Alkaline mantle melts pinpoint late Triassic thinning of the Southern Alpine lithosphere (Ivrea Zone, Italy)

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Following granulite facies metamorphism and abundant mafic magmatism in the Permian lower crust, the European – Adriatic continental crust thermally equilibrated prior to upper Triassic to lower Jurassic rifting and exhumation. During this process, decompressional partial melts from the asthenosphere intruded into the lower continental crust and locally triggered partial melting and rejuvenation of isotopic systems. Such features have been described from the Ivrea zone [1, 2].

We studied Na-rich peralkaline leucocratic pegmatoid lenses within the ultramafic Finero body (N-Italy/S-Switzerland) at the eastern end of the Ivrea zone. These pegmatoids are composed of nepheline, plagioclase, biotite, zircon, apatite, sodalite and corundum. High-precision U-Pb ID-TIMS age determinations on single crystals, fragments and on a transect through a one centimeter sized zircon, combined with *in situ* laser ablation ICP-MS data, as well as initial Hf isotopes provide evidence that zircon grew episodically between 210 and 190 Ma from melts originating from an enriched mantle source. Variations in trace element composition and in age - up to 2 million years within one zircon crystal - are compatible with a first emplacement of plagioclase/albite and nepheline megacrystal bearing pegmatoids that are subsequently brecciated by a K, REE and trace element rich, fluid-saturated liquid. Both liquids are zircon saturated. The pulsed zircon growth is interpreted to reflect episodes of enhanced crustal stretching and thinning, producing a low-percentage of mantle melting. Our data may explain why the granulite-facies parageneses in the Ivrea zone have been locally overprinted and rejuvenated, solving the decennial controversy on the age of the regional granulite-facies event.

[1] Schaltegger & Brack (2007) *Int. J. Earth Sci.* **96**, 1131–1151. [2] Quick *et al.* (2009) *Geology* **37**, 603–606.

Estimating stable isotope signatures of core formation

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The geochemical separation of isotopes at equilibrium is a process driven by material dynamics, chiefly the zero-point energy of vibrations (phonons). Isotopic signatures caused by this process might be useful for understanding the composition and conditions of formation of the Earth's core, as well as metal-silicate segregation elsewhere in the solar system [1-5]. This presentation will discuss recent progress in using first-principles models to understand isotopic fractionation caused by dissolution into metal alloys at high temperatures and/or pressures, as well as complementary techniques including spectroscopy-based modeling, experiments, and empirical calibration. Estimates of H, C, N, O, Si, S and Cr isotope fractionations in iron-rich metallic melts are calculated with density functional theory, via models of iron-rich crystals with bonding environments analogous to liquid alloy, e.g. dhcp-FeH, Fe_3C-cohenite and $Fe_{15}Cr$. Alloying atoms in these crystals are completely coordinated by iron. Equilibrium fractionation is assumed to be driven by the reduction of vibrational frequencies when heavy isotopes are substituted – though mass-independent fractionation may become significant for very heavy elements (e.g. platinum group elements, Pb). Quasiharmonic methods approximate the effects of high pressure and thermal expansion – in the case of silicon-isotope fractionation it appears that pressure effects of bond compression and increased cation coordination in silicate melts roughly cancel each other along the mantle liquidus. Stronger pressure effects are possible for other elements. The calculations suggest that iron alloys will usually be depleted in heavy isotopes, relative to other planetary materials, by as much as ~100‰/amu at 2000 K in the case of D/H fractionation between FeH and water, or as little as ~0.1‰/amu in the case of $^{53}Cr/^{52}Cr$. Isotopic signatures appear to be largest for light elements (H >> C, N, O > Si > S, Cr), and at low temperatures. All of the light-element systems studied could show isotopic separations large enough to measure, suggesting that significant core partitioning could perturb the bulk silicate Earth isotopic composition. Experimental and empirical determinations of Si-isotope and C-isotope fractionations broadly agree with theoretical models.

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