Origin and evolution of oxygen isotopes in the inner Solar System

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On a three-isotope diagram O-isotopic compositions of chondrites, chondritic components (chondrules, refractory inclusions, and matrix), and differentiated meteorites from asteroids and Mars deviate from the line of slope 0.52 along which nearly all terrestrial samples plot. Currently, chemical mass-independent fractionation effects (Thiemens & Heidenreich, 1983; Marcus, 2004) and photochemical self-shielding effects (Clayton, 2002; Yurimoto & Kuramoto, 2004; Lyons & Young, 2005) are the preferred candidates for production of the isotopic anomalies (Yurimoto et al., 2006). ^{207}Pb-^{206}Pb absolute ages and ^{26}Al-^{26}Mg model ages of CAIs and chondrules suggest that condensation of CAI precursors started early and lasted <0.1 Myr after the injection of ^{26}Al into the protoplanetary disk; chondrule formation started soon after CAIs and lasted for ~3 Myr (Amelin et al., 2002; Bizzarro et al., 2004). Most chondrules are $^{17,18}O$-enriched ($\Delta^{17}O \geq -7‰$) relative to most CAIs ($\Delta^{17}O \leq -20‰$) (Krot et al., 2005). These observations can be interpreted in terms of isotopic self-shielding during UV photolysis of CO in the initially $^{17,18}O$-poor ($\Delta^{17}O \sim -25‰$) parent molecular cloud (Yurimoto & Kuramoto, 2004) or protoplanetary disk (Lyons & Young, 2005) combined with theoretical modelling of evolution of water distribution in the solar nebula (Ciesla & Cuzzi, 2006). Two independent measurements of solar wind oxygen isotopes implanted into lunar soil give different results: $\Delta^{17}O < -20\pm4‰$ (Hashizume & Chaussidon, 2005) and $\Delta^{17}O \sim +35‰$ (Ireland et al., 2006); the former is consistent with predictions of the self-shielding models.

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