CO self shielding, H_2O formation, and the time evolution of $\Delta^{17}O$ in a dynamic early solar system

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Introduction

It has been suggested that surfaces of circunmstellar disks may produce copious amounts of ^{16}O-poor H_2O as the principle product of CO photodestruction [1, 2]. It follows that illumination of the solar protoplanetary disk surfaces may have forced variations in $\Delta^{17}O$ with time throughout the early solar system. Models for the process were constructed using an astrochemical reaction network combined with box models that capture the essential physics of radial and vertical transport within the disk. The isotopologues of all O-bearing species are included in the reaction network.

Results

Results of the calculations show that there is a time progression in peak $\Delta^{17}O$ of H_2O in the disk. Surfaces where water is produced peak first, followed by the outer regions of the disk, and finally the inner regions of the disk (Fig. 1). The inner disk evolves to $\Delta^{17}O$ similar to the bulk of solar system rocky materials in $< 10^5$ years. The model predicts higher $\Delta^{17}O$ in the inner nebula than outer regions of the nebula after 10^5 years.

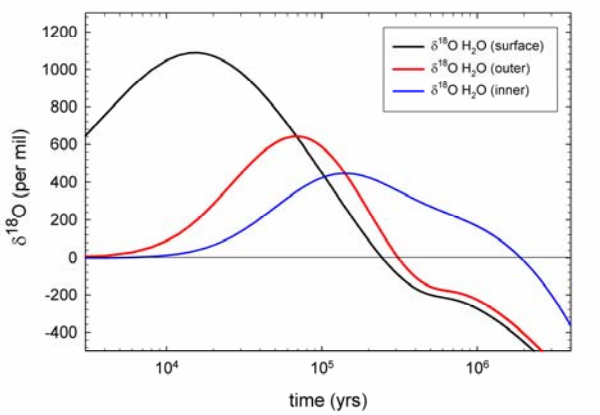

Fig. 1. Model for $\delta^{18}O$ (relative to initial) vs. time for the solar protoplanetary disk. Note time-progression in $\Delta^{17}O$ from the distal regions inward.

References

[1] Lyons J. R. and Young E. D. (2005) *Nature 435*, 317-320. [2] Young E. D. and Lyons J. R. (2003) *Lunar and Planetary Science Conference XXXIV*, 1923.