Silicon diffusion in liquid iron: Kinetic implications for metal-silicate equilibration

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Silicon is a likely light element in the Earth's core on the basis of Si depletion in the mantle relative to primitive chondrite compositions. Previous studies reveal Si solubility in liquid iron to increase at elevated pressures, which implies that Si would partition from the basal region of a magma ocean into metallic cores of impacting bodies during accretion. The core-mantle boundaries (CMBs) of differentiated bodies are characterized by chemical disequilibrium implying ongoing transport of primary elements, such as Si, between a liquid outer core and the base of silicate mantle. We are conducting a series of high *P-T* experiments to constrain the diffusivity of Si in liquid iron in order to understand the kinetics of chemical transport and equilibration during core formation and processes occurring at CMBs.

Experimental diffusion couples comprised of highly polished cylindrical disks of 99.97% Fe and metallic Fe_6Si were contained in an MgO capsule and annealed within the *P-T* range 2023–2523 K and 7–25 GPa in a multi-anvil apparatus. To minimize the occurrence of diffusion prior to reaching the target temperature, a rapid heating rate of 20°C/sec was used to ramp the temperature to the required value. Experimental durations were very short (< 30 sec) and terminated by quenching at ~500°C/sec by switching off the electrical power. Recovered capsules were cut and polished parallel to the axis of the cylindrical sample and measured using EMPA 10 µm-step line scans. The data were fit to the error-function solution to the diffusion equation in accord with "zero-time" initial condition profiles.

Preliminary results indicate that silicon diffuses in liquid iron at least one order of magnitude slower that Fe self-diffusion [1], which could influence the viscosity of the outer core if silicon is present.

[1] Dobson (2002) *PEPI* **130**, 271-284.

The bacterial C-isotope archive: modern anoxygenic phototrophs elucidate past processes in S and Fe-rich systems

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Anoxygenic phototrophic bacteria oxidizing sulfide, thiosulfate, elemental sulfur or Fe(II) are considered to be among the earliest organisms on Earth. As sulfur and iron were abundant on early earth, Fe and S oxidation states and isotopic signatures in the rock record are routinely utilized as markers for the rise of oxygen. In another approach, studies of modern S and Fe-oxidizing anoxygenic phototrophs afford us the opportunity to investigate how these organisms may have influenced the geochemical evolution of our planet.

Sulfide-rich, meromictic, Lake Cadagno (Switzerland) is an ideal location to study purple and green sulfur anoxygenic phototrophic bacteria as analogues of ancient systems (*eg., Tonolla et al , 2003; Canfield et al , 2010).* The stable chemocline allows for the development and maintenance of a geochemical gradient and S-cycling microbial community.

We present work carried out on the C-isotopic signatures imparted by S-metabolizing anoxygenic phototrophic bacteria both in pure culture and in the lake waters to understand how C-fixation pathways, water column cycling, sedimentation and diagenesis can influence the isotope record. Combining $^{13}C/^{12}C$ analysis of field and pure culture POM and DIC, FISH-SIMS and eco-physiological studies, we aim to elucidate the C-isotope signature of the microbial carbon lifecycle. Part of our focus is to clarify whether the isotopic biosignature is a combination of all bacterial community members or dominated by a single member. Future work will compare this S-rich system to Fe-rich analogues.

[1] Tonolla, M., Peduzzi, S., Hahn, D., Peduzzi, R. (2003). FEMS Microbiology Ecology **43**, 89-98. [2] Canfield, D.E., Farquhar, J., Zerkle, A.L. (2010) Geology **38**, 415-418.

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