**OXYGEN ISOTOPE TRACING OF THE EARLY SOLAR SYSTEM.** T. R. Ireland, Research School of Earth Sciences, The Australian National University, Canberra, Australia <trevor.ireland@anu.edu.au>

**Introduction:** The analysis of the Genesis wafers establishes a solar composition that is enriched in $^{16}O$ by around 60‰ relative to terrestrial oxygen [1]. Such a composition was predicted from models of early solar system formation invoking photodissociation and self-shielding of CO caused by incident UV photons. Several scenarios have been invoked including inner solar system [2], outer solar system [3], and inheritance from the precursor molecular cloud [4]. These models are based on an initial solar system that is $^{16}O$-enriched (i.e. solar) with a planetary system that evolves to a more $^{17}O$, $^{18}O$ enriched composition. Evidence for these $^{17}O$, $^{18}O$ enriched components are found in meteorite matrices [5,6]. While the overall distribution of oxygen isotopes appears consistent with Photodissociation and Self-Shielding, issues remain concerning the locale of the PSS processing, the nature of the materials that are being processed, and the reaction mechanisms.

**The Solar Composition:** The solar composition is inferred to represent the bulk of the solar nebula. This then represents the combination of gases and solids in the solar system. For oxygen this includes CO (and $CO_2$), $H_2O$, silicates and oxides. Oxygen then is an unusual element because it is abundant and exists in phases that are likely in a variety of states that we would regard as volatiles, all the way through to refractory materials. The solar composition is clearly enriched in the volatile elements C, N, O. But, no matter the speciation, the solar composition is likely to be representative of the chemical and isotopic composition of the solar nebula.

**The Planetary Composition:** For the Planetary composition, (i.e. the oxygen isotope composition close to terrestrial), this does not hold. The planetary component is highly depleted in the gaseous phases and so some degree of separation from the solar composition could be expected. Thus the planetary system consists of the refractory silicates and the $^{17}O$-$^{18}O$ enriched water component and is therefore expected to be heavier than solar. However, did the planetary composition start at solar and evolve with mixing of the water, or did it start with a different composition?

Ozima et al. [7] have argued that the up scaling of domain size of meteorites to asteroids to planetesimals to planets should indicate that the solar composition should be close to terrestrial. While this is not supported by the Genesis results [1], it does raise the issue of why the composition of the planetary system is as homogeneous as it is and 6% deleted in $^{16}O$ (or enriched in $^{17}O$ and $^{18}O$). If the planetary system was progressively enriched in $^{17}O$ and $^{18}O$ as postulated, wouldn't we find more variability in the compositions of the final solids particularly regarding inner solar system versus outer?

The Stardust mission offers some insight. In the particles analyzed, the same bimodality between solar and planetary (=terrestrial) compositions was found [8]. In hindsight, finding the solar composition out that far is probably not surprising, finding the planetary composition is.

**Did CAI start with a $^{16}O$ – rich composition?:** An important consideration is whether CAI started with a solar composition or whether they reacted with the solar gas close to the Sun to attain their current compositions. CAI and in particular hibonite-bearing inclusions can have large isotopic anomalies in refractory elements (Ca and Ti) but have oxygen isotope compositions that are close to the solar composition. With these large anomalies it would be expected that oxygen would also be anomalous. But it is not.

**Nebular gas:** Reaction with gases of differing composition is a fundamental aspect of the oxygen isotopes in early solar system materials. These nebular gases will effectively change composition with temperature. At relatively low temperatures, the composition could be dominated by water and so compositions enriched in $^{17}O$ and $^{18}O$ might be expected. At high temperatures in a regime with high dust/gas, a composition close to planetary will be produced. It is likely that only in close proximity to the Sun can a gas with solar composition be produced. Mixing of planetary and solar compositions is a likely scenario and hence CAI and chondrules do not equilibrate with a pure end member, but rather a mixture of these gases.

**References:**

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