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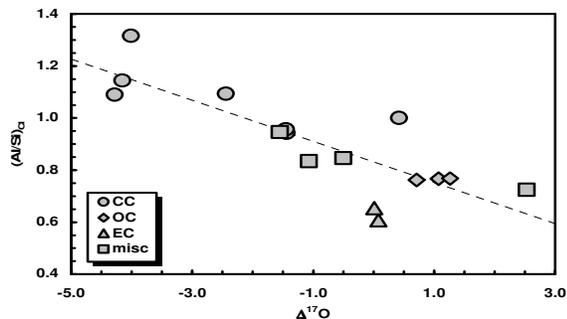
Chemical and O isotopic correlations among chondrite groups

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Discovery of mass-independent O isotopic variations of components in chondrites, in bulk meteorites, and in planets, was originally thought to reflect incomplete mixing of O from different nucleosynthesis sources [1]. Two solar system causes have been suggested: (i) differential photodissociation of distinct isotopomers of CO, enriching nebular gas in reactive heavy O [2]; (ii) gas-phase molecular reactions producing mass-independent O isotopic exchange [3]. Nebular processes caused chemical fractionations observed in chondrite bulk compositions. If nebular processes also produced mass-independent O isotopic variations, then they may correlate with chondrite bulk chemistry, which would help elucidate nebular history.

Weak negative correlations exist between CI-normalized refractory-lithophile-element/Si or Mg ratios and $\Delta^{17}\text{O}$ among chondrite groups. Refractory-siderophile elements show a similar trend – Ir/Ni decreases with increasing $\Delta^{17}\text{O}$. This could reflect mixing of differing amounts of ^{16}O -enriched CAI-like components into bulk chondrites. However, there are also weak positive correlations of moderately-volatile-lithophile-element/Mg ratios. Mass balance shows this is not due to dilution by volatile-poor, ^{16}O -enriched CAIs. The trend could indicate evolution of reactive nebular gas to $^{17,18}\text{O}$ -enriched compositions with falling temperature. For moderately-volatile-siderophile elements, the situation is complex. For most chondrite groups, Ga/Ni increases with $\Delta^{17}\text{O}$ as was the case for Na/Mg. However, ordinary and R chondrites are distinctly depleted in Ga/Ni compared to that trend. Thus, nebular temperature and O isotopic composition are not linked in a simple way, and factors such as nebular location relative to sites of O isotopic fractionation may have been important.



References

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- [2] Clayton R.N. (2002) *Nature* **415**, 860-861.
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The evolution of oxygen isotopes in the solar nebula

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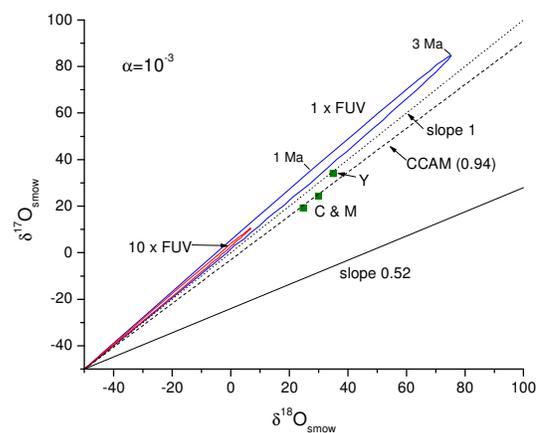
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Clayton recently suggested that self shielding of CO at the X-point of the solar nebula was responsible for the slope-1 fractionation observed in the oxygen isotopes of refractory phases in primitive meteorites [1]. Here we evaluate this idea, but rather than consider the high temperature X-point region, we focus on self shielding at the cooler disk surface.

We solve the 1-D continuity equation, including vertical diffusion, at a specified radial distance. The diffusion coefficient is assumed to be the turbulent viscosity, $v_t = \alpha H$. The rate of photolysis of CO isotopomers is computed using fits to previously evaluated shielding functions [2].

The figure below shows the time evolution of the fractionation of total nebula H_2O evaluated at 5 AU and at the disk midplane, for $\alpha=10^{-3}$ and for two values of FUV (far-ultraviolet) flux. Total nebula H_2O is computed as the sum of O liberated from CO (and converted to H_2O) and H_2O already present in the collapsing cloud that formed the nebula. Estimates of the fractionation of initial nebula H_2O as inferred from analyses on carbonaceous chondrites by Clayton and Mayeda (C & M) and by Young (Y) are shown. The figure demonstrates that self shielding can produce large fractionation in nebular H_2O , but with slope > 1 . Derivation of more accurate shielding functions is in progress.



References

- [1] Clayton R.N. (2002) *LPSC XXXIII*, abstract #1326.
- [2] van Dishoeck E.F. and Black J.H. (1988) *Astrophys. J.* **334**, 771-802.