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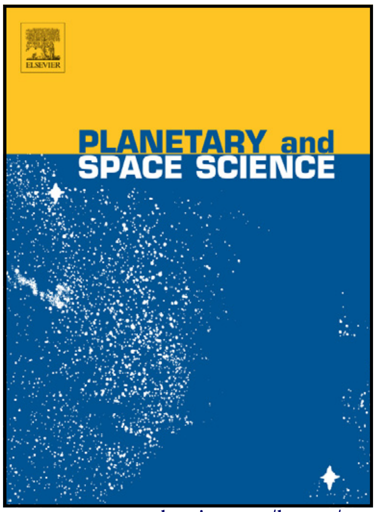

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PII: S0032-0633(13)00333-4
DOI: http://dx.doi.org/10.1016/j.pss.2013.12.009
Reference: PSS3654

To appear in: *Planetary and Space Science*

Received date: 8 April 2013
Revised date: 22 November 2013
Accepted date: 11 December 2013

Cite this article as: C. Tornow, P. Gast, U. Motschmann, S. Kupper, E. Kührt, I. Pelivan, Water formation in early solar nebula: II. Collapsing cloud core, *Planetary and Space Science,* http://dx.doi.org/10.1016/j.pss.2013.12.009

Water formation in early solar nebula: II. Collapsing cloud core

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Abstract:

The formation of water is a repetitive process and depends on the physical conditions in the different stages of the solar nebula and early solar system. Our solar nebula model considers the thermal and chemical evolution of a collapsing globular cloud core. We simulate the collapse with a semi-analytical model which is based on a multi-zone density distribution. This model describes the formation of a central protostellar object surrounded by a disk and a thin outer envelope. It considers an adiabatic equation of state, viscous gas flow and a resistive magnetic field. Due to the low temperatures in the hydrostatic stage of the core, icy layers of water mixed with other molecules build on the dust grains. In the course of the collapse the ice sublimates and drives a complex chemical evolution located in a warm region around the proto-stellar object called hot corino. Moreover, the relatively high temperatures in this region allow the gas phase formation of water together with other molecules. The abundances of the chemical compounds are computed from rate equations solved in a Lagrangian grid. We can show that there was high water density in the early and late accretion zone of the Earth. This water was sublimated from the dust or formed by hot neutral reactions in the gas phase. Thus, according to our collapse model, there were two sources delivering the water incorporated into the Earth.

Key words: solar nebula, astrochemistry: water formation, collapsing cloud core, solution of MHD equation

1. Introduction

Star formation can be called a self-propagating process, i.e., if it had started, say, due to a super-novae shock compression of a large molecular complex in a giant molecular cloud (GMC), the first generation of stars causes turbulent compressions of their surrounding cloud material leading to the formation of the second generation cores. A typical mechanism for this second generation shock compression can be an extending ionisation front formed by one or more young OB stars. In these