Mechanisms for shear zone development in the deep orogenic crust

J.H. Marsh* and C.C. Gerbi, Department of Earth Sciences, University of Maine
N.G. Culshaw, Department of Earth Sciences, Dalhousie University
*jeff_marsh@umit.maine.edu; (207) 581 2221

Within the Central Gneiss Belt (CGB) of the southwestern Grenville Province, Ontario, Canada, a number of allocthonous lithotectonic domains are juxtaposed along crustal-scale shear zones. Extensive exposure of variably reworked granulites of the interior Parry Sound domain (iPSD) has enabled investigation of the structural and petrologic character of domain-bounding shear zones within the deep orogenic crust. Detailed mapping along the southwestern margin of the iPSD suggests that spaced outcrop-scale shear zones have coalesced and progressively reworked layered granulites into a transposed amphibolite-facies tectonite. These rocks comprise the Twelve Mile Bay Shear Zone (TMBSZ), which separates the iPSD from para-autocthonous rocks to the south. This study is focused on understanding the grain- and outcrop-scale mechanisms involved in shear zone development, the attendant rheological changes, and the timing of shear zone activity relative to other regional tectonometamorphic events.

Northwest of TMBSZ, samples collected across individual outcrop-scale shear zones (i.e., across large strain gradients) have distinct differences in mineralogy and microstructure. In mafic layers the original granulite texture and cpx + opx + pl + hbl +/- grt assemblage is commonly retained away from the shear zones (within "panels"). With proximity to the shear zones pyroxenes and garnet are progressively consumed in hydration reactions producing hornblende and biotite, which define a new planar foliation within the highly attenuated and deflected layering. Felsic layers generally have only minor mineralogical changes across the zones, but develop an increasingly intense and largely recrystallized microstructure into the sheared margin. The shear zones are often cored by variably deformed pegmatite dikes that likely intruded prior to, or during the early stages of shearing. Evidence for shear zone initiation along mineralized fracture sets that cut unsheared granulites, often with clear, cm-dm wide alteration halos, is preserved in adjacent rocks closer to the domain interior.

Approaching the TMBSZ, the proportion of undeformed panel is decreased considerably and a finer-grained tectonite fabric becomes dominant. Panels in this area are more podiform, and relict layering is often at a much lower angle to the transposed fabric that wraps it. Large feldspar porphyroclasts, often with extensive tails parallel to layering, are commonly observed in the tectonite suggesting that these rocks represent widened and strongly attenuated pegmatite-cored shear zones. Thus, it is inferred from field relations that the amphibolite facies tectonites which comprise the TMBSZ represent iPSD granulites that have been reworked through progressive consumption and rotation of relict panels, and growth of the bounding shear zones.

In addition to the detailed investigation of the processes involved in shear zone development (e.g., fluid infiltration, deformation and recrystallization processes, metamorphic reactions, etc.), we are also concerned with the role of TMBSZ-related structures within the Grenville orogen. Estimates of peak and syndeformational P-T-M_{fluid} conditions for this area are in progress and will ideally be linked with corresponding dates so that a portion of the domains tectonometamorphic history can be reconstructed. Dating of specific tectonometamorphic events will likely require precise geochronologic methods where grains, or portions of grains, can be analyzed *in-situ* within a known micro-textural setting. Thermochronologic methods, such as ^{40}Ar /^{39}Ar cooling ages for hornblende and biotite, may be utilized in the future to better constrain the exhumational stages of the orogeny.