Geophysical Research Abstracts
Vol. 20, EGU2018-5562, 2018
EGU General Assembly 2018

Heat production driven high-temperature metamorphism

Martin Hand (1), Kiara Alessio (1), Laura Morrissey (2), and Chris Clark (3)

(1) Department Earth Sciences, University of Adelaide, Australia, (martin.hand@adelaide.edu.au), (2) School of Natural and Built Environments, University of South Australia, Australia, (laura.morrissey@unisa.edu.au), (3) Department of Applied Geology, Curtin University, Perth, WA, Australia, (c.clark@curtin)

High thermal gradient metamorphic conditions in the crust can be generated by a number of mechanisms: direct advection of heat via magmatism, high basal heat flow associated with extension/removal of lithospheric mantle, rapid exhumation of deeply buried rocks and high rates of radiogenic heat generation. Of these, the latter is generally regarded as least important, based largely on geochemical perceptions about the composition of the crust. However, it is becoming increasingly evident that many metamorphic terranes preserve higher rates of heat production than those assumed for typical crust. This leads to the systematic underestimation of heat production values incorporated within orogenic thermomechanical models.

Thermal modelling shows that measured rates of radiogenic heat production in many instances can, with reasonable assumptions, generate the recorded high geothermal gradient metamorphic conditions. Importantly if erosion rates are slow or limited by the formation of orogenic plateaus, metamorphism will be long lived. For high heat production rate terranes such as the Eastern Ghats in India and parts of Central Australia, durations of high–T metamorphism constrained by geochronology and/or mineral compositional diffusional modelling appear to be in excess of 100 Ma, even at depths as little as $\sim$20 km. An additional factor that can contribute to the development and maintenance of high geothermal gradients in crustal rocks is the recent observation that fluid-absent partial melting and associated melt loss (key factors in the generation and preservation of granulite terranes) does not deplete Th–U concentrations in the granulitic residuum. Consequently terranes that underwent fluid-absent melting and melt loss retain a significant fraction of their heat production capacity.

With the increasing availability of calibrated airborne geophysical datasets and affordable hand held gamma ray spectrometers, it is now feasible to measure representative heat production rates at scales relevant to regional metamorphic systems, rather than rely on adhoc application of indiscriminately collected (in the context of metamorphism) global geochemical datasets.