

Phase relations in meta-komatiites during dehydration melting

NAIR, R.^{1*} CHACKO, T.² VERWIMP, J.¹

¹Department of Geoscience, University of Calgary, Canada T2K 1N4 (*rnair@ucalgary.ca)

²Department of Earth and Atmospheric Sciences, University of Alberta, Canada T6G 2E3

Komatiitic-basalts and komatiites are relatively abundant in the volcanic record of Archean cratons compared to Phanerozoic terranes. It has been suggested that these rocks may have constituted the Archean oceanic crust. It is important to understand the role these rocks would have played in the transformation of oceanic crust during purported processes like slab melting, eclogite formation etc. Whereas metamorphic phase relations of mid-ocean ridge (MORB) type basalts have been widely studied in the past, there is a paucity of knowledge on the phase relations of komatiitic basalts and komatiites.

We report results of preliminary dehydration melting experiments (1000°C, 7-20 kbar) on a natural amphibolite of komatiitic composition with starting composition in wt.% oxides : SiO₂ 48.26, TiO₂ 0.50, Al₂O₃ 7.19, Fe₂O₃ 13.31, MnO 0.23, MgO 18.66, CaO 8.49, Na₂O 0.51, K₂O 0.05 (1). The experiments were conducted on a piston cylinder apparatus for a duration of 2-7 days using procedures outlined in (2).

Experiment	P (kbar)	T (°C)	Phases Present
7IG006	7	1000	Ol, Cpx, (Opx), Melt
7IG005	10	1000	Ol, Cpx, Opx, Melt
7IG004	12.5	1000	Ol, Cpx, Opx, Melt
7IG001	15	1000	Grt, Cpx, Opx, Melt, (Amph)
7IG003	15	1000	Grt, Cpx, Opx, Melt, [Amph]
7IG002	17.5	1000	Grt, Cpx, Opx, Melt
7IG007	20	1000	Grt, Cpx, Opx, Melt

Table 1: Experimental conditions and phase relations. Abbreviations after (3). (), [] indicate minor and trace proportions, respectively.

Phase relations (Table 1) indicate a melt residue dominated by ol, opx and cpx at P < 15 kbar and grt, opx and cpx at P ≥ 15 kbar. The incoming of garnet is at a significantly higher pressure than in MORB compositions (~10 kbar). Our results present interesting comparisons with recent crystallization experiments on a komatiite bulk composition at similar P-T conditions (4). This earlier study reported Ol coexisting with grt at P > 14 kbar and no olivine at P < 14 kbar. A melt phase was not reported at 1000°C and 10-18 kbar in these earlier experiments, but is ubiquitous in our experiments. A first order implication of the new results is that if Archean oceanic crust were komatiitic, crustal thickness > 45 km is required to stabilize garnet in the melt residue. This is important to consider in Archean geodynamic models like crustal delamination that invoke density inversions resulting from stabilization of garnet bearing assemblages in the mafic lower-crust.

[1] Furnes et al. (2007) *Science* **315**, 1704-1707. [2] Nair and Chacko (2002) *J. of Petrol.* **43**, 2121-2142. [3] Kretz (1983) *Am. Mineral.* **68**, 277-279. [4] Foley et al. (2003) *Nature* **421**, 249-252.

Transport of uranyl and arsenate in the presence of SiO₂, Al₂O₃, TiO₂ and FeOOH

SREEJESH NAIR^{1*}, BRODER J MERKEL¹

¹ Department of Hydrogeology, Technische Universität Bergakademie Freiberg, Gustav-Zeuner Str.12, 09599 Freiberg, Germany

sreejeshmc@gmail.com (* presenting author)
merkel@geo.tu-freiberg.de

Uranium is a naturally occurring radioactive and chemically toxic metal, which is widespread in nature. Reactive transport of U(VI) with various ligands and different minerals has been studied extensively. Arsenic is analogous to phosphate and is a well-known contaminant to the environment. Uranyl-arsenate complex formation at near-neutral to alkaline pH conditions was proved by XAS and XANES [1]. They reported the formation of UO₂AsO₄⁻, analogous to UO₂PO₄⁻. However, little information is available about the migration of U(VI) and As(V) in systems containing both elements. The changes in sorption behaviour of U(VI) and As(V) in columns containing bentonite [2] and iron-coated sand [3] were reported. Since As(V) co-exists with U(VI) in several mining areas, it is important to understand the species behaviour to implement proper remediation procedures. Less or no information is available about the transportation of U(VI) and As(V) in the presence of SiO₂, Al₂O₃, TiO₂ and FeOOH, which are very common in natural environments. Hence column experiments were carried out for uranium (0.5 µM/L), arsenate (0.5 µM/L) and both uranium and arsenic containing solutions (0.5:0.5 µM/L) with SiO₂ (10 g), Al₂O₃ (10 g), TiO₂ (0.5 g) and FeOOH (0.1 g) at pH 6.5. Transport behaviour of U(VI) and As(V) through SiO₂ packed columns are identical for solutions containing either U(VI) or As(V) separately, or both together. Almost identical transport behaviour was observed for TiO₂ column also. In the presence of equimolar U(VI) and As(V) a substantial increase in As(V) mobility and slight decrease in U(VI) migration through Al₂O₃ was observed. When Al₂O₃ is replaced by FeOOH, a significant change in the pattern of mobility was shown for As(V) and minor changes for U(VI). The changes in transport behaviour of both elements can be attributed to the competitive sorption between uranyl and arsenate species or due to the formation of the above mentioned uranyl-arsenate species. Further investigations are recommended in order to understand the migration of contaminants in the environment and to implement proper measures in the remediation process.

[1] Gezahegne et al. (2009) *Geochimica Et Cosmochimica Acta* **73**, A430-A430.

[2] Bachmaf et al. (2009) *Geochimica Et Cosmochimica Acta* **73**, A67-A67.

[3] Schulze & Merkel (2011) *The New Uranium Mining Boom: Challenge and Lessons Learned*, 573-578