Tectono-thermal evolution of deep crust in a Mesoproterozoic continental collision setting: the Manicouagan example

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Exposure of high-P metamorphic rocks in continental collision belts provides invaluable information on the evolution of deep crust and on crust-mantle interactions during orogenic processes. In the Mesoproterozoic Grenville Province, a prime example is the Manicouagan Imbricate Zone (MIZ), discovered in 1992 in the context of a Lithoprobe-funded project, that experienced high-P-T conditions during a Grenvillian crustal shortening event at ca. 1.0 Ga. MIZ is located west of AG-Lithoprobe line n° 51 at the southern margin of the so called "Parautochthonous belt" of the Eastern Grenville Province, structurally above Paleoproterozoic supracrustals and their archean basement (Gagnon terrane). To the south it is overlain by "allochthonous" units that were at high to mid-crustal levels at ca. 1.0 Ga. MIZ comprises igneous rocks with intrusion ages ranging from Labradorian to Grenvillian, broadly representative of major events responsible for the makeup of the Province as a whole, that are correlative with "allochthonous" units. It is characterized by P-conditions locally up to 1800 MPa under a high-T regime (850-900°C) and by synmetamorphic mafic intrusions of tholeiitic within-plate signature. These features attest to a major thermal perturbation at the base of the thickened crust and emplacement of asthenospheric melts that are interpreted as a result of drastic thinning of the lithospheric mantle and rise of asthenosphere close to the crust-mantle boundary, at some stage of the 1.0 Ga crustal shortening event. MIZ has the structural configuration of a thrust stack, with fabrics related to northwest-directed thrusting (lower levels), overlain by units showing evidence of "orogen parallel" extension (middle levels), and top-to-the-southeast extension (opposite to the general thrust direction, upper levels). Exhumation of such a deep crustal section as MIZ has been likely controlled by: (a) crustal weakening due to high T-conditions combined with gravitational instability due to removal of lithospheric mantle; and (b) the presence of a crustal-scale ramp (basement in Gagnon terrane) along which tectonic transport was channeled, leading to extrusion from underneath the "allochthonous" units by northwest-directed thrusting complemented by extension at the top the pile. Thinning of lithospheric mantle has been invoked to explain a variety of features in Phanerozoic continental collision belts and, more recently, in the central Grenville Province. However, data used to support this mechanism have mainly come from middle to high levels of subsequently thinned crust. MIZ is unusual in that it allows investigation of thermally perturbed deep crustal levels.