High precision Cr isotopic analysis of terrestrial and extraterrestrial materials (application to Cr-rich layer from Isua BIF)

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In order to shed light on the origin of Cr-rich layer found in the Isua Banded Iron Formation, a high precision Cr isotopic measurements of terrestrial and extraterrestrial materials are currently being undertaken.

Application of 2nd order fractionation correction on data collected from single collector TIMS measurements allowed us to improve our precision by a factor of 3 compared to multiple collector analysis previously done in our laboratory. Applying this method to the analyses of NBS979, JP-1, Allende and Shaw, we were able to obtain epsilon Cr(53) of 0.00+/-0.05, +0.05+/-0.08, -0.50+/-0.14 and +0.41+/-0.10, respectively.

The sample preparation for the Cr-rich layer is currently in progress, and we hope to obtain a preliminary Cr isotopic data within the next few months.

A thin layer of magnetite highly enriched in Cr (800 ppm) was found within the 3.8 Ga Isua Banded Iron Formation (BIF), western Greenland (Takano 1998). Since this layer is also enriched in Ir, there is a possibility that this enrichment is a result of an extraterrestrial input. In order to decipher the nature of this Cr-rich layer, we are currently undertaking a high precision Cr isotopic analysis of terrestrial and extraterrestrial materials.

Since the Cr isotopic anomaly (if it exists) in such Cr-rich layer is expected to be extremely small, it is essential to achieve a very high precision on our Cr isotopic measurement. As was the case in Lugmair and Shukolyukov (1998), we have notice the presence of residual mass fractionation effect after the application of primary fractionation correction using an exponential law. This linear correlation between 53Cr/52Cr and 54Cr/52Cr was used to make a second order fractionation correction. One should, however, note that the application of this second order correction will produce an apparent negative epsilon Cr (53) on samples with positive Cr(54) anomaly such as carbonaceous chondrites (cf Shukolyukov and Lugmair 1998). Such an effect, however, can be used as a useful tracer to search for an evidence of extraterrestrial input and to decipher the nature of the impactor.

Our current analytical method utilizes our 9-collector MAT 262 Thermal Ionization Mass Spectrometer in a single collector peak jumping mode. A silica gel-Al-boric acid emitter (Birck Pers. Comm.) was newly prepared for this work. A single run consists of 300 scans through all Cr isotopes plus mass 56 to monitor Fe, and 6-8 (but sometimes up to 17) runs were typically made on each sample load. All Cr isotopes were measured using a faraday detector while the small Fe peak was monitored using a secondary electron multiplier.

Our current results for the NBS979 standard, JP-1 (terrestrial rock standard), Allende (carbonaceous chondrite) and Shaw (ordinary chondrite) are shown below using an epsilon notation. Before applying the second order fractionation correction, the average epsilon Cr(53) and epsilon Cr (54) values for the NBS979 standard were 0.00+/-0.20 and 0.00+/-0.37, respectively. The epsilon Cr (53) value after the correction, on the other hand, was 0.00+/-0.05. Similarly, the epsilon Cr (53) value for JP-1 was +0.05+/-0.08 after the correction. The epsilon Cr (53) values for Allende and Shaw were -0.50+/-0.14 and +0.41+/-0.10, respectively. Although the values for these meteorites are still preliminary, they are in a good agreement with the published data for carbonaceous and ordinary chondrites (cf. shukolyukov and Lugmair 1998).

Although we feel it is necessary to analyze few more bulk meteorite samples to strengthen our current results, the sample preparation for the Cr-Ir rich BIF layer is already in progress, and we hope to obtain a preliminary Cr isotopic data for this sample within the next few months.

Reference

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