6.1.12

^{146,147}Sm-^{142,143}Nd constraints on early silicate planetary differentiation

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Introduction

Radioactive systems comprising isotopes of refractory, lithophile elements provide unique constraints on mineral segregation in early planetary magma oceans and therefore improve our understanding of early silicate differentiation. Here we present Sm-Nd and Lu-Hf isotope systematics for six new eucrites and angrites, complementing the data of [1]. In addition, results for the extinct radioactivity ^{146}Sm-^{142}Nd are reported for 15 eucrites (basaltic and cumulative) and 2 angrites. We also present new Sm-Nd and Lu-Hf isotope data for 3 KREEP basalts and the SNC meteorite, Lafayette.

Results and discussion

No ^{142}Nd anomaly has been unambiguously detected in either eucrites or angrites, whereas a positive ^{142}Nd anomaly measured in the nakhlite Lafayette (+0.5 ε) is in agreement with a previous finding [2]. The KREEP basalts are characterized by negative ε_{142Nd} (< -0.4 ε) and slightly negative ε_{143Nd} and ε_{Hf} at the time of their formation (3.8 Ga) consistent with results of [3]. The existence of an enriched component complementary to the depleted source of most lunar low-Ti and high-Ti basalts has been clearly identified. The present isotopic data on lunar samples can be explained by the early crystallization of a magma ocean, involving pyroxene-olivine cumulate segregation in its deep parts. The same process can be invoked for the Martian mantle because the nakhlites and the depleted shergottites have a Nd-Hf isotopic signature similar to high-Ti lunar basalts. In contrast, residual liquids make up a visible component of the source of KREEP basalts, a zone rich in plagioclase and ilmenite cumulates, in accordance with the high Hf/Sm ratio of these rocks. Detectable amounts of ^{146}Sm were still alive when these last liquids were crystallizing. The silicate evolution of small planetary bodies, such as 4-Vesta, is different. Pressure conditions in the mantle are too low to permit cumulate mineral segregation and therefore significant Sm/Nd fractionation at the bottom of a magma ocean. It is so far only on the Moon that an enriched component characterized by negative ^{142}Nd has been clearly identified.

References

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6.1.13

U-Pb and Hf-W chronometry of zircons from eucrite A881467

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The decay of ^{182}Hf to ^{182}W with a half-life of ~ 9 million years has been used to constrain the core formation event in Earth, Mars, Moon and Vesta (the parent body of eucrites). In this abstract we report the first U-Pb and Hf-W measurements in zircons from the non-cumulate eucrite A881467 using the multi-collector Cameca ims1270 large geometry ion microprobe at the Swedish Museum of Natural History. Three zircon grains were analysed for U-Pb composition and they have ^{207}Pb/^{206}Pb ages of 4553.3±11.0, 4545.9±10.4 and 4556.2±14.4 million years. The inferred ^{182}Hf/^{180}Hf at the time of crystallization of Asuka 881467 zircons is $(1.4\pm0.55)\times10^{-4}$. The ^{207}Pb/^{206}Pb ages of zircons suggest that they are at least 10 to 20 million years younger compared to the age of the solar system. Therefore the minimum estimate for the initial ^{182}Hf/^{180}Hf at the time of start of solar system formation is ~ 3.0×10^{-4}. This value is similar to old value estimated for early solar system [1] but a factor of 3 higher than the current accepted value of ~ 1.0×10^{-4} [2-4] for ^{182}Hf abundance. This is first successful report on U-Pb ages and Hf-W mineral isochron for eucrite. It is an important step in calibrating short-lived chronometer with a long-lived chronometer. The inferred (^{182}Hf/^{180}Hf) value from this meteorite data is higher than the currently accepted value for early solar system. The reason for elevated ^{182}Hf abundance inferred from zircon data is under investigation.

References

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