^{182}Hf-^{182}W, accretion of the Earth and the origin of the Moon

S.B. JACOBSEN AND Q.-Z. YIN

Dept. of Earth & Planet. Sci., Harvard Univ., Cambridge, MA 02138, USA (jacobsen@neodymium.harvard.edu)

The time scale and functional shape of Earth's accretion and core formation may be investigated using the ^{182}Hf (half-life: 9 Ma)-^{182}W extinct nuclide chronometer (Jacobsen and Harper 1996, Harper and Jacobsen, 1996) because the Hf/W ratio is fractionated both strongly and uniquely by core formation. W is partitioned into the metal phase and Hf into the silicate mantle during the formation of the Earth. The core will develop a deficit in ^{182}W, while the silicate Earth will develop a ^{182}W excess during the early stages of accretion. If the accretion process continues for more than 50 Ma then this difference may be erased. Here we present new model results for the Hf-W system, as the two most important parameters used for such calculations in the past have now been drastically changed by the new results of Yin et al. (2002). First, according to the new results, the silicate Earth has a radiogenic W isotope signature of $\varepsilon_{W(CHUR)} = +2$ (in contrast to the previous value of +0.2 ±0.3 of Lee and Halliday (1996)), and second, the initial solar ^{182}Hf/^{180}Hf has been lowered from 2.75×10^{-4} (Lee and Halliday, 1996) to 1.0×10^{-4} (Yin et al., 2002). The models are based on isotopic and chemical mass balance between a primitive nebular reservoir, the primitive mantle and the core. The results of using a variety of accretion histories from dynamical accretion models have the following features in common: 1) they can produce the observed ε_W anomaly in the silicate Earth provided the initial growth stage of the Earth is rapid (> ~65% completed in the first 10 Ma), 2) the remaining growth must be effectively finished in another 20-40 Ma. The W isotope composition of the Moon has now been revised from $\varepsilon_W = +6$ down to a value of only 1.3 ε_W-units higher than the Earth (Lee et al., 2002). As late (> 50 Ma) giant impacts result in a ε_W anomaly in the Earth of less than 0.5 ε_W units higher than chondrites, it is necessary to have the Moon form by a giant impact at ~25-40 Ma. A scenario in which the Earth's core is formed after 60 Ma and the Moon simultaneously by a giant impact is now implausible.

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Trace-metal dynamics in wetland sediments; Laboratory measurements and numerical simulations

P.R. JAFFE AND S. XU

Department of Civil and Environmental Engineering, Princeton University, Princeton, NJ 08544, USA

Mobility of trace metals in wetland sediments is controlled by the vertical redox profile that develops in these sediments. This profile is determined by the reactive transport of different electron acceptors in the sediments. Transport is affected by diffusion and advection, and for oxygen also the transport through the roots of wetland plants. Reactions affecting the electron acceptors include their utilisation by bacteria during the degradation of organic matter. The objective of our research is to obtain a mechanistically based understanding of the dynamics of trace metals in wetland sediments. The long-term goal is to assess how changes in either water quality or vegetation affect the sequestration or release of trace metals in wetland sediments. For this purpose we are conducting laboratory experiments and developing a numerical model, to gain a better understanding of the processes that affect the redox profile in wetland sediments and the fate of contaminant metals in these same sediments. Vertical concentration profiles of the key redox species, as well as that of trace metals, are being measured in microcosms maintained in a greenhouse in which cattails are planted at different densities in a sandy soil. A solution containing nutrients, various terminal electron acceptors, and trace metals is pumped at a constant rate into the microcosms. Water level above the sediment surface is maintained constant by allowing the excess fluids to drain from the microcosms. Infiltration is controlled by draining water from the bottom of the microcosms at a constant rate using peristaltic pumps. To determine the effect of the carbon load, acetate is applied to one microcosm as an external carbon source, while another microcosm relies only on root exudates as a carbon source. The vertical concentration profiles are being monitored in all microcosms using gold-amalgam microelectrodes and cyclic voltametric techniques. This is done over several diurnal cycles in order to determine the effect of plant activity on these profiles. A reactive transport model has been developed, consisting of a set of coupled, steady state mass balance equations, accounting for advection, diffusion, bioturbation and reaction of an organic substrate, electron acceptors, corresponding reduced species, and contaminant metals of interest. The model accounts for the effect of plants including the release of oxygen and uptake of nitrogen by plant roots, as well as flow induced by evapotranspiration. Model outputs are then compared to the measured concentration profiles to provide guidance for further model refinement.