

Influence of impactors on the chemical composition of the Earth

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The relative abundances of highly siderophile elements (HSE: Os, Ir, Ru, Pt, Rh, Pd) in the Earth's primitive upper mantle (PUM) and the continental upper crust (UCC) is a key issue for understanding their origin and the influence of impactors on the chemical composition. The past twelve years we have measured the HSE in many mantle suites of the Earth by neutron activation. Estimates of Rh/Ir, Ru/Ir, Pd/Ir, and Pt/Os derived from most mantle suites indicates modestly suprachondritic compositions for average PUM. The enigmatical mantle Ru/Ir ratio of 2.01 ± 0.12 (Schmidt 2004) in comparison of 1.51 ± 0.04 of the known different chondrite groups has been observed by other groups as well (Pattou *et al.* 1996; Becker *et al.* 2006). From highly melt depleted peridotites (Schmidt *et al.* 1998) and metasomatized mantle xenoliths (Schmidt *et al.* 2003) we conclude that the effects of melt depletion, refertilization and metasomatism can be discounted. However, the Os, Ir, Ru, Pt, and Pd pattern on PUM perfectly match IVA iron meteorite data (Charlotte) recently derived by Walker *et al.* (2005). The question raises if HSE in PUM are added to the accreting Earth by a late bombardment of (a) iron meteorites, (b) some unsampled inner solar system materials (more highly fractionated than enstatite chondrites), or (c) excess Rh, Ru, Pt, and Pd in the depleted mantle may have predated the late veneer, or (d) added by crustal recycling (Schmidt *et al.* 2000), or (e) HSE are mixed from the differentiated outer core into the mantle after core formation (Snow and Schmidt 1998)?

The HSE and Ni pattern of the upper continental crust (UCC) is strongly fractionated. Highly fractionated Ru/Ir is unparalleled in terrestrial magmatic systems. In fact, the HSE and Ni systematics closely resembles IIIAB iron meteorites (many impact craters on Earth are produced by this type of iron meteorite projectiles, e.g. Schmidt *et al.* 1997), pallasites, and the evolved suite of Martian meteorites (Shergotty, Nakhla, Zagami), possibly representing the elemental pattern of the Martian crust (Jones *et al.* 2003). Probably the UCC preserves an imprint of such meteorites. Calculations show that a projectile with a radius of 54 ± 4 km as an upper limit would yield the abundances of HSE and Ni in the UCC.

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First direct sampling of superhot supercritical vapor phase fluids at the Mid-Atlantic Ridge

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Within the German Special Priority Program 1144 "From mantle to ocean: energy-, material-, and life-cycles at spreading axes", unique hydrothermal fluids were sampled at two newly discovered hydrothermal vent fields located at the spreading axis of the Mid-Atlantic Ridge at 4°49'S. Turtle Pits and Sisters Peak, both located at 3000 m water depth, emanate vapor phase fluids with stable sampling temperatures of about 390°C-407°C. In addition, temperature measurements recorded short-term spikes of up to 464°C, by far the highest temperature ever measured in submarine hydrothermal fluids. The fluids, representing a supercritical vapor phase sampled near the critical point of seawater, are characterized by a Cl depletion of 50% compared to seawater. The estimated temperature and depth of the initial phase separation with ~430°C, and 360 bar agree with the depth of the reaction zone about 500 m below the seafloor (constrained by Si concentrations). The overall fluid geochemistry is similar to those observed in other phase-separating systems at mid-ocean ridges, with an extremely high mobility of Fe and enhanced H₂ concentrations. Most chloride-normalized element concentrations are greater than seawater, indicating advanced water-rock interaction. Despite a similar chlorinity and major element composition, different fluid samples emanating from the same vent orifice show a very heterogeneous endmember composition with respect to metals such as Cu, Zn, Pb and rare earth elements, indicating the mixing of the superhot vapor phase with another liquid or solid phase. Small differences in the fluid geochemistry between Turtle Pits and Sisters Peak can be related to a somewhat deeper zone of phase separation beneath the Sisters Peak field.

Total and Cl-normalized major and trace element concentrations will be evaluated with respect to possible mixing processes of different types of fluids in the subsurface. The respective influences of vapor-brine fractionation, (low-Cl) water-rock equilibria, and a different elemental speciation in supercritical vapors on the fluid geochemistry of the Turtle Pits and Sisters Peak fluids will be discussed.