Iron lite: Experimental constraints on the composition of Earth's core

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Identifying the light element(s) dissolved in Earth's core is important for understanding the power source driving the geodynamo that sustains Earth's magnetic field, for modelling the core formation process, and for constraining reactive transport across the core-mantle boundary. The abundance of the light element(s) in the bulk core are set during metal segregation within the accreting proto-Earth in a deep magma ocean. The light element abundance in the outer core increases with time due to expulsion from the inner core during crystallization, adding deep buoyancy for convection. Experimental and theoretical efforts to constrain the light element(s) in the core yield a range of results. Recent diamond cell melting experiments and sound velocity measurements favor some combination of Si and O [1,2]. Theoretical results favor combinations of S and Si, or S and O [3-5]. Recent core formation models indicate reducing conditions during metal segregation and favor Si as a predominant light element [6]. Our approach at placing constraints on the light element is to understand melting phase relations in simple iron alloy systems, and to build up a data base that allows us to develop thermodynamic models for predicting phase equilibria and liquid metal properties in more complex systems relevant to Earth's core. By comparison of liquid metal properties with the observed seismic properties of the core, its density, seismic wave speed, and radial structure, we can place definite constraints on the core's present composition [7]. Here we present our most recent results for melting phase relations in the binary systems Fe-S, Fe-C, Fe-Si and Fe-O. We use in situ radiographic techniques to constrain eutectic and liquidus compositional relationships in binary systems, and will present melting curves for phases in these systems to pressures in excess of a megabar.

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Anaerobic microbial iron oxidation in an iron-meromictic lake

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The Archean and early Proterozoic Ocean was anoxic, rich in iron(II), and poor in sulfide [1]. From this ocean massive deposits of iron-oxides precipitated and formed the Banded Iron Formations (BIF). Based on stratigraphic studies, experimental data of bacterial cultures with new anaerobic iron-oxidizing capabilities, and on theoretical considerations, it was proposed that some BIFs may have been formed by anaerobic photosynthetic iron-oxidizing bacteria instead of the abiotic reaction of iron(II) with oxygen produced by cyanobacteria [2,3]. However, activity of such anoxygenic photoferrotrophs has not yet been demonstrated in a modern water column and their ecology is completely unknown [4].

We examined modern biological iron-oxidation in an iron-meromictic lake with a water column chemistry resembling an Archean Ocean. Physicochemical profiling, *ex situ* water incubations under simulated environmental conditions, and *in situ* ^{14}C-bicarbonate incubation experiments were employed to detect and quantify the different iron-oxidizing metabolisms. Both summer and winter stratification of the water column was investigated. The abundance of photoferrotrophs and nitrate-dependent chemolithoferrotrophs was estimated by MPN cultivation and characterized by cloning/sequencing of the 16S rDNA gene. Results indicate that phototrophic iron-oxidation occurs during both winter and summer stratification while nitrate-dependent chemotrophic iron-oxidation is mainly present during summer. For the first time, the activities of all known types of anaerobic microbial iron-transforming metabolisms were detected in a modern stratified water column.

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