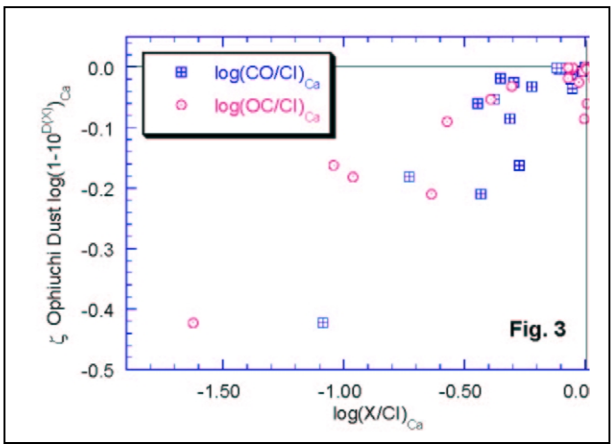
Isn't the moderately volatile element depletion in the inner Solar System inherited from interstellar dust?

YIN, QINGZHU

Department of Earth and Planetary Sciences, Harvard University, 20 Oxford Street, Cambridge, MA 02138, USA. (qingzhu@geochemistry.harvard.edu)

The pronounced moderately volatile element depletion (MOVED) relative to the average solar composition is a characteristic signature in most primitive chondrites and bulk terrestrial planets. None of the remaining planets or even meteorites shows an enrichment of volatile elements that would balance the depletion in the inner Solar System. Whether this depletion occurred in the solar nebula stage or in the planetary formation stage has been the subject of long lasting debate. Here I show that the MOVED patterns demonstrate a clear connection between the rocky materials of the inner solar system and the interstellar dust. The inheritance of interstellar materials in the solar system is not only documented by the presence of presolar grains, various isotopic anomalies, but also expressed in the chemical element distribution in the inner solar system materials.



The basic arguments have been presented recently by Yin (2002). Shown in Fig. 1 is the ISM dust composition that is positively correlated with that of primitive meteorites for moderately volatile elements (CO and ordinary chondrite, OC, are used as examples). Dust composition is calculated from the observed ISM gas composition using the widely held assumption that gas+dust = solar. ζ Ophiuchi Cool Gas is used as an example. Both data sets are normalised to CI and Ca.

The Universe recycles with high efficiency. Dust and gas are discarded by stellar winds, stored in interstellar medium, processed in dense molecular clouds, collected by gravity and supernova "snowplows", consumed and re-produced in stars. While many details remain poorly understood, if planetesimals and planets formed from the disk of gas and dust surrounding the young Sun, and not all dust underwent complete vaporisation, it is inevitable that the chemical composition of interstellar dust will be reflected in the rocky bodies of inner solar system.

References

Yin Q.Z., (2002), *LPSC* **XXXIII**, CD#1436.

Nickel isotopes in meteorites: constraints on the early solar system

G. QUITTÉ, A.N. HALLIDAY

Institut für Isotopengeologie und Mineralische Rohstoffe, ETH Zentrum, Sonneggstrasse 5, Zurich, Switzerland (quitte@erdw.ethz.ch, halliday@erdw.ethz.ch)

Introduction

The study of Ni isotopes in the field of cosmochemistry is of great interest for two reasons. First, the short-lived ^{60}Fe decays to ^{60}Ni with a half-life of 1.49 Myrs and this chronometer should provide strong constraints on the events in the early solar system, particularly on the age of chondrules, and on metal-silicate differentiation processes responsible for planet-wide Fe-Ni fractionation. Second, nickel is located on the high mass side of the iron-peak region and is characterized by two isotopes partially produced in neutron-rich environments. Ni anomalies found in meteorites could thus potentially constrain nucleosynthetic processes.

Samples and Techniques

Various kinds of meteorites have been sampled. A chemical separation procedure has been established, based on the method detailed in Morand and Allègre (1983). All Ni ratios have been measured using a Nu Plasma MC-ICPMS and are normalized to ^{62}Ni/^{58}Ni = 0.05338858 using an exponential law. The whole procedure has been checked for possible isotopic and matrix effects: no effect has been found within the precision of the measurements. Results are expressed in epsilon units relative to an ALDRICH standard solution. The external reproducibility for a standard solution is about 30 ppm (0.3 epsilon) for the ^{60}Ni/^{58}Ni ratio and 80 ppm (0.8 epsilon) for ^{61}Ni/^{58}Ni.

Results and Discussion

The Ni isotopic compositions of iron meteorites, carbonaceous chondrites and the metal phase from a pallasite are identical to our terrestrial standard. Even if ^{60}Fe was present at the time of the formation of these meteorites, the Fe/Ni ratio is too low to expect a detectable anomaly with the present precision. The pallasite olivines also show no Ni anomaly although a ^{60}Ni-excess of more than 1 epsilon is theoretically expected from the Fe/Ni ratio and the age. Its normal isotopic composition may be because Ni is susceptible to secondary alteration and mobilisation. Our analyses of Bouvante confirm the earlier result of Shukolyukov and Lugmair (1993): two samples are characterized by ^{60}Ni-excesses of 10.0±0.7 epsilon and 12.2±0.6 epsilon respectively, although the differentiation of the parent body occurred about 11 Myrs after the formation of chondrites. These values are consistent with the initial ^{60}Fe/^{56}Fe ratio of $(1.6\pm0.5)*10^{-6}$ previously inferred from CAIs (Birck and Lugmair, 1988). The next step in our study will be to analyse other CAIs and chondrules.

References

Birck J.L. and Lugmair G.W., (1988), *EPSL* **90**, 131- 143.
Morand P. and Allègre C. J., (1983), *EPSL* **63**, 167-176.
Shukolyukov A. and Lugmair G. W., (1993), *Science* **259**, 1138-1142.