Chalcophile and Highly Siderophile Element systematics in Mid-Ocean Ridge Basalts

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Mid-Ocean ridge basalts (MORBs) constitute an exceptional window to investigate the chalcophile element (S, Se and Te) and the highly siderophile element (HSEs: Os, Ir, Ru, Pt, Pd, Re) signatures of the depleted MORB mantle (DMM), provided that the behavior of these elements during MORB evolution is entirely understood. Hence, we analyzed S, Se, Te, HSEs and ^{187}Os in 20 Southern Mid-Atlantic Ridge (SMAR) MORBs, which range in composition from typical N-MORBs to plume-overprinted E-MORBs [1].

All samples display positively-sloped CI-normalized HSE patterns (Pt_N/Ir_N=2.8-88.3, Pd_N/Ir_N=3.1-17.3, Re_N/Pd_N=40-270), with E-MORBs having higher Pt and Pd contents than N-MORBs. S, Se and Te concentrations range from 715-1143 ppm, 107-242 ppb and 1.63-9.46 ppb, respectively. S contents increase with decreasing Mg# and Se concentrations. Se and Te positively correlate with each other and with incompatible PGEs (Pt, Pd). In addition Se/Te increase with decreasing Te concentrations defining a clear non-linear trend. After filtering out possible effects of seawater alteration, volatilitization upon eruption and sulphide fractionation on S, Se, Te and HSE contents, the Se/Te and Pd/Ir ratios appear as indicators of the mantle source composition, correlating with discriminant parameters like La_N/Sm_N and Sr-Nd-Pb isotopic signatures. While both N- and E-MORBs are characterised by supra-chondritic Se/Te and Pd/Ir, N-MORBs generally show higher Se/Te but lower Pd/Ir (Se/Te=51-92 vs. 26-38, Pd_N/Ir_N=3.1-7.0 vs. 4.4-17.3). Partial melting modelling [2] performed to reconstruct the DMM composition, predicts an incompatible behaviour of both Se and Te during partial melting as well as chondritic abundances of Se, Pt and Ir but sub-chondritic Pd and Te contents in the SMAR mantle source. This ultimately supports supra-chondritic Se/Te and sub-chondritic Pd/Ir ratios in the MORB mantle source and has important implications on the Se, Te and HSE budget estimate of the Earth's primitive mantle.

[1] le Roux *et al*.. (2002) *EPSL* **203**, 479–498. [2] Rehkämper *et al*.. (1999) *GCA* **63**, 3915-3934.

Deep melting of subducted carbonate and carbonatite melt diapirs in the Earth's mantle

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Minor amounts of alkalis (Na and K) can drastically reduce the solidus temperatures of carbonated silicate mantle, by as much as 400-500°C. Low-degree melting of carbonated peridotite and eclogite at pressures of 3-10 GPa produces Na- and K-bearing carbonatite melt. Mass-balance calculations of samples obtained below apparent solidi show clear deficits of alkalis suggesting the presence of minor alkali-rich liquid or solid carbonate phases. Here we determined the true solidi in Na- and K-bearing carbonated systems and report the stability of new alkaline carbonate phases [1]. Starting materials correspond to Na- and K-bearing Mg-Ca-carbonatite. Experiments were run at pressures from 3-21 GPa and 750-1450°C using multianvil apparatus.

Major carbonate phases in both the Na-carbonatite and K-carbonatite systems are aragonite and magnesite. Magnesite is a liquidus phase together with silicates. Aragonite contains significant amounts of Na_2O (up to 7 wt.%), K_2O (up to 1 wt.%), and MgO (up to 8 wt.%) in the Na-carbonatite system. The solidus temperature is defined by the stability of double carbonate phases. The solidus slope has a significant change between 6 and 10 GPa. Above 10 GPa the solidus becomes flat at a temperature near 1150ºC. In the Na-bearing system it may have a slightly negative slope above 15 GPa according to stability of K-Ca carbonate in this system. Several K- and Na-bearing double carbonates were observed in both the Na-carbonatite and K-carbonatite systems. The major phases observed in the experiments are $(K,Na)_2Mg(CO_3)_2$ and $(K,Na)_2Ca_4(CO_3)_5$. Low-degree partial melts are Na- and K-rich, for Na- and K-bearing carbonatite, respectively, due to early melting of double alkali carbonates.

According to solidi temperatures significant melting of subducting carbonates would likely occur at the transition zone depths Taking into account the amount of subducted carbonated (1-2 wt.% CO_2) in the top 500 m of model slab we proposed a model for mobile carbonatite melt diapirs, generating from the slab in the transition zone, migrating upwards, modifying and oxidizing possibly reduced mantle section [2], precipitating diamonds, creating enriched source regions, and initiating volcanism at the surface.

[1] Litasov *et al*.. (2013) *Geology* **41**, 79-82. [2] Rohrbach & Schmidt (2011) *Nature* **472,** 209-212.

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