Understanding zirconium-in-rutile thermometric results in high metamorphic grade rocks

K. TAYLOR-JONES[1] AND R. POWELL[2]

[1]Department of Earth Science, University of Cambridge, CB2 3EQ, United Kingdon

[2]School of Earth Sciences, University of Melbourne, Vic 3010, Australia

The zirconium content of rutile, where equilibrated with quartz and zircon, is an experimentally well-established thermometer. However application of this thermometer to metamorphic rocks of the hotter realms of the granulite facies, where it routinely returns temperatures in excess of 900°C, raises some troubling questions. Firstly, diffusion data for zirconium in rutile imply that high temperature thermometric signatures should be difficult to retain under plausible rates of cooling. Secondly, observations from natural samples include large, inter-grain ranges of rutile zirconium contents uncorrelated with rutile grain size, and flat zirconium profiles across individual rutile grains. Such observations are counter to what would be expected from diffusive closure of zirconium. We propose that the observed zirconium in rutile behaviour in granulite facies rocks can be accounted for by a combination of sluggish grain boundary diffusion, the difficulty of zircon nucleation (either adjacent or as lamellae), and high temperature diffusive closure of silica in rutile. As a consequence of the ideas presented, it is suggested that zirconium-in-rutile thermometric results on high-grade metamorphic rocks are unlikely to be suitable for cooling rate estimation.