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Foreword

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 of 2014, GEM's new research program was 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.

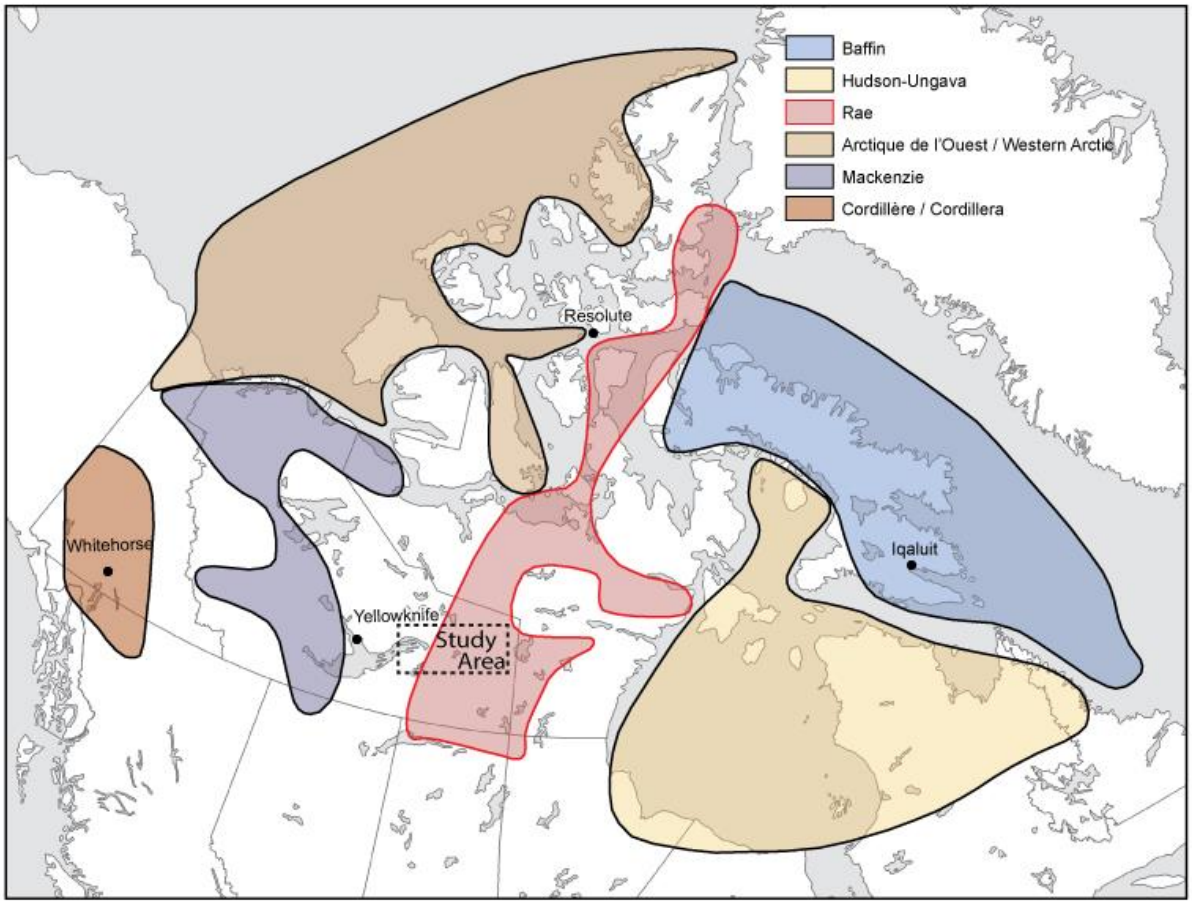

Figure 1. Location map of the study area (dashed line), showing the major areas of interest for the Geo-mapping for Energy and Minerals (GEM) program.

Introduction

From June to October 2014, three activities (Kjarsgaard et al., 2013a, Knight et al., 2013, and Plourde et al., 2013) were completed that augment data acquired under the Operation-GEM project of the Geo-mapping for Energy and Minerals (GEM) program of the Geological Survey of Canada. Three reports generated from activities within the study area (Fig. 1, Sharpe et al., 2014, and Kjarsgaard et al., 2014a, b) compiled, integrated and interpreted geochemical data and surficial landform observations previously released for the Thaidene Nene MERA (Mineral and Energy Resource Assessment) study area, (Kjarsgaard et al., 2013b, Kerr, et al., 2013, Sharpe, et al., 2013) and the adjacent Operation GEM Mary Francis Lake – Whitefish Lake – Thelon River study area.

Activities

For GEM the following activities were completed during the summer of 2014:

Activity 1: Sharpe et al., (2014) provided analysis and interpretation of the glaciated terrain and surficial sediment in support of a mineral exploration investigation in a study area bounded by Mary Frances Lake and Whitefish Lake (to the west) and the Thelon River to the east. The area lies to the southwest of the Thelon Wildlife Sanctuary, east of the area of interest for Thaidene Nene, and encompasses ~3,500 km^2 (parts of NTS 75-I, 75-J, 75-O, 75-P).

The report contains 54 figures/photographs of the surficial landscape and concludes that sediment sampling and analysis should take into account specific glacial terrain elements of mapped glacial landscapes. Furthermore, in order to accurately assess the direction and distance of sediment transport requires consideration of multiple primary and secondary processes recorded in landforms (e.g. eskers, drumlinized till) and sediment attributes (e.g. striations, rounding).

The report also concludes that targeted mineral exploration based on terrain analysis and sediment sampling of both till and glaciofluvial sediment is of upmost importance in a successful mineral exploration program. Furthermore, a surficial sediment sampling plan should accommodate an assessment of the degree and effects of meltwater /ice erosion and/or deposition and integrates the findings into regional mineral exploration strategy.

Activity 2: Kjarsgaard et al., (2014a) compares portable X-ray fluorescence spectrometry (pXRF) data from dried, shaken, and un-sieved but with pebbles removed (i.e. a clay-silt size proxy) till samples with 'conventional' laboratory geochemistry data for the clay-silt size fraction (< 0.063 mm), determined by ICP-ES/MS analyses following each of lithium borate fusion, 4-acid, and aqua-regia digestion methods, plus new data obtained for the < 2 mm size fraction (via lithium borate fusion and 4-acid digestion with ICP-ES/MS analysis) for 241 till samples collected as part of the east arm MERA project (Kjarsgaard et al., 2013b).

The report concludes that the relationship between pXRF data and fusion or 4-acid data of till samples is in general highly systematic (i.e. high values are high and low values are low), and is

a useful analytical tool for field based sampling. While the pXRF data does not exactly replicate the laboratory data (in terms of precision and accuracy), the pXRF data can be post-analysis corrected (based on analysis of standards) if warranted. A six step field protocol for the analyses of surficial sediments by pXRF spectrometry is presented in this report. These field protocols for sample preparation and analysis should further facilitate the detection of anomalous sample sites and geographic localities that can be re-sampled with an increase in sample density during the same field season. These tactics should increase the success of a mineral exploration and/or environmental sampling programs, as well as making fieldwork more cost-effective by altering sample strategies based on in-field results.

Activity 3: Kjarsgaard et al., (2014b) integrates and interprets geochemical data for till samples (till), previously released for the Thaidene Nene MERA study area, (Kjarsgaard et al., 2013b) and the adjacent Operation GEM Mary Francis Lake – Whitefish Lake – Thelon River study area (Kjarsgaard et al., 2013a).

This new data set contains 400 till samples (Fig. 2) analysed for the <0.063 mm size fraction by three different digestion methods (aqua regia, 4-acid, lithium borate/tetraborate fusion) followed by ICP-MS/ES analysis and 346 analyses for the <2 mm size fraction, analysed by two different digestion methods (4-acid, lithium borate/tetraborate fusion) followed by ICP-MS/ES analysis. This data is interpreted with recognition that silica content can be extremely high, varying from >96 wt% SiO_2 in the east to ~ >65 wt% SiO_2 in the west (i.e. typical levels for till from the Canadian shield). The high silica content for till in the east portion of the study area have a pronounced geochemical dilution effect on other elements. A simple, but elegant transformation of the raw data is used to produce SiO_2 "normalized" element maps that are used for comparison to indicator mineral maps. These results display how high silica content dilutes the geochemical signature and masks the true extent of exploration targets.

Further Research

Actvity 1. Landscape architectural elements observed in the area west of the Thelon River should be compared to those elements in the area of Thaidene Nene to investigate any down glacial flow changes in both depositional and erosional processes.

Actvity 2. Processed till samples that were used to obtain "conventional" geochemistry are currently being analysed with a pXRF spectrometer. The resulting data will be compared with data obtained by two different digestion methods (4-acid, lithium borate/tetraborate fusion) followed by ICP-MS/ES analysis, and size fractions (<2 mm and <0.063 mm) and to the pXRF data from dried/shaken (clay-silt size proxy) data reported in Kjarsgaard et al. (2014a).

Actvity 3. Robust statistical analyses on the effect of SiO_2 dilution and masking of geochemical signatures, and the comparison of the transformed data to indicator mineral patterns for the Thaidene Nene MERA study area and the adjacent Operation GEM Mary Francis Lake – Whitefish Lake – Thelon River study area is planned.

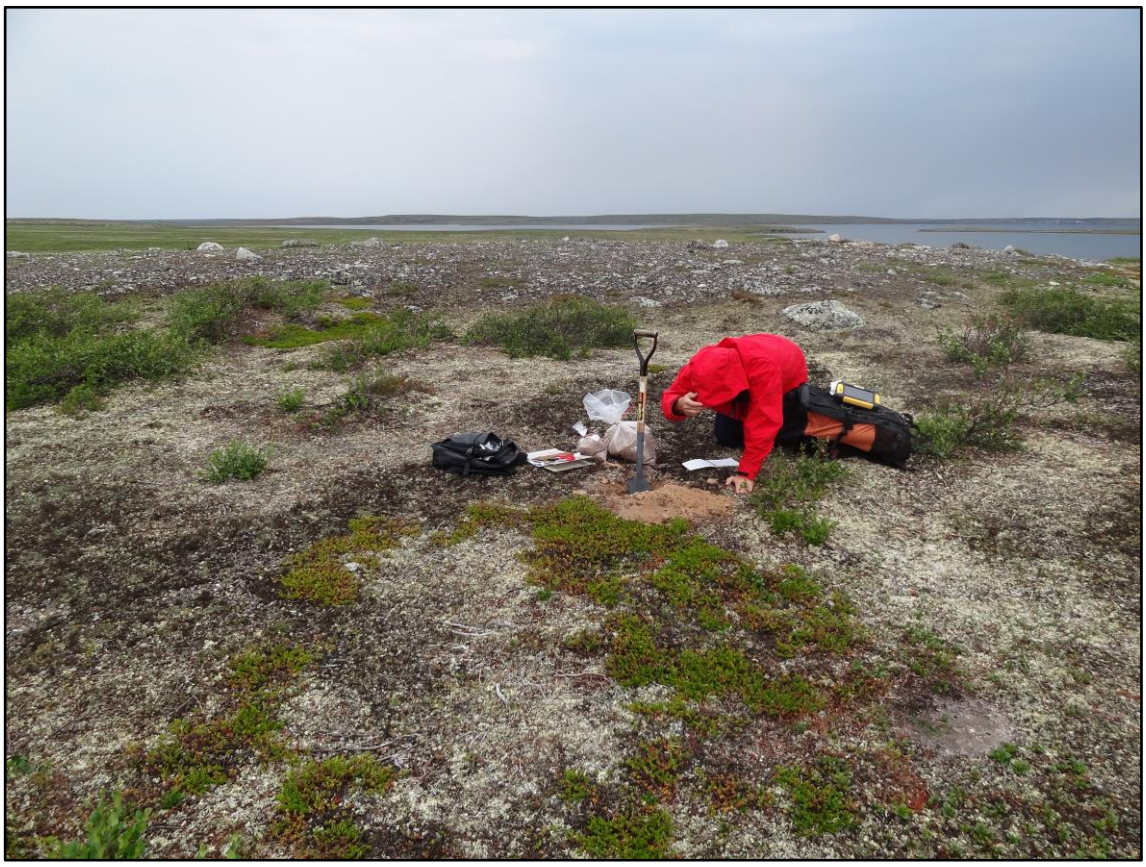

Figure 2. Typical till sample site. Note the 15 kg sample for heavy mineral studies and 1 kg sample for till geochemistry, both for direct shipping to laboratories for analyses. A Trimble Yuma (yellow on top of the orange pack) was used for digital field data capture and displaying thematic maps.

Acknowledgments

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Referencess

Kerr, D.E., Knight, R.D., Sharpe, D.R., Cummings, D.I., Russell, H.A.R. and Kjarsgaard, B.A., 2013. Surficial geology of the proposed national park reserve on the East Arm of Great Slave Lake *in* Mineral and Energy Resource Assessment for the Proposed Thaidene Nene National Park Reserve in the area of the East Arm of Great Slave Lake, Northwest Territories, D.F. Wright, E.J. Ambrose, D. Lemkow 15 and G.F. Bonham-Carter (eds.). Geological Survey of Canada, Open File 7196, p.143-154.

Kjarsgaard, B.A., Knight, R.D., Grunsky, E.C., Kerr, D.E., Sharpe, D.R., Cummings, D.I., Russell, H.A.J., Kerswill, J.A., and Wright, D.F., 2013b. Till geochemistry studies of the Thaidene Nene MERA study area *in* Mineral and Energy Resource Assessment for the Proposed Thaidene Nene National Park Reserve in the area of the East Arm of Great Slave Lake, Northwest Territories, D.F. Wright, E.J. Ambrose, D. Lemkow and G.F. Bonham-Carter (eds.); Geological Survey of Canada, Open File 7196, p. 313-337.

Kjarsgaard, B.A., Knight, R.D., Plourde, A.P., and Reynen, A.M.G., 2014a. Portable XRF spectrometry of surficial sediment samples in the region of East Arm, Great Slave Lake, Northwest Territories, Canada; Geological Survey of Canada, Open File 7607. doi:10.4095/293951

Kjarsgaard, B.A., Knight, R.D., Plourde, A.P., Sharpe D.R., and Lesemann J-E., 2013a. Geochemistry of till samples, NTS 75-I, 75-J, 75-O, 75-P (Mary Frances Lake – Whitefish Lake – Thelon River area), Northwest Territories; Geological Survey of Canada, Open File 7351. doi: 10.4095/292390

Kjarsgaard, B.A., Plourde, A.P., Knight, R.D., and Sharpe, D.R., 2014b. Geochemistry of regional surficial sediment samples from the Thelon River to the East Arm of Great Slave Lake, Northwest Territories, Canada; Geological Survey of Canada, Open File 7649. doi:10.4095/295195

Knight, R.D., Kjarsgaard, B.A., Plourde, A.P., Sharpe D.R., and Lesemann J-E., 2013. Significance of indicator minerals from till and esker samples, NTS 75-I, 75-J, 75-O, 75-P (Mary Frances Lake – Whitefish Lake – Thelon River area), Northwest Territories. Geological Survey of Canada, Open File 7540. doi:10.4095/293341

Plourde, A.P., Knight, R.D., Kjarsgaard, B.A., Sharpe, D.R. and Lesemann, J-E., 2013. Portable XRF spectrometry of surficial sediments, NTS 75-I, 75-J, 75-O, 75-P (Mary Frances Lake – Whitefish Lake – Thelon River area), Northwest Territories; Geological Survey of Canada, Open File 7408. doi:10.4095/292714

Sharpe, D.R., Lesemann, J-E., Knight, R.D., Kjarsgaard, B.A., and Plourde, A.P., 2014. Glacial landscape architecture and sediment sampling, Mary Frances Lake – Whitefish Lake – Thelon River area (NTS 75-I, 75-J, 75-O, 75-P), Northwest Territories, Canada; Geological Survey of Canada, Open File 7554. doi:10.4095/295461

Sharpe, D.R., Russell, H.A.J. and Knight, R.D., 2013. Glaciofluvial features and their significance in the proposed national Park Reserve, East Arm of Great Slave Lake *in* Mineral and Energy Resource Assessment for the Proposed Thaidene Nene National Park Reserve in the area of the East Arm of Great Slave Lake, Northwest Territories, D.F. Wright, E.J. Ambrose, D. Lemkow and G.F. Bonham-Carter (eds.). Geological Survey of Canada, Open File 7196, p. 155-190.