European Mineralogical Conference
Vol. 1, EMC2012-190, 2012
European Mineralogical Conference 2012

Open system processes and the consequences for phase equilibria modeling of melt-depleted ultrahigh-temperature (UHT) granulites, with examples from the Eastern Ghats Province, India

M. Brown (1), F. Korhonen (2), and C. Clark (3)

(1) University of Maryland, Department of Geology, Laboratory for Crustal Petrology, College Park, MD 20742-4211, United States (mbrown@umd.edu, 301 314 7970), (2) Geological Survey of Western Australia, Department of Mines and Petroleum, Perth, WA 6004, Australia, (3) Curtin University, Department of Applied Geology, GPO Box U1987, Perth, WA 6845, Australia

H_2O content and oxidation state during peak metamorphism strongly influence phase relations in (UHT) granulite facies rocks. However, it is difficult to accurately determine values for these components by routine analytical techniques, leading to uncertainty in the appropriate values to use in phase equilibria calculations, and, as a result, doubt concerning the P–T stability of phase assemblage fields and P–T conditions for peak metamorphism. To address this ambiguity the range of appropriate values for H_2O and ferric iron at peak conditions implied by the phase assemblage should be evaluated using M(H_2O) and M(O) vs T (at fixed P) and P (at fixed T) phase diagrams. In addition, net melt loss from (UHT) granulites equilibrated at suprasolidus P–T conditions is required to preserve peak phase assemblages in the subsolidus, but melt loss at 'outcrop' implies melt percolation through these rocks prior to and possibly immediately after peak metamorphism. Thus, these systems generally were open with respect to a reactive melt phase, which was actively migrating through a chemically heterogeneous matrix. Prograde net melt loss is (justifiably) routinely ignored in phase equilibria modeling of formerly suprasolidus (UHT) granulites based on bulk rock compositions where the objective is to characterize the retrograde P–T evolution. However, in some circumstances the bulk rock composition may have been modified by ongoing post-peak net melt loss during cooling to the solidus, which will affect phase equilibria modeling where the objective is to determine the peak P–T conditions. Furthermore, to determine the prograde evolution requires an assumption about the protolith composition or inversion of net melt loss to provide a model composition. These issues will be illustrated with reference to UHT granulites from the Eastern Ghats Province, one of several UHT terranes globally that record both a protracted history of UHT metamorphism and extreme net melt loss. Phase equilibria calculations were undertaken in the NCKFMASHTO chemical system using the Holland & Powell dataset and THERMOCALC. Appropriate a–x relationships were used for: melt, biotite, orthopyroxene, spinel–magnetite, garnet, hydrous cordierite, sapphirine, osumilite, K-feldspar, plagioclase, and ilmenite–hematite. The aluminosilicates, quartz and rutile were treated as pure end-members. Peak P–T conditions of »900°C at $\sim$0.8GPa were retrieved from UHT granulites from multiple localities in the Eastern Ghats Province. In all cases, phase assemblages in microstructures interpreted to record the post-peak evolution in the presence of melt indicate near-isobaric cooling to the elevated solidii. At peak P–T conditions for some localities melt may have been present in amounts that imply percolation of melt through these rocks. As melt flux declined during initial post-peak cooling, the percolation threshold determined the amount of melt retained. Cordierite–K-feldspar–quartz ($\pm$ sillimanite, biotite, plagioclase) intergrowths aligned in the foliation are interpreted to have formed at this stage by reaction between osumilite and melt during cooling to the elevated solidii. Examples of melt reintegration to produce model protolith compositions suitable to evaluate the prograde P–T evolution will be discussed.