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Melt production and buffering in the Namaqua Metamorphic Complex, South Africa

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The Namaqua Metamorphic Complex exposes mid- to lower-crustal igneous and high-grade metamorphic rocks in a belt that extends for more than 1500 km across southern Africa. The studied locality at Hytkoras in the granulite-facies part of the Bushmanland terrane of western Namaqualand hosts a variety of granulite-facies rocks as well as broadly granitic intrusives. The metamorphic rocks can be divided in three distinct groups: (i) pelitic, aluminous granulites (g–bi–cd–sill–feld–q–melt), (ii) Mg–Fe–Al-rich 'magnesian gneisses' (cd–bi–opx $\pm$ g $\pm$ feld $\pm$q $\pm$ melt) and (iii) mafic granulites (aug–opx–pl–q–melt $\pm$ hb $\pm$ bi). PT estimates from pseudosection modelling indicate peak conditions of 800–840 ºC and 5–6 kbar for all rock types. Modelling employing representative melt-reintegrated bulk compositions suggest voluminous melt production in all three lithologies corresponding to major melt-producing reactions. For the pelitic granulites the suprasolidus muscovite-breakdown produces $\sim$15 vol. % melt (plus peritectic ksp + sill) while the bi–sill consuming melting reaction produces $\sim$10 vol. % melt (plus abundant peritectic cd + g + ksp). For a representative 'magnesian gneiss' the major melt-producing reaction corresponds to the g–bi consuming, opx–cd producing reaction through which $\sim$15 vol. % melt is produced. For the mafic granulites the major melt-producing reaction corresponds to the terminal hornblende-breakdown in the opx stability field. The latter reaction produces $\sim$30 vol. % melt. In all investigated cases only minor melt is produced by continuous melting prior to the onset of the named melting reactions. The fact that the inferred equilibrium assemblages of the three rock types correspond to the named major melt-producing reactions is interpreted as symptom of major heat consumption and -drainage. We suggest that – at constant heat input – the heat/energy consumed during a major melting reaction is a first-order control on the dwelling time of an equilibrium assemblage in specific fields of a pseudosection. This has potentially far-reaching implications on the interpretation of PT-paths and the PT-evolution of granulite terrains in general.