ADSORPTION AS A MECHANISM TO DELIVER WATER TO THE EARTH.

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Introduction: The origin of water in the terrestrial planets has been long debated. The two most popular theories envision supply of water from outside of the local feeding zone after most of the Earth had accreted, either by means of comets or of asteroids of composition similar to carbonaceous chondrites. However, these theories have some severe limitations. Both mechanisms would produce isotopic and geochemical signatures inconsistent with observations for the Earth's water and mantle, which rules out a substantial water contribution from these sources.

The amount of water vapor present in the accretion disk within 3 A.U. equals about three times the Earth's mass [1]. Therefore, the inner solar system should have had sufficient water to allow for adsorption of vapor to the surfaces and pore spaces of grains that subsequently accreted to form the inner planets.

Methods: We modeled the adsorption of water from 1500K to 1000K using a Monte Carlo simulation with a grid of 10000 adsorption sites, and an iterative process allowing the surface to reach a steady state saturation at each temperature. Water molecules not only interact with the substrate by means of weak bonds (~5kJ/mole) but also establish hydrogen bonds with other water molecules present in a monolayer [2]. We took this cooperative behavior into account by increasing the bond energy proportionally to the number of nearest neighbors (max allowed = 4). Incoming molecules stuck to the surface if their kinetic energy was lower than 5kJ/mole. If a particle collided on an occupied site, the resident molecule was dislodged only if the incoming particle had an energy exceeding the total bond energy of the adsorbed molecule. The energy of the incoming molecules was computed using the Maxwell-Boltzmann probability distribution. We allowed only for the adsorption of one monolayer, neglected porosity and surface roughness, considered water an infinite reservoir, and assumed that all the particles interacting with the surface were water molecules.

Preliminary results: This simple model allows for a coverage up to ~ 50% of the available adsorption sites. To scale this into moles of water, we pulverized the Earth into homogenous spheres of 0.1 m in radius, with total volume equal to the Earth's volume. We then computed the total surface area available for adsorption. Given that each adsorbed water molecule occupies about $10Å^2$ [2], we obtained the number of available adsorption sites (3.6E47). Since half of these sites can be occupied, then the adsorbed water potentially stored in the dust corresponds to ~ three times the Earth's oceanic + atmospheric + crustal water (OAC) [3] and ~ 1.5 times the Earth's OAC + mantle water [3]. If the grain size increases, however, the amount of water adsorbed on the surface decreases; in this model the biggest grain size that allows for 1 Earth's OAC water to be adsorbed is ~ 0.3 m. On the other hand, porosity and surface roughness would increase the number of adsorption sites as well as sheltering adsorbed molecules from bombardment.

Even though this is a simple model, it indicates that adsorption may play an important role in delivering water to the Earth.

Reference: [1] Lécluse C. and Robert F. (1994) *Geochimica et Cosmochimica Acta* **58**, 2927-2939. [2] de Leeuw N.H. *et al.* (2000) *Physics and Chemistry of Minerals* **27**, 332-341. [3] Morbidelli et al. (2000) Meteoritics and Planetary Science **35**, 1309-1320.