Collisional erosion and the non-chondritic composition of the Earth

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The "chondritic assumption" that underlies estimates of the bulk composition of the Earth rests on the view that terrestrial planets are derived from the solar composition having undergone only those cosmochemical fractionation processes that are observed among the "chondritic" or undifferentiated meteorites. These fractionations include various depletions in volatile elements, variable Mg-Si-refractory ratios and a cosmochemical metal/silicate fractionation. Planetary embryos, accreted in local feeding zones within 10^6 years, may preserve some of these chemical variations. However, modern models of planetary formation postulate that terrestrial planets then grow from ~10^2 embryos sourced across wide heliocentric distances, involving energetic collisions, in which material is lost as well as gained. This stage should average out some of the "chondritic" fractionations, but potentially introduces two non-chondritic chemical fractionation processes: post-nebular volatilisation and preferential collisional erosion. That post-nebular volatilisation was widespread is demonstrated by the non-chondritic Mn/Na ratio in all the small, differentiated, rocky bodies for which we have samples, including the Moon and Mars. The Bulk Silicate Earth (BSE) has chondritic Mn/Na, but shows several other compositional features in its pattern of depletion of volatile elements suggestive of post-nebular volatilization. The extent of collisional erosion during the formation of the Earth may be estimated from the whole Earth Fe/Mg ratio of 2.2±0.1, which is significantly greater than the solar ratio of 1.9±0.1, implying net loss of ~10% silicate relative to metal during the Earth's accretion. If this collisional erosion preferentially removed differentiated crust, the assumption of chondritic refractory element ratios in the BSE would not be valid, with the BSE depleted in elements according to their geochemical incompatibility. In the extreme case, the BSE might only have half the chondritic abundances of the highly incompatible heat-producing elements Th, U and K. Such an Earth model resolves several geochemical paradoxes: the depleted mantle occupies the whole mantle, is completely outgassed in ^{40}Ar, and produces the observed ^{4}He flux through the ocean basins.

Aragonite as a precursor phase of cyanobacterial calcite precipitation and the influence of EPS on the nucleation process: A STXM study

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The global carbon cycle is influenced by many environmental processes such as the precipitation of carbon-bearing minerals like carbonates. Although the importance of unicellular planktonic cyanobacteria in the process of lacustrine and marine $CaCO_3$ precipitation has been investigated for decades, the mechanism(s) of mineral nucleation still have not been fully clarified. Synchrotron-based Scanning Transmission X-ray Microscopy (STXM) so far is the only technique which allows for the investigation of this important biogeochemical question with good chemical sensitivity at a spatial resolution of <30 nm.

Cyanobacteria were cultured under varying nutrient concentrations and treated with different amounts (3-6 mM) of Ca^{2+}. Whole cells and focused ion beam milled ultrathin sections were spectromicroscopically analyzed by STXM.

Discussion of Results

Ca^{2+}-adsorption within different types of extracellular polymers (EPS) was quantified using the NEXAFS fingerprints of the *C-1s* and the *Ca-2p* absorption edges. Furthermore, aragonite was identified to be an unstable precursor phase of the thermodynamically more stable calcite which forms the final precipitate. The potential for aragonite nucleation was shown to be dependent on the nutrient concentrations and decreased with increasing culture age.

This presentation will discuss how the combination of soft X-ray spectromicroscopy and geomicrobiological experiments helped to understand the biogeochemical process of bacterially mediated mineral nucleation.

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