

Experimental and natural constraints on the composition of UHP metamorphic fluids

C. SPANDLER^{1*}, T. PETTKE² AND J. HERMANN³

¹School of Earth and Environmental Sciences, James Cook University, Townsville, Australia

(*correspondence: carl.spandler@jcu.edu.au)

²Institute of Geological Sciences, University of Bern, Switzerland

³Research School of Earth Sciences, Australian National University, Canberra, Australia

In recent years significant progress has been made on several fronts to understand the composition of the fluids exsolved from crustal and mantle rocks during ultra-high pressure (UHP) metamorphism. Constraints can be obtained from studying the remnants of UHP fluids now preserved as polyphase inclusions trapped in natural UHP minerals (e.g. garnet [1]), but extracting meaningful chemical information from these inclusions is often complicated by mineral-fluid interactions during metamorphism and subsequent exhumation.

Recent experimental innovations, such as employing diamond traps [2] or trapping synthetic fluid inclusions [3] during experimental runs, allows investigation of fluid-rock interaction and fluid chemistry in representative rock compositions under UHP conditions. The experimental results to date are consistent with extrapolations from mineral solubility data [4] and theoretical phase relations [5], and indicate that fluids liberated from crustal protoliths at UHP conditions are hydrous with significant silicate (Na-K-Al-Si) components. Incompatible trace element contents of these fluids tend to be controlled by the stability of accessory phases (e.g. phengite, allanite, rutile). In contrast, serpentinites that lack trace element-rich accessory phases dehydrate under UHP conditions to form fluids that are relatively enriched in incompatible elements (elevated LREE/HREE, elevated Nb/Zr, elevated U/Th) to leave residual peridotite with a distinctive chemical signature. (e.g. high B, LREE depleted, low U/Th) If large volumes of serpentinite have been subducted into the mantle, dehydrated serpentinite should represent a distinct mantle reservoir that may later be sampled during partial melting to form mafic magma.

[1] Scambelluri *et al.* (2008) *Geology* **36**, 59–62. [2] Kessel *et al.* (2005) *Nature* **437**, 724–727. [3] Spandler *et al.* (2007) *Chem Geol* **239**, 228–249. [4] Manning (2004) *EPSL* **223**, 1–16. [5] Hack *et al.* (2007) *Am J Sci* **307**, 833–855.

Experimental phase and melting relations of metapelite in the upper mantle – Implications for the petrogenesis of intraplate magmas

C. SPANDLER^{1*}, G. YAXLEY², D.H. GREEN² AND D. SCOTT²

¹School of Earth and Environmental Sciences, James Cook University, Townsville, Australia

(*correspondence: carl.spandler@jcu.edu.au)

²Research School of Earth Sciences, Australian National University, Canberra, Australia

To examine the melting behaviour and phase relations of sedimentary rocks at upper mantle conditions, we have performed a series of piston-cylinder experiments on a synthetic pelite starting material over a pressure and temperature range of 3.0 to 5.0 GPa and 1100 to 1600 °C. The anhydrous pelite solidus is between 1150 and 1200 °C at 3.0 GPa and close to 1250 °C at 5.0 GPa, whereas the liquidus is likely to be at 1600 °C or higher at all investigated pressures, giving a large melting interval of over 400 °C. The subsolidus paragenesis consists of quartz/coesite, feldspar, garnet, kyanite, rutile, \pm clinopyroxene \pm apatite. Feldspar, rutile and apatite are rapidly melted out above the solidus, whereas garnet and kyanite are stable to high melt fractions (>70%). Clinopyroxene stability increases with increasing pressure and quartz/coesite is the sole liquidus phase at all pressures. Clinopyroxenes are jadeite and Ca-eskolaite rich, with jadeite contents increasing with pressure. All supersolidus experiments produced alkaline dacitic melts with relatively constant SiO₂ and Al₂O₃ contents. At 3.0 GPa, initial melting is controlled almost exclusively by feldspar and quartz, giving melts with K₂O/Na₂O ~1. At 4.0 and 5.0 GPa, low-fraction melting is controlled by jadeite-rich clinopyroxene and K-rich feldspar, which leads to compatible behavior of Na and melts with K₂O/Na₂O >>1.

Our results indicate that sedimentary protoliths entrained in upwelling heterogeneous mantle domains may undergo melting at greater depths than mafic lithologies to produce ultrapotassic dacitic melts. Such melts are expected to react with and metasomatise the surrounding peridotite, which may subsequently undergo melting at shallower levels to produce compositionally distinct magma types. This scenario may account for many of the distinctive geochemical characteristics of EM-type ocean island magma suites. Moreover, unmelted or partially melted sedimentary rocks in the mantle may contribute to some seismic discontinuities that have been observed beneath intraplate and island-arc volcanic regions.