American Mineralogist, Volume 104, pages 791–809, 2019

Geothermometry of the western half of the Central Metasedimentary Belt, Grenville Province, Ontario, and its implications

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Abstract

Calcite-graphite carbon isotope thermometry results are presented for 150 new marble samples across the western Central Metasedimentary Belt (CMB) of the Ontario segment of the Grenville Province. The results show a gradual increase in peak metamorphic temperature from under 500 °C in the Tudor Township area in the east to over 700 °C along the western margin of the CMB. Modestly elevated $\delta^{13}C$ values above 3‰ across all terranes in the study area suggest a common temporal, and perhaps depositional origin, for the ~1.3 Ma limestone protoliths. The preserved thermal gradient is consistent with variations in marble mineralogy and character. Based on published geochronology, we argue that these temperatures correspond to peak metamorphism during the 1090–1020 Ma Ottawan orogeny, with the exception of preserved contact aureoles most notably associated with the Tudor gabbro and the Cheddar granite. The lack of significant thermal discontinuities at terrane boundaries and other shear zones, including the Bancroft shear zone and the CMB boundary zone, indicate that the entire region including the adjacent Central Gneiss Belt remained largely intact during and after the Ottawan peak metamorphic event. Variations in deformation style of pre-existing igneous complexes appear to correspond to the Ottawan thermal conditions, which include crystalline thrust sheets at high temperature, and mildly foliated domes to undeformed plutons at decreasing temperatures. In light of the peak temperatures and smooth thermal gradient we show to be superimposed on the established Grenvillian architecture, much of the western CMB should be considered part of the allochthonous medium pressure belt, and separate from the Ottawan orogenic lid that defines the eastern CMB.

Keywords: Grenville Province, Ottawan orogenic lid, thermometry, metamorphism, marble, calcite, graphite, stable isotopes, carbon isotopes, crustal rheology; Isotopes, Minerals, and Petrology: Honoring John Valley