Oxygen Isotope Reservoirs in the Solar System

T.R. IRELAND[1,2] AND M. ASPLUND[1.3]

[1] Planetary Science Institute, The Australian National University, Canberra ACT 0200
[2] Research School of Earth Sciences, ANU, trevor.ireland@anu.edu.au
[3] Research School of Astronomy and Astrophysics, ANU, martin@mso.anu.edu.au

Differences in the oxygen isotopic compositions of meteoritic and planetary materials can either be interpreted in terms of initial heterogeneity, or as a product of processing in the early solar system. Determing the solar oxygen isotopic composition is a key parameter in resolving potential contributions. We have recently reported that the solar oxygen isotopic composition is enriched in ^{17}O and ^{18}O relative to terrestrial. Isotopic measurements of solar wind implanted in iron metal grains indicates Δ^{17}O=+26‰, and suggests a solar composition close to δ^{17}O=δ^{18}O≈+50‰ [1]. This is in good agreement with our new improved measurement of the solar photosphere that indicates δ^{18}O=+41±60‰ [2].

These observations suggest that the bulk protonebular oxygen isotopic composition differs from the composition of the residual planetary system. Such a situation will arise if there is a difference in isotopic composition between the dust and gas of the primordial molecular cloud. While the planetary system is wholely sourced from the dust component, the Sun also obtains a substantial fraction of its oxygen from carbon monoxide gas. The dust brings the refractory element inventory to the Sun, hence CI chondrites are a good representation of the solar abundances of the non-volatile elements. But the gas contribution will not affect the rock component of the planetary system because of the low reactivity of CO. The primordial gas of the molecular cloud should be even more enriched in ^{17}O and ^{18}O than we observe for the Sun, but is still related to the dust by a ^{16}O fractionation such as observed to occur in molecular clouds. In this case, an isotopic dichotomy may also exist for carbon. Our new measurements of the photosphere indicate δ^{13}C=+30±45‰ [2] while lunar soil, solar wind and solar system bodies apparently span a much larger range.

Oxygen isotope reservoirs in the solar system can therefore be related by ^{16}O fractionation. The planetary system would represent the bulk O isotopes of the molecular cloud dust. The ^{16}O enrichments observed in refractory inclusions and chondrules represent unmixing of different components of the dust in molecular clouds.

References

[1] Ireland T.R., Holden P., Norman M.D., and Clarke J. (2006) *Nature* **440,** 776-778.
[2] Scott P.C, Asplund M., Grevesse N., and Sauval A.J. (in press) *Astronomy and Astrophysics*.