

Fe kinetics of marine particle uptake and desorption determined from laboratory experiments

ANNA BECK* AND JESS ADKINS

Caltech, Geological and Planetary Sciences, Pasadena, CA 91125 (*correspondance: abeck@caltech.edu)

Particle residence times in the ocean are short enough for the adsorption and desorption of Fe(III) from marine particles to control the dissolved [Fe] profile. Previous laboratory experiments measured Fe(III) uptake rates using radiotracers under simulated natural conditions and in the presence of various particles. However, since at least 99.9% of dissolved Fe(III) in the ocean is bound to organic ligands, we carried out similar laboratory experiments with Fe(III) bound to desferrioxamine B, a naturally occurring siderophore, and used ^{54}Fe as a tracer.

We find the adsorption of ^{54}Fe onto a fresh, labile iron oxide (ferrihydrite) to be first order dependent on particle concentration and has a rate of $-0.17 (\pm 0.05)$ pmol Fe/(mg particle)/day. Experiments with ferrihydrite concentrations of less than 200 mg/L reach steady state after 100+ days, a time period two orders of magnitude larger than particle residence times in the water column, underscoring the significance of the adsorption kinetics on the profile of [Fe]. The uptake of ^{54}Fe onto clay (montmorillonite) has a very fast (<10 min) initial uptake followed by a slower, possibly first order, absorption that are both dependent on particle concentration. In stark contrast to clay and ferrihydrite, there is insignificant absorption of ^{54}Fe onto 3 other types of marine particles—stable iron oxide (goethite), opal (pulverized diatoms), and carbonate shells (forams). In desorption experiments, we find that 1) all particle types reach steady state in 1 week or less, and 2) the uptake mechanism onto ferrihydrite is irreversible. Fe cycling models currently lack these differences in particle preference and their respective rates.

Reconciling abundances of highly siderophile elements and major volatiles in the silicate and near-surface Earth

H. BECKER^{1*} AND M. FISCHER-GÖDDE²

¹Institut für Geologische Wissenschaften, Freie Universität Berlin, Malteserstrasse 74-100, D-12249 Berlin, Germany (*correspondence: hbecker@zedat.fu-berlin.de)

²Institut für Planetologie, Universität Münster, Wilhelm-Klemm-Strasse 10, D-48149 Münster, Germany

Ratios of highly siderophile element (HSE) abundances permit to distinguish between different classes of chondrites and may help in tracing the presence and evolution of differentiated metal and the differentiation of planetary crusts and mantles. The HSE can also play an important role in constraining the origin of the more abundant highly volatile elements in the terrestrial planets, in particular, if both groups of elements were added after core formation and the magma ocean stage. Recent constraints from peridotites and komatiites suggest that the relative abundances of Ru and Pd in the silicate Earth are suprachondritic. In contrast, other HSE show chondritic relative abundances, with Re/Os and Rh/Ir more similar to ratios in ordinary or enstatite rather than carbonaceous chondrites. HSE abundances and geochronological data for pre-3.8 Ga lunar impact rocks indicate that at least two ≥ 4.2 Ga old meteoritic components occur widely dispersed across the lunar nearside: a somewhat volatile element depleted (carbonaceous?) chondritic component in granulitic impactites and in some impact melt rocks, and a differentiated metal component, similar to some IVA iron meteorite compositions. The Earth may have accreted similar materials after 4.5 Ga, however, much larger quantities would be necessary to explain the HSE abundances in the Earth's mantle. Late accretion of 80-85 % of a slightly volatile depleted carbonaceous chondrite composition and 15-20 % of differentiated metal reproduces integrated abundances of the HSE, S, H, C and N in the silicate Earth + atmo- and hydrosphere, remarkably well, and would be consistent with the isotopic composition of S, H, C and N. Small discrepancies in abundances may reflect poorly known partition coefficients (Rh) and volatile loss (N). Required HSE abundances in the metal are equivalent to abundances in liquid metal that has fractionated 40-60% solid metal in the core of a ~2000 km diameter protoplanet. In order to prevent segregation of metal into the Earth's core, the bulk of this material should have accreted some time after the giant impact and solidification of the terrestrial magma ocean.