Metamorphic Thermal Pulses Caused by Compaction-Driven Fluid Flow

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Fluids play multiple roles during metamorphism, including metasomatizing rocks, triggering reactions, and supplying heat. Petrological and isotopic studies in New Hampshire [1] revealed amphibolite-granulite facies thermal "hot spots" surrounded by large metamorphic field temperature (*T*) gradients in which *T* increased by ~150 °C over radii of a few kilometers. The coincidence of quartz-graphite vein networks and oxygen isotope alteration halos with the "hot spots" lead to the hypothesis that short-lived focused fluid flow can generate metamorphic thermal anomalies through pulsating heat advection.

We test the hypothesis of fluid-driven heat transfer using a two-dimensional model that simulates compaction-driven fluid flow. In this flow regime, pulsating focused fluid flow could be induced if a decompaction weakening mechanism operates [2]. Two heating scenarios were compared and contrasted to explore the conditions that produce thermal anomalies as large as 150 °C over a few kilometers: one is gradual basal heating (<= 100 °C/Myr) at the base of the model, the other is abrupt basal heating (instantaneous 100 °C increase). The first boundary condition approximates advancement of isotherms in typical regional metamorphic settings dominated by thermal conduction, whereas the second simulates elevated heat fluxes at the contact with an external heat source. Our results suggest that fluid channellization during compaction could produce short-lived thermal anomalies >100 °C only via the abrupt basal heating boundary condition (e.g., magma intrusion and/or hot external fluids). Fluid conduits developed during gradual basal heating (e.g., thermal conduction) could also generate thermal anomalies, but their magnitudes are less than 100 °C because these conduits are compacted in a short time span. Possible pulsed garnet growth (Devonian) in the hot spot region [3], could be explained by the thermal and fluid transients in our model.

[1] Chamberlain and Rumble, 1988, J. Pet., v. **29**, p. 1215-1232. [2] Connolly and Podladchikov, 2007, JGR, v. **112**, B10205. [3] Sullivan *et al* 2013, AGU Fall Meeting, Abstract #V51B-2654.