THE EFFECTS OF TERRESTRIAL WEATHERING ON SAMARIUM-NEODYMIUM ISOTOPIC COMPOSITION OF CHONDRITES

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Introduction: Following their fall to Earth, meteorites experience weathering. During this process, their mineralogy and chemical composition can be deeply modified [e.g. 1]. Most studies about meteorite weathering have dealt with mineralogy and major elements geochemistry. Fewer studies also have focused on particular trace elements such as Ba, Sr, and REE [2, 3]. The number of the studies is even more limited when it comes to isotopic investigations. However, paucity of information in this topic does not correlate with its importance.

The systematics of rare earth elements (REE) and Sm-Nd isotopic pairs are the basis for petrogenetic and radiometric dating studies of terrestrial and extra-terrestrial rocks. As a result of their slightly different nuclear and chemical properties, the REE respond to common petrological processes, such as partial melting and partial evaporation, by developing fractionated light-REE (from La to Sm) or heavy-REE (from Eu to Lu) enriched elemental patterns [e.g. 4]. Despite their importance in cosmochemical studies, REE and especially Sm-Nd isotopic system have been rarely studied in a systematic manner to track meteorite weathering effects on their composition.

In this study we aim to systematically evaluate REE composition of ordinary chondrites from the Antarctic cold desert and Atacama (Chile) and Lut (Iran) hot deserts. We also analyzed the Sm-Nd isotopic systematics of the meteorites with heavily affected REE compositions.

Results: In comparison to the Antarctic meteorites, hot desert samples show greater disturbances and REE fractionation relative to the average fall values. Similar to Antarctic samples, ΣREE contents in the hot deserts meteorites is lower than the average fall values. Our Sm-Nd isotopic data show that $^{147}Sm/^{144}Nd$ ratios in the hot desert meteorites are showing significant deviations from the chondritic isochron and the values reported for ordinary chondrite falls. The $^{147}Sm/^{144}Nd$ in the measured hot desert chondrite ranges from 0.0777 to 0.1973. These ratios are generally lower than the average of 0.1958 reported for falls [5]. The average $^{147}Sm/^{144}Nd$ for the Atacama and Lut samples is 0.1433 ± 0.0287 (n=10) and 0.1876 ± 0.0080 (n=7), respectively. This indicates a higher variation and lower values of $^{147}Sm/^{144}Nd$ for the Atacama samples than those from the Lut desert. The εNd values range from -2.20 to 1.61, which is wider than the -1.07 to 0.64 range for falls [5]. The average εNd value for the Atacama and Lut desert samples are -1.05 and -0.58, respectively.

Discussion and Conclusions: Our data reveals that terrestrial weathering of meteorites both in Antarctica and hot deserts changes their trace element (Sr, Ba, REE, Hf, Th, and U) concentrations. In addition, Sm-Nd isotopic measurements of ordinary chondrites from the Atacama and Lut hot deserts show significant effects of terrestrial weathering as manifested by their non-CHUR $^{147}Sm/^{144}Nd$ and $^{143}Nd/^{144}Nd$ ratios. Disturbance of Sm/Nd ratio is responsible for lower $^{147}Sm/^{144}Nd$ ratio which is more evident in the Atacama samples as they have more fractionated REE patterns. Lower Sm/Nd ratios show the effects of mixing with a terrestrial component. The majority of the Atacama meteorites regardless of their weathering degrees (at least W≥2) are indeed contaminated.

Both $^{147}Sm/^{144}Nd$ ratio and εNd values do not show a straightforward relationship with the weathering degrees. However in both cases, the samples with the highest negative isotopic disturbances are H chondrites from the Atacama and Lut deserts.

More studies such as in situ analysis will be needed to find the main factors controlling contamination of Sm-Nd isotopic composition of hot desert meteorites. Care must be taken account while dealing samples collected from hot deserts, even if they look fresh, and including the Atacama desert which is shown to be an extraordinary region hosting high population of meteorites, including unique samples [6,7].

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