

ACCRETION DISK ORIGIN OF EARTH'S WATER: LABORATORY EXPERIMENTS

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The presence of water on the Earth is an enigma. It is generally agreed that it was too hot at 1 AU for hydrous minerals to be stable in the accretion disk. Thus, Earth's water is conventionally believed to be delivered by comets or wet asteroids after Earth formed. However, wet asteroids and comets have elemental and isotopic properties that are inconsistent with those of Earth¹, limiting the amount of water derived from comets and wet asteroids. Drake [1] proposed that water was introduced during planet growth in the accretion disk in a form stable under high temperature conditions. This hypothesis is supported by the presence of water in the disks around young stars² and by numerical simulations of water adsorption on silicate grains under conditions corresponding to those in the accretion disk³⁻⁵ which showed that molecular chemisorption of water on forsterite (a main constituent of the dust grains) might account for the formation of several Earth oceans⁴. Here we show by laboratory experiments (see Figure) that water adsorbs dissociatively on the olivine {100} surface at the temperature (~500-1500 K) and water pressure (~10⁻⁸ bar) expected for the accretion disk, leaving an OH adlayer that is stable at least up to 900 K. This high temperature stability may result in the accretion of many Earth oceans to Earth and other terrestrial planets, provided that a viable mechanism to produce water from hydroxyl exists.

References: [1] Drake, M.J. 2005. *Meteoritics and Planetary Science* **40**, 519-527. [2] Bethell, T. & Bergin, E. 2009. *Science* **326**, 1675-1677. [3] Stimpfl, M., Walker, A.M., Drake, M.J., de Leeuw, N.H. & Deymier, P. 2006. *Journal of Crystal Growth* **294**, 83-95. [4] Muralidharan, K., Deymier, P., Stimpfl, M., de Leeuw, N.H. & Drake, M.J. 2008. *Icarus* **198**, 400-407. [5] Muralidharan K. and Drake M.J., 2011. *Meteoritics and Planetary Science*, this volume.

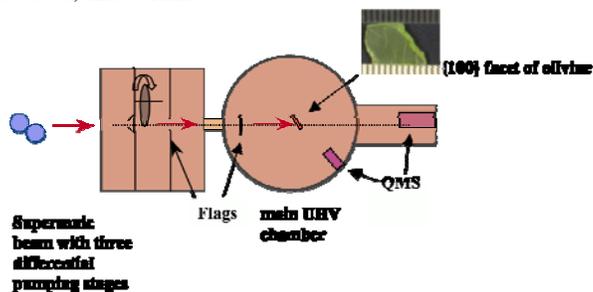


Figure: Schematic drawing of the ultra high vacuum chamber (UHV) and quadrupole mass spectrometer (QMS). Blue filled circles represent water molecules. Green is olivine crystal.