METAMORPHIC HISTORY AND TIMESCALES OF COOLING AND EXHUMATION OF PARTIALLY MELTED ROCKS: STUDIES IN THE NORTH AMERICAN CORDILLERA

By

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ABSTRACT

Petrologic studies of partially melted paragneiss and amphibolite gneiss from the Valhalla metamorphic core complex, B.C. document a complex retrograde history that includes melt-involving net transfer reactions and partial re-equilibration at lower pressure conditions. Forward modeling of the interdiffusivity of Fe+Mg in garnet from above the Gwillim Creek shear zone indicates a slow then fast cooling history that is different from fast cooling from peak recorded in samples from within the shear zone. Thermobarometry and thermodynamic modeling of these gneisses constrain a cooling and decompression P–T path segment consistent with retrograde amphibolite facies re-equilibration. 2-D thermal modeling suggests that slow followed by fast, then slower cooling can be accommodated by movement up a shallow thrust ramp, then rapid thrusting up a steeper ramp, and finally normal-sense shearing with erosional denudation. Ductile flow onto a cool footwall, perhaps enhanced by rheological changes associated with the presence of significant partial melt, is a viable mechanism of cooling and partial exhumation of lower crustal rocks.

The migmatitic lower plate of the Ruby Mountains–East Humboldt Range (RM–EHR) metamorphic core complex represents the exhumed root of the Sevier Hinterland. New major and accessory phase (Zr–in–rutile, Ti–in–quartz, Ti–in–zircon, monazite ± xenotime ± garnet) thermobarometry, aided by garnet zoning analysis and thermodynamic modeling delineate a P–T history characterized by a phase of high temperature, probably tectonic loading followed by decompression and melting during continued heating for rocks from the Winchell Lake nappe (WLN). Rocks below the emplacement fault for this allochthon record no evidence of tectonic loading and associated metamorphism. Hence a different P–T path characterized by more widespread melting during prograde heating and compression is compiled for this block. Based on different interpretations for the context of partial melting, the emplacement of the WLN must have been a significant event in the tectonic history of the RM–EHR.

U–Th–Pb Secondary Ion Mass Spectrometry (SHRIMP) results from zircon and monazite indicate that, for the crustal block beneath the WLN, prograde metamorphism

began by ~96 Ma. Cooling and melt crystallization was initiated by 83.2 ± 1.8 Ma (leucosome monazite), consistent with a phase of zircon rim growth. Possible reheating and monazite growth events occurred again at ~70 Ma. In the WLN, prograde metamorphism began by 83.8 ± 1.1 Ma. Cooling and melt crystallization, interpreted to be contemporaneous with thrust emplacement of the WLN onto the rocks below, was recorded by zircon and monazite growth/recrystallization at ~70 Ma. Renewed Eocene–Oligocene high Y monazite rims are found in both crustal blocks. These probably represent a phase of heating during Eocene–Oligocene magmatism and extensional deformation. U–Th–Pb geochronology results are consistent with the juxtaposition of two crustal blocks with different prograde histories prior to the main phase of the exhumation of the RM–EHR. Differences in the timing and tectonic significance of multiple partial melting episodes within the WLN indicates that partial melting can play many roles in the evolution of exhumed orogenic crust.