Preliminary Results of Geological Mapping, Uranium-Lead Zircon Dating, and Micropaleontological and Lead Isotopic Studies of Volcanogenic Massive Sulphide–Hosting Stratigraphy of the Middle and Late Paleozoic Sicker and Lower Buttle Lake Groups on Vancouver Island, British Columbia (NTS 092B/13, 092C/16, 092E/09, /16, 092F/02, /07)

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Introduction

Volcanogenic strata of the mid-Paleozoic Sicker Group on Vancouver Island (Figure 1) occur in several distinct basement highs (referred to herein as ‘uplifts’). These rocks host the world-class Myra Falls volcanogenic massive sulphide (VMS) deposit (combined production and proven and probable reserves in excess of 40 million tonnes of Zn-Cu-Au-Ag sulphides), as well as numerous other VMS deposits and occurrences, including those in the Big Sicker Mountain area in the southeastern part of the Cowichan Lake uplift (Figure 1). Three of these deposits in the Cowichan Lake uplift, the Lenora, Tyee and Richard III (MINFILE occurrences 092B 001, 092B 002, 092B 003; MINFILE, 2008) have seen limited historical production. The Lara deposit (MINFILE occurrence 092B 129), farther to the northwest, also contains a significant drill-indicated resource of 1 146 700 tonnes grading 3.01% Zn, 1.05% Cu, 0.58% Pb, 32.97 g/t Ag and 1.97 g/t Au (Kelso et al., 2007). Geological mapping (Massey and Friday, 1987; Mortensen, 2005; Ruks and Mortensen, 2006) suggests that the the Big Sicker Mountain area consists mainly of deformed mafic to felsic volcanic and volcaniclastic rocks of the Nitinat and McLaughlin Ridge formations, and high-level intrusions of the Saltspring intrusive suite, as well as abundant gabbroic dikes and sills of the Triassic Mount Hall gabbro (Figure 2). Recent geological mapping in the Cowichan Lake uplift (this study) has been a continuation

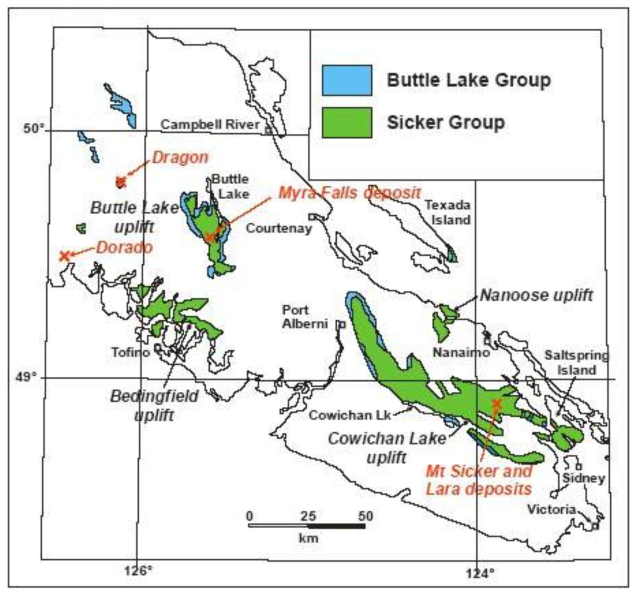

Figure 1. Distribution of Paleozoic strata of the Sicker and Buttle Lake groups on Vancouver Island and the Gulf Islands.

of our efforts to develop a stratigraphic framework for Sicker arc development and VMS mineralization in the Sicker Group. Work conducted on Cowichan Lake uplift mineral tenure owned by project sponsors Treasury Metals Inc. and Westridge Resources Inc. concentrated on resolving the geological setting and age of the Lara VMS deposit and other VMS occurrences in the area, as well as examining new bedrock exposure created by recent logging activity. Reconnaissance fieldwork on new bedrock exposure owned by Westridge Resources Inc. culminated in the discovery of a new, polymetallic VMS occurrence. Mapping in the Mount Brenton area by Treasury Metals Inc. has identified a prospective zone where intensely sericite-al-

Keywords: *Sicker Group, Paleozoic, Vancouver Island, Cowichan Lake uplift, volcanogenic massive sulphide, stratigraphy, uranium-lead zircon geochronology, lithogeochemistry*

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tered and pyrite-mineralized felsic ash tuff is overlain, in turn, by silicified argillite and a chlorite-altered ash tuff of intermediate composition. A similar geological setting is associated with massive sulphide mineralization at the Lenora deposit (Ruks and Mortensen, 2006). Geological mapping and sampling were also focused in the vicinity of the Lady A iron formation (Treasury Metals Inc.; MINFILE 092B 033). The Lady A is similar to other iron formations occurring in rocks that are stratigraphically above VMS mineralization at the Lenora, Tyee and Richard III occurrences, and is believed to represent oxide-facies iron mineralization related to hydrothermal mineralizing systems similar to those that formed the underlying VMS deposits. Resolving the timing of iron formation mineralization in the Sicker Group is critical for establishing the duration of VMS-related hydrothermal activity.

Geological mapping in the Cowichan Lake uplift of the Port Alberni area (Massey and Friday, 1989) indicates that this area is largely underlain by basalt to basaltic andesite volcanic rocks of the Duck Lake and Nitinat formations, respectively, in addition to felsic tuffaceous volcaniclastic rocks belonging to the McLaughlin Ridge Formation. McLaughlin Ridge Formation rocks in the Port Alberni area are interpreted to represent deposition distal from a volcanic centre, which is thought to be represented in the Saltspring Island–Cowichan Lake area by felsic intrusive rocks of the Saltspring intrusive suite (Massey and Friday, 1989). However, geological mapping of new exposures in the Port Alberni area (this study) indicates that felsic volcanic rocks of potential McLaughlin Ridge Formation age are present in significant quantities, necessitating a reinterpretation of the nature of the Sicker Group and its VMS potential in the Port Alberni area.

Sedimentary, mafic volcanic and carbonate rocks of the Nanoose uplift have been tentatively correlated with both the Sicker and Buttle Lake groups (Yorath et al., 1999). However, no geochronological or biostratigraphic sampling has demonstrated an age that facilitates comparisons with the Sicker Group. To resolve outstanding stratigraphic problems in the Nanoose uplift, reconnaissance fieldwork in the area this summer focused on sampling prospective rock types for geochronology and biostratigraphy. Of particular importance is resolving the age of mafic volcanic rocks in the area.

Mapping in the Hesquiat and Gold River areas, on the Dorado and Dragon properties (Paget Resources Corporation; Figure 1), has identified several new VMS occurrences hosted in potential Sicker Group rocks. Geological mapping and sampling on the Dragon property by previous workers indicates the presence of several polymetallic massive sulphide lenses with grades up to 7.33% Zn, 1.34% Pb, 173 ppm Cu, 680 ppb Au and 19.2 g/t Ag over a 2 m thickness (Jones, 1997). Geological mapping of the Dorado and

<table>
<tr><th colspan="2">Muller, 1977 (Vancouver Island)</th><th colspan="2">Juras, 1987 (Buttle Lake Uplift)</th><th colspan="2">Yorath et al., 1999 (Alberni area)</th></tr>
<tr><td colspan="2"></td><td rowspan="3">Buttle Lake Gp</td><td>Henshaw Fm</td><td rowspan="3">Buttle Lake Gp</td><td>St. Mary Lk Fm</td></tr>
<tr><td rowspan="6">Sicker Gp</td><td>Buttle Lk Fm</td><td rowspan="2">Mt Mark Fm</td><td>Mt Mark Fm</td></tr>
<tr><td>Sediment Sill Unit</td><td>Fourth Lk Fm</td></tr>
<tr><td rowspan="2">Myra Fm</td><td rowspan="4">Sicker Gp</td><td>Flower Ridge Fm</td><td rowspan="4">Sicker Gp</td><td rowspan="2">McLaughlin Ridge Fm</td></tr>
<tr><td>Thelwood Fm</td></tr>
<tr><td rowspan="2">Nitinat Fm</td><td>Myra Fm</td><td>Nitinat Fm</td></tr>
<tr><td>Price Fm</td><td>Duck Lk Fm</td></tr>
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Figure 2. Stratigraphic nomenclature for the Sicker and Buttle Lake groups on Vancouver Island (Yorath et al., 1999).

Dragon properties indicates that mafic and felsic volcanic rocks and contained VMS mineralization are overlain by volcano-sedimentary and carbonate rocks, including calcareous tuffaceous sedimentary rocks and fossiliferous limestone, respectively. Nowhere else in the Sicker Group are carbonate rocks observed to directly, and apparently conformably, overlie felsic volcanic rocks and VMS mineralization. This relationship indicates that radical stratigraphic differences exist between rocks of the Dragon property and better studied exposures of the Sicker Group in the Cowichan Lake and Myra Falls areas. These stratigraphic differences may be explained by large changes in volcanic and sedimentological facies or the presence of an unrecognized cycle of arc magmatism and VMS mineralization on Vancouver Island.

The 2008 fieldwork in the Sicker Group commenced in early August and finished in mid-October 2008. Information pertaining to the Dorado property of Paget Resources Corporation is based on fieldwork conducted in 2007. Both reconnaissance and detailed geological mapping, together with sampling for lithogeochemistry, U-Pb zircon dating, and Nd, Hf and Pb isotopic studies, were conducted in the Cowichan Lake, Port Alberni, Nanoose, Gold River and Hesquiat areas over this period. This report presents a summary of this fieldwork, with emphasis on key stratigraphic relationships and areas of economic importance.

Regional Geology of the Sicker Group

The mid-Paleozoic Sicker Group on southern and central Vancouver Island represents the oldest rocks in the Wrangellia Terrane. Equivalents of the Sicker Group are not present in Wrangellia in northwestern British Columbia, southwestern Yukon and southern Alaska, where the oldest rock units are the Skolai Group, which is no older than Pennsylvanian (e.g., Katvala, 2006). This, and other differences between the Wrangellian stratigraphy on Vancouver Island and that in more northerly exposures, emphasize the lack of understanding regarding much of Wrangellia (e.g., Katvala, 2006) and the need for further studies. The Cowichan Lake uplift on Vancouver Island and adjacent portions of the Gulf Islands is the largest of four uplifts that expose the Sicker and overlying late Paleozoic Buttle Lake groups (Figure 1).

Previous detailed studies of the Sicker Group have focused mainly on the stratigraphic setting of VMS mineralization at the Myra Falls deposits in the Buttle Lake uplift (Figure 1; e.g., Juras, 1987; Barrett and Sherlock, 1996). Regional mapping of the Cowichan Lake uplift by Massey and Friday (1987, 1989) and Yorath et al. (1999) led to a stratigraphic framework that may be applicable to the entire Sicker Group (Figure 2). This framework, however, is based on mapping in only one of the four main uplifts of Sicker Group rocks, and is supported by a limited amount of biostratigraphic and isotopic age data (e.g., Brandon et al., 1986). Major along- and across-strike facies changes and geochemical variations are to be expected in submarine volcanic sequences such as the one that forms the Sicker Group; hence, the regional applicability of the stratigraphic framework of Yorath et al. (1999) must be tested with detailed mapping and subsequent lithogeochemical and U-Pb dating studies. This is critical for regional exploration for VMS deposits within the Sicker Group. For example, the questions of whether VMS deposits and occurrences in the Cowichan Lake uplift are all of the same age, and whether their hostrocks are directly correlative with those that host the Myra Falls deposit, are of obvious importance.

The Sicker Group within the Cowichan Lake uplift is presently interpreted to represent three distinct volcanic and volcaniclastic assemblages that together are thought to record the evolution of an oceanic magmatic arc (Massey, 1995; Yorath et al., 1999). The lowermost Duck Lake Formation yields mainly normal mid-ocean-ridge basalt (N-MORB) geochemical signatures (Massey, 1995) and is interpreted to represent the oceanic-crust basement on which the Sicker arc was built. The upper portions of the Duck Lake Formation yield tholeiitic to calcalkaline compositions and may represent primitive arc rocks. The Duck Lake Formation is overlain by the Nitinat Formation, which comprises mafic, submarine volcanic and volcaniclastic rocks with dominantly calcalkaline compositions and trace-element signatures typical of volcanic arc settings. These rocks are interpreted as an early stage of arc development. The andesitic to mainly dacitic and rhyolitic McLaughlin Ridge Formation overlies the Nitinat and is believed to be correlative with the Myra Formation, the hostrocks for the Myra Falls deposits (Figure 2). Rocks of the McLaughlin Ridge and Myra formations reflect a more evolved stage of arc activity. Eruption of Nitinat volcanic and volcaniclastic rocks appears to have occurred from several widely scattered centres, whereas the McLaughlin Ridge Formation within the Cowichan Lake uplift is thought to represent eruption from one or more major volcanic edifices. The abundance of proximal felsic volcaniclastic rocks and the presence of voluminous comagmatic felsic intrusions in the Saltspring Island and Duncan areas (Figure 1) indicate that one of these major volcanic centres was located in this area. Plant fossils indicate that at least a minor amount of the McLaughlin Ridge volcanism occurred in a subaerial setting. In the Port Alberni area, the McLaughlin Ridge Formation has previously been interpreted to comprise felsic, fine-grained tuffaceous volcaniclastic and epiclastic rocks, suggesting deposition distal from a volcanic centre. The identification of significant quantities of proximal felsic volcanic rocks in the Alberni area this year suggests that an additional felsic volcanic centre may be located in the Port Alberni area. Deposition of sedimentary and volcano-sedimentary rocks of the overlying Fourth Lake Formation of the Buttle Lake Group followed the cessation of Sicker arc magmatism, and scarce mafic volcanic rocks contained within the Fourth Lake Formation yield enriched tholeiitic rather than the calcalkaline compositions that characterize the McLaughlin Ridge. Massey (1995) speculated that the Buttle Lake Group may represent a marginal-basin assemblage that developed on top of the Sicker arc.

Studies of the Sicker and Buttle Lake groups on southern Saltspring Island by Sluggett (2003) and Sluggett and Mortensen (2003) provided new U-Pb zircon age constraints on both felsic volcanic rocks of the McLaughlin Ridge Formation and several bodies of Saltspring intrusions. This work demonstrates that two distinct episodes of felsic magmatism occurred in this portion of the Cowichan Lake uplift. One sample of felsic volcanic rocks from the McLaughlin Ridge Formation and three samples of Saltspring intrusions yielded U-Pb ages in the range 356.5–359.1 Ma. A somewhat older U-Pb age of 369.7 Ma was obtained from a separate body of the Saltspring intrusions at Burgoyne Bay on the southwest side of Saltspring Island, indicating that magmatism represented by the McLaughlin Ridge Formation and associated Saltspring intrusions occurred over a time span of at least 15 Ma. There is insufficient age control available at this point to determine whether the magmatism was continuous or episodic during this time period.

Rocks in the Nanoose uplift (Figure 1) have been tentatively correlated with both the Sicker Group and the Buttle Lake Group, and comprise fine clastic rocks, chert, diabasic to andesitic volcanic rocks and limestone (Yorath et al., 1999). A fossil sample from crinoidal limestone in the Nanoose uplift provided brachiopods that yielded a Permian age and fusulinids that yielded a Middle Pennsylvanian age (Muller, 1980). However, diabasic and andesitic pillow lavas in the area have unknown stratigraphic affinities. On the Ballenas Islands, however, these pillow lavas are associated with green and grey chert, and are interbedded with a red tuff breccia which contains both scoriaceous mafic volcanic clasts and crinoidal limestone clasts. The association between mafic flows, chert and a conspicuous breccia unit containing crinoidal limestone clasts is strikingly similar to geological relationships observed in the Lacy Lake–Horne Lake region (Ruks and Mortensen, 2007), suggesting a potential correlation between the two areas.

The age and stratigraphy of rocks underlying the Dragon and Dorado properties, in the vicinity of Gold River and Hesquiat, respectively, is poorly constrained. The Dragon property is located approximately 80 km west of Campbell River, 20 km northwest of Gold River and 65 km northwest of the Myra Falls mine of Breakwater Resources Ltd. (Figure 1). Regional mapping of the Dragon property area by Muller (1977) interpreted the rocks underlying the Dragon property as amphibolite-grade metamorphic rocks belonging to the Westcoast Crystalline Complex. Muller described the Westcoast Crystalline Complex as amphibolite-faces metamorphic rocks belonging to the Middle Paleozoic Sicker Group, the Late Paleozoic Buttle Lake Group and the Triassic Karmutsen Formation. After the discovery of massive sulphides in float on the Dragon property by prospector E. Specogna, work by Noranda geologists culminated in the discovery of the Falls and North VMS occurrences (Kemp and Gill, 1993). Further geological mapping and diamond-drilling by Noranda and Westmin geologists indicated that these showings, with grades up to 7.33% Zn, 1.34% Pb, 173 ppm Cu, 680 ppb Au and 19.2 g/t Ag over a 2 m thickness, are associated with the contact zone between underlying bimodal volcanic rocks and overlying sedimentary rocks and limestone (Jones, 1997). Volcanic rocks of the Dragon property that underlie massive sulphide mineralization consist of massive, flow-banded rhyolite, andesite and tuffaceous felsic and intermediate volcanic rocks. Sedimentary and carbonate rocks overlying and interlayered with massive sulphide mineralization on the Dragon property consist of chert, mudstone, calcareous mudstone, fossiliferous felsic tuff, fossiliferous wackestone and marble.

The Dorado property is located approximately 17 km north of the village of Hesquiat, on the west coast of Vancouver Island. Like the Dragon property, rocks underlying the Dorado property were originally interpreted by Muller (1977) as amphibolite-facies metamorphic rocks assigned to the Westcoast Crystalline Complex. However, geological mapping of the area by Marshall et al. (2006) has shown the region to be underlain by abundant mafic volcanic rocks of potential Sicker Group affinity, and by sedimentary and carbonate rocks of potential Buttle Lake Group affinity. Following up on reports by Marshall et al. (2006) of polymetallic VMS-style stockwork mineralization in the area, Paget Resources Corporation staked the Dorado property and soon after discovered several polymetallic massive sulphide occurrences. Massive sulphide mineralization on the Dorado property is associated with the contact between massive, variably silica-altered, clinopyroxene- and feldspar-phyric andesite and overlying tuffaceous, volcano-sedimentary rocks.

Results of New Fieldwork in the Cowichan Lake Area

Mapping for 2008 fieldwork was conducted using ESRI's ArcPad™ 7 on a Hewlett-Packard IPaq HX4700 Pocket PC wirelessly connected to a GlobalSat® BT-359W Bluetooth GPS receiver. The BC Geological Survey's regional geology compilation for UTM Zone 10, southwestern BC, as well as numerous geological maps derived from mineral exploration assessment reports, were used for reference (Massey et al., 2005).

Westridge Resources Inc.

Due to fire-season access restrictions during this field season, only 1 day has been spent on Westridge Resources Inc. ground thus far. As a result, additional work on the Westridge Resources mineral tenure is planned for late November of 2008. Work carried out thus far has concentrated on resolving the geological setting of the Breen Lake massive sulphide occurrences (MINFILE 092B 090; Figure 3).

The Breen Lake area is underlain by east-striking, steeply dipping, andesitic and rhyolitic volcanic rocks that have been intruded by gabbro. The most prospective massive sulphide mineralization discovered to date in the Breen Lake area is the Jane showing. This showing consists of two adits reported to intersect several massive sulphide lenses (pyrrhotite-sphalerite-chalcopyrite) up to 0.46 m wide and 1.52 m long, of which a 0.91 m sample assayed 16.1% Zn (Fyles, 1950; Pattison and Money, 1988). The adits of the Jane showing were located during the 2008 site visit, but no sulphide mineralization could be found due to infill of the adits with overburden. The adits are collared in a zone of strongly foliated felsic ash tuff, which is presumed to be the host to the mineralization. Approximately 500 m to the east of the Jane adit, a new massive sulphide showing was discovered in new exposure created by recent logging-road construction at the north end of Breen Lake. This showing consists of a 10–20 cm wide band of massive pyrite, chalcopyrite and trace sphalerite mineralization hosted in a sericite- and chlorite-altered, intermediate to dacitic ash tuff (Figure 4). Much of the showing is covered by road-building material and overburden, so the true size of the mineralization remains to be established. Additional work to be conducted on Westridge Resources ground this winter will focus on evaluating the geological setting of this new discovery, as well as that of other mineral occurrences in the vicinity. Particular attention will be given to mapping new exposures of Sicker Group stratigraphy created by recent logging-road construction in the area.

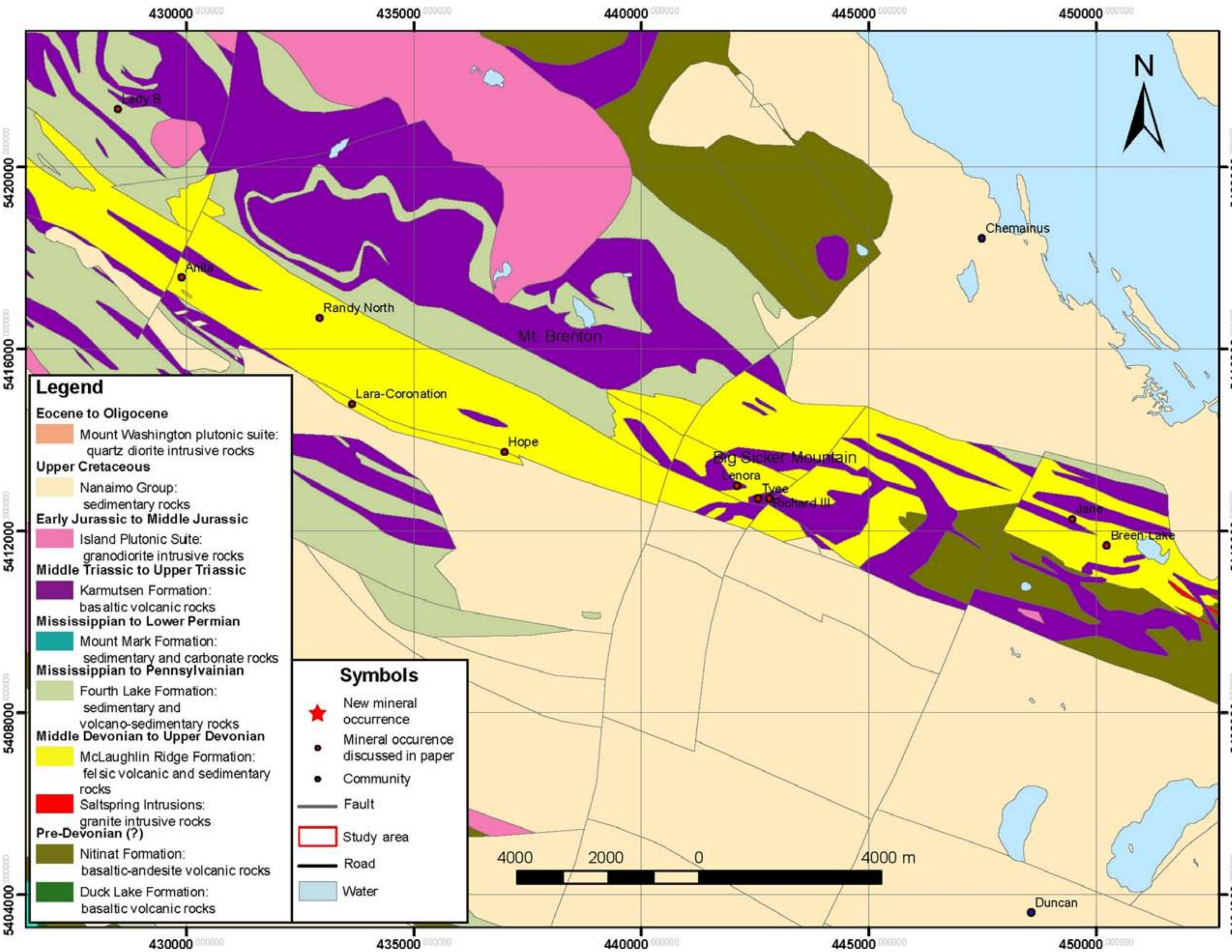

Figure 3. Regional geology, selected mineral occurrences and areas of study for 2008 fieldwork in the Cowichan Lake area (*modified from* Massey et al., 2005).

Treasury Metals Inc.

Work conducted on Treasury Metals Inc. ground this field season (the 'Lara property') focused on visiting known mineral occurrences with the goal of establishing their geological setting and age, as well as on conducting fieldwork in areas of new exposure created by logging-road construction. Unfortunately, due to a depressed forestry market during the past few years, very limited logging has been conducted on the Lara property and, as a result, there has been little new exposure created since the last main phase of exploration on the property in the 1980s by Laramide Resources Inc., Abermin Resources Corp. and Minnova Inc. However, forestry companies have recently marked much of the Lara property for logging, so there is a good chance that new bedrock exposures will be created there in the near future.

The Lara property hosts many VMS occurrences, the most notable of which is the Lara VMS deposit or Coronation trend (Figure 3). It consists of two main zones, the Coronation and Coronation Extension zones, collectively referred to as the Coronation trend, that combine for an indicated resource at a 1% Zn cut-off of 1 146 700 tonnes at 3.01% Zn, 1.05% Cu, 0.58% Pb, 32.97 g/t Ag and 1.97 g/t Au (Kelso et al., 2007). Sulphide mineralization of the Coronation and Coronation Extension zones is hosted by strongly silicified, coarse-grained rhyolite crystal tuff and ash tuff (Kelso et al., 2007). Surface mapping and sampling of two Coronation zone trenches was conducted during this study. The westernmost trench mapped in the Coronation zone (UTM Zone 10, 433489E, 5414841N, NAD83) is a flooded pit with sparse bedrock exposure at its north end (Figure 5a). Here, dark grey to black, medium-grained massive sulphides, consisting of 95% black sphalerite and 5% chalcopyrite, are in sharp contact with an intensely silica- and sericite-altered felsic ash tuff containing trace to 0.5% quartz and feldspar crystals up to 3 mm in size (Figure 5a). Bedding in this altered tuff dips steeply to the north. Massive sulphide mineralization in this pit contains elongated blebs of carbonate up to 2 cm wide and 10 cm long. The easternmost trench mapped in the Coronation zone (UTM Zone 10, 433558E, 5414824N) contains similar, medium-grained, massive sulphide mineralization comprising abundant black sphalerite with lesser chalcopyrite and pyrite (Figure 5b). This mineralization is hosted within a strongly silicified felsic crystal tuff with 2% quartz crystals up to 2 mm in size and abundant bull-quartz veining (up to 30 cm in width). Significant structural complexity is exposed in this trench, with felsic tuff on the east side of the massive sulphides being observed to fold into the plane of the mineralization (Figure 5b). No folding was observed in areas of the trench west of the massive sulphide mineralization, suggesting the potential for sinistral drag folding along the plane of massive sulphide mineralization. The absence of fault gouge associated with potential fault motion in this area may be explained by strain accommodation via massive sulphide recrystallization. Abundant concordant bull-quartz veining in felsic crystal tuff immediately east of the massive sulphide mineralization is probably the result of space filling during folding (Figure 5b).

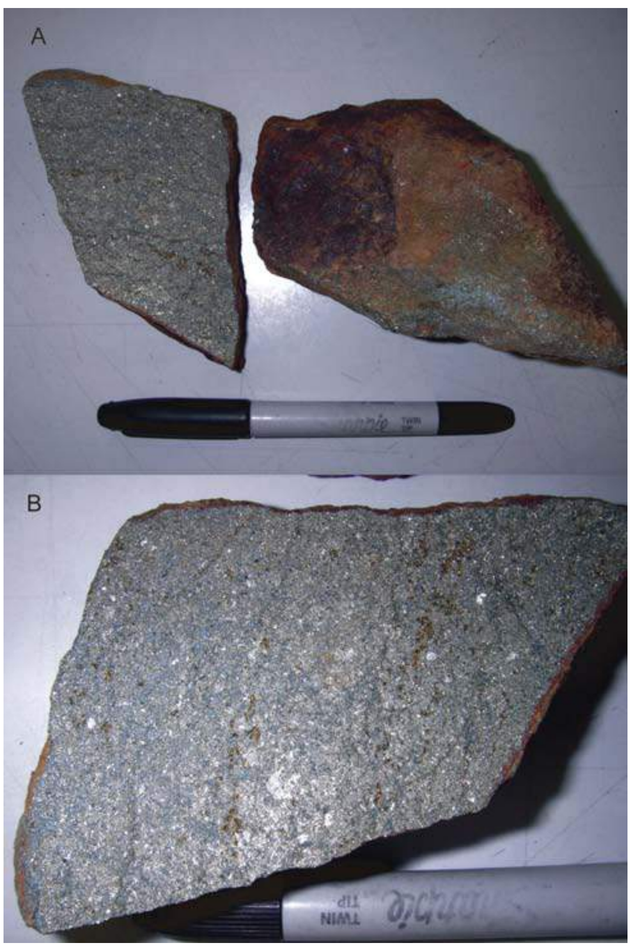

Figure 4. New massive sulphide mineralization discovered on the Westridge Resources Inc. mineral tenure in the Breen Lake area: **A)** medium- to coarse-grained massive pyrite with interstitial chalcopyrite and trace sphalerite; **B)** close-up of massive sulphide mineralization.

The Randy North showing (MINFILE 092B 128), located approximately 2 km to the north of the Coronation zone (Figure 3), consists of several zones of anomalous polymetallic mineralization hosted in strongly sericite-altered felsic volcaniclastic rocks (Kelso et al., 2007). Exposures in the vicinity of the Randy North showing are often covered by thick moss, making geological mapping of the area problematic. In this area, moderately to strongly sericite-altered and highly foliated felsic crystal tuff, with 1–3% quartz crystals up to 5 mm size, hosts zones of intense pyrite stockwork mineralization. A small outcrop of medium-grained, sandy intermediate tuff was observed approximately 400 m to the southwest of this area (downsection?). Moderately sericite-altered, quartz–

potassic-feldspar porphyry becomes dominant to the west of the area, extending for at least 400 m along strike. This unit contains up to 20% potassic feldspar and quartz phenocrysts up to 5 mm in size, and may represent the subvolcanic heat source for the Randy North mineralizing system.

The Hope showing (MINFILE 092B 110) is situated along the southern flanks of Mount Brenton and approximately 3.5 km southeast of the Coronation zone (Figure 3). The showing comprises a small roadside outcrop of silicified felsic crystal tuff with 1% quartz crystals up to 2 mm in size. This tuff is intruded by gabbro, with intense silicification at the contact. Mineralization observed at the showing consists largely of disseminated pyrite with trace chalcopyrite veinlets and malachite staining. Sampling of the Hope showing by previous workers has yielded results up to 0.2% Cu, 0.85% Pb, 2.95 g/t Au and 25.03 g/t Ag, with barium contents averaging about 2% (Belik, 1983). Sampling of Hope showing mineralization for Pb isotope analysis has been conducted in order to determine if it is syngenetic with felsic volcanic rocks in the area.

Approximately 1.7 km north of the Hope showing, a potentially new prospective zone for VMS mineralization has been identified (Figure 3). Although much of this zone is poorly exposed in roadbed outcrop, key stratigraphic relationships are still visible. Here, an intensely sericite-altered felsic ash tuff, with 1–2% disseminated pyrite and trace quartz crystals, is overlain by a silicified argillite. Overlying the silicified argillite is a chlorite schist with 15–20% ankerite augen up to 5 mm in size. Collectively, this package dips steeply to the northeast. Massive sulphide mineralization at the Lenora adit, located approximately 6 km to the southeast (Figure 3), is associated with the contact between a similar, intensely sericite-altered felsic ash tuff and silicified argillite (Ruks and Mortensen, 2006). The stratigraphic package that hosts anomalous polymetallic mineralization of the Randy North zone is also capped by argillite (Kelso et al., 2007).

The Anita zone (MINFILE 092B 037), located approximately 4.7 km northwest of the Coronation zone (Figure 3), consists of polymetallic sulphide mineralization situated close to the contact between mafic tuffaceous rocks and felsic volcaniclastic rocks. The best drill intersection of the Anita horizon to date is diamond-drill hole 87-37, which intersected 2.5 m of 2.37% Cu, 0.73% Pb, 2.73% Zn, 46 g/t Ag and 0.72 g/t Au hosted in a pyritic felsic tuff. Another hole, 88-49, included a 4.9 m interval of 2.3% Cu, 0.49% Pb, 3.66% Zn, 73.9 g/t Ag and 1.9 g/t Au. The lithology that hosts the mineralization in the Anita zone is not known, as this information is not available in assessment reports. Mapping in the Anita zone (this study) has located several exposures of moderately to intensely sericite-altered felsic ash and crystal tuff, with up to 1% quartz crystals up to 4 mm in size. Sampling of felsic volcanic rocks associated with the Anita zone for U-Pb (zircon) geochronology was conducted in order to determine if it is part of the same

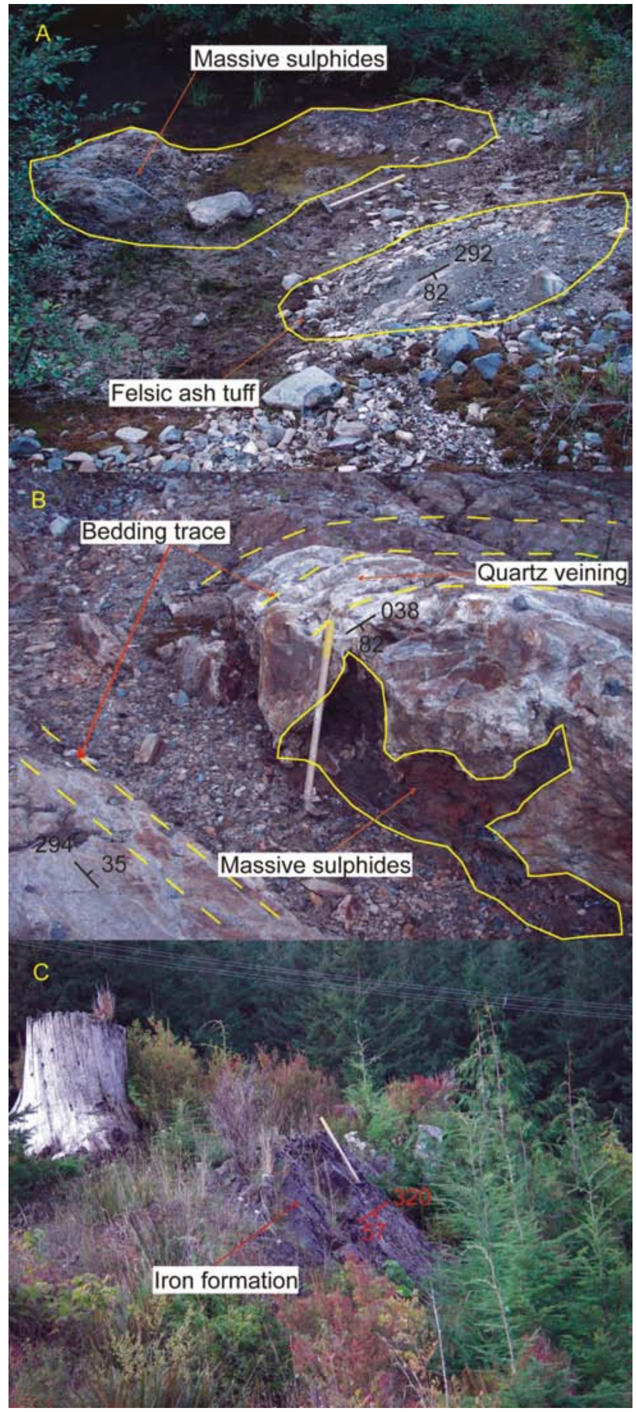

Figure 5. A) Massive sulphide mineralization in contact with silicified felsic ash tuff at the northwest pit, Coronation zone, Lara property of Treasury Metals Inc. **B)** Massive sulphide mineralization hosted by silica- and sericite-altered felsic ash and crystal tuff, northeast pit, Coronation zone; rocks on the east side of the massive sulphide mineralization are folded into the mineralization, suggesting the presence of drag folding. **C)** Fine- to medium-grained massive magnetite of the Lady B iron formation of Treasury Metals Inc. (MINFILE 092B 33).

stratigraphic package that hosts the Coronation trend or the Big Sicker Mountain VMS deposits. Fieldwork this summer also indicated that the MINFILE location for the Anita showing is incorrect, with the Anita shaft located at UTM co-ordinates Zone 10, 429862E, 5417127N (NAD83), approximately 450 m south of the MINFILE position.

The Lady B iron formation (MINFILE 092B 033) is similar to other iron formations occurring in rocks that are stratigraphically above VMS mineralization at the Myra Falls, Lenora, Tyee and Richard III occurrences, and is believed to represent oxide-facies iron mineralization related to hydrothermal mineralizing systems similar to those that formed the underlying VMS deposits. Resolving the timing of iron formation mineralization in the Sicker Group is critical for establishing the duration of VMS-related hydrothermal activity. The Lady B iron formation is located beneath a major power line, and is accessible from the south via a deactivated logging road in the vicinity of the Anita zone (Figure 3). The showing consists of a 15 m by 3 m outcrop of fine- to medium-grained, massive black magnetite (Figure 5c). The massive magnetite contains rusty pyritic zones up to 30–40 cm in size and trace blebs of chalcopyrite up to 2 mm in size. Abundant dacitic to intermediate volcanic rocks are located to the south of showing. These volcanic rocks are less felsic than those associated with VMS occurrences to the south (downsection?), and comprise light grey-green, dacitic to intermediate tuff with abundant feldspar crystals and weakly sericite-altered, flattened pumice clasts. Crystal-poor, ash-rich layers of similar colour are also abundant, many of which contain chlorite-altered, flattened pumice clasts. In certain locations, ash-rich zones pick up a strong fabric, becoming phyllitic in texture and potentially representing zones of shearing. Volcanic rocks most proximal to the Lady B iron formation were sampled for U-Pb (zircon) geochronology in order to resolve the age of iron formation mineralization and constrain a minimum age for VMS-related hydrothermal activity in Sicker Group rocks of the Cowichan Lake area.

Results of New Mapping in the Port Alberni Area

Mapping of Sicker Group bedrock geology and sampling for lithogeochemistry, U-Pb zircon and Ar/Ar hornblende geochronology, and Pb, Nd and Hf isotope tracer studies was conducted in the Port Alberni area. This work was concentrated 1) in the vicinity of recent logging activity southeast of Horne Lake; 2) on mineral tenure owned by Bitterroot Resources Ltd. and Mineral Creek Ventures Inc.; and 3), in the McLaughlin Ridge area, in the vicinity of Kammat and Peak lakes (Figures 1, 6). Bedrock exposure in all areas is moderate, with the best exposures occurring in logging-road cuts. Off-road exposures are typically covered with thick layers of moss and organic detritus, often in forested, low-light conditions.

Horne Lake Area

The oldest rocks encountered in recent mapping southeast of Horne Lake (Figure 6, region A) are assigned to the Nitinat Formation (Massey and Friday, 1989). These consist largely of dark green, often clinopyroxene-phyric andesitic sandy tuff, lapilli tuff, tuff breccia and agglomerate. Andesite clasts are dominantly subangular to subrounded, variably hematite or silica altered, variably clinopyroxene phyric, and attain sizes up to 15 cm. Clinopyroxene crystals reach sizes up to 1 cm and are typically euhedral. Chlorite and epidote amygdules are often present, reaching sizes up to 5 mm.

Andesitic volcanic rocks pass upwards into a package of low-energy marine sedimentary rocks, consisting of argillite, radiolarian chert and silty to sandy intermediate tuff. This relationship is strikingly similar to that observed in the Lacy Lake–Horne Lake area, where chert, argillite and intermediate tuff also overlie mafic volcanic rocks (Ruks and Mortensen, 2007).

Felsic volcanic rocks predominate farther upsection. These consist primarily of dacite and rhyodacite lapilli tuff, tuff breccia and dacite intrusions. Felsic volcaniclastic rocks in this area contain potassic feldspar and biotite, as well as quartz-phyric dacite and rhyodacite clasts ranging from <1 to 30 cm in size and from subrounded to subangular in shape (Figure 7a). Matrix material in felsic volcaniclastic rocks of this area consists largely of feldspar, with more rare examples containing a mixture of feldspar and euhedral clinopyroxene. The presence of euhedral clinopyroxene crystals in the matrix of dacite-rhyodacite lapilli tuff and tuff breccia is significant, as it indicates the coexistence of mafic and felsic volcanism, or the reworking of underlying mafic volcanic material. In one locality, a feldspar- and biotite-phyric dacite plug is observed to intrude felsic sandy tuff (Figure 7b). Feldspar and biotite phenocrysts reach sizes of 5–7 mm. Trace quartz phenocrysts were also observed. Potential peperitic interaction zones were observed along the margin of the intrusion. In these zones, margins of the dacitic plug were brecciating in sandy tuff, with subangular to angular clasts of dacite porphyry ranging from <1 to 10 cm in size.

Bitterroot Resources Ltd. and Mineral Creek Ventures Inc.

Work continued on the Bitterroot Resources Ltd. mineral tenure in the Port Alberni area this year (the 'Debbie property'), with the focus of resolving the age of Sicker Group stratigraphy and contained mineral occurrences in the area (Figure 6, regions B and C). Much of the bedrock underlying the Bitterroot Resources and Mineral Creek Ventures mineral tenure is interpreted to comprise rocks of the Duck Lake and Nitinat Formations (Massey and Friday, 1989). The Duck Lake Formation consists of pillow basalt, pillow

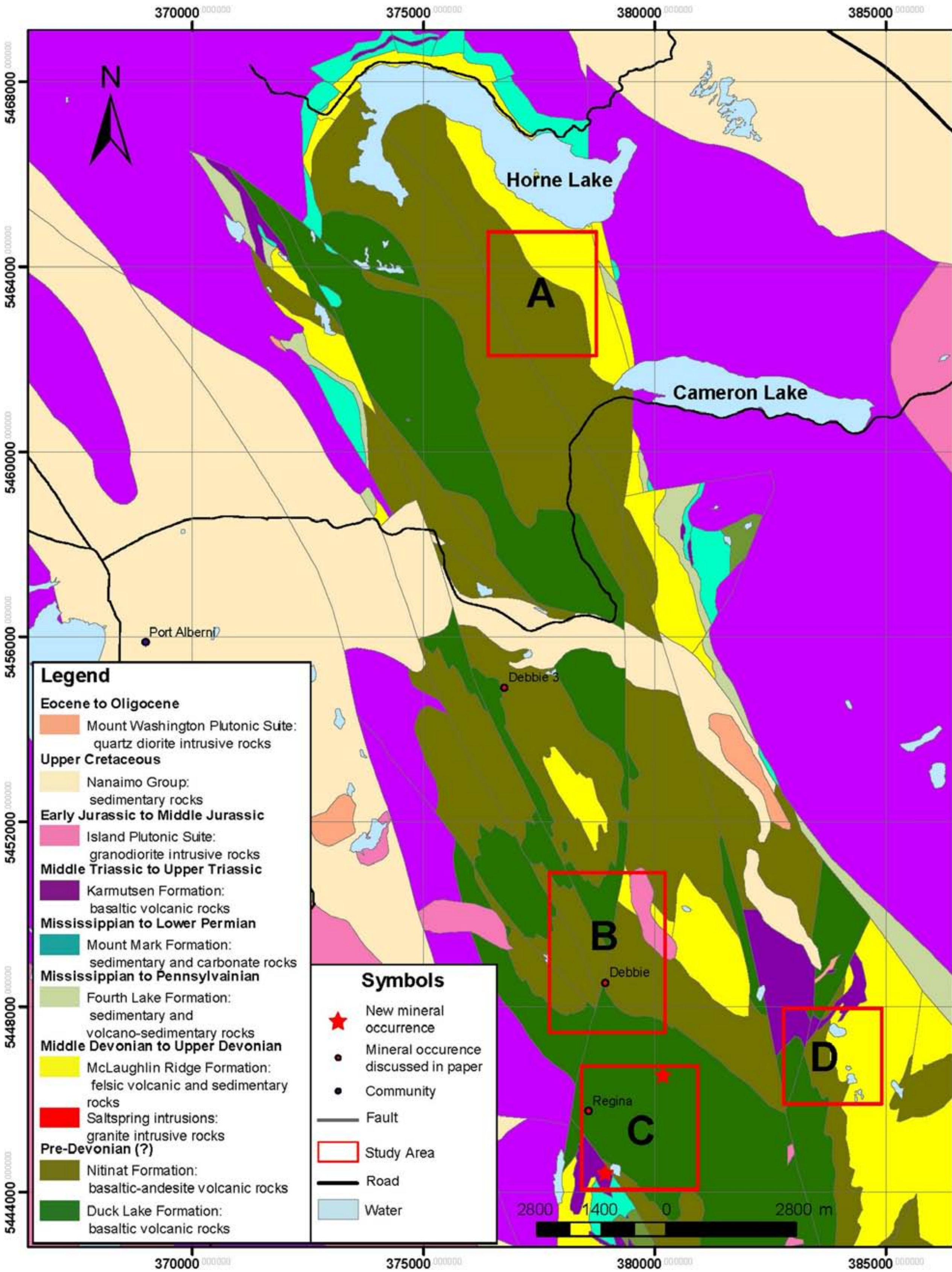

Figure 6. Regional geology (*modified from* Massey, 2005), selected mineral occurrences and areas of study for 2008 fieldwork in the Port Alberni area.

breccia and interflow mafic tuffaceous sedimentary rocks, and is believed to represent the oceanic crust upon which the Sicker arc was built (Massey and Friday, 1989). As such, Duck Lake Formation rocks are interpreted as the oldest in the Sicker Group and, by default, the oldest in Wrangellia (Massey and Friday, 1989). The VMS mineralization of the Debbie 3 occurrence (MINFILE 092F 445), owned by Bitterroot Resources and Mineral Creek Ventures, consists of four stratiform lenses of banded massive sphalerite with minor chalcopyrite and galena, each band ranging between 5 and 20 cm in thickness. The best grade obtained from sampling of this mineralization by previous workers includes 14.1% Zn, 0.87% Pb and 0.12% Cu over a 20 cm thickness. The mineralization is hosted in fine-grained chloritic schist with variable carbonate, sericite and silica alteration (Ruks and Mortensen, 2007). The chloritic schist hosting Debbie 3 mineralization is spatially associated with clinopyroxene-phyric andesitic volcanic rocks assigned to the Nitinat Formation. The Debbie 3 VMS occurrence is therefore believed to represent the oldest VMS mineralization in the Sicker Group. Since most exploration for VMS mineralization in the Sicker Group has focused on bimodal volcanic rocks belonging to the McLaughlin Ridge and Myra formations, the relatively unexplored Duck Lake and Nitinat formations represent attractive targets for this style of mineralization.

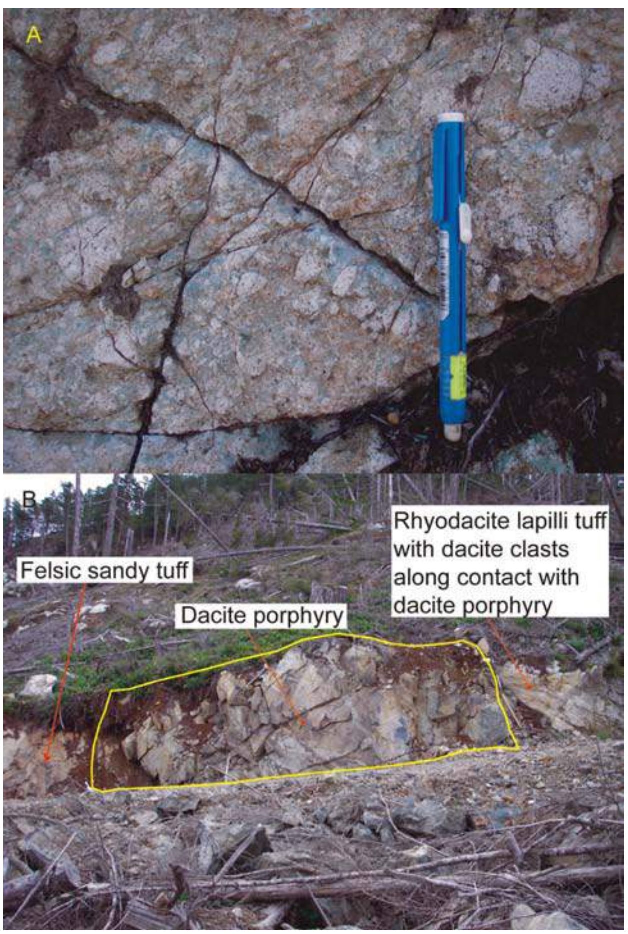

Figure 7. Newly discovered felsic volcanic rocks in the Horne Lake area: **A)** rhyodacite lapilli tuff; **B)** feldspar-quartz–phyric dacite porphyry intruding felsic lapilli and sandy tuff; clasts of dacite porphyry are found in the tuff near the contact zone with the intrusion, suggesting potential peperitic interaction.

Due to the absence of rocks in the Nitinat and Duck Lake formations that are amenable to radiometric dating, much of the work conducted on the Bitterroot Resources and Mineral Creek Ventures mineral tenure this season focused on locating and sampling radiolarian chert for biochronology. Samples of chert associated with mafic to intermediate tuff assigned to the Nitinat Formation were collected from various locations on the property, most notably from chert interbedded with intermediate tuff in the vicinity of the Debbie exploration tunnel (Figure 6) and workings in the immediate vicinity.

In the Duck Lake area (Figure 6, region C), mapping and sampling were conducted on the Duck Lake Formation type section (Massey and Friday, 1989), as well as in the vicinity of the Regina Cu-Au vein occurrence. Along the Duck Lake Formation type section, massive pillow-basalt flows alternate with interflow sandy to silty mafic tuff containing rare chert beds. Several samples of sandy mafic to intermediate tuff were collected for U-Pb (zircon) geochronology. Pillow-basalt flows were sampled for geochemical and isotope-tracer studies. Where recrystallization was not too strong, chert was collected for radiolarians.

A new mineral occurrence was discovered on the Bitterroot Resources and Mineral Creek Ventures mineral tenure during this fieldwork. This new mineral occurrence is located approximately 130 m southwest of Duck Lake (Figure 6, region C). Here, a unit of massive diabase assigned to the Triassic Karmutsen Formation is crosscut by several gossanous zones up to 30 cm in width (Figure 8b). These zones are filled with 3–4% coarse pyrite and up to 0.5% coarse-grained to blebby chalcopyrite. Intense silicification of the diabase is associated with these gossanous zones. A bed of fine-grained massive sulphide (dominantly pyrite) was discovered in a new exposure along China Creek Main (Figure 6, region C). The bed is approximately 20 cm wide and interbedded with siliceous argillite (Figure 8a). Mafic sandy tuff and scoriaceous mafic volcanic rocks are also found in the immediate vicinity of the mineralization. Siliceous interbeds within the massive sulphide mineralization were sampled for radiolarian biostratigraphy.

McLaughlin Ridge: Peak and Kammat Lakes Area

The type section for the McLaughlin Ridge Formation (Yorath et al., 1999) is located on McLaughlin Ridge, approximately 18 km southeast of Port Alberni and 1 km southwest of Peak Lake (Figure 6, region D). The McLaughlin Ridge Formation in this area consists of volcaniclastic strata, lesser greenstone and minor chert. Volcaniclastic rocks in the McLaughlin Ridge Formation type-section area are believed to represent andesitic volcanic rocks that have been reworked from the underlying Nitinat Formation. Yorath et al. (1999) correlated rocks of the McLaughlin Ridge Formation type-section area with felsic volcanic rocks and contained VMS mineralization found in the Cowichan Lake and Buttle Lake uplifts (e.g., the Big Sicker Mountain/Lara and Myra Falls deposits, respectively). However, there are no radiometric or biostratigraphic ages to support any of these correlations.

Reconnaissance fieldwork this summer was conducted in the Peak and Kammat Lakes area (Figure 6, region D), in the immediate vicinity of the McLaughlin Ridge Formation type section (Yorath et al, 1999). Here, abundant buff-weathering, often chevron-folded, red and green radiolarian chert is interbedded with green, intermediate, silty to sandy tuff. The tuff is well sorted, with coarser fractions containing abundant feldspar crystals. Radiolarian chert was sampled in several localities. In one locality, laminated radiolarian chert was observed to have its bedding deflected by an aphyric clast of unknown lithology (Figure 9). This clast might be a coarse clast transported via turbidite flow, or it may be a volcanic bomb. The latter possibility is significant as it would indicate the coexistence of volcanism during chert deposition and would aid in correlations between stratigraphy in the McLaughlin Ridge area and that of other Sicker Group localities.

Rocks encountered in the Peak and Kammat Lakes area are dominated by radiolarian chert interbedded with intermediate tuff, but the chert becomes interlayered with basaltic sills to the southwest. Basaltic sills intruding the chert package often contain abundant spherulites and quartz amygdules up to 4 mm in size; acicular feldspar phenocrysts up to 1 mm in size; and subhedral, chlorite-altered mafic phenocrysts up to 1.5 mm in size. Chert layers ap-

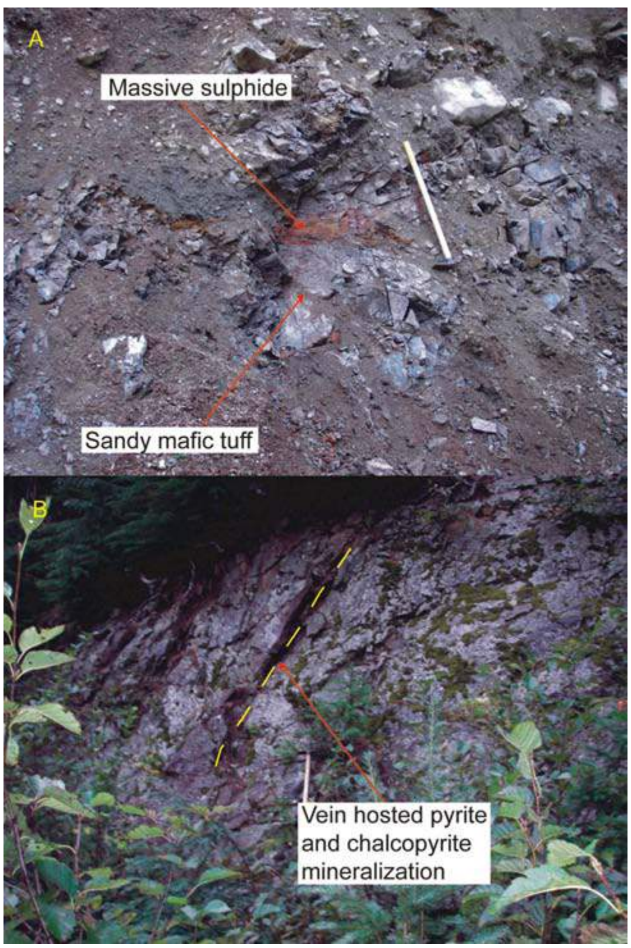

Figure 8. Newly discovered mineralization in the Port Alberni area: **A)** stratiform massive pyrite in a new exposure along Duck Lake Main; the mineralization is interbedded with siliceous argillite, chert and mafic sandy to lapilli tuff; **B)** gossanous and silica-altered zones within a massive diabase are associated with quartz-vein–hosted pyrite and chalcopyrite mineralization; the dashed yellow line is the trace of the mineralized zone.

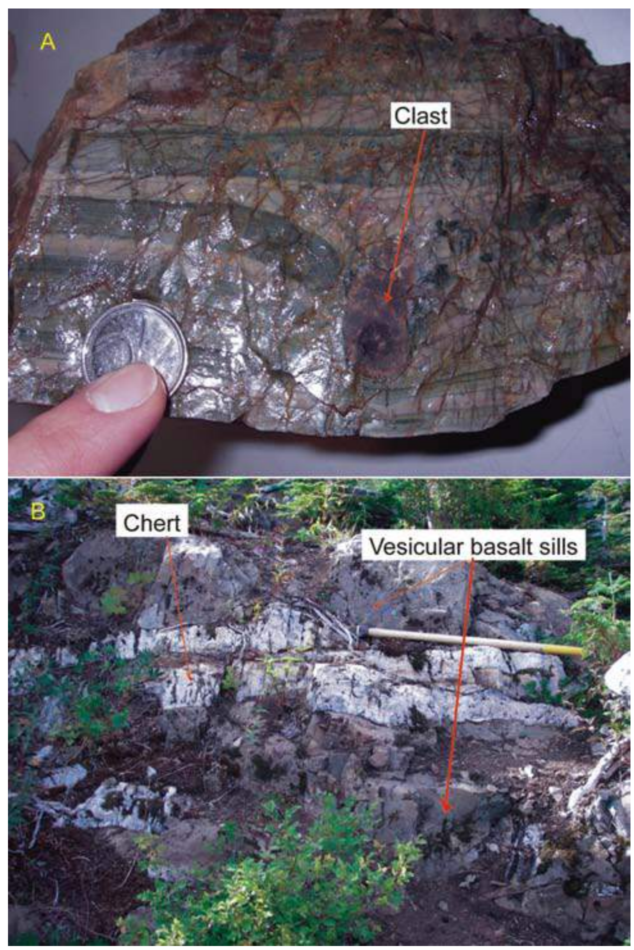

Figure 9. **A)** Bedding in radiolarian chert is deflected by a fine-grained, purple, rounded clast of unknown lithology. **B)** Highly quartz-vesicular and often spherulitic basalt sills intrude radiolarian chert; recrystallization of radiolarian chert is often observed in areas where basalt sills are abundant.

pear, in places, to have been mildly brecciated and recrystallized by the sills. A large gabbroic intrusion has been mapped to the southwest of these sills, and there is a high probability that these basaltic sills may be apophyses derived from this larger intrusion. Geochemical sampling of these sills has been conducted in order to determine their affinities. A localized chlorite- and serpentine-altered zone within the gabbro was observed to contain trace malachite staining. Malachite staining in this zone is associated with a small pyrite-bearing pod approximately 20 cm in size.

The abundant chert, intermediate tuff and gabbro observed in new bedrock exposures in the Peak and Kammat lakes area during this study all occur in areas previously mapped as McLaughlin Ridge, Nitinat and Duck Lake formations (Yorath et al., 1999). Since these new exposures of interbedded chert and intermediate tuff are not typical units observed in the Nitinat and Duck Lake formations, this suggests that there are significant problems with existing geological maps for the area that can only be resolved with additional mapping.

Results of Reconnaissance Geological Fieldwork in the Nanoose Uplift Area

One day of reconnaissance geological fieldwork was conducted in the Nanoose uplift area (Figure 1). This work focused on sampling for U-Pb (zircon) geochronology and radiolarian biostratigraphy. Sedimentary rocks were most common and comprise interbedded argillite, grey-black siltstone, fine to coarse sandstone and green chert. Sandstone in the area ranges from moderately to poorly sorted arenite and lithic arenite. This sandstone contains an abundant feldspathic component and, in places, abundant subrounded chert clasts. Samples for U-Pb (zircon) detrital geochronology were taken from several localities. Substantial outcrops of green chert were also observed, especially in the immediate vicinity of the Department of National Defence naval base. This chert is typically highly fractured and, in places, was observed to contain potential radiolarian fossils. A large body of granodiorite of unknown age was also observed and sampled for geochronology.

Results of Geological Mapping on the Dorado and Dragon Properties (Paget Resources Corporation), Hesquiat–Gold River Area

Dorado Property

Geological mapping at 1:5000 scale of a portion of the property (Paget Resources Corporation; Figures 1, 10) was conducted over six days in 2007. The first visit was designed to follow up on the discovery by Marshall et al. (2006) of polymetallic VMS-style stockwork mineralization hosted in mafic volcanic rocks. Reconnaissance geological mapping in the vicinity of Marshall's showing by Paget Resources Corporation geologists led to the discovery of polymetallic massive sulphide mineralization (Figure 10, regions A and B). Massive sulphide mineralization has so far been discovered in two locations on the Dorado property, and is associated with the contact between mafic volcanic rocks and overlying tuffaceous sedimentary rocks.

The first massive sulphide mineralization discovered on the Dorado property is located in a shot-rock blast pit, near the contact between a variably silica-altered, chlorite amygdule–bearing, feldspar-phyric basaltic flow and overlying intermediate tuffaceous sandstone (Figure 10, region A). Here, a massive sulphide pod, measuring 1.5 m by 3 m and consisting of fine-grained pyrrhotite with trace chalcopyrite, is hosted within the basalt. Sulphide stringers up to 1 cm wide are abundant near the massive sulphide mineralization. Numerous massive sulphide boulders of similar composition are found in close proximity to the showing; some of them appear to have been used as substrate for a bridge crossing a creek that drains immediately to the east of the pit. The most silicified zones within the host basalt are associated with abundant quartz and epidote veinlets. Some zones of autobreccia are present in the basalt host. These zones contain abundant grey, glassy, angular silicified clasts up to 2 cm in size. Approximately 430 m southwest of this zone is a second zone of massive sulphide mineralization (Figure 10, region B). Here, boulders of fine- to medium-grained massive pyrrhotite+chalcopyrite, up to 50 cm in size, occur as float beneath a large, gossanous outcrop of highly silica-altered, feldspar-clinopyroxene–phyric andesite porphyry (Figure 11). Pyrrhotite mineralization is abundant, as both stringers and disseminations. Euhedral feldspar and clinopyroxene phenocrysts form approximately 25% of the rock. Plagioclase feldspar constitutes approximately 85% of the phenocryst assemblage and reaches sizes up to 3 mm. Clinopyroxene phenocrysts are variably chlorite altered, form 15% of the phenocryst assemblage and reach sizes up to 1 cm. This altered and mineralized porphyry was traced in the map area for approximately 350 m to the southwest along an overgrown logging skidder road. Less altered, variably sulphide-mineralized examples of feldspar- and clinopyroxene-phyric andesite are abundant in the map area (Figure 10, region C) and are most likely representative of massive intermediate flows. These mafic volcanic rocks are massive and less porphyritic to nearly aphyric in nature. They often contain abundant epidote alteration in the form of ovoid patches up to 10 cm in width. Fine-grained sulphide minerals are often found in the cores of these patches. In places, pyrrhotite and chalcopyrite stringers are present, typically with strong silica alteration along their margins.

Overlying altered and mineralized mafic volcanic rocks are intercalated tuff and massive intermediate volcanic rocks

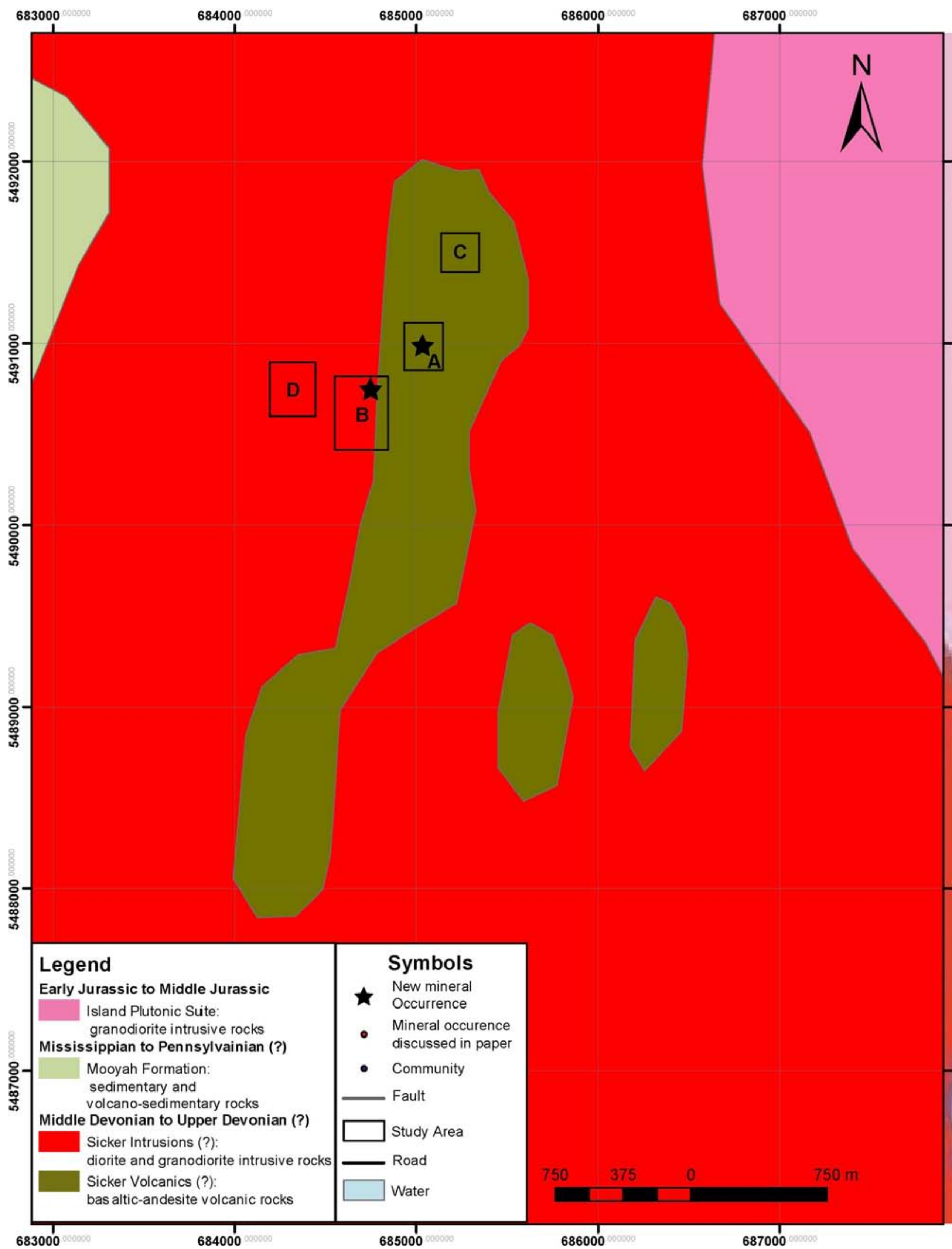

Figure 10. Regional geology, selected mineral occurrences and areas of study for 2007 fieldwork on the Dorado property of Paget Resources Corporation (*modified from* Marshall et al., 2006).

(Figure 10, region D). Volcaniclastic rocks comprise heterolithic lapilli tuff with mafic volcanic and chert clasts in a feldspar-crystal matrix. Sandy intermediate tuff, containing abundant feldspar crystals and variable concentrations clinopyroxene crystals, is also abundant. Massive feldspar-phyric porphyry of intermediate composition is associated with tuffaceous zones, but whether it represents intrusions or flows is undetermined.

Dragon Property

The Dragon property is located approximately 80 km west of Campbell River, 20 km northwest of Gold River and 65 km northwest of the Myra Falls mine of Breakwater Resources Ltd. (Figure 1). A combination of reconnaissance and 1:5000 scale mapping was conducted on the Dragon property over 10 days. This work focused on establishing the geological setting for known mineral occurrences on the property, and for understanding the stratigraphy of the property geology in general. The work was successful in identifying several prospective new zones of mineralization, including a new polymetallic massive sulphide discovery (Figure 12).

Massive sulphide mineralization of the Dragon property typically consists of varying proportions of fine- to medium-grained massive pyrrhotite, chalcopyrite and sphalerite at the contact between felsic volcanic rocks and overlying volcano-sedimentary and carbonate rocks. This prospective horizon has been traced over a strike length of 4.4 km, and shows signs of VMS-style alteration and mineralization throughout (Figure 12).

The original massive sulphide discoveries on the Dragon property include the Falls and North showings, which comprise three massive sulphide lenses with grades up to 7.33% Zn, 1.34% Pb, 173 ppm Cu, 680 ppb Au and 19.2 g/t Ag over 2 m (Jones, 1997; Figure 12). This massive sulphide mineralization is interlayered with laminated chert, mudstone and calcareous mudstone that strikes southwesterly and dips steeply to the northwest. Bivalve (?) fossils have been observed in cherty tuff overlying the Falls and North showings.

During the course of this summer's fieldwork on the Dragon property, a new massive sulphide showing was discovered approximately 1 km south of the Falls and North showings (Figure 12, region A). This showing consists of several fine- to medium-grained, pyrrhotite+chalcopyrite–bearing massive sulphide boulders, up to 1.5 m by 1 m in size, found in float (Figure 13a). One of the boulders contains massive sulphide mineralization in contact with strongly silica-altered aphyric rhyolite, indicating a rhyolitic host for the mineralization. These boulders were discovered at the top of a large set of cliffs consisting of aphyric, flow-banded massive rhyolite, and are located proximal to the contact zone between felsic volcanic rocks and overlying sedimentary and carbonate rocks. This contact zone is exposed in outcrop approximately 50 m to the west. Here, strongly silica-altered and stockwork-sulphide–mineralized rhyolite with localized zones of flow breccia is overlain by argillite, chert, siltstone, calcareous argillite and limestone. Rhyolite breccia in this area contains angular, jigsaw-fit clasts, up to 6 cm in size, in a dark-coloured matrix of fine-grained disseminated garnet and biotite clots up to 1 cm in size. Chert beds in this contact zone often contain 0.5–1% disseminated pyrrhotite, and argillite beds contain abundant pyrrhotite veinlets. Calcareous wackestone beds contain abundant coral fossils.

Another new zone of mineralization was discovered approximately 1 km north of the Falls and North showings (Figure 12, region B). Here, similar to the geological setting of the new massive sulphide discovery south of the Falls and North showings, intensely silica-altered and stockwork-sulphide (pyrrhotite and chalcopyrite)–mineralized aphyric rhyolite is conformably overlain by felsic tuff, chert, argillite and carbonate, which dip steeply to the west-northwest (Figure 13b). Intensely silica-altered rhyo-

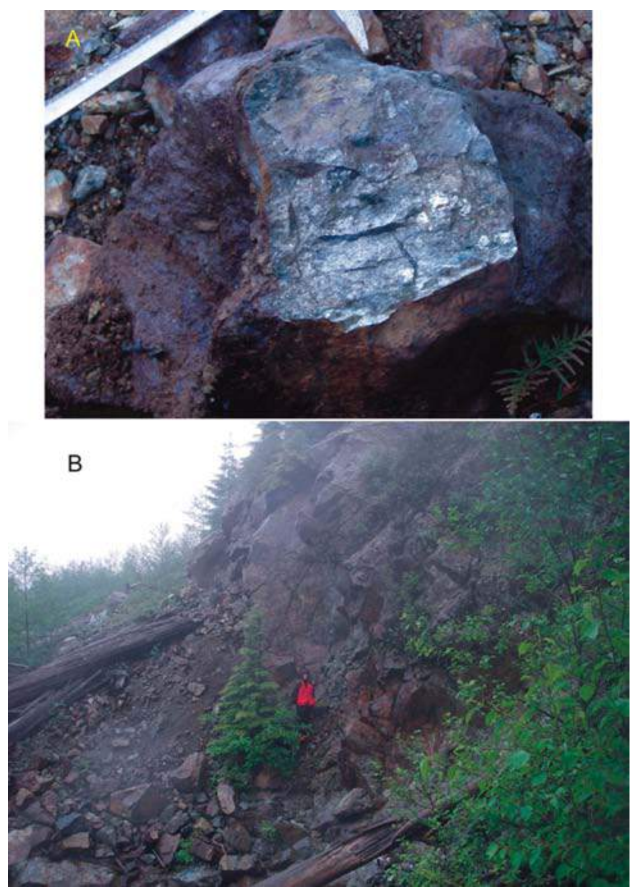

Figure 11. **A)** Massive pyrrhotite and chalcopyrite mineralization from region B of the Dorado property of Paget Resources Corporation; **B)** Strongly silica-altered and stockwork-sulphide–mineralized, clinopyroxene- and feldspar-phyric andesite porphyry from region B of the Dorado property.

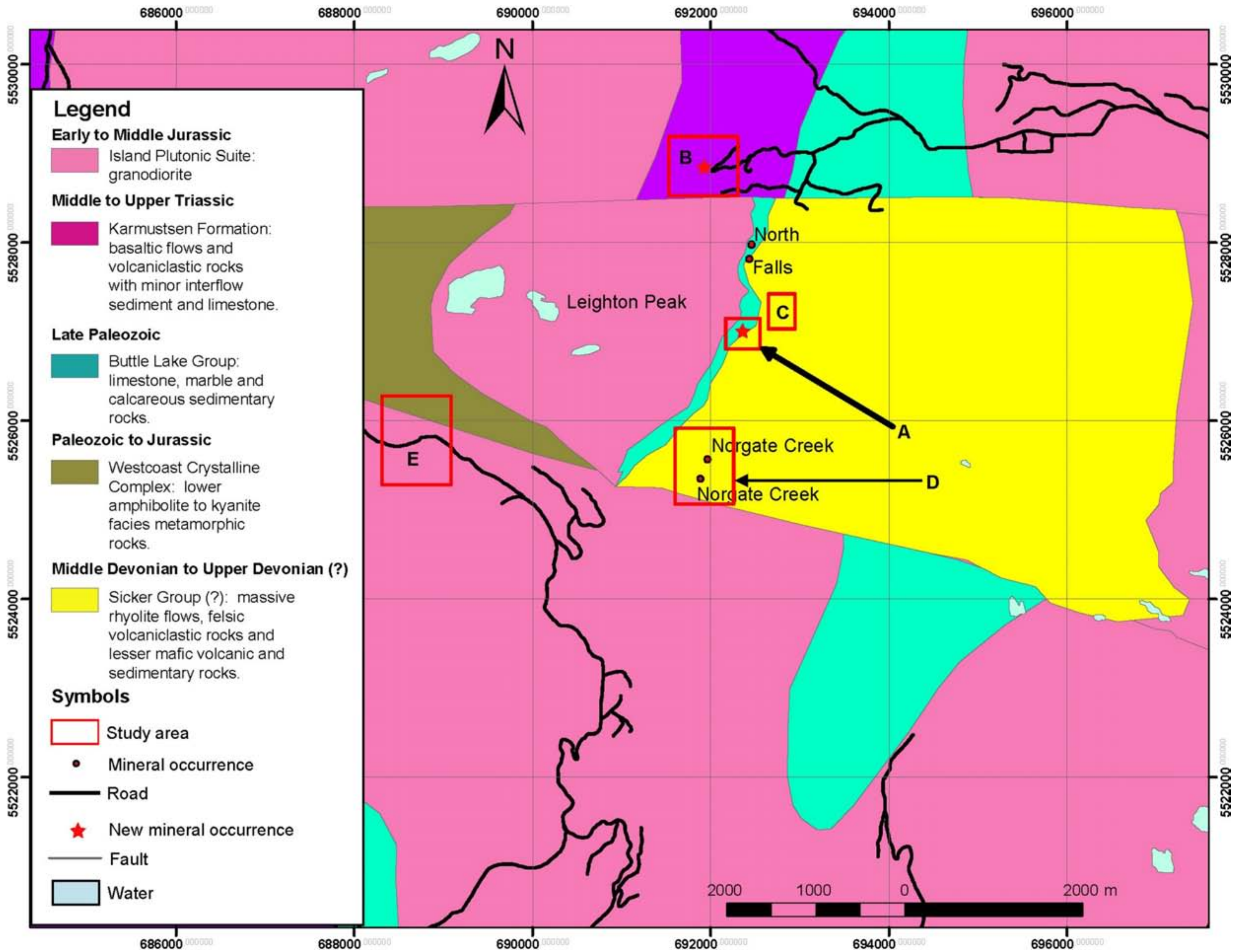

Figure 12. Regional geology (*modified from* Massey, 2005; Jones, 1997), selected mineral occurrences and areas of study for 2008 fieldwork on the Dragon property of Paget Resources Corporation.

lite in this area is highly gossanous and hosts abundant pyrrhotite and chalcopyrite stringers up to 2 cm thick. Disseminated sulphides consist largely of pyrrhotite and reach concentrations up to 2%. Greater concentrations of disseminated sulphides are associated with areas of strong silica alteration. Green chert containing bands of fine-grained garnet immediately overlie altered and mineralized rhyolite. Fossiliferous felsic ash tuff overlies the chert and contains crinoid and coral fossils. Carbonate increases in concentration upsection and consists of calcareous mudstone, and medium- to coarse-grained marble that is interbedded with chert and silicified argillite (Figure 13b). Chert contains up to 1% pyrrhotite blebs up to 2 mm in size.

The ridge east of Leighton Peak hosts substantial thicknesses of massive, flow-banded, largely aphyric rhyolite (Figure 12, region C). Flow banding is very abundant in felsic volcanic rocks, and its orientation generally mimics that of regional fabrics, which dip moderately to steeply to the west-northwest. Folding in the flow banding is abundant, and tends to occur as outcrop-scale isoclines (Figure 13c). Since no prominent foliations were observed in the vicinity of these tight folds or in the field area, it is probable that the folding is not tectonic but rather related to folding of the rhyolite due to viscous drag during eruption. In places, thin sedimentary horizons can be observed between flows. These are typically black graphitic argillite, often containing angular clasts of aphyric rhyolite up to 1 cm in size. Felsic volcanic rocks are also very abundant in the Norgate Creek area, located approximately 2 km south-southwest of the Falls and North showings (Figure 12, region D). These rocks typically comprise massive, weakly quartz-phyric rhyolite that is variably silica altered and mineralized with sulphide stringers (pyrrhotite, sphalerite and chalcopyrite). Near the top of a recent logging slash in the Norgate area, a strongly metamorphosed heterolithic tuff breccia was observed proximal to the contact with overlying sedimentary and carbonate rocks. Here, metamorphosed volcanic clasts up to 10 cm in size are variably stretched, angular and often jigsaw fit. Eighty percent of the clasts contain abundant white sugary muscovite, and may represent metamorphosed felsic volcanic clasts. Fifteen percent of clasts are represented by a light grey variety containing 3% biotite porphyroblasts, and might represent metamorphosed intermediate volcanic rocks. Five percent of the clasts contain nearly 100% medium- to coarse-grained biotite, and may represent metamorphosed mafic volcanic rocks. The matrix of this breccia contains abundant biotite porphyroblasts up to 3 mm in size. In places, this breccia acquires a fabric reflected in strongly stretched metavolcanic clasts in a biotite-rich matrix. Mineralization in the Norgate Creek area consists of pyrrhotite and sphalerite stringers in felsic volcanic rocks, and occurs both at the contact zone with overlying carbonate sedimentary rocks and nearly 1 km east of this contact, within the felsic volcanic pile.

In the Conuma River area, approximately 4 km to the southwest of the Falls and North showings, felsic volcanic rocks consist of heterolithic tuff breccia, graded beds of tuffaceous sedimentary rocks and quartz-feldspar porphyry

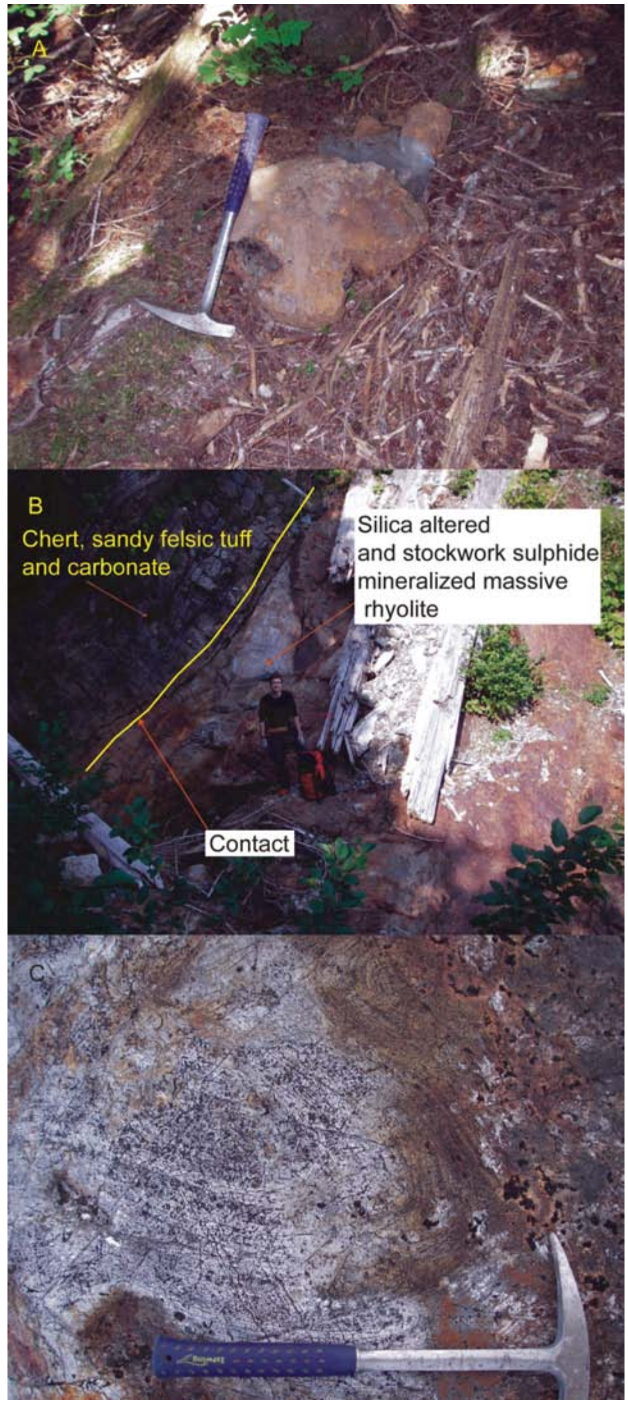

Figure 13. **A)** New massive sulphide mineralization discovered this summer on the Dragon property of Paget Resources Corporation. **B)** Contact zone between massive, silica-altered and stockwork-sulphide–mineralized rhyolite and overlying chert, felsic tuff and carbonate rock; this contact hosts all known massive sulphide occurrences on the Dragon property. **C)** Folded, flow-banded rhyolite on the ridge to the east of Leighton Peak.

sills (Figure 12, region E). In one outcrop, a heterolithic lapilli tuff with white, aphyric, felsic volcanic clasts and grey siltstone clasts up to 2 cm in size normally grades into sandy tuff, silty tuff and mudstone. These rocks are interpreted to represent turbidites. In the same outcrop, these volcano-sedimentary rocks are intruded by a quartz-feldspar–phyric rhyodacite sill. This sill has irregular contacts with the volcano-sedimentary rocks and, in many places, is observed to contain engulfed clasts of volcano-sedimentary rocks. Fine-grained garnets are present as disseminations within all rock types in the outcrop but are found in larger concentrations within grey siltstone clasts. In the immediate vicinity of this outcrop is a heterolithic tuff breccia containing large, subrounded clasts of quartz-feldspar porphyry and grey siltstone up to 10 cm in size. These clasts are set in a matrix consisting largely of feldspar crystals. Garnet and biotite porphyroblasts are present in both the matrix and the siltstone clasts. Stratified rocks in the Conuma River area have been observed to dip both moderately and steeply to the southwest and northeast, respectively, which is significantly different from the prominent west-northwest dip observed in stratified rocks to the north of Norgate Creek and east of Leighton Peak. More bedrock mapping is required in this area to constrain the location of the contact between felsic volcanic rocks and overlying sedimentary and carbonate rocks. Not only is this contact highly prospective for VMS mineralization, but it also serves as a stratigraphic marker horizon that can help resolve differences in structural style throughout the property.

Mapping on the Dragon property this summer has shown that potential Sicker Group felsic volcanic rocks are much more extensive than is shown on existing geological maps of the area (e.g., Figure 12, regions B and E). More mapping needs to be conducted in the area to further constrain the extent of potential Sicker Group bedrock geology.

Summary

Fieldwork in 2008 has continued with the focus of resolving the stratigraphy and tectonic history of the Sicker Group and its contained mineral occurrences via a combination of bedrock mapping and sampling for geochronology (U-Pb, Ar/Ar), biostratigraphy (macrofossils, radiolarians and conodonts), geochemistry (major and trace elements) and isotopic analyses (Nd and Pb; whole rock and sulphides, respectively). In the Cowichan Lake uplift, the goal of the fieldwork has been to resolve the geological and stratigraphic setting of VMS mineralization, particularly for those VMS deposits and occurrences on mineral tenure owned by Treasury Metals Inc. and Westridge Resources Inc. During this summer, a new polymetallic massive sulphide showing was found on Westridge Resources ground, and a prospective zone for VMS mineralization was identified on Treasury Metals ground. Sampling for U-Pb (zircon) geochronology in the immediate vicinity of the Lady B iron formation (Treasury Metals Inc.) was conducted to constrain the longevity of the VMS mineralizing hydrothermal system in the Cowichan Lake area.

Fieldwork in the Port Alberni area focused on examining new bedrock exposures southeast of Horne Lake, as well as continuing examinations of bedrock and mineralization hosted by rocks of the Nitinat and Duck Lake formations on ground owned by Bitterroot Resources Ltd. Examinations of new exposures in the Kammat and Peak lakes area were also conducted. Southeast of Horne Lake, recent logging activity has resulted in the discovery of a large area underlain by proximal felsic volcanic rocks. This finding is highly significant, as Sicker Group rocks of the Port Alberni area have previously been interpreted to represent a depositional area distal from felsic magmatic centres (Yorath et al., 1999). Not only does this new discovery indicate the presence of a new centre of felsic magmatism in the Sicker Group, but it has large positive implications for the VMS potential of Sicker Group rocks in the Port Alberni area. Reconnaissance fieldwork in new exposures of Sicker Group rocks of the Peak-Kammat lakes area has shown that significant revisions are necessary to the existing geological map for the area. Sampling of abundant radiolarian chert in this area was conducted to determine an age for rocks of the McLaughlin Ridge Formation type section (Yorath et al., 1999). Abundant sampling for geochronology and radiolarian biostratigraphy was conducted on ground owned by Bitterroot Resources Ltd., to determine the age of mafic volcanic rocks of the Nitinat and Duck Lake formations. Resolving the ages of these units is critical for understanding the temporal evolution of the Sicker arc, and the earliest history of the Wrangellia Terrane. Two new mineral occurrences were discovered on the Bitterroot Resources mineral tenure: stratiform massive sulphide mineralization interlayered with mafic volcanic rocks and silicified argillite; and pyrite-chalcopyrite mineralization associated with strongly silica-altered zones in massive diabase.

Reconnaissance fieldwork in the Nanoose area focused on resolving the age of sedimentary, carbonate and volcanic rocks that have previously been interpreted as potential correlatives to the Buttle Lake and Sicker groups. Abundant sampling for U-Pb (zircon) detrital geochronology and radiolarian biostratigraphy was conducted.

In the Gold River and Hesquiat areas, geological fieldwork was carried out on potential Sicker Group rocks underlying the Dragon and Dorado properties, respectively (Paget Resources Corp.), where new polymetallic massive sulphide occurrences were discovered. On the Dorado property, massive sulphide mineralization was discovered by Paget Resources Corporation geologists in several localities, both proximal to the contact zone between clinopyroxene-phyric, variably silica-altered and stockwork sulphide–

mineralized mafic volcanic rocks and overlying tuffaceous sedimentary rocks. A new polymetallic massive sulphide occurrence and a new highly prospective zone for VMS mineralization were discovered on the Dragon property. Massive sulphide mineralization on the Dragon property is located proximal to the contact between massive, variably silica-altered and stockwork sulphide–mineralized felsic volcanic rocks (dominantly rhyolite flows) and overlying volcano-sedimentary rocks, chert and carbonate rocks. The juxtaposition of fossiliferous carbonate rocks and felsic tuff with underlying VMS mineralization and felsic volcanic rocks is observed nowhere else in the Sicker Group It raises the possibility that volcanic rocks and mineralization on the Dragon property may represent a cycle of arc magmatism and VMS mineralization not previously recognized on Vancouver Island.

Future Work

Fieldwork in 2009 will be pursued in the Cowichan Lake and Port Alberni areas, with additional work planned in potential outcrops of Sicker Group rocks in the Bedingfield Bay and Muchalat Inlet (Gold River–Hesquiat) areas. In the Cowichan Lake area, work will focus on understanding the stratigraphic and volcanological setting of VMS occurrences hosted by the Sicker Group, particularly those of the Lara/Coronation, Randy and Anita zones, north and west of Big Sicker Mountain (MINFILE occurrences 092B 129, 092B 128 and 092B 037, respectively). Particular emphasis will be placed on understanding the stratigraphic and volcanological setting of other potential VMS occurrences in the immediate vicinity of, and west of, Cowichan Lake. Additional regional work in the Alberni area will focus on identifying stratigraphic marker horizons within the Sicker Group that can be used to constrain the age of lithological units in the area, particularly those belonging to the Duck Lake and Nitinat formations.

In the Bedingfield Bay and Muchalat Inlet areas, similar regional and focused outcrop-scale mapping and sampling will be conducted to better understand the stratigraphy and volcanological setting of potential Sicker Group rocks and VMS occurrences, most notably in the vicinity of the Rant Point occurrence (MINFILE occurrence 092F 494) and the Dorado and Dragon properties (Paget Resources Corporation). In parallel with the geological mapping and synthesis work, the authors will also carry out additional U-Pb dating, lithogeochemical, and Nd, Hf and Pb isotopic studies to constrain the age and magmatic evolution of Sicker Group volcanic rocks and to develop a framework through which VMS occurrences hosted by the Sicker Group can be distinguished from younger, epigenetic sulphide occurrences.

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References

Barrett, T.J. and Sherlock, R.L. (1996): Volcanic stratigraphy, lithogeochemistry and seafloor setting of the H-W massive sulfide deposit, Myra Falls, Vancouver Island, British Columbia; Exploration and Mining Geology, v. 5, p. 421–458.

Belik, G.D. (1983): Trenching, geophysical and geological report on the Lara property, Victoria Mining Division, British Columbia, 48 53 N, 123 52 W, NTS 92B/13W; BC Ministry of Energy, Mines and Petroleum Resources, Assessment Report 11123, 71 p.

Brandon, M.T., Orchard, M.J., Parrish, R.R., Sutherland Brown, A. and Yorath, C.J. (1986): Fossil ages and isotopic dates from the Paleozoic Sicker Group and associated intrusive rocks, Vancouver Island, British Columbia; *in* Current Research, Part A, Geological Survey of Canada, Paper 86-1A, p. 683–696.

Fyles, J.T. (1950): Jane, Sally and Sally No. 2; *in* Minister of Mines Annual Report, 1949, BC Ministry of Energy, Mines and Petroleum Resources, p. A224–A225.

Jones, M.I. (1997): 1996 assessment report, Dragon property, diamond drilling, Alberni and Nanaimo Mining Divisions, NTS map areas 92E/16E, 92L/1E, 49 55 00 N, 126 20 00 W; BC Ministry of Energy, Mines and Petroleum Resources, Assessment Report 24895, 189 p.

Juras, S.J. (1987): Geology of the polymetallic volcanogenic Buttle Lake camp, with emphasis on the Price hillside, central Vancouver Island, British Columbia, Canada; unpublished Ph.D. thesis, University of British Columbia, Vancouver, BC, 279 p.

Katvala, E.C. (2006): Re-examining the stratigraphic and paleontologic definition of Wrangellia; Geological Society of America, Abstracts with Program, v. 38, p. 24.

Kelso, I., Wetherup, S. and Takats, P. (2007): Independent technical report and mineral resource estimation, Lara polymetallic property, British Columbia, Canada; unpublished company report prepared by Caracle Creek International Consulting for Laramide Resources Ltd.

Kemp, R. and Gill, G. (1993): Geological, geochemical and diamond drilling report on the Specogna-Muchalat property, NTS 92E/16, Alberni Mining Division; BC Ministry of Energy, Mines and Petroleum Resources, Assessment Report 23125, 48 p.

Marshall, D., Lesiczka, M., Xue, G., Close, S. and Fecova, K. (2006): Update on the mineral deposit potential of the Nootka Sound region (NTS 092E), west coast of Vancouver Island, British Columbia; *in* Geological Fieldwork 2005, Geoscience BC, Report 2006-1, p. 323–330.

Massey, N.W.D. (1995): Geology and mineral resources of the Duncan sheet, Vancouver Island, 92B/13; BC Ministry of Energy, Mines and Petroleum Resources, Paper 1992-4.

Massey, N.W.D. and Friday, S.J. (1987): Geology of the Chemainus River–Duncan area, Vancouver Island (92C/16, 92B/13); BC Ministry of Energy, Mines and Petroleum Resources, Paper 1988-1, p. 81–91.

Massey, N.W.D. and Friday, S.J. (1989): Geology of the Alberni–Nanaimo Lakes area, Vancouver Island (92F/1W, 92F/2E and part of 92F/7); BC Ministry of Energy, Mines and Petroleum Resources, Open File 1987-2.

Massey, N.W.D., MacIntyre, D.G., Desjardins, P.J. and Cooney, R.T., (2005): Digital map of British Columbia: Tile NM10 Southwest BC; BC Ministry of Energy, Mines and Petroleum Resources, GeoFile 2005-3.

MINFILE (2008): MINFILE BC mineral deposits database; BC Ministry of Energy, Mines and Petroleum Resources, URL <http://www.empr.gov.bc.ca/Mining/Geoscience/MINFILE/Pages/default.aspx> [November 2008].

Mortensen, J.K. (2005): Stratigraphic and paleotectonic studies of the Middle Paleozoic Sicker Group and contained VMS occurrences, Vancouver Island, British Columbia; *in* Geological Fieldwork 2005, BC Ministry of Energy, Mines and Petroleum Resources, Paper 2006-1, p. 331–336.

Muller, J.E. (1977): Geology of Vancouver Island; Geological Survey of Canada, Open File 463, 1:250 000 scale.

Muller, J.E. (1980): The Paleozoic Sicker Group of Vancouver Island, British Columbia; Geological Survey of Canada, Paper 79-30, 23 p.

Pattison, J.M. and Money, D.P. (1988): 1987 drilling report on the West claims; Project # 094/107, situated 1 km west of Crofton, BC in the Victoria Mining Division; BC Ministry of Energy, Mines and Petroleum Resources, Assessment Report 17007, 252 p.

Ruks, T.R. and Mortensen, J.K. (2006): Geological setting of volcanogenic massive sulphide occurrences in the Middle Paleozoic Sicker Group of the southeastern Cowichan Lake uplift (NTS 092B/13), southern Vancouver Island; *in* Geological Fieldwork 2006, Geoscience BC, Report 2007-1, p. 381–394.

Ruks, T. and Mortensen, J.K. (2007): Geological setting of volcanogenic massive sulphide occurrences in the Middle Paleozoic Sicker Group of the Cowichan Lake uplift, Port Alberni area, southern Vancouver Island, British Columbia; *in* Geoscience BC Summary of Activities 2007, Geoscience BC, Report 2008-1, p. 77–92.

Sluggett, C.L. (2003): Uranium-lead age and geochemical constraints on Paleozoic and Early Mesozoic magmatism in Wrangellia Terrane, Saltspring Island, British Columbia; unpublished B.Sc. thesis, University of British Columbia, Vancouver, BC, 56 p.

Sluggett, C.L. and Mortensen, J.K. (2003): U-Pb age and geochemical constraints on the paleotectonic evolution of the Paleozoic Sicker Group on Saltspring Island, southwestern British Columbia; Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Program with Abstracts, v. 28.

Yorath, C.J., Sutherland Brown, A. and Massey, N.W.D. (1999): LITHOPROBE, southern Vancouver Island, British Columbia: geology; Geological Survey of Canada, Bulletin 498, 145 p.