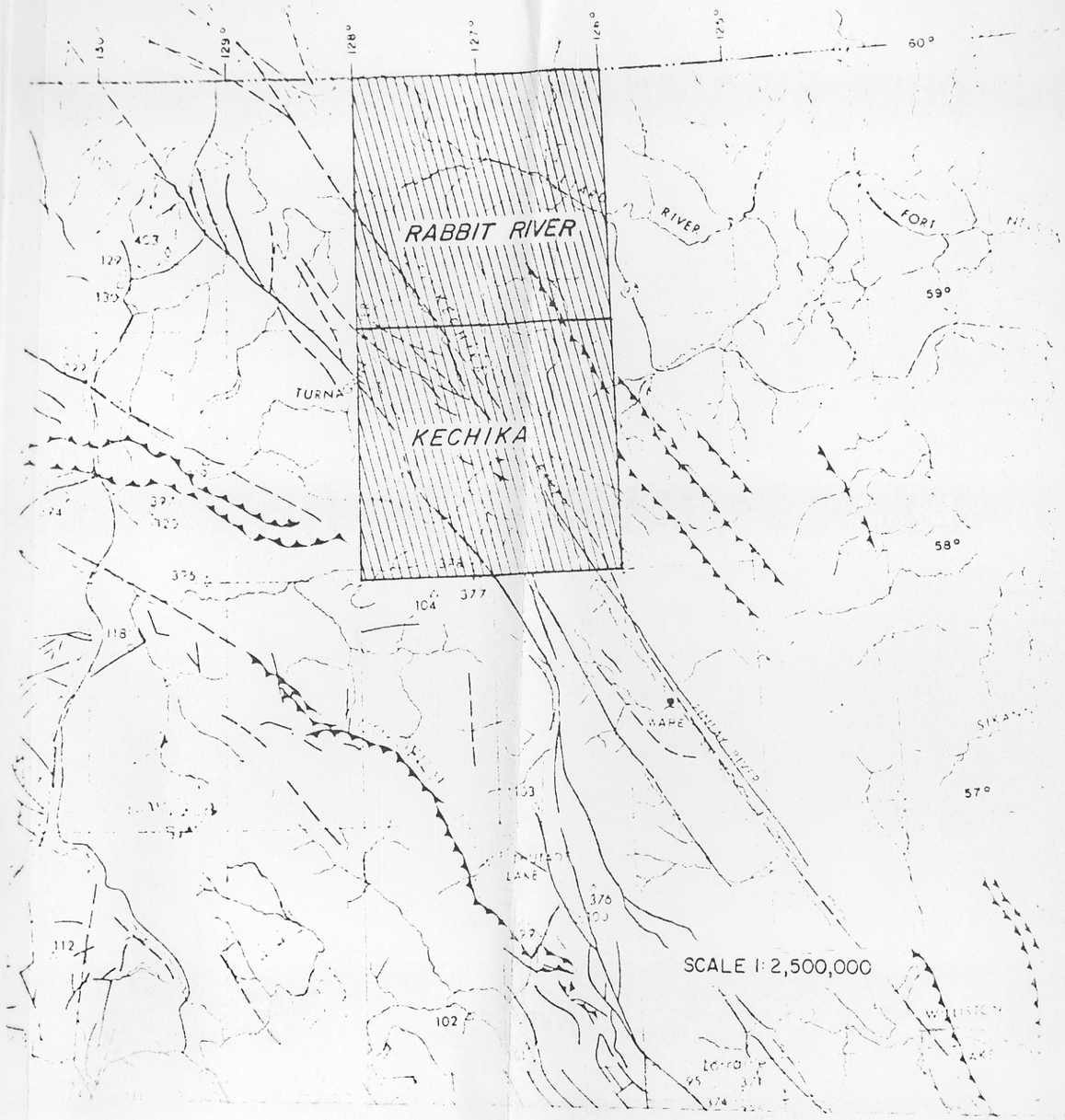

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WILLISTON LAKE PROJECT

RECONNAISSANCE OF KECHIKA
and
RABBIT RIVER MAP AREAS

MARCH 1979 R.V.L./y.m. DWG. L-8613

RECONNAISSANCE MAPPING

Two days were spent on reconnaissance mapping. The following observations were made.

1. The continuous belt of Devono-Mississippian black clastic rocks that trends across Ware and Tuchodi Lakes map areas disappears abruptly at approximately latitude 58°15'N and longitude 126°15'W, in southeasternmost Kechika map area. It is not clear whether the disappearance is due to faulting, uplift and erosion, or a facies change. A thick sequence of carbonates appears there on strike with the black clastic unit, and continues northward to the vicinity of Netson Lake.

2. The belt of black clastics in southeasternmost Kechika map area contains numerous gossans and a thick section of chert pebble conglomerates that were likely deposited as a submarine fan.

3. A very distinctive brownish-coloured, pyritic siltstone unit that is blue-grey on a fresh surface forms many of the ridges in the area of subdued relief between Netson Lake - Netson Creek and Gataga Mt. - Terminus Mt. These rocks are identical to the Silurian siltstone beds that directly underlie much of the black clastic belt in Ware map area, and is undoubtedly the same unit. Intimately associated with, and possibly overlying this siltstone unit, is a sequence of black cherts and black, but brownish-weathering, shales that possibly are of Devono-Mississippian age. These latter rocks however, could be of Silurian to middle Devonian age and may therefore belong to the Road River formation. They differ from the belt of black clastics in southeasternmost Kechika map area in that they lack gossans, and are brownish-weathering rather than the distinctive gunsteel grey color. Rhythmites, similar to those occurring in the lower part of the Devono-Mississippian section

in Ware map area, and some bedded barite found on one ridge top, provide further evidence that the rocks are of Devono-Mississippian age.

4. North of Terminus Mtn., the topography becomes very subdued and heavily covered with vegetation, limiting outcrops, and making accurate geological mapping impossible.

5. Texasgulf's group of claims, BOYA 1-6, in the Rabbit River map area, covers ground underlain by massive carbonates of uncertain age. No black shales were seen to outcrop on the property.

6. Amoco's group of claims NETSON 1-3, SOLO 1-3 at Netson Lake on the Kechika map area covers brownish weathering shales and black cherts and cherty shales of possible Devono-Mississippian age. The rocks are only slightly rusty in places, and contain no gossans or bedded barite. No mineral showings were found, although Amoco has done property work, including laying out a grid, and taking soil samples along it. Ten stream silt samples were taken to be analysed for Pb, Zn and Cu, in case any sulphide mineralization went unrecognized by prospecting.

7. Amoco's group of claims, GATAGA 1-2, at Gataga Mtn., covers a small discontinuous belt of black, rusty, cherty argillite and chert of probably Devono-Mississippian age. No gossans, mineral showings or bedded barite were observed on the claims, although a soil sampling survey had evidently been carried out.

CONCLUSIONS

Owing to the lack of gossans, gunsteel grey-coloured shales, and almost total lack of bedded barite, it was thought that regionally the rocks were not as favourable for Ba-Pb-Zn mineralization, as those in the Ware and Tuchodi Lakes map areas. Similarly, it was concluded that owing to a lack of the above features, coupled with an apparent lack of sulphide mineral occurrences on Amoco's claim blocks, phase two of the investigation was not justified, and the project was discontinued.

The belt of shales and cherts either belongs to the upper part of the Road River formation and is Silurian to middle Devonian in age, or is Devono-Mississippian in age, but of a facies not likely to contain Ba-Pb-Zn deposits.