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Hon. Mike Holland
Minister of Natural Resources and Energy Development

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CRITICAL MATERIALS FOR GREEN ENERGY: GLOBAL TO LOCAL GEOLOGICAL AND OTHER CONSIDERATIONS

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Countries, provinces and states, companies, and individuals around the world are targeting significant increases in the use of renewable energy and electric vehicles to reduce greenhouse gas emissions and mitigate the effects of climate change. Wind turbines, solar panels, and batteries require a variety of materials, such as cobalt, lithium, rare earth elements, platinum group elements, manganese, graphite, indium, and gallium, in their production. These are often called “critical minerals/materials” because their supply is often dependent on non-geological factors and is difficult to replace or recycle. The federal government released the first Canadian list of critical minerals in March 2021, which included those listed above, and twenty-three others. This was followed by significant funding for Green Energy projects in the April 2021 budget. This presentation will provide an overview of the definition of critical materials and will emphasize that the Canadian list includes materials that the country has in abundance and thus could supply to partners around the world. Cobalt, lithium, and rare earth elements will be used as examples to focus on present and predicted requirements for these less common materials, their distribution from a global, Canadian, and local (Saskatchewan and New Brunswick) perspective, with a focus on geological relationships, and potential implications for the environment and the economy.

Abstract for oral presentation

Funding provided by the University of Saskatchewan, and Natural Science and Engineering Council of Canada

REVIEW OF RECENT RESEARCH IN THE GRANDE ANSE FORMATION, SOUTHEAST NEW BRUNSWICK

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The Grande Anse Formation has been a largely unstudied, and therefore stratigraphically problematic, unit of the Cumberland Basin that outcrops north of the Minudie Anticline on the Maringouin Peninsula of southeast New Brunswick as well as in northernmost Nova Scotia. Previous biostratigraphic work indicated a temporal equivalence to some part of the lower Pennsylvanian succession south of the Minudie Anticline along the Joggins Fossil Cliffs shoreline, in what is known as the Athol Syncline.

Recent work has identified the Minudie Anticline to be a salt wall, the formation of which had a major influence on lower Pennsylvanian sedimentation in the Cumberland Basin. Sedimentological study has noted a marked similarity between facies of the Grande Anse Formation and the Ragged Reef Formation south of Joggins. Both contain an abundance of red mudstone, of (semi-) humid climate, well-drained floodplain origin, intersected by red and grey sandstone of braided, east flowing, fluvial origin.

Geochemical investigation of coarse clastic deposits in the two units has further indicated no statistical difference in their elemental compositions. In contrast, underlying units along the Joggins coast (Little River, Joggins, Springhill Mines formations) have visibly different facies, and many statistically significant differences in composition. The resulting working hypothesis, therefore, is that salt tectonics produced oblique-to-the-north evacuation of Windsor Group (Mississippian) evaporites. This created the space that accommodated the thick succession of strata (Little River, Joggins, and Springhill Mines formations) in the developing Athol Syncline. At the same time, to the north of the salt wall, there was no net deposition but there was uplift and folding of post-Windsor Group strata. As salt tectonism waned, any extrusive salt was then buried under strata of the Grande Anse and Ragged Reef formations. It remains unclear whether these latter two units formed contemporaneously and in disconformity to angular unconformity on older units (in which case the Ragged Reef Formation could be considered the junior synonym of the Grande Anse Formation) or whether deposition of the Ragged Reef Formation gradually onlapped both the salt wall and the folded strata further north. In the latter case, only the Spicers Cove Member of the Ragged Reef Formation might be directly equivalent to the Grande Anse Formation.

Petrographic studies of the Grande Anse Formation have indicated that lithification was dominated by eodiagenetic processes. Several mineral phases are typical of shallow subsurface changes that would be expected in the (semi-) humid environment indicated by the sedimentology and geochemistry. Very distinct phases might be considered indicative of arid, evaporitic conditions. However, the presence of a recently buried salt-wall may have influenced shallow ground water chemistry.

Abstract for oral presentation

NEARSHORE SUBMERGED AND SUBAERIAL LANDFORMS, NORTHWESTERN BAY OF FUNDY, NEW BRUNSWICK

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Submerged and subaerial meltwater and moraine deposits along the northern coastal areas of the Bay of Fundy are indicative of a complex history of relative sea-level change due to fluctuations in relative levels of isostatic and eustatic adjustments at the end of the Pleistocene. Bathymetric data delineates submerged landforms that demonstrate a correlation between the Pineo Ridge moraine of eastern Maine across a distance of ~70 km eastward to Saint John, New Brunswick. The moraine represents an ice-marginal position at the end of the last glaciation, constructed as the ice front retreated northward to a stable inland position.

Submerged deltas occurring southward off the New Brunswick coast in the Pocologan area, and unrelated to current drainage systems, are attributed to deposition during the initial phase of northward retreat of the ice margin. A few kilometers north, extensive subaerial deposits of ice-contact waterlain sediments demonstrate the onset of a major phase of rapid melting and formation of the large Pennfield – Pocologan kame-delta complex. These deposits blanket an area of approximately 79 km^2, to depths of up to 35 m at some locations. The kame-delta complex comprises four previously named parts that are defined by various elevations, as high as 89 m, above present sea level. Abundant kettles in deposits at this 89 m elevation suggest a relative maximum Late Wisconsinan marine submergence of approximately 85 m for this part of the Bay of Fundy. However, precise contributions to elevation changes from isostatic rebound are presently unknown. Subsequent dissection of the deposits at higher elevations is the result of a gradual lowering of relative sea level and of meltwater activity while the ice-front continued to decay.

The quality and quantity of the aggregate resources within the kame-delta complex, as well as its location near the Atlantic Seaboard, may represent a significant opportunity for extraction and export opportunities.

Abstract for oral presentation

APLITE BODIES FROM THE CAPE SPENCER GOLD DEPOSIT AREA, SOUTHERN NEW BRUNSWICK: NEW CONSTRAINTS ON THE MINERALIZED SYSTEM?

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The Cape Spencer gold deposit is located 15 km southeast of the city of Saint John, New Brunswick. Gold mineralization and associated alteration occur along strongly faulted and sheared lithological contacts. Anomalous gold values were discovered in the 1950s and, since then, several exploration programs have taken place and two main gold-bearing zones and various prospects have been discovered. Gold mineralization at Cape Spencer is mainly hosted within illitized (illite-carbonate ± quartz ± pyrite ± specularite), pyrite-rich rocks along thrust faults and folds and associated quartz ± carbonate ± plagioclase ± sulphide (pyrite, chalcopyrite) ± specularite veins that vary from several millimeters to several decimeters in width. Specular hematite-rich rocks are thought to be favourable hosts for mineralization as earlier specularite veins are cut by mineralized quartz-carbonate veins that contain pyrite replacing specularite, thus giving way to gold-rich pyrite concentrations.

The main rock units in the area include the Precambrian mafic and felsic volcanic rocks of the Coldbrook Group and the Millican Lake Granite, which are frequently observed in thrust or high-angle fault contact with the purple/grey siltstone, slate, coarse-grained polymictic conglomerate, and granite-cobble conglomerate of the Cape Spencer Formation (unknown age). The Carboniferous reddish-brown quartz-pebble conglomerate, medium-grained sandstone, and shale of the Balls Lake Formation and the grey quartzose sandstone and siltstone, shale, and conglomerate of the Lancaster Formation are in thrust contact with the Cape Spencer Formation. A penetrative S1 cleavage is present in all the lithologies, and a second, spaced crenulation cleavage can be observed in the finest sedimentary units. In addition, leucocratic non-foliated sill-like aplite bodies comprising quartz, orthoclase, and plagioclase, and minor epidote, specularite, and pyrite, intrude both the Millican Lake Granite and the Cape Spencer Formation. These bodies, varying from 10 cm to 50 cm thick, occur parallel to the foliation in the surrounding rocks, and exhibit a secondary earthy hematization that results in pink weathering.

Whole rock major- and trace-element lithogeochemistry together with zircon U-Pb geochronology were employed to evaluate the petrogenesis of these aplitic bodies in an effort to build on the understanding of the mineralizing system and the geological evolution of the region. This information will contribute to understanding the relative timing of the local and regional controls on mineralization and complement studies involving U-Pb (zircon, monazite, apatite) and 40Ar/39Ar (illite) geochronology to better constrain the timing of the mineralizing events.

Abstract for oral presentation

GEOLOGICAL MAPPING PROJECTS IN NORTHERN NEW BRUNSWICK

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To better define regional tectono-stratigraphic relationships in the Cambro-Ordovician rocks of the southern Bathurst Mining Camp and central New Brunswick, two projects are currently underway.

The first project is a continuation of the examination of the Tetagouche Group in central New Brunswick.

In the 1990s and 2000s, the introduction of the Bathurst Supergroup and the recognition of the Sheephouse Brook Group, did not consider the Hayden Lake, Push and Be Damned, or Turnbull Mountain formations, which were included in the Tetagouche Group in central New Brunswick. However, in map areas 21 O/01 and P/04, rocks assigned to the Hayden Lake Formation occur within the Sheephouse Brook thrust nappe, suggesting a Sheephouse Brook Group affinity. The uncertainty of the position of the Hayden Lake Formation within the stratigraphic framework of the Bathurst Supergroup necessitated this re-evaluation.

Petrographic, geochemical, and geochronological analyses from these formations will be used to determine their relationship with respect to the currently accepted tectono-stratigraphy of the Bathurst Supergroup. Results will be used to support one of three potential outcomes, namely: a) reinterpretation of the areal extent of the Tetagouche Group/nappe; b) redefinition of the Sheephouse Brook Group to include the Turnbull Mountain, Hayden Lake, and Push and Be Damned formations or; c) defining a new group.

The second project is the production a 3D geological model of the southern portion of the Bathurst Mining Camp.

Previous geological mapping in the southern part of the Bathurst Mining Camp has constrained surface distribution of the main lithologies and major faults; however, the geometry of geological units at depth is not well constrained/understood. Recent 1:20 000-scale geological mapping, limited areal extent, and the structural separation of the Sheephouse Brook Group/nappe from the remainder of the Bathurst Supergroup make this area an ideal test case for 3D modelling.

This project will integrate geophysical data sets, observations from surface outcrops, drill log data, and petrophysical properties to produce a 3D geological model. Drill logs will be used to constrain the limits of key stratigraphic horizons at depth. Measurements of density, magnetic susceptibility, DC-resistivity, and induced polarization will characterize physical properties for each major lithotype within the study area. Model sections will be produced to constrain the geometry of faults and contacts, and the depth of some of the key stratigraphic horizons. It is hoped that this model will be useful as guide for volcanogenic massive sulphide exploration in the Sheephouse Brook Group.

Abstract for oral presentation

NEW BRUNSWICK GEOTHERMAL MAPS AND DATABASES: AN UPDATE

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The interior of the earth is hot, and so it is a potential source of green energy that also can have a minimal surface environmental footprint. One example, geothermal electricity, is produced either by utilizing already hot water present in deep subsurface fractures and pores, or by injecting water into dry, but hot, rock at depth, and using this heated water for power generation. To be economically viable, however, sufficient heat must be available at shallow subsurface depths in order to minimize expensive drilling and pumping costs. That means a steep geothermal gradient (in degrees Celsius per kilometre depth) is required. New Brunswick is not a tectonically or volcanically active region. Therefore, any geothermal potential would lie in (1) radiogenic intrusive rocks or in (2) sedimentary basins containing rock with water-filled pores heated either by normal earth heat flow or by radiogenic rocks forming the basement of the basin; and coupled with low thermal conductivity rocks in the basin fill to act as insulation. Where geothermal gradients in sedimentary basins are promising, thermal conductivity and effusivity must then be assessed in order to model heat flow and to reconstruct the thermal history in the basin.

Previous maps of geothermal gradients in New Brunswick have not drawn from very extensive datasets, with some papers making assertions on the province's geothermal potentiality based on information taken from as few as five drilling reports. The updated databases pull critically assessed information from several hundred well and drilling reports available from the southeastern half of the province. The resulting subsurface thermal contour map demonstrates a general agreement with previously published maps. Most location points in the study area have averaged temperature gradients between ~ 10°C and 30°C per kilometer depth. These values are not prospective for geothermal energy using current technology. However, there are a few anomalous locations, associated with New Brunswick's salt deposits, where average gradients appear to be greater than 30°C per kilometer depth: data that will require further investigation.

For comparison with existing thermal-conductivity ranges for particular rock types, the current study also tabulates the thermal conductivity of nine major rock types extracted from core in selected boreholes across the southeast of the province: Carboniferous-Triassic sandstone, mudstone, conglomerate, anhydrite, limestone, halite, and potash; Devonian granite; and Triassic basalt. Thermal conductivities for all rock types were measured using air-saturated samples. Results from the sedimentary rocks are in general agreement with previously published work, but the measured basalt thermal conductivity averaged 2.30 W/mK, 28% greater than the largest published average, and the granite averaged 2.51 W/mK, 19% less than the lowest published average. Some sandstones were also reassessed when water-saturated (more realistic of subsurface conditions), and results show a much narrower range of thermal conductivities (2.7–3.62 W/mK) versus previous studies.

Abstract for oral presentation

TAYLOR BROOK ZN-PB-AG PROPERTY, NEW BRUNSWICK

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The Taylor Brook deposit is classified as a polymetallic (Zn-Pb-Ag) VMS deposit within the Bathurst Mining Camp in New Brunswick. The deposit consists of one to four stratabound horizons of heavily disseminated to semi-massive and massive sulphides with a strike length of approximately 650 m and a down-dip extent of greater than 300 m. The eastern portion of the Taylor Brook deposit has been drilled to shallow depths but has not been delineated to the east or west, nor at depth and remains open.

The Taylor Brook deposit is situated approximately 6 km along strike and northeast of Trevali Mining Corporation's Stratmat project and is believed to host mineralization similar to that identified at the Stratmat deposit. The northeast-trending Stratmat Shear Zone, which encompasses the Stratmat deposit, appears to be trending onto the Taylor Brook Property. This shear zone is truncated to the north by the regional Coles Brook Fault and possibly to the south by the Nepisiquit Brook lineament. The Taylor Brook area may also be a separate entity within the Bathurst Mining Camp.

The Taylor Brook property has not been explored in any detail since 1998. Recent exploration by Jaeger Resources included re-interpretation of historical data, which resulted in new ideas and staking additional ground with the potential for discovery of new mineralized areas. This included a new extensive ground based grid over which VLF and magnetometer geophysical surveys were carried out. HLEM surveys were also conducted over selected areas. Lithogeochemical and geometallurgical studies were also initiated with some interesting results.

A favourable geological setting, together with the results of the work completed to date, indicate why the Taylor Brook Property has the potential for additional untested drill targets and why there is potential to increase the known deposit resource.

Jaeger Resources would like to thank the Province of New Brunswick for supporting this project through The New Brunswick Junior Mining Assistance Program.

Abstract for oral presentation

AGE, TECTONIC SETTING, AND PETROGENESIS OF LATE EDIACARAN SILICIC VOLCANIC AND PLUTONIC ROCKS IN THE CALEDONIA HIGHLANDS OF SOUTHERN NEW BRUNSWICK

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The Coldbrook Group is a unique suite of Late Ediacaran volcanic and epiclastic rocks that, together with related plutons, formed during a short (<10 million years) magmatic episode in the Avalonian Caledonia terrane of southern New Brunswick. In this study, petrographic and geochemical data combined with U-Pb zircon dating and zircon chemistry were used to provide new insight about the origin, evolution, and age of the voluminous silicic volcanic rocks of the Silver Hill Formation that dominate the upper part of the Coldbrook Group and to clarify their previously postulated relationship to associated high-level granitic plutons of the Bonnell Brook suite. Based on textural criteria the silicic volcanic rocks are mainly eutaxitic pyroclastic rocks and less abundant lavas characterized by porphyritic and eutaxitic textures. Variations in whole-rock chemical characteristics, zircon chemistry, and age indicate that the silicic volcanic rocks of the Silver Hill Formation and the associated granitic plutons are not all cogenetic, and differences in zircon population morphology were used to investigate magma evolution processes among the dated samples. Rhyolite in the Silver Hill Formation type area yielded a weighted mean Chemical Abrasion – Thermal Ionization Mass Spectrometry (CA-TIMS) $^{206}Pb/^{238}U$ age of 551.65 ± 0.15 Ma, similar (within error) to the 551.71 ± 0.15 Ma age date for a nearby fine-grained granite dome related to the Bonnell Brook pluton. Whole-rock and zircon chemistry suggest that the main body of the Bonnell Brook pluton was emplaced at a deeper level and is not cogenetic with the fine-grained granite and Silver Hill Formation rhyolite. The main belt of rhyolite in the Fundy Trail Parkway area is younger (549.18 ± 0.07 Ma) and consistent with an age date of 551.19 ± 0.20 Ma obtained for an underlying lithic tuff unit. Transitional felsic I- to A-type chemical signatures suggest that magmatism occurred in an extensional within-plate setting, consistent with the tectonic regime at that time throughout Avalonia, but the cause of the exceptionally voluminous magmatism at that time in the Caledonia terrane compared to other parts of Avalonia remains uncertain. A CA-TIMS age from felsic tuff in the Broad River Group yielded an age of 615.49 ± 0.14 Ma, confirming the age gap between the Coldbrook Group and older arc magmatism of the underlying Broad River Group and related plutons that was determined from less precise earlier geochronological work.

Abstract for poster presentation

Funding: Research agreements between the Geological Surveys Branch (GSB) of the New Brunswick Department of Energy and Resource Development and Acadia University and a NSERC Discovery Grant to S.M. Barr

RE-EXAMINATION OF ENDOGRANITIC AND EXOGRANITIC GRANOPHILE MINERALIZATION AT THE KEDRON STOCK AND ITS RELATION TO SN-W-ZN-IN MINERALIZED LEUCOGRANITE SYSTEMS IN SOUTHWESTERN NEW BRUNSWICK

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In the southwestern portion of New Brunswick, there is a series of Late Devonian intrusion-related tin, tungsten, molybdenum, and indium deposits, including the previously mined Mount Pleasant deposit. Having been the focus of various exploration programs, the Kedron Stock is similar to the mineralized leucogranitic systems in this region of New Brunswick. Shell Resources Canada and Billiton were among the first to conduct detailed exploration programs in the Kedron area, completing numerous trenches and seven drill holes between 1978 and 1984. In 2007 and 2008, Geodex drilled seven more holes and further described the mineralization-alteration and stockworks throughout the cupola (endogranitic) and the hornfelsed Silurian metasediments (exogranitic). Two quartz-feldspar porphyry dykes also occur on the property.

Much like the Mount Pleasant Granitic Suite, the granites, aplites, pegmatites, and porphyries of the Kedron cupola are highly fractionated, with high concentrations of lithium, beryllium, and fluorine — the presence of these fluxes in leucogranitic magmas supresses the temperature of crystallization thus increasing the extent of fractionation. As a result of this extreme fractionation, the exsolved volatiles produced endogranitic and exogranitic mineralized zones in and around the Kedron cupola. These zones are locally rich in tin, zinc, silver, copper, and indium.

Various styles of mineralization, dominantly found in zones of intense alteration (greisenization, chloritization, and sericitization), with locally developed quartz-rich stockwork veins and also associated with biotitization in the exocontact, are present. In an attempt to provide context to the styles of mineralization and to determine the relationship between the mineralization, alteration, and stockwork, polished thin sections were prepared from available drill core. Widespread veining and alteration of the Kedron Stream Granite has caused the initially pink-colored alkali feldspar to become turbid and white. Within the hydrothermal veins and stringers, abundant pyrite, galena, sphalerite, chalcopyrite, cassiterite, arsenopyrite, and bismuthinite are associated with quartz. Indium content reaches nearly 20 ppm locally, and in some zones, the concentration of silver locally ranges up to > 100 g/t. Molybdenite and wolframite occur occasionally as stockwork vein minerals.

Abstract for poster presentation

INFRARED MICROSCOPY OF FLUID INCLUSIONS IN WOLFRAMITE FROM THE WILDCAT BROOK MO-W OCCURRENCE, SAINT GEORGE BATHOLITH, SOUTHWESTERN NEW BRUNSWICK: PRELIMINARY RESULTS

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The Wildcat Brook occurrence (~417 Ma) is the oldest known intrusion-related Mo-W system hosted within the early Devonian Magaguadavic pluton along the northern margin of the Siluro-Devonian Saint George Batholith in Charlotte County, southwest New Brunswick. Molybdenum mineralization comprises disseminated, vein-hosted, and unidirectional solidification texture (UST)-hosted intergrowths of molybdenite-muscovite-quartz in intensely sericitized zones within leucocratic felsic dykes. In contrast, W mineralization occurs in a texturally distinct generation of wolframite-scheelite-quartz-muscovite-chlorite-pyrite veins hosted within metasedimentary host rocks (early Silurian Digdeguash formation). Whereas the textural association of molybdenite with quartz as a coeval magmatic-hydrothermal mineral is unambiguous, the origin and P-T characteristics of W-mineralizing fluids are unconstrained because of a lack of association between wolframite-scheelite and UST texture, the W-bearing veins are temporally and spatially distinct from those hosting Mo, wolframite-scheelite post-dates quartz in the host veins, and no fluid inclusions of primary origin are present in quartz or scheelite in the W-bearing veins.

Using an infrared microscope coupled with a heating-freezing micro-thermometry stage, fluid inclusions are being investigated within wolframite, a mineral that is opaque when viewed in transmitted white light. However, observed at 20°C in transmitted IR light, primary fluid inclusions in wolframite are vapour-rich (V:L ratios ~ 35-40 vol%) containing an aqueous liquid phase, and a vapour phase with abundant CO_2. Whereas secondary inclusions in quartz in the W-bearing veins show evidence for fluid unmixing, primary inclusions in wolframite trapped an apparently homogeneous fluid phase, suggesting that boiling/unmixing did not induce W precipitation. In contrast, secondary fluid inclusions in wolframite and quartz show evidence of heterogeneous entrapment indicating that decompression-induced unmixing of fluids occurred after wolframite deposition. Post-W decompression events may have been responsible, in part, for some of the Mo mineralization and would be consistent with the observation of UST textured igneous rocks in proximity to Mo mineralization. Comparison of the Wildcat Brook wolframite-hosted fluid inclusions with those in wolframite from other intrusion-related Sn-W-Mo occurrences in New Brunswick and Nova Scotia (Tin Hill/Burnt Hill, Cowan Hill Pond) is in progress with the goal of better understanding the nature of those geochemical and physical processes responsible for W mineralization in different tectonic zones of the Appalachians.

Abstract for oral presentation

THE NEW BRUNSWICK EXPLORATION ASSISTANCE PROGRAM

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The New Brunswick Exploration Assistance Program is offered by the Department of Natural Resources and Energy Development to help fund selected mineral exploration projects undertaken by junior mining companies and prospectors in the province. The program encompasses the New Brunswick Prospectors Assistance Program, the New Brunswick Junior Mining Assistance Program, and the Prospectors Promotion Program. The NBEAP budget for 2021–2022 is $877,000.

The New Brunswick Prospectors Assistance Program provides financial support to prospectors searching for metallic or industrial minerals (except aggregates) in the province. This year, fifty-eight prospectors received grants ranging from $1000 to $10,000 for their exploration projects.

The Prospector Promotion Program is intended to facilitate the process of optioning New Brunswick mineral prospects to mining companies. This program supports promotional activities for prospectors at the Prospectors and Developers Association convention in Toronto and the Association for Mineral Exploration Roundup in Vancouver.

The New Brunswick Junior Mining Assistance Program provides financial assistance to junior mining companies working in the province. This program provides 50% of eligible costs up to a predetermined maximum, for mineral exploration projects. This year, twenty-three projects were supported under this program with individual grants ranging from $10,000 to $30,000.

The New Brunswick Exploration Assistance program has been very successful in helping to locate and enhance mineral exploration targets throughout the province, and in promoting these properties locally and nationally. Consequently, the program is highly regarded by the New Brunswick Prospectors and Developers Association and the mining industry in general.

Abstract for poster presentation

LEAD AND SULPHUR ISOTOPE ANALYSIS OF GOLD ZONES IN THE CLARENCE STREAM AND OAK BAY DEPOSITS, SOUTHWESTERN NEW BRUNSWICK: EXAMINATION OF FLUID SOURCES AND CONTROLS ON DISTRIBUTION OF MINERALIZATION

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In southwestern New Brunswick, several structurally-controlled auriferous zones at the Clarence Stream and Oak Bay deposits are situated along complex accretionary zones. These zones are largely hosted by volcanic and sedimentary units of the Ordovician St. Croix and Silurian Mascarene belts, which were intruded by numerous Silurian to Devonian felsic to mafic intrusive rocks. Examining sulphur and lead isotopes from these two deposits, combined with previous Pb-S isotopic studies, reveals further details about the source of the mineralized fluids.

Sulphide separates from the South, George Murphy, Richard, and Jubilee zones of the Clarence Stream deposit have sulphur isotope signatures similar to those from the Devil Pike Brook and Bald Hill deposits, which are hosted within the New River and Annidale belts, respectively. The $\delta^{34}S$ values of the sulphides in all these deposits is around 0.0 ‰, similar to typical mantle-derived sulphides. The average $\delta^{34}S$ from the South and Lily Hill zones (Oak Bay deposit) is negative (-6.8‰); mixing fluids of different isotopic compositions and (or) reaction with the metasedimentary host rocks are probable causes for the depleted sulphur isotope signature in these samples.

Although a heterogenous magmatic source was assumed for the lead isotope values in 3 sulphide samples from the Clarence Stream deposit, the remaining samples from this deposit (n = 5) and the Oak Bay samples (n = 2) locally show high radiogenic Pb signatures. In most samples, one or several radiogenic Pb-bearing fluid(s) overprinted the initial Pb-isotope system during or after ore formation. The Magaguadavic and Whittier Ridge granites are two probable sources of radiogenic Pb in the Clarence Stream sulphides. The fractionated phases of the Magaguadavic Granite, which have high U and Th contents, could have remobilized and (or) precipitated sulphides. The Whittier Ridge Granite is similar to the uraniferous Mount Douglas Granite and intruded the Clarence Stream area after the main episode of gold mineralization. Radiogenic Pb could also be transferred by the hydrothermal fluid from Whittier Ridge granitic dykes, which may have added Pb as a later paragenesis in the pre-exiting mineralized veins. Lead in the Oak Bay deposit was probably derived from hydrothermal fluids emanating from the nearby Tower Hill Granite, either during or after deposition of sulphide and gold mineralization. Mineral chemistry of apatite and titanite in the mineralized veins from both deposits show that different hydrothermal fluids contributed to ore formation. Also, inconsistency of the Pb values in the different zones of the Clarence Stream deposit reflects various hydrothermal fluid events with different fluid sources.

Abstract for oral presentation

A VISEAN TO NAMURIAN MINI PULL-APART BASIN WITHIN THE MIDLAND AREA, SOUTHEASTERN NEW BRUNSWICK: IMPLICATIONS FOR THE FAULT HISTORY AND REGIONAL TECTONICS

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Recent integration of seismic profiles, industry reports, boreholes, and field interpretations confirm the existence of an 80 km^2 pull-apart basin within the Midland area of southern New Brunswick. During the Late Tournaisian(?) to Visean-Namurian periods, the Millstream Subbasin was created as a result of differential strike-slip movement along the Belleisle Fault to the north and the Kennebecasis Fault to the south, which were both intermittently active as dextral systems. Results from samples collected for palynological analysis corroborate the Late Tournaisian(?) to Visean-Namurian time period presumed for these events. The Millstream Subbasin is bounded by a minor system of normal faults; the Lower Millstream-Parleeville faults to the north and the Dickie Mountain-Peekaboo faults to the south. An initial episode of fault activity along the Lower Millstream (north) and Dickie Mountain (south) normal faults opened the basin and allowed the Late Tournaisian (?) basal thick red clastic sequences and, subsequently, the Visean limestone and evaporite facies to be deposited. After a period of quiescence, renewed transtension created the Parleeville (north) and Peekaboo (south) normal faults and resulted in the deposition of red clastic sequences above the evaporites and the downdropping of the central portions of the basin until fault movement waned during the Early Namurian. The formation of the younger normal faults is most likely due to the differential rotation of the Midland area between the Belleisle and Kennebecasis faults and (or) the transfer of the dextral movement from the Belleisle Fault to the Kennebecasis Fault.

Abstract for oral presentation

REVISIONS TO UPPER PALEOZOIC STRATIGRAPHY OF THE BLACKS HARBOUR-BEAVER HARBOUR AREA, NEW BRUNSWICK

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Outliers of upper Paleozoic sedimentary rocks are delineated by large strike-slip faults in the Blacks Harbour-Beaver Harbour area in southwestern New Brunswick. Currently, these rocks are included in the Devonian Perry Formation (Horton Group), and Visean-Pennsylvanian Balls Lake Formation (Mabou Group), and Lancaster Formation (Cumberland Group). These rocks have been subject to varied interpretations since they were first mapped during the 19th century. The Perry Formation, a red bed sequence consisting of coarse conglomerate, sandstone, and shales with minor mafic volcanic rocks, has yielded plant fossils (indeterminate debris and decorticated stem and root fossils) considered to be broadly Devonian, and most likely Famennian. Interpreting the 'Carboniferous' strata have proven to be more complex. Three units have been defined by mapping namely the: 'Fish Plant Beds' (Lighthouse Cove Formation), Cripps Stream Formation, and Beaver Harbour Formation. These units have yielded plant fossils in the form of indeterminate debris and decorticated stems and root fragments that various workers have attributed to the Silurian, Devonian, Mississippian, or Pennsylvanian. We report palynological analyses from the Perry Formation (Tunaville) and Beaver Harbour Formation (Woodland Cove, Russels Point), where shales have yielded stratigraphically significant assemblages. The Tunaville assemblage, the first from anywhere in the Perry Formation, and roughly in the middle of the sequence, is lower to middle Famennian. Two spore assemblages from near the base of the Beaver Harbour Formation indicate a possible range from Tournaisian to Holkerian (middle Visean) and are better constrained between Chadian and Holkerian (lower to middle Visean). Only the Lighthouse Cove Formation ('Fish Plant Beds') failed to yield any spore assemblages; however, mapping and structural observations support the interpretation that this unit is older than the Beaver Harbour Formation and younger than the Perry Formation: most likely Tournaisian. One new relationship has been located along the southern shore of Deadmans Cove: an angular unconformity between red beds of the Perry Formation and grey units of the Beaver Harbour Formation.

Abstract for oral presentation

MINING AND THE GREEN TRANSITION

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Decarbonization is increasingly reliant on a supply of critical materials. Because the demand for these specialty metals and materials is growing rapidly, recycling is incapable of becoming a dominant source of supply. Mining, either primary or by-product production, necessarily will play a major role. A significant portion of the public, however, wants to live in a perfect and unattainable world where there is no “dirty” resource extraction and no pollution of any kind. The mining industry needs to educate people about the necessity of producing critical materials to make our world cleaner. We are proposing an Internet-based series to connect citizens who might be open to a logical discussion about the realities facing us all.

Abstract for oral presentation

UPDATE ON BEDROCK MAPPING AND RESEARCH PROJECTS, SOUTHERN NEW BRUNSWICK

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The current focus of bedrock mapping by Sussex office staff is the Caledonia Highlands in southeastern New Brunswick. The highlands comprise nearly 3000 km^2 of mainly Neoproterozoic volcanic, volcano-sedimentary and plutonic rocks and Cambrian shallow-marine epiclastic rocks. The area was mapped at an inch to ¼ mile scale in the early 1970's and again at a regional scale in the 1990's. The latter study improved our understanding of the ca. 550 Ma Coldbrook Group and introduced the ca. 620 Ma Broad River Group. However, an expanding database of high precision U-Pb zircon ages has afforded a new appreciation of the complexity of the highlands, as trondhjemite and granodiorite plutons intruding parts of the Broad River Group have yielded Cryogenian ages of 686.8 ± 3.7 Ma and 693 ± 3.3 Ma, respectively. Our aim is to constrain the age, extent, and contact relations of this newly recognized group of Cryogenian or older volcano-sedimentary rocks in the eastern highlands. Sampling of felsic volcanic rocks suitable for U-Pb dating using thermal ionization mass spectrometry and detrital zircon dating of the clastic sedimentary rocks are primary targets. The objective of this study is to produce an improved map of the Caledonia Highlands utilizing both current and past data sources.

Other research projects include collaborative studies in partnership with Sandra Barr (Acadia University) on Grand Manan Island and Seven Mile Lake mylonite zone, and with Adrian Park (New Brunswick Geological Survey) in the southwestern New River belt. The purpose of this work is to better understand the New River belt and its major bounding structure — the Belleisle Fault and associated Seven Mile Lake mylonite zone, which are the focus of considerable exploration activity, mainly for gold. On Grand Manan Island, recent mapping and sampling for detrital zircon geochronology and geochemistry targeted a unit of massive quartzite and black shale that may be correlative with rocks recently identified in coastal Maine and on Georges Bank, which are thought to have links to Paleoproterozoic quartzite in northwest Africa. The latter study is part of International Geoscience Programme project 683 and an associated field trip "Northwest African crustal blocks in eastern North America", which will be part of the upcoming Geological Association of Canada 2022 meeting in Halifax, Nova Scotia.

Abstract for oral presentation

UPDATE FROM THE MINING RECORDER'S OFFICE

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The Mining Recorder's Office (MRO) is responsible for administering subsurface mineral rights in New Brunswick as they pertain to mineral tenure, mineral exploration, and the rights and obligations of individual prospectors and exploration companies, pursuant to the *Mining Act*.

The MRO administers 3 main aspects of prospecting and mineral exploration activities: 1) acquisition and planned exploration; 2) active exploration; and, 3) reporting of results and continuance. Updating and streamlining the administration of these duties has been a focus of the MRO in 2021.

The MRO continues to work together with public, private, industry and government stakeholders to revise and update the various forms and data-collection guidelines utilized by those active in the resource exploration sector in the province.

The MRO generates monthly updated claim maps, which are publicly available, and maintains year-to-date claim statistics. As a courtesy, it also provides monthly reminders to those claim holders with claims coming due that month.

Within the government, the MRO works closely with other government stakeholders, including Archaeological Services, Forest Planning & Stewardship, Crown Land Operations, and Aboriginal Affairs, to support the mineral exploration sector and ensure that its concerns are understood and considered. Areas of focus in 2021 were revisions to Notices of Planned Work, providing background for cutting permits, First Nations concerns, and candidate conservation areas.

In addition to the administrative duties, the MRO acts as a liaison between the exploration industry and the public and is also a point of first contact for these groups with the provincial government.

Abstract for oral presentation

STRUCTURAL ANALYSIS OF GOLD MINERALIZATION IN NORTHERN NEW BRUNSWICK: A PRELIMINARY ANALYSIS IN AID OF MINERAL POTENTIAL MAPPING

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Northern New Brunswick hosts a number of structurally controlled gold occurrences and deposits. Mapping using structural analysis techniques designed to target the more prospective ore deposit-forming features can improve mineral exploration targeting. The aim of this study is to conduct structural analysis on a number of gold occurrences hosted by Paleozoic rocks in northern New Brunswick, namely: McCormack-Ramsay Brook, Dalhousie Road, Mulligan Gulch, Simpsons Field, and Upsalquitch River, all of which lie within the Chaleurs Bay Synclinorium (Tobique-Chaleur belt). These occurrences were investigated using drill cores available at the Provincial drill core library. Structural lineaments that are spatially and genetically related to these sulphide-bearing quartz vein gold occurrences will be analyzed using geospatial data. In northwestern Chaleurs Bay Synclinorium, auriferous sulphide-bearing quartz veins are hosted by carbonate-altered clastic sedimentary rocks of the Grog Brook Group. To the west, igneous intrusive activity in the Aroostook – Percé Anticlinorium is marked by the presence of felsic dikes along major Acadian faults. Gold-bearing quartz-sulfide (pyrite, arsenopyrite, and chalcopyrite) veins are closely associated with calcite-ankerite, sericite, and silicification within of the sedimentary and mafic intrusive rocks. Mafic volcanic and intrusive rocks and interbedded clastic sedimentary rocks underlie the McCormack and Ramsay Brook areas in the southeast Chaleurs bay Synclinorium. Here, numerous contacts between the Siluro-Devonian diorite and gabbro intrusions and their host sedimentary and volcanic rocks are commonly carbonatized and silicified and are the locus of sulphide-bearing quartz and quartz-carbonate veins. The structural control on gold mineralization and vein emplacement is primarily related to dextral movement along the Rocky Brook-Millstream fault system and it splays e.g., the McCormack-Ramsay Brook faults during Early Devonian Acadian orogenesis. The geometry and relative orientation among the various sets of sulphide-bearing quartz-carbonate veins and fractures at these occurrences was determined from drill core logging and it supports the interpretation that northeast oriented faulting and related-shearing are the dominant structural controls on gold mineralization in the McCormack-Ramsay Brook area. Two or three vein sets are recognized in drill cores from the Dalhousie Road, Mulligan Gulch, and Simpson gold occurrences. In all three cases the various sets of quartz veins transect altered zones containing pyrite, arsenopyrite, and chalcopyrite. The most enriched areas commonly have >100 ppb gold and contain quartz-veins in silicified contact areas adjacent to intrusive rocks. Additional geochemical, geophysical, and petrographic research is planned to better understand the auriferous sulphide-bearing quartz veining for enhanced targeting in these areas.

Abstract for oral presentation

APPLICATION OF PORTABLE PXRF TECHNOLOGY TO IDENTIFY GEOCHEMICAL VECTORS TO GOLD MINERALIZATION IN THE MCCORMACK-RAMSAY BROOK AREA, NORTH-CENTRAL NEW BRUNSWICK

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North-central New Brunswick hosts a number of gold occurrences, many of which are struturallty controlled. In this study, drill cores from two auriferous sulphide-bearing quartz vein systems associated with the McCormack-Ramsay Brook fault zone, i.e. the Dalhousie Road and Mulligan Gulch occurrences were investigated. The portable X-ray fluorescence (pXRF, Olympus Vanta™) spectrometer was used to analyze a suite of elements in samples of sulphide-bearing quartz and (or) carbonate veins, their altered selvages, and breccia fragments. The pXRF data were processed with support of multivariate statistics, to examine the mineralization and alteration in these auriferous quartz vein systems. The Al and Fe and contents reflect the chlorite and Fe-sulphide alteration in these zones, whereas the high K reflects the sericitic to illitic alteration. Higher Al/K and Fe/K ratios from veins and altered zones, relative to country rock indicate that chlorite-sulphide is the predominant mineral assemblage. In these systems chlorite and sericite are the primary alteration phases occurring within and enveloping the quartz-veins. Quartz is the primary host of the auriferous sulphide mineralization in quartz-carbonate veins. Based on the Cluster, Pearson Correlation Coefficient, and Principal Component Analysis results, the metallogenic elements of these veins and related Au mineralization, such as Cu, Zn, S, As, Sb, and Fe exhibit an increasing trend, from the vein to nearby the mineralized and altered replacement zones. Preliminary results indicate that, at both the Dalhousie Road and Mulligan Gulch occurrences, S positively covaries with Fe, reflecting the presence of pyrite, pyrrhotite, and chalcopyrite in the core of these systems. However, high Fe and low S in some of the Mulligan Gulch samples reflect iron oxide alteration and chloritization. In terms of the relationship between Fe and As, the Dalhousie Road and Mulligan Gulch occurrences both have variable low to high As and high Fe which is interpreted to reflect a higher iron oxide content. The positive covariation of S and As in some samples reflects As-bearing pyrite and (or) arsenopyrite mineralization. At Mulligan Gulch, a positive correlation between S and Sb indicates the presence antimony-bearing minerals. The Dalhousie Road samples have a positive correlation between Ti and Zr reflecting the distribution of titanium-bearing minerals such as titanite, titanomagnetite, and zircon. High value of Zr, P, and Ti can confirm the existence of datable minerals such as zircon, apatite, and titanite. The integration of numerous pXRF data with multivariate statistical analyses and x-ray diffraction can be helpful in further investigating auriferous sulphide-bearing quartz (-carbonate) veins deposits.

Abstract for poster presentation

FROM GRAB SAMPLES TO DISCOVERY HOLES – THE WILLIAMS BROOK GOLD STORY

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Puma Exploration's Triple Fault gold project comprises a 41,500 ha gold exploration land package that includes three main properties – Williams Brook, Jonpol Gold, and Portage Lake. Boasting potential for sizeable and economically viable gold deposits, the project benefits from excellent infrastructure including a paved road, seaport access, and proximity to a rail line.

As part of an aggressive 10,000 m drill program, Puma is currently focusing its field work on the Williams Brook property, which is known to host underexplored, significant gold occurrences. Results were recently released from initial drilling at the property, which confirmed significant mineralization and pervasive alteration in all drill holes.

The Williams Brook property covers more than 30,000 hectares of favourable geological formations and is located 60 km west of the city of Bathurst, New Brunswick. It resides along the newly discovered O'Neil Gold Trend (OGT), a pervasively altered and brecciated rhyolite unit composed of numerous quartz veins, quartz veinlets, stockworks, and breccias that host significant gold showings and occurrences.

The property is home to various gold zones including the known Lynx, Pepitos, O'Neil, Chubby, and Moose zones. High-grade assay results from the 2020 exploration program across the gold zones included:
Lynx: 241.0 g/t Au, 79.8 g/t Au, 74.2 g/t Au, 63.5 g/t Au, 58.4 g/t Au
Pepitos: 52.1 g/t Au, 16.1 g/t Au, 15.0 g/t Au, 13.1 g/t Au, 4.87 g/t Au
O'Neil: 128.5 g/t Au, 44.4 g/t Au, 38.8 g/t Au, 32.8 g/t Au, 23.1 g/t Au
Chubby: 3.5 g/t Au, 1.2 g/t Au, 1.2 g/t Au, 0.45 g/t Au
Moose: 2.4 g/t Au, 2.1 g/t Au, 1.3 g/t Au, 1.1 g/t Au

Furthermore, the 2020 program resulted in the discovery of visible gold from three quartz veins at the Pepitos gold zone which graded 52.10 g/t Au and 95.5 g/t Ag, 16.15 g/t Au and 58.0 g/t Ag, and 15.05 g/t Au. The program also confirmed the presence of silver-rich, polymetallic quartz veins on the Williams Brook property with assays that graded 95.5 g/t Ag, 57.3 g/t Ag, 48.0 g/t Ag, 25.6 g/t Ag, and 13.6 g/t Ag.

On the basis of these impressive results, Puma decided to expand the 2021 exploration program to include 10,000 m of drilling, a significant increase from the originally planned 2,000 m.

To better define high-grade gold zones discovered in 2020 and to identify additional targets for the 2021 program, Puma initiated a 4,000 km-line VTEM airborne geophysical survey across the Williams Brook property, which revealed a distinct magnetic signature spanning 7 km.

The company confirmed that the anomaly coincides with gold mineralization discovered at surface last year, which included bonanza grade grab samples up to 241 g/t Au. The survey also resulted in the identification of more than 50 highly prospective targets.

Puma was excited to recently announce that all holes drilled as part of the Williams Brook inaugural drilling program intersected significant mineralization and pervasive alteration. Initial drilling is focused on the Lynx gold zone, which will be followed by Pepitos and O'Neil to better

define the structural features of the gold-bearing quartz veins and breccias, and to evaluate the possibility of a bulk sample later this year.

The Lynx gold zone comprises part of a 700 m stretch along the O'Neil Gold Trend (OGT), which is open at both ends and hosts the 7 km magnetic signature identified by the VTEM airborne geophysical survey. A total of 2,360 m of drilling was completed across 18 holes to intersect the down-dip projection of significant high-grade (previously excavated) gold vein networks exposed at the surface.

The drilling program was also designed to better understand the spatial geometry of the mineralized envelope and discover new potential high-grade zones extending at depth. Oriented core drilling was executed in partnership with Terrane Geoscience Inc., who had previously studied the alteration pattern and structural analysis of the main vein networks.

Each hole showed consistent mineralization and pervasive alteration over core lengths that varied from 10 m to 75 m. Main features included abundant quartz veins and large networks of quartz veinlets showing pervasive sericite and iron alteration. Disseminated sulphides and oxides were also present.

Visible gold was observed in several holes and sediments composed of altered siltstone interbedded with mudstone are present – aspects that are representative of a significant, low sulphidation epithermal model.

Abstract for oral presentation

INCREASING THE RESOURCES AT THE CLARENCE STREAM GOLD DISTRICT

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Galway Metals has a 100% undivided interest in the Clarence Stream gold project, which is located 70 km south-southwest of Fredericton in southwestern New Brunswick. Galway's land position comprises 60,465 ha (149,412 acres) with 65 km of strike length (and a width of up to 28 km) along the Sawyer Brook Fault System, which straddles several intrusions believed to have created the conditions necessary for gold deposition.

The Company released an updated NI 43-101 resource estimate prepared by SRK Consulting (U.S.) in September of 2017, which included, for the first time, a pit constrained resource. All prior resource estimates were based on underground mining only but there are wide, high-grade and near-surface intersects in both the South and North Zones that indicated the potential for pit development.

Following the NI 43-101 resource estimate release, Galway Metals focused on exploring for new gold deposits in the Clarence Stream Gold District and found several: the George Murphy Zone was discovered in late 2017; the Richard Zone was discovered in December 2018; the Adrian Zone in 2019; as well as 2 new gold discoveries, one northwest of the Adrian Zone and one southwest of the Jubilee Zone.

The 2020–2021 drill program increased the number of diamond drill rigs from 2 to 6 and mainly focused on expanding and infilling the newly discovered zones so that a new NI 43-101 resource estimate could be completed. Galway expects the new estimate to be released in the first half of the 4th quarter in 2021.

This presentation will recap the geology, and mineralization of each deposit, as well as the exploration potential within the Clarence Stream Gold District.

Abstract for oral presentation

THE MCINTYRE BROOK AU AND CAPTAIN CU-CO-AG-AU PROJECTS, NORTHERN NEW BRUNSWICK

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Stratabound Minerals Corp. is exploring a 59.5 km^2 package of claims under several option agreements collectively called the McIntyre Brook Project immediately east-adjacent to Puma Exploration Inc.'s Williams Brook Gold Property in northern New Brunswick. Both properties share significant new gold discoveries along the same geological and structural corridor. Stratabound's McIntyre Brook Property in particular features 40 trench samples grading between 0.20 to 41.56 g/t Au over 300 m strike at the Main Zone. With financial assistance from the New Brunswick Junior Mining Assistance Program, Stratabound recently collected soil samples for geochemical analysis across the entire property. The complementary results of both companies support compelling evidence of yet another new Maritime gold district along the same Iapetus Suture Zone coincident with a number of significant operating gold mines, deposits, and recent new discoveries in eastern North America and western Europe.

Stratabound also holds 100% ownership of the Captain copper-cobalt-gold-silver deposit located in the heart of the Bathurst base-metal district of New Brunswick. The Captain deposit hosts an NI 43-101 Measured and Indicated Resource totaling 448,000 tonnes averaging 1.75% Cu, 0.046% Co, and 0.30 g/t Au for a 2.2% CuEq% [(1)], plus an inferred resource of 162,000 tonnes averaging 1.47% Cu, 0.04% Co, and 0.24 g/t Au for a 1.87% CuEq% [(1)]. The Deposit is located along the "Brunswick Horizon", within a 20 km radius and the same stratigraphic contact that hosts the world-class Glencore Brunswick No. 12 and No. 6 mines. Stratabound completed near-surface, tight-spaced definition diamond drilling in 2020 featuring results up to 5.39% CuEq% [(1)] over 2.5 m true width. Stratabound is evaluating the potential for a high-grade, small-scale, direct-shipping mining project.

[(1)] CuEq% based on CuEq%= ((Cu lb/t*US$3.75.lb) + (Co lbs/t*US$20/lb) + (Au g/t*0.03215*US$1,750/oz) + (g/t Ag*0.03215*US$25/oz))/US$3.75/lb Cu *insitu* value and does not account for metallurgical, refining, or other losses

Stratabound's portfolio of gold projects also includes the Golden Culvert Project in the Yukon Territory and its newly acquired Fremont Gold Deposit in the California Mother Lode Gold District.

Abstract for oral presentation

WILDCAT – RECENT DRILLING DEFINES MOLY DEPOSIT

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The Wildcat discovery is situated along strike, 9 km east of the Mount Pleasant Sn-Mo-W-Zn-In deposit. The deposit is located in a package of Ordovician-Silurian sediments (Kendall Mountain, Digdeguash, and Sand Brook formations) between the Jake Lee Mountain Granite, to the north, and the Magaguadavic Granite, to the south. These granitic units have a strong positive magnetic response and can be traced throughout the district based on this distinctive magnetic signature. By comparison, the sediments are magnetically neutral. What drew attention to this area was the presence of a small, isolated magnetic high several hundred metres north of the granite contact. This magnetic high indicated the possibility of a satellite granite pluton or cupola intruding the sediments in this area.

Float samples gathered during initial exploration efforts assayed up to 0.65% MoS_2 and 0.11% WO_3 in greissen-quartz veins. Distal to these veins, Pb/Zn mineralization occurs as veins and cavity infilling in brecciated, indurated wacke to the north, south, east, and west of the discovery area. Analysis of the wolframite returned up to 13.93% WO_3 (more commonly 0.12% WO_3) while typical quartz-sulphide boulders averaged 0.055% MoS_2. The galena-sphalerite float boulders returned up to 25% Zn, 15% Pb, 32 g/t Ag, and 450 ppm Indium.

It was determined that large quartz stockworks with attendant greissenization exist around the magnetic high. The magnetic high represents pyrrhotite-pyrite-magnetite mineralization peripheral to a buried granite or porphyritic body from which the quartz vein swarms are derived. The base-metal tungsten-indium mineralization represents zoned mineralization distal to the main molybdenum mineralization. While Sn has not yet been intersected in the shallow (< 200 m) drilling to date, it is a potential target as deeper (> 250 m) drilling probes for the top of the porphyry intrusion.

A molybdenum-bearing porphyry dike was intersected in drilling in 2009 and 2010. It occurs in a mineralized, greissenized, quartz stockwork porphyry dike zone 800 m in strike and 80 m in width. Gravity and IP geophysics surveys conducted in 2016 and 2017 have broadened the target zones of distal mineralization to the north and east. Trenching in 2016 discovered new Pb/Zn mineralization on IP anomalies. An IP survey conducted in 2017 extended the potential Zn-In-Pb-Ag distal zone over 1 km to the northeast.

In 2020, a 6-hole, 1500 m drill program hit a porphyry zone of high-grade Mo (> 0.88%) over 20 m in hole WC-20-06, as spotted by Don Black. Step-out drilling of 3 diamond-drill holes all crossed similar intersections of ore grade Mo (> 0. 1%) over an average of intersections > 20 m at depths < 100 m.

In 2021, a 3,500 m, 30-hole program expanded the ore zone to 200 m along strike to the west-southwest and down dip 175 m to the north-northwest. Drill intersections through this tabular mineralized zone range from about 10 m to over 50 m. Assays are pending for the 2021 drilling, but visual estimates and pXRF results indicate a potential Mo resource approaching 2 Mt at an average grade of > 0.10% Mo. Numerous, narrow, high-grade tungsten veins are found, normally within quartz veins, above the Mo mineralization, with grades up to 17% W over 50 cm.

The exploration completed on this property since 2006 supports a geological deposit model similar to the nearby Mount Pleasant deposit or the Henderson orebody in Colorado (from Kirkham & Sinclair, 1988).

Abstract for oral presentation

ANALYSIS OF PORPHYRY CU POTENTIAL, NEW BRUNSWICK: A PRELIMINARY REVIEW

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More than 90% of porphyry deposits, which supply the majority of the world's Mo and Cu, occur in convergent margin settings with the remainder in post-collision or other tectonic settings. Most of the porphyry Cu ± Mo systems originate by injection of fertile oxidized intermediate I-type magma saturated with volatiles and rich in S and metals. The porphyry mineralization process is divided into three phases: source, magma generation and magma, and deposit emplacement. Given that the existing intrusions are I type (magnetite series), the origin can be old continental crust and (or) enriched mantle sources. Vein-type copper-rich base-metal deposits and contact metasomatic and porphyry copper (± Au and Mo) deposits are related to high-level granitoid stocks.

Devonian subvolcanic intrusions emplaced during the latter stage of, to immediately after, the Acadian Orogeny, occur throughout New Brunswick. The occurrence of porphyry copper deposit systems is a function of the level of intrusion, composition of igneous rocks, and the nature of host sequences. The oxidized I-type porphyry intrusions of central and southern New Brunswick include Eagle Lake, Sorrel Ridge, Evandale, Pokiok, Falls Creek, and Magaguadavic. Porphyry systems in northern New Brunswick include the Benjamin River porphyries (Boland Brook, Landry Brook, Dickie Brook, Charlo intrusions, Jerry Ferguson Brook, and Blue Mountain granodiorite suite), Sugarloaf, Squaw Cap, Nicholas Denys, Mulligan Gulch, Patapedia, Rivière Verte and Quisibis porphyries, and McKenzie Gulch dykes. Some of the intrusions in the Benjamin region, (e.g. Landry, Dickie Brook, and Charlo) primarily host molybdenum mineralization and have lower potential for hosting copper mineralization. Some of the multiphase intrusions have variable porphyritic textures with hornblende, biotite, plagioclase, and quartz phenocrysts. Reported ages from these intrusions include: granodiorite of Blue Mountain-Benjamin River Cu-Mo deposit (400.7 ± 0.4 Ma), McKenzie Gulch associated with Cu skarn mineralization with two ages (Plagioclase–hornblende porphyry suite with 386.2 ± 3.1 Ma and quartz–plagioclase porphyry suite with 386.4 ± 3.3 Ma), Squaw Cap Mountain granodiorite (415.0 ± 0.5 Ma), Rivière Verte granodiorite with associated Cu ± Mo mineralization (368 ± 2 Ma), Evandale (390.4 ±1.5 Ma), Magaguadavic (403 ± 2 Ma), Nicholas Denys (381±4 Ma), Patapedia (364.4 ± 0.4 Ma), Landry and Dickie Brook (419.63 ± 0.23 and 418 ± 1.3 Ma), and the Pokiok Batholith, which includes Nashwaak (420.7 ± 1.8/-2.0 Ma), Allandale (402 ± 1 Ma), Hawkshaw (411 ± 1 Ma), Skiff Lake (409 ± 2 Ma), and Hartfield (415 ± 2 Ma) phases.

Abstract for oral presentation

BLUE MOUNTAIN INTRUSIVE SUITE, NORTHEASTERN NEW BRUNSWICK: ANALYSIS OF ITS ADAKITIC SIGNATURE AND PORPHYRY CU POTENTIAL

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The Blue Mountain Intrusive Suite consists of intermediate intrusive rocks that form a part of the Ganderian Appalachians in northern New Brunswick. These Early Devonian Cu-Mo mineralized intrusive rocks have returned a U-Pb zircon age of 400.7 +/- 0.4 Ma and range from slightly peraluminous to metaluminous diorite to granodiorite of alkalic-calcic to calc-alkalic affinity. They plot in the range of magnesian granites with a low FeO^{tot}/MgO of 1.55. Their geochemical characteristics (SiO_2 55–71 wt%, Na_2O > 3 wt%, Al_2O_3 >16 wt%, Yb < 1.8 ppm, Y < 18 ppm, enriched LREE, and depleted in HREE), allow these rocks to be classified as adakites.

There are several hypotheses regarding the formation of adakitic magmas: 1) melting of oceanic crust, 2) high pressure crystal fractionation of garnet and amphibole from hydrous basaltic magma, 3) melting of lower continental crust by intrusion of hot basaltic magma beneath it, 4) melting of eclogite or garnet amphibolite rocks, and 5) crystal fractionation of hydrous mafic magma and melting of lower continental crust in contact with the mantle. Based on evidence, the fifth hypothesis is the most plausible explanation for the formation of the Blue Mountain Intrusive Suite. Key elemental ratios, e.g. Nb/Yb versus Th/Yb, indicate that samples of the Blue Mountain have a volcanic arc affinity. Also, average values for Nb/Y, Sr/Y, and La/Yb are 1.1, 73.7, and 36.1, respectively, and are consistent with adakitic magmas.

A connection between adakitic magmas and porphyry-hydrothermal Cu-Au mineralization is recognized globally. Porphyry copper mineralization is associated with slab melting or melting of metasomatized supra-subduction zone subcontinental lithospheric mantle. Due to the presence of Fe^{+3} in the magma during partial melting, copper- and gold-bearing sulphides in the source region (mantle wedge) are oxidized and the metals released to form fertile partial melts. Such melts form under high temperature, pressure, and oxygen fugacity and are volatile-rich. These melts, once formed, coalesce and rise to subvolcanic levels under regional transpressive to extensional conditions. Under high oxygen fugacity conditions, sulphur dissolves as sulphate in the adakitic melt, which contributes to the enrichment of incompatible elements, such as Cu. Samples of the Blue Mountain Intrusive Suite have S, Cu, and Mo contents up to 3524 ppm, 69 ppm, and 5.19 ppm, respectively. These values indicate fertility as does the ratio of MnO versus Y. Interestingly, the porphyry dykes associated with Cu-skarn mineralization at McKenzie Gulch in northern New Brunswick are also adakitic.

Abstract for poster presentation