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Report of activities for the Core Zone: Strategic geomapping and geoscience to assess the mineral potential of the Labrador Trough for multiple metals IOCG and affiliated deposits, Canada

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FOREWORD/CONTEXT

The Geo-mapping for Energy and Minerals (GEM) program is laying the foundation for sustainable economic development in the North. The Program provides modern public geoscience that will set the stage for long-term decision making related to investment in responsible resource development. Geoscience knowledge produced by GEM supports evidence-based exploration for new energy and mineral resources and enables northern communities to make informed decisions about their land, economy and society. Building upon the success of its first five-years, GEM has been renewed until 2020 to continue producing new, publically available, regional-scale geoscience knowledge in Canada's North.

During the summer 2014, GEM's new research program has been launched with 14 field activities that include geological, geochemical and geophysical surveying. These activities have been undertaken in collaboration with provincial and territorial governments, northerners and their institutions, academia and the private sector. GEM will continue to work with these key collaborators as the program advances.

SUMMARY

The GEM2 Hudson-Ungava project has conducted literature reviews and public geoscience re-examination of a case study within the Romanet Horst, Québec, Canada to test a scientific hypothesis upon which will rest larger-scale work in the Labrador Trough for its upcoming 2015 season. To this effect, a task-sharing agreement has been set up with Honey Badger Exploration Inc. and Energizer Resources Inc. to use their Sagar mineral property as a test-case to assess if the trough has potential for multiple metals iron oxide copper-gold (IOCG) deposits. This report presents the why, where and who of this activity and briefly summarises regional-scale iron oxide alkali-alteration attributes typical of mineral systems that can lead to IOCG and affiliated deposits. Results should shed light on the development of regional-scale alteration systems within the horst and contribute to identify other localities of the Labrador Trough with potential for IOCG and affiliated deposits. Ultimately the evolution, timing relationships and spatial distribution of the mineralising systems will support GEM2 and the Québec Ministère de l'Énergie et des Ressources naturelles goal of providing a renewed framework for mineral resources development in the Labrador Trough and adjacent Core Zone.

INTRODUCTION

Previous work. Since the early visit by Low (1895) and his recognition for iron ore potential, the Labrador Trough (also referred to as the New Québec Orogen) has been mapped at various scale, from reconnaissance only to locally quite detailed, and a model stratigraphy established based on limited geochronological data (Dimroth, 1978; Clark, 1986; Clark and Wares, 2004). Following the discovery and initial exploitation of iron ore, further mineral exploration in the Labrador Trough volcanic and sedimentary sequences has led to the recognition of the Romanet Horst and its polymetallic showings (Fig. 2; e.g., Letho, 1962; Chevé, 1985; Clark, 1986; Clark and Wares, 2004; Setterfield et al., 2006). Potentially economic interest lies in the diversified metal-rich hydrothermal mineralisation and their combinations of base, precious and specialised metals such as Cu, Ni, Co, Mo, Zn, Au, Ag, rare-earth elements (REE), high field-strength elements (Th, Ta, Zr) and uranium. From the first recognition of iron ore in the Labrador Trough (Low, 1895) to approximately the beginning of the 21st century, the exploration industry was interested mostly in Cu, Au, Ag and U so reports and synthesis focused on these metals. The preferential host for the mineralisation in the Romanet Horst was recognized to be series of veins within albitisation corridors and fault zones. More recently, specialised metals such as REE, Zr and Co have become economically critical and exploration within the horst is now considering these commodities (e.g., Clark, 1986; Fournier, 1988). Nevertheless, most authors did not report concentrations of these rare metals. In addition, the suites of metal associations within the horst appear to be randomly distributed and disorganised and preferred ore deposit models were in some cases conflictual and segmented into syngenetic and diagenetic Cu ± U (Kupferschiefer, red beds, etc.) or epigenetic Cu ± U ± Au (quartz-carbonate-sulphide veins, volcanic-hosted massive sulphides, albitite breccia, etc.). Very little data are published for REE and other critical metals within the horst.

Goals and objectives. The goal of this GEM2 sub-activity is to sufficiently increase our knowledge of the regional-scale metasomatic (magmatic-hydrothermal and hydrothermal) alteration systems of the Labrador Trough to be able to resolve long-standing inconsistencies in metallogenic models emanating from the diversified and apparently disparate metal associations and style and type of hydrothermal mineralisation along the trough. Corriveau and Mumin (2010) and Potter et al. (2014) have pointed out that the combinations of proposed ore deposit models and metal associations observed in localities such as the Labrador Trough commonly vector to IOCG-type mineral systems, which are grouped under the umbrella of iron oxide alkali alteration (IOAA) systems, a term coined after Porter (2010). This activity thus aims at better assessing the potential for polymetallic iron oxide copper-gold (IOCG) deposits as well as its affiliated iron oxide-apatite (IOA), albitite-hosted uranium, skarns, iron sulphide deposits and other polymetallic deposit-types.

The strategic geological mapping undertaken on the regional-scale alteration attributes of selected case studies will also contribute to two main scientific aims of Core Zone activity. The paleo-depth attributes and the tectonic and structural controls observed on regional-scale alteration, extensive brecciation and polymetallic mineralisation will provide further control on the tectonic evolution of the trough, including on the differential exhumation of its various sectors. It will also help in evaluating the role of deep-seated, belt-scale structures as conduits and traps for metals and magmas and provide better understanding of their role in the type of mineral potential each sector of the belt may have from near surface to a few kilometre depth.

Scientific questions. In the Great Bear magmatic zone and the East Arm of Great Slave Lake in the Northwest Territories, base–precious–specialised-metal associations and styles and types of mineral showings that seemed highly disparate such as those of the Labrador Trough were the results of depth to surface and lateral to longitudinal evolution of iron oxide alkali-alteration systems with each sector, providing geological and geophysical vectors to distinct but predictable ore deposit types (Corriveau et al., 2010a, b, 2011; Potter et al., 2013). Can the known showings of the Romanet Horst be organised into a systemic IOCG-type classification based on what has been learned on regional-scale evolution of IOAA systems by the IOCG-Great Bear region project of the Geomapping for Energy and Mineral program, phase one (Corriveau et al., 2010a, 2011; Montreuil et al., 2013, 2014; Hayward et al., 2013; Potter et al., 2014)? What geological and geophysical attributes of the horst can serve as exploration vectors based on results of the Targeted Geoscience Initiative program, phases three and four

(Corriveau and Mumin, 2010; Corriveau et al., 2010b)? Are any, and if so which, sectors have mineral potential for polymetallic iron oxide copper-gold (IOCG), iron oxide-apatite (IOA), albitite-hosted uranium, skarns, iron sulphide-copper deposits. Is there any potential for sedimentary and diagenetic Cu ± U and epigenetic Cu ± U ± Au deposits? What is the role of magmatic suites, basinal fluids and upper crust architecture, its deep-seated faults and the tectono-magmatic activity in the development of these mineral systems? What do they tell us on the evolution of the Labrador Trough?

METHODOLOGY

The present GEM2 Hudson-Ungava activity in the Romanet Horst involves a reconnaissance-scale field season and a synthesis of numerous governmental and industrial reports on the geology of the Horst of Romanet (Figs. 1, 2). This activity is conducted in collaboration with a current exploration program by the private sector in order to optimize government-industry research programs. The compilation completed within the scope of this activity extracted the alteration attributes of the main mineral showings to further test the mineral potential for iron-oxide copper-gold deposits of the Romanet Horst. This potential was suggested early on by Setterfield and Tykajlo (2000) and Corriveau (2007) based on the combinations of the metal associations, albitites, and carbonatites being documented. The latter provides evidence for mantle-to-crust pathways for magma and fluids, a condition that Mumin and Corriveau (2005) and Corriveau (2007) considered key for targeting prospective areas in the Canadian Shield in addition to IOAA alteration attributes. To this effect, the Sagar property within the Romanet Horst was selected as a test case and a collaborative agreement signed with two mineral exploration companies exploring it, namely Honey Badger Exploration Inc. and Energizer Resources Inc.

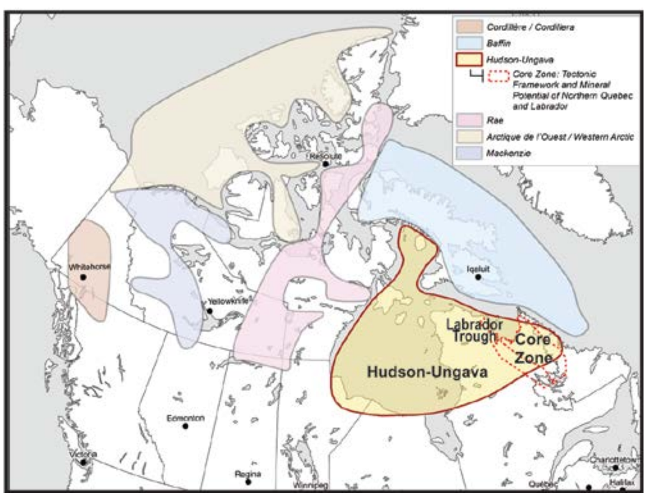

Figure 1. Location of Core Zone and adjacent orogens activity including the sub-activity within the Labrador Trough to the west.

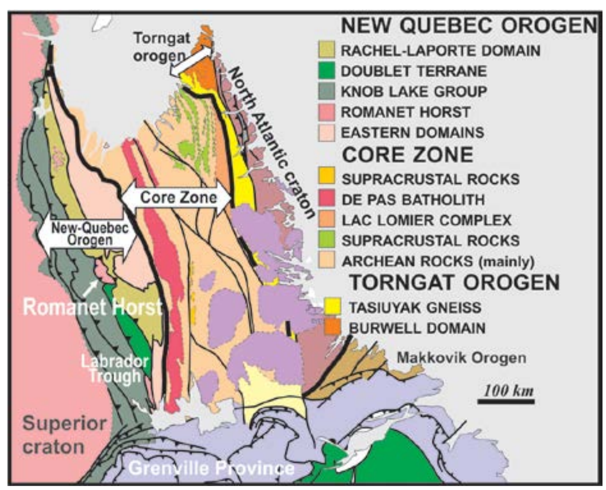

Figure 2. The Romanet Horst is a volcano-sedimentary sequence within the Labrador Trough of the New Quebec Orogen (modified from James et al., 2003; Clark and Wares, 2004; Simard et al., 2013).

Information on hydrothermal alteration, brecciation and mineralisation characteristics of the Romanet Horst has been compiled and selected field sites visited. Geophysical models have identified areas with IOCG-type signatures, as well as geological domains with very distinct signatures within the Core Zone and the Labrador Trough (N. Hayward, unpublished data, 2014). In previous years and during summer 2014, the private industry has conducted several regional-scale airborne geophysical programs and detailed ground-based prospecting and geophysical programs in the local area (Desrochers, 2014; Honey Badger Exploration Inc., 2014). As private sector exploration program progressed, geological attributes recognised as typical of regional-scale alteration systems that can lead to IOCG deposits were identified. As part of this study, we selected a number of them for strategic mapping and research. In the process, similarities between mineralisation and alteration in the Romanet Horst and that of IOAA systems worldwide were documented and sampled for rock-slab staining and further megascopic description, geochemistry and petrography. Structural studies were also initiated. The mapping was helicopter-supported, with 50 field locations examined. In parallel, the Honey Badger Exploration Inc. and Energizer Resources Inc. exploration programs extensively drilled selected targets within the horst; systematically analysed whole-rock composition of prospecting samples and drill cores with portable XRF; identified mineral suites with a portable mineral spectrometer, and conducted extensive geophysical surveys, terrain elevation models and ground prospecting. Results stemming from these programs were systematically taken into account for targeting and optimising GEM2 fieldwork (cf. Desrochers, 2014; Honey Badger Exploration Inc., 2014).

RESULTS

Protoliths targeted for alteration mapping consist of gabbro, basalt, coarse-to-fine clastic sedimentary rocks and dolomite (Fig. 3; geology from Clark and Wares, 2004; Examine database, 2014). All of these rocks were regionally deformed and mildly metamorphosed and some were also subsequently remobilised through regional and local fault movement (Clark, 1986). These precursor rocks have been pervasively replaced by albitites along major host-bounding and transverse deformation corridors (the NE-trending Romanet River fault zone and a major deformation zone that cuts through the horst in an ENE-WSW direction just about the middle of the horst and form Unit 12 of Clark, 1986). Beyond these albitites, current work under this project and private sector exploration program highlights nine other regular alteration types across the case-study area. These consist of high-temperature calcic–iron alteration (*amphibole–magnetite*), high-temperature potassic–iron alteration (*biotite–K-feldspar–magnetite*), lower-temperature hydrolytic potassic–iron alteration (*carbonates–chlorite–hematite–K-feldspar–white mica*), silicification (*quartz*), sericitisation/phyllic alteration (*white mica*), lower temperature calcic–iron alteration (*chlorite-epidote*), carbonatisation, and sulfate alteration (Ca-SO_4). The first four are typical of iron-oxide alkali alteration Facies 1 (Na), Facies 2 (High Temperature (HT) Ca–Fe), Facies 3 (HT K–Fe), and Facies 5 (Low Temperature (LT K–Fe). To date, the Facies 4 of IOAA alteration (K-feldspar felsite breccias and K-feldspar-bearing skarns; Corriveau et al., 2010b) has not been identified. Some zones display transitional alteration typical of Facies 1–2 (Na–Ca–Fe)) with the assemblage albite–amphibole and Facies 2–3 (HT Ca–Fe–K) with the assemblage amphibole–biotite–magnetite. Silicification, sericitisation and LT Ca–Fe are common outcome of fluids that evolved from IOAA to epithermal systems; this may be the case in the study area.

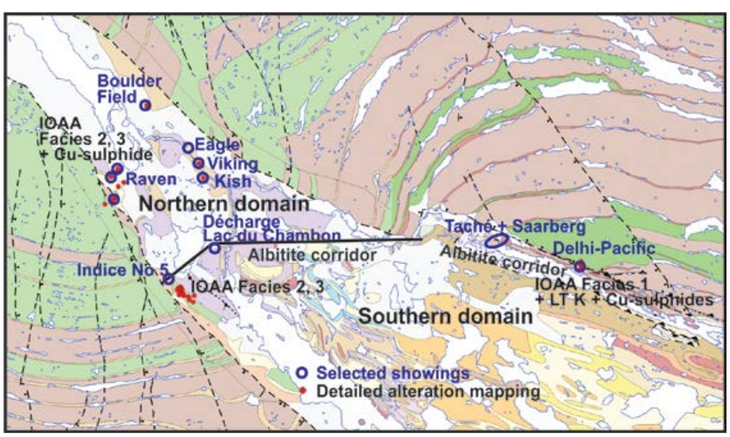

Figure 3. Mineral showings and sites of detailed alteration mapping for this public geoscience mapping (this work, Clark and Wares, 2004; Examine, 2014). Previous work had documented significant albitisation, hematisation and carbonation across the case study area (e.g., Anomalie 79-1–Bacon, Décharge Lac Chambon, Delhi Pacific, Eagle 1–Eagle Uranium–Béland, Eldorado 1, Eldorado 2, GM, Indice Deschênes, Kish, Saarberg 1, Saarberg 2, Viking). Beyond these alteration types, sericitisation, silicification and chloritisation had also been described locally. Some of the albitites zones have been mapped in details (e.g., Kearvell, 1984).

Albitites. Sodic alteration is most extensive and leads to aphanitic albitites that pervasively replace precursor sedimentary and fine-grained mafic rocks (Fig. 4). Such albitites are whitish to creamcolored, very hard and intergrown with aphanitic silica. They commonly resemble silicification zones or felsic volcanic rocks. Where the units of albitites are thick (5–100m), they are highly fractured (*locally very regular sets of parallel fractures*), veined (*quartz veinlets, dolomite veinlets, amphibole veins, sulphides veins, etc.*), brecciated and locally folded (Fig. 4). These albitites are locally pervasively sericitized and regularly mineralised with copper sulphide. They host most of the previously known showings. Such albitites are typical of the early, regional-scale Facies 1 (Na) of iron oxide alkali alteration systems (Williams et al., 2005; Corriveau et al., 2010b). With their high porosity and high permeability, they become preferential host to subsequent mineralisation within IOAA systems (Corriveau et al., 2011; Montreuil et al., 2014, unpublished data). If uplifted near surface above their active IOAA system host, these epithermal albitites become intensely sericitized and veined by sulphide-bearing mineralisation. This series of events is compatible with alteration evolution and mineralisation observed within the albitite breccia hosting the Delhi-Pacific showing (Fig. 3).

Figure 4. Fine-grained albitite, folded within the mineralized albitite breccia at Delhi-Pacific. Field of view 15 cm.

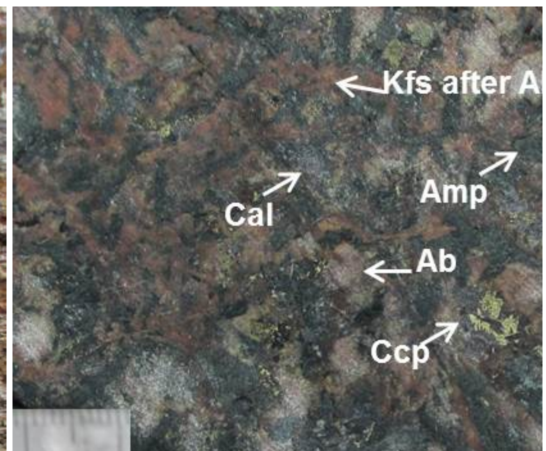

Figure 5. Gabbro replaced by albite (Ab)-amphibole (Amp)±magnetite alteration and overprinted by K-feldspar (Kfs), calcite (Cal) and chalcopyrite (Ccp).

Zones of albitite breccia can be traced for kilometres along the east-west corridor transverse to the horst marking the limit between two structural domains (Fig. 3). To the northwest, basalts, gabbros and fine-grained mafic rocks abound among detrital silicic sedimentary rocks and carbonate units. All of these units are commonly albitised (Fig. 5). They locally have a well-developed schistosity parallel to structurally transposed bedding. An overprinting tectonic foliation is not strongly developed in this domain except in marble and calc-silicate layers at Raven. North-north-east deformation corridors are altered and commonly mineralised in copper sulphides. In the southern domain, dolomites and locally albitites intercalated with graphitic schists display a tectonic foliation trending west-north-west. Locally, this fabric is a crenulation cleavage that deforms an earlier schistosity and develops parallel to the axial plane of folds affecting the transposed bedding and the earlier schistosity (Figs. 4, 6, 7).

The albitite corridors were tectonically active during and after the main mineralising events. In the southern domain, layers of albitite (former fragments of albitite breccias?) along high-strain zones are isoclinally to ptygmatitically folded and boudinaged, with their fold hinges disconnected from their limbs. Axial planes are parallel to a tectonic foliation imprinted in adjacent graphitic schists. Where infolded along with albitites, graphitic schist layers significantly thicken along fold axes. Spatially constrained brecciation and ductile-to-brittle faulting within albitites form ideal conditions to focus the flow of mineralising fluids in favorable permeable windows in larger deformation zones (e.g., fault jogs).

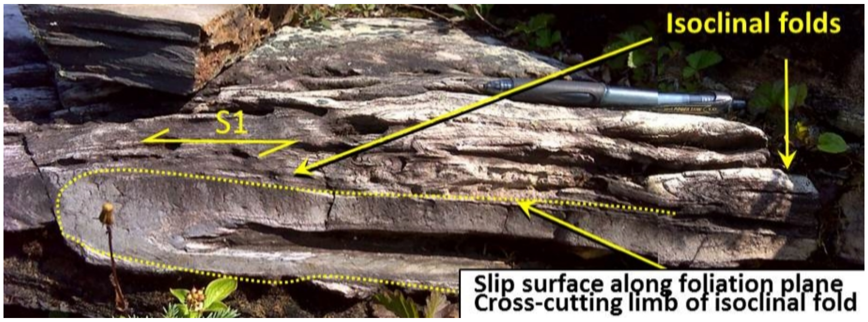

Figure 6. The sedimentary units have been tightly to isoclinally folded with several slip surfaces along the foliation planes. This tectonic compositional layering may look like primary bedding at first glance at the surface of the outcrops. However, closer examination indicates that precursor sedimentary beds and schistosity are generally parallel and form a tectonic layering.

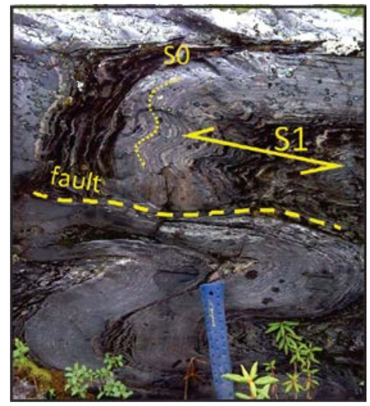

Figure 7. Folded sedimentary layers with a slip surface along limbs and an axial planar schistosity.

In addition to the regional-scale albitites, late-stage coarse-grained to pegmatitic albite veins with chlorite and hematite cut folded sedimentary rocks and are associated with uranium mineralisation (Boulder field, Eagle and Kish showings, Fig. 3; cf. Kish and Cuney, 1981; Kearvell and Clark, 1988).

Facies 2 (HT Ca–Fe) to *Facies 3 (HT K–Fe)*. The Raven mineral occurrences in the northern domain outcrop within a zone of very fine-grained mafic rocks and carbonate rocks above a strong, circular, 400 metre-diameter, positive magnetic anomaly. The mafic rocks are pervasively replaced by magnetite-amphibole alteration with a mild to moderate intensity and are crosscut locally by veins of magnetite centimetres in width. Such assemblages are typical of IOAA Facies 2 (HT Ca–Fe). What is atypical, though, is that the intensity of alteration remains mild to moderate and veins remain centimetre in width and decimetre in longitudinal extent instead of the very pervasive alteration zones diagnostic of immediate wall-rocks to iron oxide-apatite deposits and proximal alteration to IOCG deposits. Where mafic rocks are in contact with carbonate units or that carbonates occur in the vicinity, alteration evolves to a biotite–magnetite alteration paragenesis with disseminated copper sulphides (chalcopyrite) across zones decimetre in width in the mafic rocks. Replacement is penetrative and intense but spatial distribution of such alteration is again largely restricted to zones of precursor mafic rocks. Adjacent carbonates do not appear to be transformed into skarns though calc-silicate rocks parallel to the transposed bedding may prove to be originally metasomatic in origin through further research. Though the alteration paragenesis is compatible with the development of IOAA Facies 3 (HT K–Fe), a lack of skarns would be atypical of IOAA systems that further prograde upward. Conversely, it compares well to alteration fronts that rise/seep above their main zones of stability, develop in the most suitable unit(s) and then cool rapidly.

The combination of magnetite-rich copper mineralisation in association with biotite or K-feldspar in districts where albitites developed regionally and were commonly brecciated, is typical of IOAA systems that can host magnetite-group IOCG deposits. If the working hypothesis of seepage of Facies 3 (HT K–Fe) is correct, then applying the alteration-facies model permits to prognosticate mineral potential for magnetite-group IOCG deposits at depth. Geophysical models of ground and airborne data highlight the presence of gravity, magnetic and magnetotelluric anomalies compatible with the presence of highly magnetic, dense and conductive components to the iron oxide alkali alterations system in the Lac Romanet region.

Facies 5 (LT K–Fe). Earthy hematite zones are commonly spatially associated with intense sericitization and abundant zones of carbonate alteration and breccia infilling. Many pale grey or pale green schistose rocks were observed to consist of pervasive and intense sericite alteration of precursor detrital siliciclastic sedimentary rocks (Fig. 8). These rocks, as do the graphitic schists, take the aspect of metamorphosed sedimentary rocks but in some cases their distribution crosscut original sedimentary layering. In addition, stratabound specular hematite and stratabound wustite (?) alteration replace dolomites at the Viking showing and are strongly foliated (Fig. 9). Where uranium mineralisation occurs in late-stage albitite veins or host dolomites, potassium slightly increases as measured with a gamma-ray spectrometer in the field and the alteration that host uranium is observed to overprint the tectonic foliation (Fig. 10). The current erosional level only records mild development of such lower temperature alteration.

Other alteration types. The systematic use of hand-held portable XRF has enabled real-time discovery of new alteration types and new commodities within the Romanet Horst, in particular molybdenum appears to crystallise after intense sericitic alteration (Fig. 11). The very fine-grained molybdenite veins are folded and crosscut by straight chalcopyrite-bearing veins that are emplaced along the axial plane, itself parallel to the schistosity developed within the sericitic alteration. As for the high Au-U mineralisation discovered in the horst, the molybdenum is currently only revealed by boulders in the northern domain but molybdenum has been reported in association with albite and carbonate-bearing veins, specular hematite veinlets and intense red staining. Whether this spatial association of boulders bearing either uranium or molybdenite represent a vector to identify the source of the intensely mineralised boulder is uncertain at present but if this relation is systemic, it is bound to be reflected in till geochemistry.

Figure 8. Sandstone pervasively sericitized to a fine grained, foliated rock; where less intense precursor quartz grains are preserved. Field of view among lichen is 15 cm.

Figure 9. Dolomite stratabound iron oxide altered and veined by iron oxide. Both hematite and potentially wustite? Were observed in distinct alteration zones.

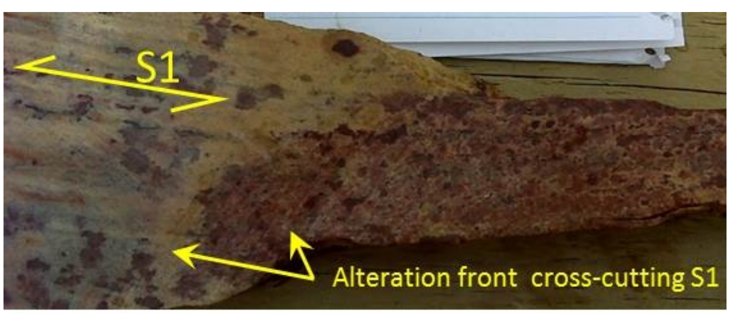

Figure 10. In the northern domain, some uranium mineralization and potassic alteration post-date the first foliation (S1) as documented in the Viking showing. On the same outcrop, hematite alteration is strongly foliated indicating that it is coeval or predate the foliation.

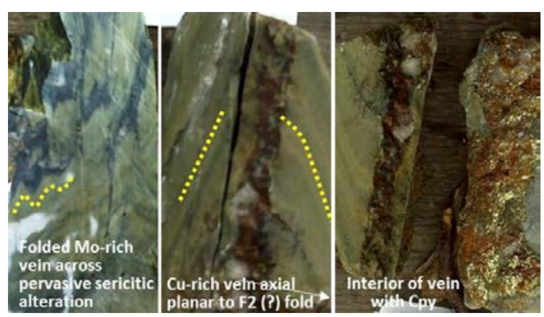

Figure 11. In the Boulder field, boulders highlight that molybdenite (Mo)-rich veins crosscut foliated sericitic alteration and are themselves folded. Chalcopyrite (Cpy) veins are clearly axial planar to the folds.

Iron oxide is commonly absent or only locally developed within albitites that are interfolded with graphitic schists, such as those at the Delhi-Pacific prospect. In contrast, such lithological domains display widespread iron sulphide–copper mineralisation in the form disseminations within replacement zones, veins, stockworks and breccias. Copper-sulphide mineralisation outcrops over several tens of metres along drill cores, as well as in the field in association with geological and geophysical attributes that are diagnostic of a system with mineral potential for magnetite- to hematite-group IOCG deposits that has evolved to epithermal style mineralisation. Chemical and tectonic/hydrothermal breccias are common and regional in scale. Close association of polymetallic iron oxide-copper and iron sulphide-copper mineralisation have been shown by Haynes (2000) to be common, and a causal link has been proposed. The present work may further test Haynes model.

Tectonic context. The Cu–Au–U mineralisation within the Romanet Horst has been interpreted as synchronous to the Trans-Hudson orogeny (Clark and Wares, 2004). Syn-orogenic magmatism in the New Quebec Orogen and Labrador Trough is contemporaneous with two sedimentary cycles within the Romanet Horst, i.e., at about 1.88 to 1.87 Ga and 1.82 to 1.77 Ga (Machado et al., 1997; James and Dunning, 2000). Some magmatic rocks within the Romanet Horst could have provided the heat source of hydrothermal activity, given their relative ages. Most of these rocks are gabbros and basalts that stratigraphically overly-, and occasionally intrude the sedimentary rocks of the horst (Clark, 1986; Clark and Wares, 2004). Carbonatites also intruded near the Romanet Horst. The Castignon carbonatite was dated at 1880 ±2 Ma (Chevé and Machado, 1988) and stratigraphic relations suggest Le Moyne carbonatite is about 4 Ma younger (Clark and Wares, 2004). These carbonatites may represent witnesses of broader regional mantellic and deep crustal magmatic hydrothermal activity.

CONCLUSIONS AND FUTURE WORK

GEM2 targeted reconnaissance mapping and the extensive exploration program undertaken by private sector highlight that the albitites are the earliest hydrothermal alteration observed in the Sagar property. Sodic alteration is demonstrably overprinted by HT Ca-Fe and HT K-Fe alteration in mafic precursors leading to regular copper-sulphide (chalcopyrite) mineralisation typical of magnetite-group IOCG deposits. In parallel, dolomitic units of the Viking showing are stratabound altered by hematite highlighting that fluids in the system did evolved at least locally to oxidising conditions known to be able to form uranium-bearing and uranium-free iron oxide deposits. Uranium mineralisation occurs in areas slightly enriched in potassium. Such LT K-Fe alteration is also associated with the reappearance of albite, but accompanied by carbonates, chlorite and hematite, differentiating this sodium-rich LT K-Fe alteration from the early regional-scale sodic alteration. Magnetite-bearing alteration types were discovered in very poorly exposed parts of the Mistamik Lake area during private sector large-scale prospecting efforts and then examined, described and sampled in further detail for this project. These alteration types and the metallic parageneses, which include Cu, Au, U, Co and probably REE, Zr and other rare and critical metals, support a mineral potential for IOCG and affiliated deposits in the Romanet Horst.

Future collaborative GEM2-MERN-academia-private sector geoscience research will further test linkages between alteration, mineralisation, crustal architecture, magmatic and tectonic evolution to provide a more robust model for mineral resources development of the Labrador Trough. Additional field work is required to further examine alteration systems hosting varied styles of mineralisation and metal associations elsewhere within the Labrador Trough. We anticipate supervising undergraduate and graduate theses to better frame alteration and mineralisation types through megascopic, petrographic, mineral chemistry and lithogeochemical analyses and establish the role of tectonic and mafic magmatism in their development. Research results will be combined with geophysical modeling, structural analysis, bedrock mapping, core logging and isotope studies to characterise the IOAA system and their continuum to other deposit types. Radiogenic and stable isotopes studies undertaken in collaboration with a Canada Research Chair in Isotope and Environmental Geochemistry and Natural Resources collaborators will help deciphering the sources of fluids and metals present in the Horst. The information will also anchor interpretation of new till geochemical and mineral indicator studies within the Labrador Trough by GEM2 surficial geology activity.

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REFERENCES

Chevé, S.R., 1985. Les indices minéralisés du Lac Romanet, Fosse du Labrador. Ministère des Ressources naturelles, Québec, ET 83-13, p. 1–62.

Chevé, S.R., Machado, N., 1988. Reinvestigation of the Castignon Lake carbonatite complex, Labrador Through, New Quebec. Geological Association of Canada - Mineralogical Association of Canada, Program with Abstract, v. 14, p. A119.

Clark, T., 1986. Géologie et minéralisations de la région du lac Mistamik et de la rivière Romanet. Ministère des Ressources naturelles et de la Faune, Québec, ET 83-22, p. 1–56.

Clark, T., Wares, R., 2004. Synthèse lithotectonique et métallogénique de l'Orogène du Nouveau-Québec (Fosse du Labrador). Ministère des Ressources naturelles et de la Faune, Québec, MM 2004-01, p. 1–177.

Corriveau, L., 2007. Iron oxide copper–gold deposits: a Canadian perspective. In: Goodfellow WD (ed) Mineral deposits of Canada: a synthesis of major deposit-types, district metallogeny, the evolution of geological provinces and exploration methods. Geological Association of Canada, Mineral Deposit Division, Special Publication 5, p. 307–328.

Corriveau, L., Mumin, A.H., 2010. Exploring for iron oxide copper–gold deposits: the need for case studies, classifications and exploration vectors. In: Corriveau, L., Mumin, A.H. (eds.) Exploring for iron oxide copper–gold deposits: Canada and global analogues. Geological Association of Canada, Short Course Notes 20, p. 1–12.

Corriveau, L., Mumin, A.H., Setterfield, T., 2010a, IOCG environments in Canada: Characteristics, geological vectors to ore and challenges: In: Porter TM (ed) Hydrothermal iron oxide copper–gold and related deposits: A global perspective, volume 4, Advances in the understanding of IOCG deposits. PGC Publishing, Adelaide, p. 311–343.

Corriveau, L., Williams, P.J., Mumin, A.H., 2010b. Alteration vectors to IOCG mineralization from uncharted terranes to deposits. In: Corriveau L, Mumin AH (eds) Exploring for iron oxide copper–gold deposits: Canada and global analogues. Geol Assoc Can, Short Course Notes 20, p. 89–110.

Corriveau, L., Mumin, A.H., Montreuil, J.-F., 2011. The Great Bear magmatic zone (Canada): the IOCG spectrum and related deposit types. Proceedings Eleventh Biennial SGA Meeting, p. 524–526.

Desrochers, J.-P., 2014. Technical report on the Sagar property, Romanet Horst, Labrador Trough, Québec, Canada (latitude, 56°22'N and longitude 68°00'W; NTS Map sheets 24B/05 and 24C/08). 43-101 report prepared for Honey Badger Exploration Inc., available at http://www.sedar.com.

Dimroth, E., Dressler, B., 1978. Metamorphism of the Labrador Trough. Geological Survey of Canada, Study 78-10, p. 210–236.

Fournier, D.A., 1988. Report on the compilation of the Mistamisk-Romanet work, Labrador Trough. Ministère des Ressources naturelles, Québec, GM 47078, p. 1–55.

Hayward, N., Enkin, R.J., Corriveau, L., Montreuil, J.-F., Kerswill, J., 2013. The application of semi-quantitative methods for the targeting of IOCG mineralization in the Great Bear Magmatic Zone, Northwest Territories, Canada, from potential field and physical property data. Journal of Applied Geophysic, v. 94, p. 42–58.

Honey Badger Exploration Inc, 2014. Corporate web site information on the Sagar property, accessed September 2014. http://www.honeybadgerexp.com/properties/sagar-quebec.html

James, D.T., Dunning, G.R., 2000. U-Pb geochronological constraints for Paleoproterozoic evolution of the Core Zone: southeastern Churchill Province, northeastern Laurentia. Precambrian Research, v. 103, p. 31–54.

James, D.T., Nunn, G.A.G., Kamo, S., Kwok, K., 2003. The southeastern Churchill Province revisited: U-Pb geochronology, regional correlations, and the enigmatic Orma Domain. Current Research, Newfoundland Department of Mines and Energy, Geological Survey Report 03-1, p. 35-45.

Kearvell, G., 1984. Brèches et altérations albitiques de la Rivière Romanet. Ministère des Ressources naturelles, Québec, DP 8524, 2 maps.

Kearvell, G., Clark, T., 1988. Étude d'indices Au-U et de brèches polygéniques dans la vallée des lacs Mistamisk et Romanet, Fosse du Labrador. Ministère des Ressources naturelles, Québec, DP 8724, p. 1–32.

Kish, L., Cuney, M., 1981. Uraninite-albite veins from the Mistamisk Valley of the Labrador Trough, Québec. Mineralogical Magazine, v. 44, p. 471–483.

Lehto, J., 1962. A report on Tache Lake Mines Limited - Ungava Property. Ministère des Ressources naturelles, Québec, GM 12414A, p. 1–14.

Low, A.P., 1895. Explorations through the interior of the Labrador Peninsula, 1893-1894. The Geographical Journal, v. 5, p. 513–542.

Machado, N., Goulet, N., Gariépy, C., 1989. U–Pb geochronology of reactivated Archean basement and of Hudsonian metamorphism in the northern Labrador Trough. Canadian Journal of Earth Sciences, v. 26, p. 1–15.

Machado, N., Clark, T., David, J., Goulet, N., 1997. U-Pb ages for magmatism and deformation in the New Quebec Orogen. Canadian Journal of Earth Sciences, v. 34, p. 716–723.

Montreuil, J.-F., Corriveau, L., Grunsky, E.C., 2013. Compositional data analysis of hydrothermal alteration in IOCG systems, Great Bear magmatic zone, Canada; to each alteration type its own geochemical signature. Geochemistry - Exploration, Environment, Analysis, v. 13, p. 229–247.

Montreuil, J.-F., Corriveau, L., Potter, E., 2014. Formation of albitite-hosted uranium within IOCG systems: the Southern Breccia, Great Beat magmatic zone, Northwest Territories, Canada. Mineralium Deposita, DOI 10.1007/s00126-014-0530-7.

Mumin, A.H., Corriveau, L., 2005. Eden deformation corridor and polymetallic mineral belt, Trans Hudson Orogen Leaf Rapids area, Manitoba (NTS 64B and 64C). Manitoba Geological Survey, Report of activity GS-7, p. 69–91.

Porter, T.M., 2010. Current understanding of iron oxide associated-alkali altered mineralised systems: Part 1 - An overview. In: Porter TM (ed.) Hydrothermal iron oxide copper–gold and related deposits: A global perspective, volume 3, Advances in the understanding of IOCG deposits. PGC Publishing, Adelaide, p. 5–32.

Potter, E.G., Corriveau, L., Kerswill, J.K., 2013. Potential for iron oxide-copper–gold and affiliated deposits in the proposed national park area of the East Arm, Northwest Territories: Insights from the Great Bear magmatic zone and global analogs. In: Wright DF, Kjarsgaard BA, Ambrose EJ, Bonham-Carter GF (eds,) Mineral and energy resource assessment for the proposed Thaidene Nene National Park reserve, East Arm of Great Slave Lake, Northwest Territories, Geological Survey of Canada, Open File 7196, Chapter 19.

Setterfield, T., Chartrand, F., Campbell, J., 2006. Report on work completed by Geovector Management between June and October 2006 on the Sagar property, Romanet Horst, Labrador Trough, Quebec, Canada. Geovector Managment Inc., p. 1–83.

Simard, M., Lafrance, I., Hammouche, H., Legouix, C., 2013. Géologie de la région de Kuujjuaq et de la Baie d'Ungava (SNRC 24J, 24K). Ministère des Ressources naturelles et de la Faune, Québec, RG 2013-04, 60 p.

Williams, P.J., Barton, M.D., Fontboté, L., De Haller, A., Johnson, D., Mark, G., Marschick, R., Oliver, N.H.S. , 2005. Iron oxide-copper-gold deposits: Geology, space-time distribution, and possible modes of origin. Economic Geology 100th Anniversary Volume, p. 371-405.