Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29878

Petrologic preconditioning revisited: insights from thermodynamic and numerical modelling

SIMON SCHORN, EVANGELOS MOULAS AND NICOLAS RIEL

Johannes-Gutenberg University

The thermal history during metamorphism is controlled, among others, by the physical properties of the lithologies involved. Of these, the latent heat that is consumed or released during melting of rocks and crystallization of melts, respectively, causes a transient but significant increase of the effective heat capacity, thus leading to protracted heating/cooling compared to melt-absent lithologies [1,2]. Recent studies document disparate temperatures of ~50–75°C recorded by coexisting fertile migmatites and refractory Mg–Al-rich gneisses, explained by the absence of melting-related prograde thermal buffering in refractory rocks compared to fertile ones [3] and buffering by focused melting at different temperatures due to bulk compositional differences [4]. Dehydration and/or melting caused by a previous metamorphic event may exhaust the buffering potential during subsequent thermal episode, thus 'preconditioning' the terrane and favoring the attainment of higher peak temperatures for a given heat budget [5]. We combine thermodynamic modelling of representative fertile and refractory bulk compositions to quantify the latent heat involved in dehydration- and melting reactions with 2D numerical models to simulate thermal processes in advectively-heated high-grade terranes. Whereas Mg-Al-rich gneisses are refractory, they experience endothermic episodes due to the dehydration of chlorite and/or orthoamphiboles, which dominate these rocks by ~50–70 vol.% at greenschist facies conditions. Conversely, hydrated metapelites and metabasites show subordinate dehydration reactions, while experiencing significant thermal buffering due to melting of mica and amphibole, respectively [2,3,4]. Polymetamorphism and preconditioning at conditions lying above the dehydration of Mg–Al-rich gneisses but below melting of fertile rocks (~500–700°C) would thus favor the attainment of higher temperatures in refractory gneisses during subsequent metamorphism. Our simulations explore parametrizations of crystallizing melts and endothermic reactions along with pseudo-convection in partially molten units [6] to quantify the relevant length- and time scales involved in long-lived thermal episodes documented in large-scale granulite terranes.

[1] Stüwe (1995), *Tectonophysics* 248, 39-51.

[2] Schorn, Diener, Powell & Stüwe (2018), *Geology* 46, 643-646.

[3] March, Hand, Morrissey & Kelsey (2025), *Scientific Reports* 15, 3038.

[4] Schorn & Diener (2019), *Journal of Metamorphic Geology* 37, 1049-1078.

[5] Caddick (2013), *Mineralogical Magazine* 77, 806.

[6] Riel, Mercier & Weinberg (2016), *Geology* 44, 31-34.