Metal-silicate element partitioning at ultrahigh pressures: He to I

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We have developed methods to re-create the conditions of the formation of the early Earth in a Laser-Heated Diamond-Anvil Cell (LHDAC) at high pressures extending to deep within the present lower mantle under equilibrium conditions. We have studied volatile trace components. Microanalysis of LHDAC samples with UV laser ablation techniques (at the Open University, UK) provided for the first time a spatially-resolved depth profile in samples. Together with standard SEM/EMP techniques, we have extended the type of volatiles investigated to include light (molecular) species, the heavy halogen, iodine, and potentially other trace elements. Systematic results on the solubility of Ar and He that suggest their relative compatibility varies with pressure in liquid silicate -- and hence are candidates for storage in the deep Earth. Finite Helium solubility in the metal phase, relative to that of the silicate, suggests the core should be considered a deep-Earth reservoir highlighting the exchange mechanisms at the CMB with the lower mantle – for example, requiring more careful examination of the processes and whether systematic for all trace elements. The pressure dependence of partitioning for He and I is weak, and more strongly dependent on the composition of the metal phase. Both helium and iodine would have partitioned early into the core during its formation and in proportion to their early abundance, creating a potential reservoir for ^{3}He, ^{4}He and ^{129}Xe. Core He could clearly contribute to the mantle ^{3}He-^{4}He budget. In contrast, trapping of radiogenic ^{129}Xe into the core appears to have little impact on current planetary xenon isotope ratio models and mantle evolution.

Understanding and quantifying your crystal populations

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Magmatic and volcanic systems invariably contain significant crystal populations on eruption or final intrusion. Yet these are rarely comprised of a single crystal population which grew solely from the batch of magma. Close investigation of crystal populations reveal that they comprise up to four main components: Phenocrysts – crystals co-genetic with their magmatic host; Xenocrysts – crystals wholly, or in part (cores), foreign to the magmatic host and magma system; Antecrysts – crystals which may be recycled one or several times before inclusion in the host magma but have an origin within the magmatic system; and Microlites, which represent small co-genetic crystals which nucleate and grow rapidly on decompression. Such a mixture of different crystal components can lead to a number of problems when attempting to constrain geochemical evolution of the system. Yet by their very nature, these complex crystal ‘cargos’ provide a window into the plumbing of magma systems and how they interact with the crust

Quantitative textural analysis techniques are employed to quantify key aspects of the crystal population both in 2D & 3D [1]. These can include crystal size distributions (CSD) [2, 3], crystal shape [3], spatial distribution patterns (SDP) [4], and clustering of crystals [5]. In addition the combination of textural and microgeochemical techniques provide the next stage in the interrogation of crystal populations [2], and allow a full understanding of the true make-up of the crystal population.

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