Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24436

Large wet orogen? Widespread H_2O-fluxed melting of the middle crust during Grenvillian orogenesis

SABASTIEN DYER AND CHRIS YAKYMCHUK

University of Waterloo

Presenting Author: scdyer@uwaterloo.ca

Fluid-fluxed melting is typically considered to generate insignificant amounts of melt during orogenesis[1]. Instead, fluid absent hydrate breakdown is the primary mechanism suggested to explain large-scale melting and long-term differentiation of continental crust during orogenesis. Recent studies have presented field evidence and models to suggest that fluid-fluxed melting plays a more important role in melt-generation than previously thought[2]. One region where fluid-flux melting has been proposed as the dominant melting mechanism is granitoid-dominated deep crust of the Grenville orogen exposed in southwest Ontario that [3] make up a contiguous region over 200 km along orogenic strike. Building on previous work in this region[3], which documents cryptic evidence for fluid-fluxed melting, we present direct evidence of coeval fluid-fluxed melting in the form of migmatite-rich reaction zones around widespread pegmatites. Mass balance calculations and thermodynamic modelling of these rocks suggests a minimum addition of ~0.6 wt% water along with other mobile components (e.g. K, Na), which can generate melt proportions greater than 20 vol% in these rocks. However, the source of this fluid—as with many fluids needed for H_2O-present melting of the crust—is enigmatic.

We explore three scenarios to explain the source of H_2O during orogenesis, including from autocatalytic melting from crustal reworking, dewatering of a subducting slab, and decompression melting of metasomatized mantle. We conduct thermodynamic modeling to examine the pathways and interactions fluids would encounter toward the middle crust and mass balance to test the plausibility of various H_2O sources. While parameters of these models can be adjusted such that any of them can provide enough H_2O for widespread partial melting in the mid-crust, dewatering from a subducting slab is the scenario with the most reasonable parameters. This suggests that H_2O fluxed melting is a significant source of melt in continental arcs as has been suggested for other orogens, such as the Cordillera[4].

References: [1]Brown, M. Geol. Soc. Am. Bull. 125, 1079–1113 (2013). [2]Weinberg, R. F. & Hasalová, P. Lithos 212–215, 158–188 (2015).[3]Slagstad, T. et al. J. Petrol. 46, 893–919 (2005). [4] Collins, W. J., et al. Geology 44(2), 143-146 (2016)