

# RUSTY SPRINGS (PB, ZN, AG, CU)

## SUMMARY

Despite many years of exploration and relatively limited success, the Rusty Springs prospect retains considerable potential for a large-tonnage deposit. The property lies within the east-vergent Taiga-Nahoni foldbelt, occurring in the core of a structural culmination exposing host Lower and Middle Devonian Ogilvie Formation dolostones. Mineralization occurs in stratabound and discordant zones along the contact with the overlying Devonian-Mississippian Unnamed Shale.

Rusty Springs 2011



Various deposit models, ranging from Mississippi Valley-type to epithermal vein-type have been employed. Poor exposure and relatively deep weathering resulting from the lack of Pleistocene glaciation account for the lack of consensus with regard to genesis, and accumulating evidence points to the potential for a high-temperature, carbonate hosted massive sulphide

deposit (manto-chimney complex).

## INTRODUCTION

The great extent of mineralized and altered rocks, together with their stratabound nature, common significant thicknesses, local high grades, and potential for supergene enrichment suggest that Rusty Springs remains an attractive drill oriented exploration target.

The Rusty Springs Property area has seen sporadic exploration since 1975, when rusty ground seeps were recognized during regional oil and gas exploration programs. Subsequent ground examination revealed silver-lead-zinc mineralization nearby. Staking of the area by Rio Alto

Exploration followed, with systematic exploration programs carried out over the years by various operators.

High-grade mineralization was discovered in the Orma Hill area in 1978, and the focus of exploration efforts were concentrated in this area. Virtually all drilling was aimed at the Orma Vein since this time. Preliminary work, previous to the Orma discovery however, outlined anomalous soil geochemical values in the Mike Hill area. Limited drilling was carried out to define the nature of this mineralization, but met only limited success.

In 1992, the final core claims comprising the Rusty Springs Property were allowed to lapse. They were subsequently restaked and optioned to Eagle Plains Resources, who now retain a 100% interest in the property.

Bulldozer trenching of the Mike Hill area in 1994 resulted in the discovery of high grade silver-lead-zinc mineralization within silicified carbonate material. Drilling carried out during 1995 was aimed at evaluating the mineralized zones exposed on the Mike Hill. Trenching and soil geochemical sampling was completed at the Big Onion area to follow-up geochemical work initiated during 1994.

In 1996, a 15 hole diamond drill program defined highly anomalous base metal values over significant widths within an apparently stratabound - stratiform horizon at the Ogilvie - Hart River contact. The 1997 program employed a reverse circulation drill in an attempt to improve penetration problems related to the highly abrasive cap rocks overlying the mineralized horizon. The drilling confirmed the presence of strata bound mineralization over a large area.

The 1998 program consisted of a combined shallow seismic and gravity geophysical survey. The survey defined a coincident positive Bouguer gravity anomaly and seismic reflection profile interpreted to be related to a shallow sulphide body at the same stratigraphic horizon as sulphide mineralization defined in 1996 - 97.

Evaluation of the Rusty Springs Property continued in 1999 with a diamond drilling and geological mapping program undertaken by the Eagle Plains Resources / CanAustra Resources joint venture. CanAustra had an option to earn a 60% interest in the Rusty Springs property by completing \$2,000,000 in exploration expenditures, and making \$70,000 in cash payments to Eagle Plains by 2003. Diamond drilling was directed toward testing geophysical anomalies defined by the 1998 combined seismic and gravity surveys and geological targets generated by 1999 mapping. A total of 616.9 meters (2024 feet) of diamond drilling was completed in three holes. None of the holes were completed to target depth due to drilling problems. One of the holes, RS9901, intersected significant base metal mineralization.

Charlie Greig, a noted structural geologist, was retained in 1999 to compile a detailed structural map of the Rusty Springs property and to define a regional framework for the Rusty Springs

mineralization. His work forms the basis for much of this report and was published in 2000 as part of the Yukon Exploration and Geology, 1999 Department of Indian and Northern Affairs.

2001 work on the Rusty Springs Property consisted of a short reconnaissance geological program.

Further work is recommended for the property and surrounding region. A 1500m diamond drilling program utilizing a modified diamond drill designed to address the difficult drilling conditions encountered at Rusty Springs is recommended for 2002.

## **LOCATION AND ACCESS**

The Rusty Springs Ag/Pb/Zn/Cu prospect is situated in the north-western part of the Yukon Territory at approximately 66° 30' North latitude and 140° 25' West longitude. The property is 8 km south of the Arctic Circle and 29 km east of the Alaska border, near the headwaters of the Salmon Fork of the Yukon River. Relief in the Rusty Springs area is on the order of 1000 metres, with the highest point in the surrounding mountains at about 1500 metres. Summits and ridges are generally rounded and subdued, and the valleys are broad as the area lies in the part of the Yukon that was not glaciated during Pleistocene time.

Access to the property is via wheel or ski-equipped aircraft or by winter road. An all-weather, (2000') airstrip was completed in 1996. Supply centres are located at Dawson City, Yukon (274km), Circle, Alaska (175km), or Fairbanks, Alaska (365km). Airstrip staging areas to Rusty Springs are available along the Dempster Highway at Eagle Plains (164kms), or from the "150 Mile" airstrip (137km). Road access has been previously developed for winter haulage from Mile 123 (Ogilvie Crossing) on the Dempster Highway over a distance of 193 km. The Dempster Highway is a government-maintained all-weather road providing access from the south. The winter road access traverses gently sloping terrain without any major topographic obstacles.

Re-starting the Caterpillar after many years



Rusty Springs Airstrip June 23/2011  
Looking northward

## **PROPERTY TENURE**

The total property area consists of 81 quartz-claims, staked in accordance with existing Yukon Quartz Mining Act Regulations.

## **HISTORY OF EXPLORATION**

The Rusty Springs property was first staked in 1975, after investigation of deep red-orange spring; and seeps in the valley of Carrol Creek led to the discovery of nearby silver, lead, zinc, and copper mineralization; the rusty seeps were first noted during petroleum exploration in the area. Since the discovery, the property has been the focus for nearly \$5,000,000.00 of exploration, including ten separate drill campaigns in two major phases (1975-83 and 1994-96) totaling over 10,000 metres of drilling in 123 holes.

Exploration has mainly targeted high-grade silver, lead, copper, and zinc mineralization within brecciated and quartz and carbonate-cemented and veined dolomite, and has been based on several genetic models, developed in part by geology students employed on the property and working on Bachelors theses. At various stages of exploration, models used to help guide exploration include: Mississippi Valley-type (MVT); Irish Plains-type (carbonate-hosted exhalative); epithermal-type (veins and(or) hydrothermal replacement along a karsted surface, with supergene enrichment); and manto-chimney-type (high-temperature, carbonate-hosted massive sulphides).

Direct targeting of drill holes utilized various techniques, including prospecting, geologic mapping, geochemistry and geophysics. Many of the drill programs were plagued by drilling

problems, such as poor recoveries in the strongly oxidized and leached mineralized intervals, or loss of water pressure in blocky brecciated zones with abundant open space. Drilling was often slow and costly in resistant siliceous 'chert' horizons that cap the mineralized stratigraphy. Trenching also met with varying success, mainly because of the deep permafrost and the deep, soliflucted overburden which predominates in unglaciated parts of the Yukon.

During the fall of 1975, while investigating an oolitic iron formation, a rusty spring-seep was observed by M.N. Chernoff. Upon investigation, the spring was found to be associated with high-grade silver, lead, zinc, and copper mineralization. A total of 92 quartz claims and 15 iron claims were staked during the fall and winter seasons.

During the 1976 summer season, a preliminary investigation of the property was conducted by Rio Alto Exploration Ltd., under the supervision of M.N. Chernoff. Exploration completed included helicopter-supported geological mapping, prospecting, sampling of mineralized float, and limited soil geochemical sampling. This work established the structural setting, confirmed the presence of high-grade silver values, and demonstrated the usefulness of soil geochemistry. The mineral occurrences were considered to be hydrothermal vein systems with supergene enrichment possibilities.

Based on encouraging results from this preliminary reconnaissance, a follow-up field program consisting of geological mapping, soil geochemical sampling, and 975 metres (3200 feet) of diamond drilling was conducted in 1977. Again, the results were considered positive, even though poor drill core recoveries were obtained. Additional ground was staked to give a total of 380 quartz claims and 15 iron claims.

A geological thesis by G. Schoel concluded that the mineralization was probably Mississippi Valley type.

During the winter of 1978, fuel, drill equipment, and supplies were ferried to the property by tractor train. That summer, two picket grids (totaling 67 line km) were established over the claims. Further geological mapping, soil geochemical sampling, diamond drilling (1840 metres), and metallurgical sampling were also completed. Poor drill core recoveries once again hampered the effectiveness of the program.

A geological thesis was undertaken by D. Hansen, again emphasizing a Mississippi Valley type model for the mineralization.

Exploration during the period 1975 to 1978 inclusive was funded by Rio Alto Exploration.

In 1979, detailed geological mapping, a soil geochemical survey, an Induced Polarization survey, and a gravity survey were completed. Joint funding of this work was by Rio Alto and E & B Explorations Ltd. of Calgary, Alberta.

A geological thesis by J. Bankowski indicated a hydrothermal exhalative nature.

In 1980, E & B Explorations Ltd. as operator, focused on the widespread mineralization discovered on the Orma Hill. Their program saw 1830 metres (6000 feet) of diamond drilling, bulldozer trenching, and some detailed geological mapping completed. Core recoveries were not significantly improved over previous years.

In 1982, Taiga Consultants Ltd. was contracted by Kenton Natural Resources to carry out a geological evaluation of the property and subsequently a comprehensive mineral exploration and diamond drilling program. During this period, 510 metres (1673 feet) of diamond drilling was completed, as well as a soil geochemical survey, a geophysical (VLF-EM) survey, detailed geological mapping of the property, and six trenches dug in order to define the style of mineralization.

The most recent research work, carried out by Jill Kirker (April 1982), strongly supports a hydrothermal origin for the mineralization.

In 1983, additional geophysical surveying and geochemical sampling were completed by Taiga Consultants Ltd. To detail geophysical conductors and geochemical zones previously outlined. During the fall of 1983, 488 metres (1600 feet) of diamond drilling were completed.

In 1986, Kenton Natural Resources Inc., as operator, drilled two holes in the valley bottom between the Mike and Orma Hills in order to test an I.P. anomaly delineated in 1979 by previous operators. This program consisted of 404m (1326') of drilling, and failed to intersect any significant mineralization. The drill was removed from the property following this short program.

The claims were gradually allowed to lapse, and in the spring of 1992, all claims comprising the property had expired.

R.W. Termuende restaked the core area of the property on July 29th, 1992. 12 quartz claims were recorded.

A \$190,000 exploration program was completed during the 1994 season. The focus of the two-stage program was to carry-out further systematic exploration in the Mike Hill area, as well as undertake initial reconnaissance work in the region surrounding the claim area. A total of 531 soil, 67 rock, and 36 silt samples were taken, over two separate control grids that were established on the property, covering the Mike Hill and Big Onion areas. Concurrent with the geological program, efforts were made to improve the infrastructure of the property, and included construction of a 530m (1800') airstrip, a 3.4km permanent road connecting the airstrip and camp areas, and 10km of drill-tote trails throughout the property. Environmental work was also undertaken in the Orma Hill area, with 8 man days spent collecting some 140 used fuel drums, refuse-burning, and general cleanup activities in areas of past development.

A two-phase trenching and diamond drilling program was carried out during 1995. Twenty-one drill holes totaling 1658 meters (5440 feet) were completed in the Mike and Orma hill areas, and a total of 400m of bulldozer trenching carried out in the Big Onion area. In addition, a 339-sample soil geochemistry survey was undertaken proximal to the Big Onion showing. A further 35 claim units were added to the existing property, bringing the total area to 71 units. In addition, improvements were made to the airstrip, and an all-weather road network was completed to access all areas of the property. The total cost of the 1995 program was \$539,000. The most impressive mineralized interval intersected in 1995 occurred in hole RS95-M7, where a 15.3m interval from a hole drilled on the Mike Hill assayed 15.1 oz/ton silver, 3% copper, and 1.3% zinc, from 28.6-43.9m.

A 15-hole, 7600' (2320m) diamond drilling program was carried out on the property in 1996 at a total cost of \$560,000. The program was designed to test for the presence of deep-seated manto-type mineralization, which was interpreted to lie beneath high-grade "chimney" veins exposed on surface in the Mike and Orma Hill areas.

In addition to geological work, significant improvements were made to property infrastructure, with three km of new roadwork completed, and the airstrip extended to 2000' (600m). Significant to the 1996 program was the discovery of stratabound mineralization, apparently over much of the property area, and beyond. As a result of the new interpretation, 478 quartz claim units were staked in the region, covering all favorable stratigraphy in the immediate area.

The \$355,000 1997 program utilized a reverse circulation drill in an attempt to mitigate drilling problems associated with the highly abrasive cap rocks overlying the mineralized horizon. While the drill performed better in the siliceous ground, there were problems with recovery and sample contamination within the mineralized zone. Two of the holes confirmed the presence of stratabound mineralization at the Hart River - Ogilvie Formation contact over a large area. During 1997, R.W. Hodder, Ph.D., P.Eng., visited the property and examined existing drill core, outcrop, trenches and technical data. He concluded that *"The limonitic interval at Rusty Springs is a resource of hundred of millions of tons, but of very subeconomic amounts of base or precious metals ... the limonitic interval and it's enclosed quartz veins and larnellae are however vital symptoms that ore forming processes existed for major deposits of silver-lead-zinc and that deposits of this type cluster in districts of enormous potential"*.

Hodder also recommended focusing on locating sulphides below the present and palm water table. The \$54,000.00 1998 program involved a combined shallow seismic and gravity geophysical survey. The surveys were run from the northeast flank of the airstrip east across the low lying swampy area. The survey defined a coincident positive Bouger gravity anomaly and seismic reflection profile interpreted to be related to a shallow sulphide body at the same stratigraphic horizon as sulphide mineralization defined in 1996 - 97.

Eagle Plains Resources continued mineral exploration at the Rusty Springs property continued in 1999 with a \$273,000.00 field program. A three hole helicopter supported, diamond drill program to test for stratabound mineralization in the area of Orma Hill was carried out concurrently with a property and regional scale geologic mapping program under the direction of Charlie Greig.

Results from the **616.9 m (2024 feet) 1999** diamond drilling program at the Rusty Springs property were largely inconclusive because none of the holes could be completed to target depth. Two of the three holes intersected quartz carbonate crackle breccia within a strongly silicified (cherty?) black mudstone that overlies the mineralized horizon elsewhere on the property. While no massive sulphide or Katshat horizon was intersected, a mineralized breccia zone was encountered between 229.2 and 264.9 meters in hole RS99-01. Mineralization consisted of finely disseminated to patchy orange - red sphalerite associated with fine quartz crackle breccia and coarser collapse type breccia. The host rock was silicified black mudstone. The best mineralized intervals were 226.8 to 233.4 meters which averaged 2819 ppm zinc over 6.6 meters, and 249.8 to 264.9 meters which averaged 3100 ppm zinc over 15.1 meters. The brecciation, strong silicification and mineralization are consistent with the nature of the cap rocks associated with the Katshat horizon elsewhere on the property. Casing was left in all three of the drillholes to facilitate future deepening of the holes to intersect the mineralized horizon.

## **REGIONAL GEOLOGICAL SETTING**

The area mapped lies within the northernmost part of the Cordilleran orogenic belt, known locally as the Taiga -Nahoni foldbelt, where Precambrian to Cretaceous predominantly sedimentary rocks of the eastward and northward tapering North American miogeocline were deformed in latest Cretaceous to Tertiary time (Norris 1996, Lane 1998). The area was first mapped by Norris (1981), who outlined a structural culmination, in part coincident with his Porcupine Anticline, cored by rocks of the Lower and Middle Devonian Ogilvie Formation. Norris (1981) shows stratigraphically lower rocks of Early Paleozoic, Cambrian, and Proterozoic age bounding the west side of the culmination and brought up by mainly west vergent contractional faults.

## **PROPERTY GEOLOGY**

Nine map units, ranging in age from Proterozoic to Cretaceous, correspond largely with those mapped by previous workers (e.g., Chernoff 1976, Kirker 1980a, Tempelman-Kluit 1981). Ages of the map units were taken mainly from Norris (1981, 1996). Exposure is generally poor near the valley bottom and consequently the focus for property-scale geologic mapping was on the rocks underlying surrounding ridges. The geology in the immediate vicinity of the mineralized and altered zones at Rusty Springs, which crop out at lower elevations in the vicinity of two lower hills, named the Mike and Orma hills, was examined briefly.

### **Lower to Upper Proterozoic Rocks**

Rusty weathering fine-grained sandstone (quartzite), interbedded with maroon and local green siltstone and silty mudstone (siltite), occurs in a northerly trending belt in the southwestern most corner of the area mapped. The siliciclastic rocks, which were only briefly examined, appear to be conformable with steeply east dipping Lower Paleozoic dolostone and quartz-rich sandstone to their east.

### **Lower Paleozoic Rocks**

Like the older rocks which they appear to overlie conformably, rocks of probable Late Cambrian through Early Devonian age occur in a northerly trending belt along the west margin of the map area. The Lower Paleozoic rocks consist of white weathering dolostone, rusty weathering quartz-rich sandstone (quartzite), and siliceous fine grained clastic rocks, including green and maroon siltstone and silty mudstone (siltite). Rocks of similar general appearance occur to the north, but were neither examined nor differentiated from the older siliciclastic rocks. The Lower Paleozoic rocks are inferred to be in thrust contact with younger Paleozoic and Mesozoic rocks to the west, although a down-to-the-east normal fault was mapped along trend to the south by Norris (1981). The presence of inferred thrust is supported by the marked easterly vergence of folds in the area.

### **Lower and Middle Devonian Ogilvie Formation**

Pale grey weathering dark grey dolostone and subordinate limestone and argillaceous rocks of the Ogilvie Formation underlie the central part of the Rusty Springs property in the core of the Porcupine-Rusty Springs anticlinorium. They form common talus slopes on the flanks of Orma and Mike hills, but outcrop is scarce, even on roads and cat trails. Dolostone is fetid, and commonly brecciated, veined, and(or) vuggy. Breccia cements consist mainly of dolomite and sparry calcite with local quartz; vugs are commonly lined with calcite and quartz, and veinlets are of similar mineralogy. Another common constituent of Ogilvie Formation breccias is pyrobitumen-it is commonly intergrown with dolomite cements and always associated with quartz and(or) calcite spar (Kirker 1982); it also locally coats vugs. Dolomite crystals in dolostone are typically fine- to medium-grained and locally coarse-grained, with coarser-grained varieties typically weathering a paler grey colour. Locally, weakly dolomitized limestone contains recognizable brachiopods, ostracods, corals, and crinoids (Hansen 1979, Davis and Aussant 1982), although no diagnostic fossils have been reported. Float boulders and the few outcrops of the Ogilvie Formation suggest that it is not well stratified, but bedding is more apparent in diamond drill core, particularly where brecciation is less intense, and bedding to core axis angles typically suggest that the strata in the vicinity of Mike and Orma hills are gently dipping. Mainly on the basis of their contained fauna, Hansen (1979) interpreted the dolostones of the Ogilvie Formation as a shallow water "reefal" unit, while Kirker (1982) suggested a shallow water shelf environment. The base of the Ogilvie Formation at Rusty Springs is not exposed, but a drill hole between Mike and Orma hills penetrated about 210 metres (probable true thickness) of dolostone, with local interbedded shale and rare limestone and quartzite (Chamberlain 1986).

At the top of the Ogilvie Formation at Rusty Springs is the informally named "Katshat unit", a recessive, gossanous oxide- and clay-rich unit which corresponds to a significant degree with the mineralized zones on the property. In general the unit appears to be stratabound, separating the dolostone from overlying siliciclastic rocks, but in detail its contacts are highly irregular. The Katshat unit most likely represents altered and mineralized Ogilvie Formation limestone--it is discussed in more detail below.

### **Devono-Mississippian Fine-Grained Siliciclastic Rocks**

Disconformably overlying the Ogilvie Formation are siliceous mudstone, slate, shale, siltstone, and rare limestone of probable Devono-Mississippian age. The rocks were assigned by Norris (1981) to the Hart River Formation (Early and Late Carboniferous age), but they are more likely correlative with fine grained clastic rocks, such as the Upper Devonian Canol Formation, the Unnamed shale, the Upper Devonian and Lower Carboniferous Ford Lake shale (Norris 1981, 1996), and the Kayak Formation (Richards et al. 1996), because the Hart River consists mainly of limestone (Norris 1981, 1996). Herein the rocks have been assigned to the Unnamed shale.

The lowermost rocks in the sequence, best exposed on Orma and Mike hills and referred to locally as black 'chert', are perhaps more accurately referred to as a silicified and(or) siliceous mudstone. Thin laminations and recrystallized radiolaria are locally preserved (Hansen 1979). The siliceous rocks are up to 40 metres thick (Hodder 1997) and are commonly veined and brecciated; veins and breccia matrices consist mainly of quartz, calcite, and dolomite. The brecciated siliceous rocks appear in most places to cap the mineralized Katshat unit of the uppermost Ogilvie Formation, and black siliceous(?) fragments are locally a common component of the dolostone breccias that commonly comprise upper Ogilvie Formation rocks beneath the Katshat unit.

Up-section from the siliceous rocks, and comprising the bulk of the rocks assigned to the Unnamed shale, are relatively recessive pyritic, carbonaceous shale, mudstone, silty mudstone, and local thin- to medium bedded, poorly sorted fine grained litharenite. They are generally thinly bedded, and typically siliceous, although local calcareous shale was also noted. Local true slate and rare dark grey, fetid and laminated algal limestone occur not far above its contact with the Ogilvie Formation. Erosion of this part of the unit, which is as much as 500 metres thick, has led to the broad and open drainage basin within which the Rusty Springs property sits.

The transition of the fine grained clastic sequence to the overlying mixed carbonate and clastic unit is commonly marked by the presence of thin to medium bedded siliceous fine sandy siltstone or fine grained sandstone. These rocks are typically pale grey and locally rusty weathering up close, but appear very dark from a distance because of a common covering of black lichen.

### **Upper Carboniferous and Permian(?) Limestone and Fine Grained Calcareous and Siliceous Clastic Rocks**

Medium bedded, pale grey weathering, medium to dark grey sandy and locally pebbly fetid limestone and rare dolostone characterize this unit. The limestone commonly contains irregular dark grey chert nodules and occurs in several(?) horizons of amalgamated beds that are up to several tens of metres thick. They form many of the better outcrops in the area and because of their resistant character, they underlie many of the ridges surrounding the broad upper drainage basin of Carrol Creek. The upper limit of the map unit is defined by presence of the uppermost continuous limestone sequence, while the transition from the underlying siliciclastic sequence is commonly marked by scattered float blocks of pebbly limestone. The pebbles are typically round to sub-round and are dominantly chert. Pebbly lithologies are more common to the southwest, whereas to the east, sandy limestone is more common and pebbly limestone occurs only locally. In addition, a limestone horizon containing abundant in situ corals was noted in the east but not to the south or southwest, and composite limestone horizons appear somewhat thicker (up to 50-60 metres) and may contain thicker-bedded to massive layers of up to 15 metres thickness. In spite of the predominance in outcrop of pebbly and cherty limestone, a significant portion of the map unit consists of relatively recessive, variably calcareous fine grained clastic rocks. They include dark weathering, thin bedded and laminated siliceous or calcareous silty mudstone, and calcareous to siliceous shale, as well as local fine grained siliceous sandstone and siltstone. The total thickness of the limestone and associated clastic units is about 550-700 metres.

The rocks of this sequence have been included previously in the Upper Carboniferous Ettrain Formation, but Pennsylvanian and Permian fossils have been reported from within the area mapped, and so it is probably longer-ranging and likely includes rocks mapped as Jungle Creek Formation by earlier workers. If so, it is difficult to distinguish Ettrain from Jungle Creek in the field.

### **Jurassic and Lower Cretaceous Dark Weathering Siliciclastic Rocks**

Lying conformably above the sequence containing the resistant grey carbonates is a dark weathering package of shale, silty mudstone, and sandstone of approximately 600 metres thickness. Included in this map unit are rocks that Norris (1981) assigned to the Jurassic and Lower Cretaceous Kingak, Porcupine River, and Husky formations. The low part in the Rusty Springs area consists of common pale to medium brown weathering silty mudstone with local buff-weathering carbonate layers, and dark brown weathering shale. Near the east-central part of the area mapped, near its base, the sequence includes a thick (up to 46 metres, Chernoff 1976) oolitic hematite-magnetite siliceous iron formation. Several kilometres along strike to the north, and at the same stratigraphic level, the base of the unit is marked by massive black carbonaceous and siliceous mudstone and silty mudstone. Similarly resistant siliceous rocks mark the upper part of the unit, which underlies many of the highest ridges in the south and east parts of the area mapped. They are very dark weathering and consist mainly of blocky weathering, medium grained feldspathic cherty quartz arenite and carbonaceous fine grained siliceous litharenite.

## **Lower Cretaceous Shale, Siltstone, and Quartz Arenite**

The two units bounding the east side of the map area were taken from the mapping of Chernoff (1976), who shows numerous overturned beds within their bounds. He assigned the shale, siltstone, and quartz arenite comprising the units to the Cretaceous Marten Creek and Goodenough (sic) formations. Norris (1981) assigned them a Lower Cretaceous age, and included them in the his "Kwc" unit and the Mount Goodenough Formation.

## **Structural Geology**

Folds are the dominant structural feature in the map area, and wavelengths of the typical east vergent open to tight and locally overturned folds are on the order of 1-5 kilometres . The folds occur across the crest of an approximately 20 kilometre wide, northerly trending and doubly-plunging anticlinorium centered on the mineralized showings at Rusty Springs. The east side of this domal feature corresponds to the Porcupine Anticline of Norris (1981). Brittle faults are common on the property, and have been intersected in drillholes and interpreted from geophysical surveys and surface features (such as linear stream patterns), but none of these faults appears to offset map units at the property scale. The plunge reversal that corresponds with the mineralized area and which has been interpreted by some (e.g., Chernoff 1976) to have been associated with a brittle fault, appears, from the map patterns, to be fold-related and the consequence of some deeper-level structure, such as a lateral ramp.

Several property-scale cross-sections have been prepared previously, beginning with that of Chernoff (1976), and followed by Kirker (1980) and Tempelman-Kluit (1981). Chernoff (1976) shows a large-scale easterly-overturned antiform which is centered on the Rusty Springs showings and which he interprets as being cored by intrusive rocks and floored by northtrending, east-directed thrust faults. In contrast, Kirker (1980) and Tempelman-Kluit show inferred, north-trending faults, but interpret them as west-vergent contractional faults. They also show related folds with generally open geometries (Kirker 1980, Tempelman-Kluit 1981). Our cross-sections, based on improved bedding control compiled in part from previous work and benefitting from drillhole control, suggests that the structural setting is somewhat more akin to that shown by Chernoff (1976), in that the transport direction across the anticlinorium is toward the east. An east-directed transport direction is also more in accord with the regional sense of vergence.

Speculatively, the area may be floored by a large-scale east-vergent contractional fault, in part as envisioned by Chernoff (1976). Key to this interpretation are the steeply dipping and overturned Cretaceous rocks along the east side of the area mapped by Chernoff (1976). They may represent the eastern, overturned limb of the northern Porcupine Anticline, and may be floored by an inferred southern continuation of an east vergent contractional fault shown by Norris (1981) as bounding a panel of Upper Proterozoic to Lower Paleozoic rocks on their east side about 15-20 kilometres to the north-northeast. If this is the case, the doubly plunging anticlinorium

underlying the Rusty Springs area may reflect the influence of a deep-seated feature, such as a lateral ramp, along the inferred contractional fault.

## **Mineralization**

Although exploration models utilized at Rusty Springs have tended to exclusively target either stratabound or discordant styles of mineralization (e.g., Mississippi Valley-type or Irish Plains-type for the former, hydrothermal veins for the latter), there appears to be good evidence for both styles on the property, and they appear to be genetically related. Both styles of mineralization are found almost exclusively in the upper Ogilvie Formation and in the vicinity of the Mike and Orma (Hansen and Bankowski 1979), and their spatial association, similar geochemical signatures, and their association with similar brecciated and dolomitized zones, suggests a genetic link. Potential rests mainly with the stratabound mineralization, which may have greater thickness, much greater continuity, and can be much more readily explored for.

### **Vein-type Mineralization: The Orma Zone**

Mineralization at the Orma zone, on the northwest flank of Orma hill, has been the focus for the bulk of the exploration work at Rusty Springs. Up to the 1990's, virtually all of the drilling on the property occurred there. The zone has yielded many of the highest grades in grab samples, trenches, and drill core (e.g., DDH80-1: 583 g/mlt Ag, 8.23 % Pb, 1.48 % Cu over 6.5 metres) and trenching and drilling have confirmed that it is a discontinuous vein and vein stockwork zone which trends northwest and dips steeply. Vein-type mineralization also appears to be present locally at Mike Hill, with the difference that relatively high Zn and trace Au values commonly accompany the Ag, Pb, and Cu common to mineralization at the Orma zone (Downie 1994; e.g., DDH95-07: 518 gm/t Ag, 0.77 % Pb, 3.0 % Cu, and 1.3% Zn over 15.3 metres).

Veins consist of massive galena-tetrahedrite (tennantite?, as is suggested by elevated As:Sb ratios in some assays, Liedtke (1980)), locally up to 1.0 m thick, which assay roughly 10-50 ounces per ton Ag. The veins are contained within a broader, commonly oxidized mineralized and altered zone (in part a vein stockwork) of up to 6 or 7 metres thickness. The altered zone typically assays 30 to 60 grams ounces per ton Ag (Davis and Aussant 1982). Alteration within Ogilvie Formation carbonates, as described by Bankowski (1980b), is characterized by silica replacement, dolomitization, local brecciation, sanding (silicic alteration?), and decomposition (supergene alteration), and is manifest in part as a darker grey colour of the host rocks. The margin of the altered zone has a northwest trend, subparallel to that of the mineralized zone, and it appears to terminate, or turn bedding-parallel, to the southeast at the contact with overlying siliciclastic rocks (Bankowski 1980b). Minerals identified from the oxidized zones include smithsonite, cerussite, malachite, azurite, aurichalcite, pyrolusite, hemimorphite, plumbojarosite, gibbsite, valentinite, and natroalunite (Hansen 1979, Kirker 1980b); sphalerite and pyrite are also preserved locally with galena and tetrahedrite in siliceous vein and vein-breccia material.

### **Stratabound Mineralization: The Katshat Unit**

Near the end of the 1996 exploration program, stratabound mineralization along the contact between the Ogilvie Formation and overlying Devono-Mississippian siliciclastic rocks became the principal exploration target (Termuende and Downie 1997). Almost all holes drilled in footwall Ogilvie Formation dolostone had essentially been barren, and with relatively thick oxidized mineralization cored at the contact in several previous drillholes that were collared in hangingwall siliciclastic rocks, it was realized that substantial potential existed for stratabound mineralization. It was also recognized that the most extensive geochemical anomalies on the property coincided with the contact, and that many drillholes targeting them had been collared in the strongly oxidized mineralized material-these holes had been plagued by poor core recoveries.

The oxidized material common to the upper contact of the Ogilvie Formation was referred to locally as the Katshat unit. It consists of strongly leached, porous limonitic to kaolinitic material with an earthy, gougy consistency, and is similar in appearance to the oxidized material surrounding discordant mineralization. It is typically 20 to 40 metres thick, and although it appears stratabound at the property scale, in detail it is irregular and discordant. Many of the minerals noted above as occurring in the Orma zone are also common in the Katshat unit. X-ray diffraction studies indicate that much of the Katshat material consists of granular Fe, Mn, Ag, Pb, An, Cu, Ba, Al, P, and V oxide, carbonate, sulphate, and silicate mineral species, as well as quartz veinlets and laminae locally containing sulphides and sulphosalts like those in Orma zone veins and vein stockworks (Hodder, 1997). The Katshat unit is invariably overlain by brecciated and veined siliceous or silicified mudstone and chert of probable Devono-Mississippian age, which caps and in part has protected it from erosion. It is underlain by Ogilvie Formation dolostone, also typically brecciated and veined. The Katshat unit is strongly anomalous in Ag, Cu, Pb, and Zn over broad intervals and across a wide area (for e.g., 1.1 gm Ag, 88 1 ppm Cu, 139 ppm Pb, 3301 ppm Zn over 19.1m in hole RS96-04 from the southwest part of Mike hill, and 1.6 gm Ag, 1475 ppm Cu, 1321 ppm Pb, and 2701 ppm Zn over 22.2m in hole RS96-14 from the south end of the airstrip on Orma hill;). Results such as these suggest the possibility of tremendous continuity and potential, but the oxidized nature of the mineralization and the sub-economic grades also suggest that the preferred target be unoxidized portions of the horizon below the present and(or) paleo- water table (Hodder 1997). Unoxidized Katshat unit was the target of the latest drill program, which attempted to test the upper Ogilvie Formation to the east and south of Orma hill. Results were mixed. Because of problems penetrating the very resistant siliceous and brecciated rocks which overlie the upper Ogilvie Formation and cap the Katshat horizon, the mineralized horizon was never reached. However, the presence of the siliceous rocks suggests that a strong stratabound mineralizing system existed well away from the surface exposures on Mike and Orma hills, and as such, the new information confirms that the Rusty Springs system is very large, and that it has significant potential remaining to be tested.

### **Timing of Mineralization**

The interpretation that Rusty Springs is a Mississippi Valley-type deposit related to karsting along the upper Ogilvie Formation contact suggests that the mineralizing event was likely

bracketed by the ages of the Middle Devonian rocks below and the Upper Devonian to Mississippian rocks above. On the other hand, the discordant nature of mineralization and alteration at Rusty Springs indicates that it postdates deposition of the Lower to Middle Devonian Ogilvie Formation and at least the lowermost part of the overlying Devonian-Mississippian section. In addition, one can argue that evidence such as the lack of obvious cleavage development in the Ogilvie Formation dolostones, which contrasts sharply with that common to most rocks across the property, including other carbonates, suggests that the mineralizing event may even have postdated much of the latest Cretaceous to Tertiary deformation affecting the area (alternatively, it is possible that this may reflect a contrast in competency between the more competent silica-altered and dolomitized rocks associated with mineralization and other less competent lithologies, or that a more subtle stylolitic cleavage exists in the dolostones-Wher study is needed). The parallelism of the Orma zone with structural trends (a fold axial plane?) and localization of Katshat-style mineralization in anticlinal hinge zones at Orma and Mike hills may also supports the hypothesis that mineralization post-dated deformation. A relatively young age is also supported by the rare occurrence of discordant metre-scale vein-breccia bodies of quartz or Fe-carbonate at higher stratigraphic levels (Carboniferous to Permian) in the area surrounding Rusty Springs, and by limited Pb isotope data suggesting which that approximate those of Cordilleran Ag vein deposits of Late Mesozoic age (Kirker 1982).

## **Genesis**

As mentioned above, several deposit models, including those for MVT and hydrothermal replacement along a karsted surface, have been employed in an effort to aid exploration at Rusty Springs. Poor exposure and consequent lack of local bedding control has hindered the collection of evidence with which to evaluate the various models, as has leaching and oxidation of the mineralized zones and dolomitization of footwall rocks. However, discussion of some of the existing evidence is worthwhile so that some models may be critically evaluated and perhaps ruled out, and others put forward in the hope that they aid exploration.

## **Mississippi Valley-type**

Few, if any, of the textural features distinctive of MVT type deposits (e.g., Leach and Sangster 1993) have been positively identified on the property. For example, although the breccias common on the property have been interpreted as solution collapse features (e.g., Hansen 1979, Hodder 1997), cements and infillings of carbonate and local quartz are either massive or encrusted symmetrically around breccia fragments (e.g., Kirker 1982). There is no evidence for infilling by internal sediment, which would be strongly suggestive of a karst environment. Stratigraphic evidence also appears to argue against a karst environment. No regolith or is preserved along the contact between the Ogilvie Formation and the overlying siliciclastic rocks that would indicate subaerial exposure, and even evidence for uplift, such as the presence of coarse grained clastic rocks, is lacking. According to Liedtke (1980), very little relief exists on

the contact, and if anything, subsidence is indicated: the stratigraphic transition is from a shallow water environment in which platformal carbonate was deposited, to a deeper water environment in which basinal shales were deposited.

Differences from classic MVT deposits also exist in the geochemistry and mineralogy at Rusty Springs, as has been noted by many previous workers. The high copper and silver contents, as well as low Zn:Pb ratios are generally atypical of MVT deposits (Leach and Sangster 1993), as are locally very high As and Sb values and the high Al values occurring in the Katshat unit (Termuende and Downie 1997). A geochemical fingerprint such as this is more consistent with an epithermal origin for metals within the host unit. Similar arguments can be made on mineralogic grounds, with the siliceous character of alteration, particularly in the hangingwall, and the common presence of tetrahedrite and argentiferous galena, which are more diagnostic of vein rather than stratabound Ag-Pb-Zn deposits, in the mineralized zones. Fluid inclusion and sulphur isotope data from quartz, calcite, and sphalerite at Rusty Springs are also more comparable to those from epithermal deposits than from those of MVT (Kirker 1982).

Regionally, the evidence also argues against an MVT setting. As Hodder (1997) notes, it is significant that the Ogilvie Formation at Rusty Springs is comprised largely of dolostone in an area in which limestone generally predominates. Even within the Ogilvie Formation itself, the regional dolomitization common to MVT districts appears to be absent--Norris (1996) describes only local dolomite beds in the lower part of the Ogilvie Formation in measured sections farther south in the Ogilvie Mountains.

In spite of the arguments against the presence of MVT mineralization, it remains possible that the mineralization and alteration evident on the Rusty Springs property may simply be the distal expression of a more typical MVT system origins lie in a hydrothermal karst system rather than a meteoric or meteoric-hydrothermal one (c.f. Leach and Sangster 1993).

### **High-temperature, carbonate-hosted massive sulphides: manto-chimney complexes**

The mineralizing system at Rusty Springs bears some of the features of high-temperature, carbonate-hosted massive sulphide deposits (Titley 1993), which are also commonly referred to as manto-chimney complexes, and are rich sources of base and precious metals. This type of deposit, although occurring in quite varied structural or stratigraphic settings, is typically wholly or partially stratabound, commonly contains abundant pyrite, and contains Pb and significant Ag. Copper and Au can be present but are less common than Ag-Pb-Zn, and enrichment in one or the other of Cu-Pb-Zn can be variable. The deposits are generally thought to occur by replacement processes, initiated by hot fluids and(or) gases, above or near centres of thermal activity, and so intrusions are commonly (though not always) spatially associated. Vein, skarn, and even porphyry copper deposits may be closely associated the manto-chimney ores, and it is generally accepted that all are genetically related to the associated intrusions (Titley 1993).

The potential for manto-chimney deposits at Rusty Springs was initially recognized by Termuende (1996). The few preserved hypogene ore minerals recognized at Rusty Springs, such as galena and tetrahedrite, are common in the manto-chimney class, and the silica alteration common on the property is also commonly peripheral to ore or in this deposit type, or at least to districts in which such deposits occur. In addition, dolomitization is known to play a role in the formation of many high-temperature, carbonate-hosted deposits, and breccia bodies are also common to these systems (Titley 1993). The apparent controls on mineralization at Rusty Springs, such as the overlying impermeable fine grained siliceous shale cap, and perhaps the anticlinal fold hinges at Mike and Orma hills, also bear similarities to some manto-chimney deposits (e.g., Tombstone, Arizona; Titley 1993). This factor of predictability is an important advantage in exploration for manto-chimney ores, since they are known to be difficult to explore for. One of the main arguments against the application of the manto-chimney model at Rusty Springs is the lack of direct evidence for intrusive rocks, either on the property or in the region, although Chernoff (1976) shows an inferred intrusion at depth below the domal core of the Rusty Springs antiform. The nearest known plutons to Rusty Springs are Devonian(?) in age and outcrop to the north in the vicinity of Old Crow (Woodsworth et al. 1991).

### **Other economic potential in the vicinity of Rusty Springs**

Little in the way of significant mineralization has been found in the immediate area around Rusty Springs, but recent work and a reevaluation of work done previously indicates that some potential exists and that it should be tested. For example, in the most recent drilling, an interval approximately 40 metres thick within the Devono-Mississippian pyritic shales that overlie the Ogilvie Formation was highly anomalous in zinc; it included intersections of 7 and 15 metres which returned nearly 3000 ppm Zn. Although the hole did not reach its target, it is estimated that the Zn-rich zone lies approximately 100-150 metres up-section from the Ogilvie Formation, at about 250 metres depth. The zone occurs within a siliceous or weakly silicified carbonaceous pyritic mudstone, and sphalerite occurs as fine to medium grained honey brown disseminations, both within mudstone clasts, and within matrix host rocks to zones of quartz or quartz-carbonate microbreccia. The pyritic and locally zinc-rich shales may be the source for the gossanous springs near the base of the north end of Mike hill which lend their name to the Rusty Springs property and, in fact, sediment issuing from the springs themselves was highly anomalous in zinc (Chernoff 1976). This suggests further that the recessive shale package may have potential for hosting Zn deposits, either similar in character to Rusty Springs, or perhaps of the sedex type, much as rocks of similar age, character, and tectonic setting farther southward in the Cordillera do (e.g., Macmillan Pass area, Y.T.; Gataga district, B.C.; Dawson et al. 1991). One might begin to evaluate this potential immediately south-southeast of the area mapped, where rusty creeks and springs, similar in appearance to those at the Rusty Springs property, were noted in the drainage that lies in the recessive core of Norris' (1981) Porcupine Anticline. The springs likely emanate from rocks correlative with the recessive and pyritic Devono-Mississippian rocks that overlie the Ogilvie Formation in the area mapped.

With regard to other possibilities, rare iron carbonate breccia and siliceous veins and vein-breccias were noted in outcrop or float while mapping the surrounding ridges, but none bore visible sulphides, appeared extensive or was accompanied by significant alteration. About 40 kilometres farther south, however, at the Pama (Bern) occurrence, which lies just inside the western boundary of the proposed Fishing Branch Protected area, an impressive, steeply dipping, north-northwest trending quartz-carbonate breccia zone that is hosted by carbonates can be traced for greater than two kilometres. It is outlined by a broad and intense soil geochemical anomaly (O'Donnell 1974) and near its southern end it contains tetrahedrite, copper oxides, and zinc and lead sulphates that bear some similarities to mineralization at Rusty Springs. The Pama property has never been drill-tested, yet smithsonite-rich samples yield assays of up to 47.80% Zn. Although it is hosted in carbonates and has at least some mineralogic similarities to Rusty Springs, no truly convincing evidence was found at the Pama that was suggestive of a significant element of stratigraphic control to mineralization. The breccia zone is hosted by limestone that is probably correlative with the uppermost limestones in the vicinity of Rusty Springs (Upper Carboniferous and Permian(?); considerably younger than the Ogilvie Formation). The breccia appears to dip steeply to the east-northeast, and lies subparallel to the steeply dipping eastern limb of what appears to be a gently southerly plunging, asymmetric, east vergent antiform. The breccia appears to be hosted entirely within limestone, and the limestone is only very locally dolomitized, which is in sharp contrast to Rusty Springs, where the better part of the Ogilvie Formation is dolomitized. Overlying the limestone is a sequence of relatively recessive, fine grained black carbonaceous rocks that appear to be capped by more resistant siliceous sandy beds. The sequence is similar in appearance to the Jurassic and Lower Cretaceous rocks along the east margin of the area mapped at Rusty Springs.

## **2001 PROGRAM AND RESULTS**

Mineral exploration at the Rusty Springs property continued in 2001 with a \$16,500.08 field program. Geological work consisted of helicopter reconnaissance and rock sampling in areas of interest identified by past programs. A total of 11 samples were collected. All samples were shipped to Eco-Tech Laboratories in Kamloops, B.C. where they were analyzed for 30 element ICP using aqua-regia digestion. High-grade samples were further fire assayed. The samples were also analyzed for Germanium content.

The results of the 2001 program continue to confirm the spectacular nature of the mineralization found throughout the Rusty Springs property area. Samples TTRS01R02 and TTRS01R08 returned Bonanza silver grades from float samples collected in the area of the Trog 2 and Conner 4 claims respectively. Two other samples collected in the area of the Trog 1 - 4 claims also returned highly anomalous values. Sample TTRS01R01, a sample of carbonate breccia float with massive coarse grained galena returned values of 98.2 g/t Ag and 3.22% Pb. Sample TTRS01R03 returned values of 62.3 g/t Ag, 3.07% Cu, 13.2% Pb and 1.44% Sb. Both of these samples also contained As values in excess of 10000ppm. Sample TTRS01R04, a sample of massive oolitic iron collected from the Iron Formation in the area of the Trog 50 claim returned

anomalous Zn(454ppm) and Ba(315ppm) values. TTRS01R05, a sample of dolomite float with malachite replacement malachite returned values of 88.9 g/t Ag and 40.7% Cu. TTRS01R06, collected in the area of the Trog 20 claims, returned anomalous Ba values (1490ppm) from a piece of limonite breccia float. TTRS01R07, a sample of rounded, transported Katshat material collected from a drainage on the Conner 1 claims, returned values of 1.2 g/t Ag and 159ppm Zn. TTRS01R10, a sample of dolomite breccia float with aurichalcite collected on the Matt 4 claims returned Zn values in excess of 10000ppm. TTRS01R11, a sample of zinc mineralized crackle breccia hosted by silicified black shale from DDH 99-01 at a depth of 256.4m returned values of 7.4 g/t Ag, 698ppm Pb and 823ppm Zn. None of the samples returned anomalous Ge values.

## **CONCLUSIONS AND RECOMMENDATIONS**

In spite of many years of sound exploration work, the genesis of the Rusty Springs prospect remains incompletely understood, yet it's considerable potential for a large-tonnage Ag-PbZn-Cu deposit remains inadequately tested. The extent of the mineralized and altered rocks at Rusty Springs suggests that the hydrothermal system is large and, in fact, limits to the altered and brecciated zones in the upper Ogilvie Formation have yet to be established, with the possible exception of on the northeast. The size of the mineralizing system, together with its apparent stratabound nature, its commonly significant but subeconomic thicknesses, its local high grades, and its potential for supergene enrichment, indicates that Rusty Springs remains an attractive exploration target. Future exploration should be drill-oriented and should target the uppermost Ogilvie Formation beneath Devono-Mississippian fine grained clastic rocks to the south and southeast of Mike and Orma hills.

Results from the 1999 diamond drilling program at the Rusty Springs property were largely inconclusive because none of the holes could be completed to target depth. The abrasive and generally fractured nature of the rocks overlying the mineralized Katshat horizon have been an obstacle to drill testing throughout the history of exploration on the property. The objective of the 2002 program is to complete the three holes drilled during 1999 using a specialized drill and specific hole conditioning techniques designed to optimize recovery and depth limits in abrasive and fractured ground. Hytech Drilling Limited, a drill contractor based in Smithers, B.C. has a heli-portable customized hydraulic diamond drill that has been built specifically for diamond drilling in bad ground conditions. In concert with this drill, it is further recommended that cement should be used to stabilize the drillhole walls to prevent hole collapse. All holes should be collared using the maximum of combination of casing and large diameter (HQ2) drill pipe. After advancing through bad ground conditions (sand faults, rubble zones), the drill rods should be removed, the hole cemented, and then recored with smaller diameter drill rod (NQ2 or BQ2). The cement will form a stable wall and prevent the incursion of black sand and other rubble around the rods and drill string. Drilling tools designed for abrasive ground conditions should be used, including hexagonal core barrels.

A 1500 meter diamond drilling program is recommended for the Rusty Springs property. The three holes collared in 1999 should be redrilled and completed to projected Katshat Horizon target depths defined by past drill programs and the 1999 mapping results. The 1500 meter proposal includes footage to follow up stratabound massive sulphide mineralization with a single step out hole.

Updated August 23, 2011