Two sources of water and pre-biotic molecules in the inner solar nebula

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Using a multi-stage model of the solar nebula (SN) we derive the chemical abundances and deuterium to hydrogen (D/H) ratios for water and pre-biotic species. The model consists of three consecutive stages described as:

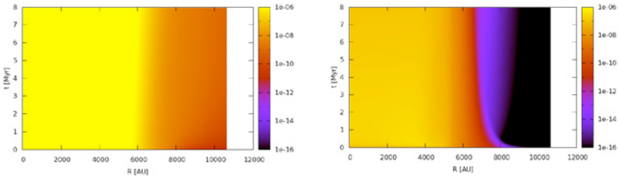
a spherical quasi-stationary core surrounded by the inter-core material of the parental cloud,

a collapsing core forming a proto-stellar source, an extending disk, and a spherical envelope, and

an accreting two-dimensional turbulent disk with gas and dust moving at different velocities

The collapse is simulated by a semi-analytical solution of the magneto-hydrodynamic equations based on a multi-zone mass density. In all stages the same chemical module is used (Semenov & Wiebe [1]).

Large amounts of water and the major pre-biotic molecule H_2CO were produced with relatively high D/H ratios in the dust phase of the first SN stage (source 1, see figure). During the collapse these dust grains flow into the inner nebula being the accretion range of rocky planets. In this range a hot corino forms as a result of the collapse. There, hot neutral gas phase reactions produce H_2O and H_2CO (source 2) along with the equivalent desorbed species but with lower D/H ratios. Thus, this ratio distinguishes molecules originating from different sources (i.e. model stages) of the nebula.



Relative HDO and HDCO abundances w.r.t. total hydrogen.

[1] D. Semenov and D. Wiebe (2011) *Astrophys. J. Supp.*, **196**:25 (37pp)

Metal fluxes at the sediment-water interface in a reservoir affected by AMD

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Water reservoirs are a main source of water supply, and knowledge of the metal fluxes at the water-sediment interface is essential to predict their ecological quality. Moreover, redox oscillations promoted by turnover events may significantly alter metal cycling, especially if the reservoir is impacted by acid mine drainage (AMD). Under controlled laboratory conditions, several sediment cores were immersed in a tank of reservoir water and subjected to alternating oxic-anoxic conditions. A detailed sequential extraction was then performed on the sediments to speciate the metals into the solid phases, the pore and tank water was systematically analyzed, and a diffusion-reaction model was calibrated using the experimental results to quantify the reaction rates and the sediment-water fluxes.

The results showed that under oxic conditions, protons, Fe, and As decreased in the tank due to schwertmannite precipitation, whereas Al, Zn, Cu, Ni, and Co increased due to Al(OH)3 and sulfide dissolution. The reverse fluxes occurred during hypoxia. The model, extended to the complete year, computed that between 25% and 50% of trace metals and less than 10% of Al precipitated under hypoxic conditions re-dissolved during the oxic period, while only 22% and 9% of the Fe and As precipitated under oxic conditions re-dissolved during hypoxia. Consequently, the sediment showed a total acidity neutralization capacity of 3.34 mol/m2/y, with Al, Fe, and proton removal accounting for 55%, 30%, and 13% of this capacity respectively. Compared with coastal marine environments, metal fluxes were up to two orders of magnitude higher, and the sulfur system was the major redox control, meaning that SO4 was the major oxidant of OM and S(II) was the major O2 consumer, with values near 90% in both cases.

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DOI:10.1180/minmag.2013.077.5.20