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MULTIPLE PHASES OF DEFORMATION AND METAMORPHISM IN THE KUUJJUAQ-TASIUJAQ AREA OF THE NEW QUEBEC OROGEN, QUEBEC; EVIDENCE FROM PRELIMINARY U-Pb GEOCHRONOLOGY AND STRUCTURAL STUDIES

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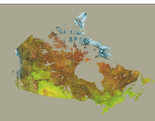

This poster presents part of an ongoing study within the GEM-2 Hudson-Ungava Project: “Core Zone and Bounding Orogens”.

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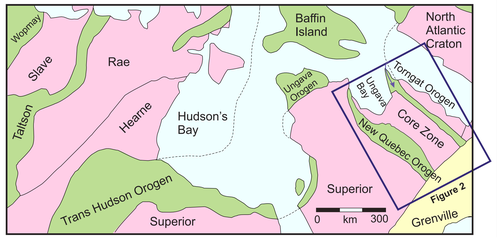


Archean Cratons >2.5 Ga
Paleoproterozoic orogens ~2.3 - 1.7 Ga
Orogens < 1.7 Ga

Figure 1: Cratons and orogens of the Eastern Churchill Province. The New Quebec Orogen is coeval with the younger part of the Trans-Hudson Orogen.

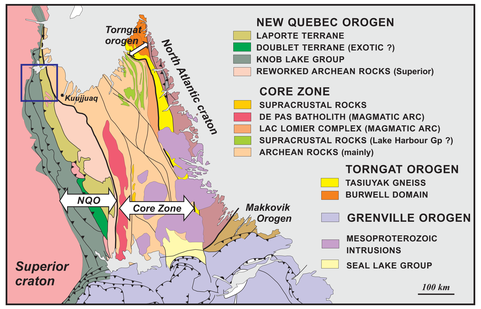


Figure 2: Simplified bedrock geological map of the Core Zone and bounding orogens, the New Quebec Orogen and the Torngat Orogen. The Paleoproterozoic New Quebec Orogen is also known as the Labrador Trough. The NQO formed as a result of terrane accretion to the Superior margin at ca. 1.82 Ga, followed by terminal collision with the Core Zone in a SW-directed dextral transpressional regime at ca. 1.80 to 1.77 Ga (Wardle et al. 2002). The box shows the location of **Figure 3** in the Kuujjuaq area where this study is based. Modified from Corrigan et al. (2015), after James et al. (2003).

Project background and preliminary results

The New Québec orogen (NQO) is a Paleoproterozoic orogenic belt in the southeastern Churchill Province of the Canadian Shield. The NQO formed as a result of terrane accretion to the Superior margin at ca. 1.82 Ga, followed by terminal collision with the Core Zone in a SW-directed dextral transpressional regime at ca. 1.80 to 1.77 Ga. The foreland of the orogen, contains autochthonous rocks deposited on the Archean Superior craton margin, shortened and imbricated in SW-verging thrust stacks; these are limited to the southern parts of the NOQ and only small exposures are present in the Kuujjuaq-Tasiujaq area. These domains are tectonically overlain by allochthonous metavolcanic and metasedimentary rocks of the Gerido, Mélèze, and Rachel-LaPorte Zones. These allochthonous rocks represent the hinterland of the orogen, and are juxtaposed against the Kuujjuaq Terrane, the northwestern-most part of the Core Zone. Metamorphic grade changes from upper greenschist facies at the edge of the Superior craton, to granulite facies in the Core Zone and associated rocks. The primary structural features of the NQO in the Kuujjuaq–Tasiujaq area are SW-verging thrust faults that imbricated the foreland and hinterland zones over the Superior craton. Between thrust faults the rocks dip to the NE, in tight to isoclinal folds with steep NE-dipping axial planes. All the allochthonous rocks of the NQO, as well as extensive intrusive and extrusive mafic packages associated with them are affected by these folds, constrained only to be younger than ca. 1.85 Ga. In the Kuujjuaq-Tasiujaq area there is evidence for multiple generations of structures, some of which are syn-orogenic. Greenschist to amphibolite facies rocks in the Rachel-LaPorte zone include metasedimentary rocks in which the main S0-S1 foliation dips moderately SE, overprinted by an F2 crenulation with fold hinges plunging SW resulting in an S2 cleavage dipping NW, in turn overprinted by an F3 crenulation with fold hinges plunging N, resulting in an S3 cleavage dipping W. In sheared metabasaltic units with strongly developed foliation dipping moderately NNE, there are overprinting folds with axial planes dipping steeply NW and fold hinges plunging NE. The fold vergence suggests a dextral, oblique, top-down-to-the-ESE shear sense. In both these examples the structural fabrics suggest at least one phase of deformation that post-dates the SW-directed transport that imbricated the rocks on the Superior margin. The Leaf Bay domain of the Kuujjuaq Terrane contains retrogressed garnet orthopyroxene granulite and tonalite with foliations dipping S that pre-date collisional deformation. The supracrustal assemblages include sheared mafic and semipelitic schists with foliations dipping shallowly E, overprinted by an S2 cleavage dipping steeply SE. These fabrics could be a result of SE-directed transport post-dating orogenesis, suggesting that previously undocumented extensional deformation may be preserved in the NQO. The predominant sense of shear in the NQO rocks is a dextral top-to-the-southwest motion, with a general trend from homogenous flattening in the north to elongation in the southeast, interpreted here are a result of protracted oblique transpressional collision. New in-situ U-Pb zircon geochronology on granulite to upper amphibolite facies metamorphic rocks on both sides of the proposed suture between the Core Zone and NQO record a protracted period of metamorphic zircon growth between ca. 1.88 Ga and 1.84 Ga, indicating that high temperature metamorphism and accretion was already under way than previous interpretations suggested. Monazite growth in the rocks of the NQO immediately adjacent to the Core Zone occurred as two distinct phases at ca. 1.77 Ga and ca. 1.73 Ga, with preliminary data suggesting a link to fluid circulation during extensional deformation. These data indicate that there are significant unresolved questions with respect to linking deformation and metamorphic ages to specific packages of rocks within the orogen; the NQO may preserve more extensive period of orogenic activity than previously thought.

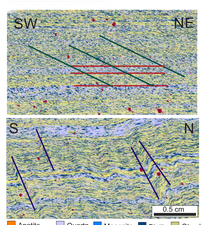
Methods

- Field mapping in 2014 and 2015
- Mineral Liberation Analysis (MLA) using scanning electron microscopy on oriented thin sections to identify mineralogy and microstructures (MUN)
- In-situ LA-ICP-MS U-Pb geochronology of zircon and monazite (UNB Fredericton)
- Preliminary results presented here

1 Rachel-LaPorte Zone

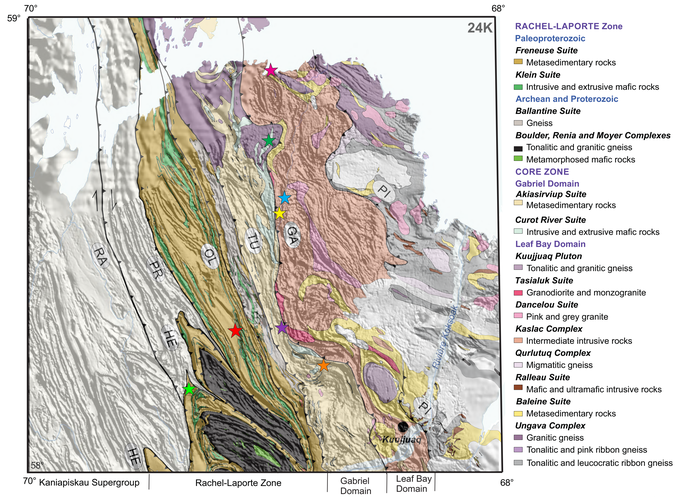
- Upper greenschist to lower amphibolite facies rocks
- Overprinting relationships indicating multiple episodes of deformation
- Metamorphic grade increases towards the NE
- Regional fabric dips NE, formed by SW-directed transport

Plate 1: Upper greenschist facies metasedimentary rocks of the Rachel-LaPorte zone showing a strong regional S2 cleavage overprinting S0-S1 bedding cleavage.



S0-S1 dipping moderately SW
S2 with F2 fold hinges plunging SW
S3 with F3 fold hinges plunging NNW

Plate 2: MLA false colour image of oriented thin sections from a garnet biotite muscovite schist, Rachel-Laporte Zone, showing three generations of structures, all developed at upper greenschist facies conditions.



RA Lake Rachel fault; **HE** Lake Hérodier fault; **PR** Pointe Reef fault; **OL** Lake Olmstead fault; **TU** Lake Turcotte fault; **GA** Gabriel fault; **PI** Lake Pingiajjulik fault;

Figure 3: Simplified geology for the Kuujjuaq-Tasiujak area of the New Quebec Orogen. Gray scale image of aeromagnetic data emphasizes the strong structural fabrics present in the Rachel, Laporte and Kuujjuac Terranes.The dominant thrust direction in the Rachel-LaPorte Zone is to the south-west, but multiple overprinting events are present in all areas. Aeromagnetic data from the Ministère de l'Energie et des Ressources Naturelles du Québec (Dumont et al. 2010). Modified after Simard et al. 2013. Boxes 1, 2, and 3 summarize the main features of the Rachel-LaPorte Zone and the Gabriel and Leaf Bay Domains of the Kuujjuaq Terrane. The stars show different samples illustrated on the poster. They are colour coded for locations.

2 Kuujjuaq Terrane
Gabriel Domain

- Upper amphibolite facies rocks
- Overprinting relationships indicate multiple episodes of deformation
- Regional fabric dips NE, formed by SW directed transport
- Decompression likely as indicated by plagioclase-biotite coronas surrounding garnet
- Retrograde metamorphism indicated by chlorite overgrowths on mafic mineral phases, e.g. hornblende and actinolite

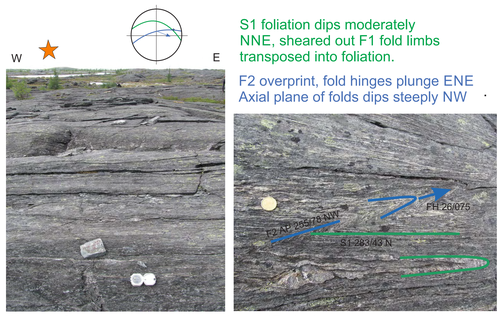


Plate 4: Sheared metabasalt showing NNE dipping regional scale S1 foliation, overprinted by F2 kink folds. The kink fold vergence in this outcrop suggests a top-down-to-the-ESE shear sense, as a possible post-compressional transport direction.

3 Kuujjuaq Terrane
Leaf Bay Domain

- Upper amphibolite to granulite facies rocks, metamorphic grade increases to the
- Strong retrograde metamorphic overprint, decompression possible as indicated by plagioclase-biotite coronas surrounding garnet
- Overprinting relationships indicating multiple episodes of deformation
- Regional fabric dips NE like in the Gabriel Domain, but is here strongly overprinted by a steep NW-dipping fabric

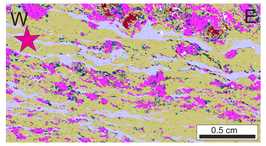


Plate 9: Retrogressed garnet orthopyroxene granulite from the Leaf Bay Domain in false colour MLA image. The garnets in this sample show significant breakdown to plagioclase, quartz, biotite and chlorite. The presence of calcite suggests that hydrothermal alteration occurred throughout the rock. Preliminary in-situ LA-ICP-MS geochronology results indicate that most zircons in this sample are ~1.8 Ga, with minor populations of ~2.2 - 2.3 Ga, and ~2.6 Ga.

Plate 8: Actinolite schist with steep SE-dipping F2 crenulations overprinting the regional NE-dipping S1 fabric.

Plate 3A and B: Pegmatitic gabbro from the Montangnais Suite of mafic extrusive and intrusive rocks in the Rachel-LaPorte Zone.

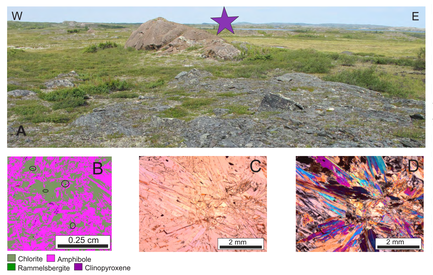


Plate 5: A-Metamorphosed ultramafic boudin in the Gabriel Domain. This rock contains ~650 ppm Ni, and 6 - 10 ppm PGE.

B-Detailed false colour MLA image of the above sample.The circles indicated where rammelsberite, a hydrothermal nickel-arsenide, occurs in a matrix of chlorite (green) and gedrite-anthophyllite series amphiboles (pink).

C and D: Plane light and cross polars photomicrograph showing radial growth of gedrite-anthophyllite series amphiboles in the boudin shown above.

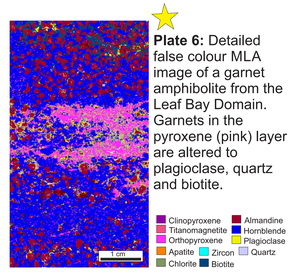


Plate 6: Detailed false colour MLA image of a garnet amphibolite from the Leaf Bay Domain. Garnets in the pyroxene (pink) layer are altered to plagioclase, quartz and biotite.

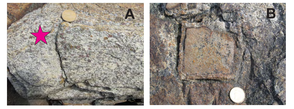


Plate 10: Rocks from the Leaf Bay shore.
A: Granulite (Plate 8)
B: Ultramafic block in granulite, with rim of amphibole needles
C and D: Sheared, folded tonalite gneiss.

Upcoming work in this area will investigate whether the fabrics are Archean or Proterozoic.

Plate 7A: Outcrop of garnet biotite muscovite schist from the Leaf Bay Domain.The fabric shown here is an intersection of NE dipping S0-S1 and a steep E-dipping S2 fabric.

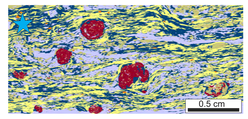


Plate 7B: Detailed false colour MLA image of a garnet biotite muscovite schist from the Leaf Bay Domain. The garnets are altered to biotite, albite and quartz. Preliminary in-situ LA-ICPMS geochronology results indicate that the monazites in this sample represent two distinct populations of 1.73 Ga and 1.77 Ga, interpreted as evidence for episodic metamorphism that outlasted regional terminal collision with the Superior Province.

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