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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.

INTRODUCTION

Three weeks of field work was completed in the Montresor River area (Figs. 1, 2) as a contribution to bringing mapping and understanding of the Rae Province up to modern standards. Last mapped in 1982 (Frisch and Patterson, 1983; Frisch, 2000), the area was selected to address enigmatic relationships identified during reconnaissance work in 2012 (Berman et al., 2014) and thus to offer insight into the regional geological history and mineral potential of this poorly known and underexplored part of Nunavut. Two areas were selected to examine geological features in the relatively well exposed northeastern and southwestern parts of the Montresor belt (Fig. 2), focusing on relationships among major geological units.

As defined by Frisch and Patterson (1983), the Montresor belt is a Paleoproterozoic metasedimentary belt unconformably overlying Archean basement. It has been correlated with the Amer belt 50 km to the south (Frisch, 2000) and considered to be part of the widespread Rae cover sequence (Rainbird et al., 2010). The region was targeted for reconnaissance work in the GEM-1 Geo-mapping Frontiers project (2011-2013), during which data mining (Harris et al., 2013) and new reconnaissance-level geophysical (Miles and Oneschuk, 2013), geological (Berman et al., 2013) and geochronological (Davis et al., 2014) information were acquired.

Results of the new work provided the impetus to re-examine the Montresor belt. A comparison of high-resolution aeromagnetic images supports correlation of magnetic marker units and synclinal structures with those of the Paleoproterozoic Amer belt (Tschirhart et al., 2013). However, metamorphic rocks previously considered to be part of the Archean basement also resemble units of the lower Amer group, and have a U-Pb metamorphic monazite age of ca. 1.85 Ga (Berman et al., 2014), inviting re-examination of the basement-cover hypothesis.

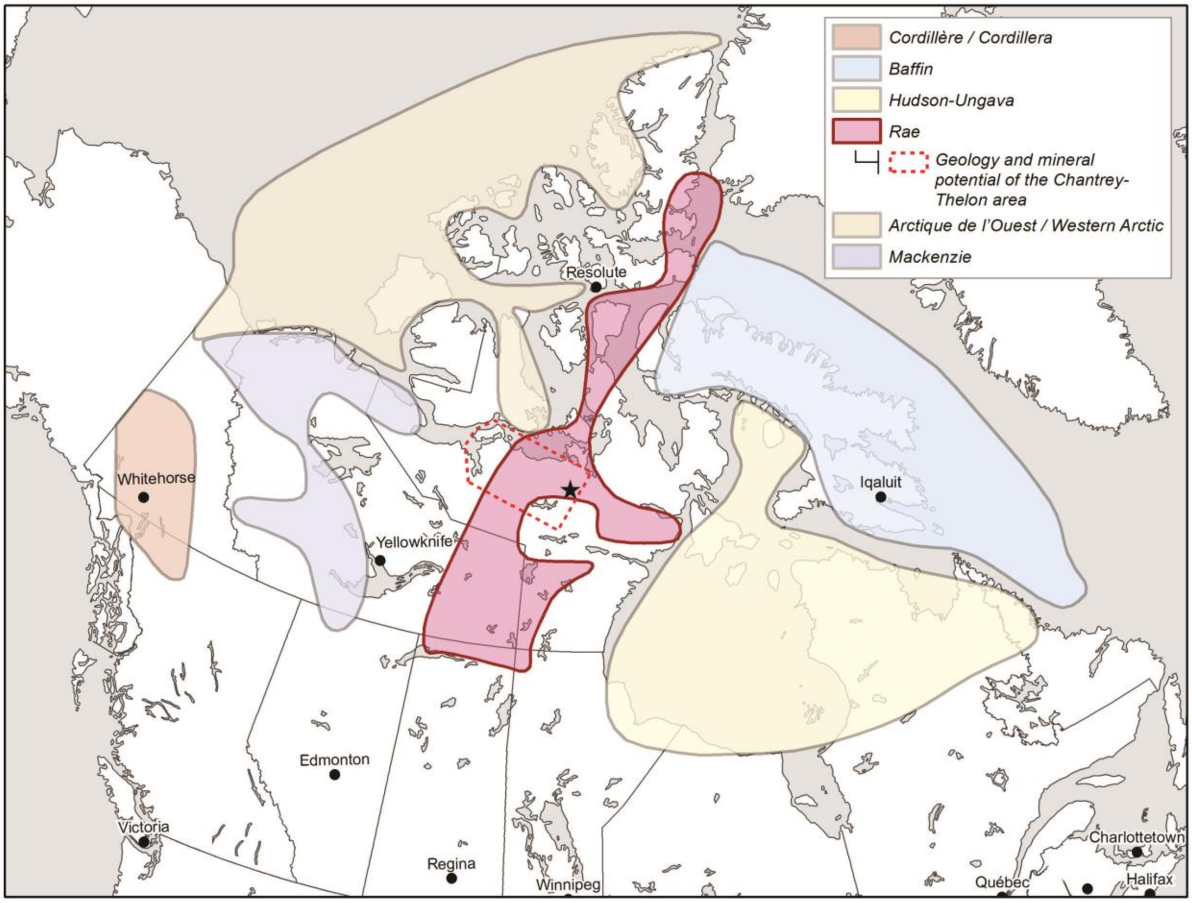

Fig. 1: Location map showing the Chantrey-Thelon activity and Montresor study area (star)

Furthermore, discovery of a mineralized breccia zone in 2012 indicated that a re-evaluation of mineral potential was warranted in a region previously considered to be barren.

METHODOLOGY

A crew of four geologists accessed the field area by air from Baker Lake. Foot traverses of 10-22 km were conducted from two 9-day fly camps. Field observations from 120 stations were recorded in Ganfeld. The ground gravity data (Fig. 2) were acquired using a CG-5 gravimeter. Sample spacing was 250 m and the observations were tied to the Canadian Gravity Standardization Net through the Ookpik Hanger gravity base in Baker Lake. The vertical and horizontal locations were determined through differential GPS and computed using GNSS solutions. The elevation accuracy is better than 10 cm for all station locations. Corrections to the gravity data include latitude, elevation and Earth's tide, followed by a Free Air correction and a Bouguer reduction using a density of 2.67 g/cc. A terrain correction was included in the final calculation to account for a steep cliff at the northwest end of the line.

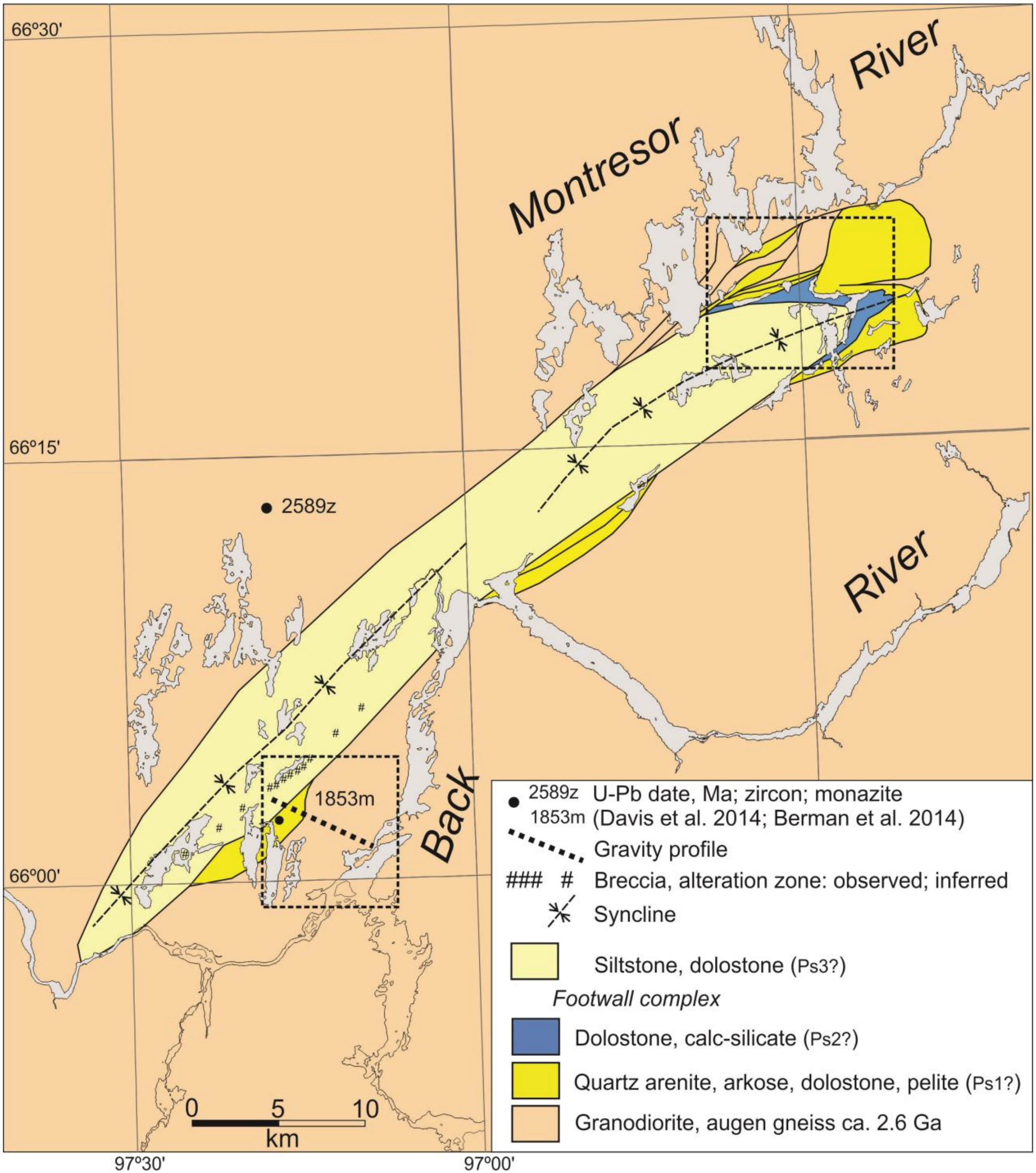

Fig. 2: Sketch map of the Montresor belt showing the location of the two areas of new field work (dashed boxes). Possible correlations are shown of Montresor units with regionally extensive Paleoproterozoic sequences (Ps1, Ps2, Ps3) based on lithotectonic assemblages (Rainbird et al., 2010; Pehrsson et al., 2013).

RESULTS

Northeastern Montresor belt

New observations suggest that the units inferred to be depositional basement by Frisch (2000) form a structural footwall complex to the Montresor syncline. Lithological units include augen gneiss (Fig. 3), quartz arenite and related arkose; dolostone and related calc-silicates (Figs. 4, 5), as well as argillite and micaceous schist, the latter unit intruded by boudinaged sills of gabbro (2.047 Ga; M. Hamilton, unpublished data) and foliated tonalite. Bedding indicators are rare in the variably recrystallized metasedimentary units. Although metamorphic grade is difficult to discern in the quartz-rich rocks, calc-silicate assemblages include tremolite-calcite-diopside, indicating amphibolite-facies conditions. All units are transected by sparse narrow dykes of hornblende granodiorite, biotite granite and pegmatite.

Fig. 3: Augen gneiss showing well developed foliation and lineation. The lens of gneiss occurs as a panel within the imbricated footwall complex.

Contacts between augen gneiss and sedimentary units, characterized by 1-10 m deformation corridors of flaggy foliation, penetrative lineation, grain size reduction and obliteration of primary textures (Fig. 6), are interpreted as ductile fault zones. Map patterns of units and fault zones suggest polyphase structural imbrication of gneisses and sedimentary units

Fig. 4: Intensely fractured, fine-grained calc-silicate rock from the footwall complex. Associated with quartz arenite, the unit may be part of the regionally extensive Rae cover sequence (Ps1; Rainbird et al. 2010; Pehrsson et al. 2013)

(Fig. 2). Similar map patterns have been reported for the northern Amer belt and attributed to development of a D1 fold and thrust belt (Patterson, 1986; Calhoun et al., 2014).

Quartz arenite and dolostone (Fig. 7) have been interpreted as continuous basal units of the Montresor belt (Frisch, 2000). However, exposure of the ridge-forming quartz arenite is discontinuous, and the unit has similar extent to that of the structural footwall complex, suggesting that it may be part of the imbricated sequence. Furthermore, the dolostone unit exhibits metamorphic assemblages including tremolite-calcite-diopside, in contrast to the weakly metamorphosed siltstone-sandstone units of the Montresor syncline. The possibility that the structural footwall complex includes these units, and that a low-angle detachment fault separates it from the structurally overlying siltstone-sandstone units, is being further explored through metamorphic and geochronological studies.

Southwestern Montresor belt

In the southwest, the lowermost part of the belt consists of weakly metamorphosed siltstone, in tectonic contact with a footwall unit composed of coarse-grained pelitic schist (Fig. 8) and pegmatite. Assemblages including muscovite, andalusite, sillimanite, biotite, cordierite

Fig. 5: Gently south-dipping, bedded dolostone-chert from an imbricate panel within the footwall complex. Associated with micaceous schist and wacke, this package may be part of the regionally extensive Rae cover sequence (Ps2).

Fig. 6: Blastomylonitic augen gneiss in deformation zone bounding imbricate panels within the footwall complex.

Fig. 7: Gently south-dipping dolostone – chert - calc-silicate sequence from a thick dolomitic unit (Ps2 equivalent?) in the northeastern Montresor belt.

Fig. 8: Pelitic schist in the footwall to the southwestern Montresor belt. The muscovite-rich unit contains abundant andalusite, sillimanite, cordierite and rare garnet.

and garnet suggest mid-amphibolite facies metamorphic conditions (~575^{o}C, 3.3 kbar at ca. 1.85 Ga; Berman et al., 2014). Foliation in the schist is generally concordant with the belt margin and a well-developed mineral stretching lineation plunges gently southwest. The schist belt is bordered to the southeast by augen gneiss with similar structural character to the schist. The contact is a ~50 m wide high-strain zone characterized by mylonite and l-tectonite (Fig. 9) with a gently southwest-plunging stretching lineation which also is evident in a generation of biotite pegmatites that is discordant outside of the high-strain zone. A younger generation of muscovite-garnet pegmatite dykes transects the high-strain fabric locally. The field relationships suggest a late-tectonic history involving post-peak metamorphic detachment followed by ductile transcurrent movement, elements of the Trans-Hudsonian tectonothermal history not previously documented.

Fig. 9: L-tectonite with augen gneiss protolith, within the high-strain zone between the pelitic schist and augen gneiss units.

During the 2012 reconnaissance, a zone of alteration and brecciation (Fig. 10) was discovered in siltstones of the southwestern Montresor belt. A grab sample returned an assay of 1600 ppm Cu, 1700 ppb Ag and 24 ppb Au - values well above background levels. Fieldwork in 2014 established the stratabound nature of the zone over a strike length of at least 4 km and thickness of about 500 m. It can be traced based on aeromagnetic features a further 11 km to the southwest and 5 km to the northeast. Vestiges of igneous rocks are preserved within the pervasively altered and brecciated corridor, suggesting a link between magmatic fluids and hydrothermal alteration. Compositions include monzodiorite, aplite and rare phlogopite-rich ultramafic rock (Fig. 11).

Fig. 10: Breccia from 500 m – thick breccia-alteration zone in southwestern Montresor belt. The breccia consists of altered rock fragments cemented by microcrystalline quartz.

Fig. 11: Hybrid granite-ultramafic rock. Fine-grained, discontinuous dykelets and xenoliths of phlogopite-rich rock in medium-grained granite suggest magma mingling: intrusion, metasomatism and chilling of mafic melt into crystallizing felsic magma.

These features have similarities to those of IOCG deposits such as Olympic Dam (cf. Oreskes and Einaudi, 1990), where breccia-style mineralization is related to an intrusive body at depth, marked by a positive gravity anomaly. A single-point anomaly characterizes the regional gravity field over the Montresor breccia zone. To further constrain the nature of the gravity signature, a 10-km NW-SE transect was conducted over major geological features. Preliminary analysis suggests the presence of positive anomalies that cannot be correlated with the density variations of exposed units, and thus supports the presence of dense subsurface bodies.

CONCLUSIONS

Production of a revised geological map of the Montresor belt is underway, integrating field observations from the 1982 survey with the recent and forthcoming geophysical, geochemical, geochronological and geological work. Additional geochemical and geochronological analyses will be obtained on major rock units and structures and released in the form of Current Research and Open File reports.

A M.Sc. project is underway at Carleton University (C. Dziawa, supervised by Dr. Fred Gaidies), aimed at constraining the pressure-temperature-time history of the ca. 1.85 Ga regional metamorphic event. This work will form an integral part of interpretation of the Trans-Hudsonian tectonothermal history, to be further constrained by U-Pb dating of accessory minerals in deformation zones, thereby contributing to broader understanding of the extent and nature of the Trans-Hudson orogeny in northern Canada.

Work is also beginning on characterizing the southwestern Montresor breccia zone and its mineral potential. Assays will be carried out on 6 samples to determine metal contents and ratios. Representative altered rocks will be analyzed to investigate possible fluid compositions, with the goal of constraining metallogenic models and providing guidance for mineral exploration. Results of the gravity survey will be integrated with bedrock observations to provide constraints on subsurface geometry and possible hidden features.

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