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Water-ammonia ionic ocean on Uranus and Neptune?

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The magnetic field of Uranus and Neptune detected by Voyager could be due to an active dynamo in a water ocean in the planets' interior [1]. The interior models suggest the existence of such an ocean [2]. Molecular Dynamics models and lab experiments show that at P>50 GPa and T>1000 K, water is dynamically ionized, consisting of H3O+, OH- and H2O [3]. In this presentation we discuss how the existence of an ionic ocean will manifest itself in the tropospheric cloud structure, particularly in the form of a hydrogen sulfide (H2S-ice) cloud. In fact, a cloud was introduced ad hoc in the 3-5 bar region to explain microwave absorption [4] and the methane [5] observations of Uranus and Neptune. Our equilibrium cloud condensation model shows that a cloud *does not* form in this region [6] when conventional enrichment factors (20-30X solar at Uranus, and 30-50X solar at Neptune) are used for all heavy elements [7]. On the other hand, an H2S-ice cloud can form in the 3-5 bar region, if ammonia was substantially depleted in the deeper atmosphere. Since ammonia dissolves readily in water, the resulting water-ammonia ionic ocean (H3O+ (NH4+) OH-) would provide an effective means of depleting NH3. The loss of NH3 at tens-thousands of kilobar level in this manner allows H2S to be mixed to the upper troposphere, because its loss through an NH4SH cloud becomes trivial. A cloud of H2S-ice can now form. We conclude the H2S cloud invoked to explain the ground-based data [4,5] and the magnetic fields of Uranus and Neptune [1] are indirect manifestations of a deep water-ammonia ionic ocean on these planets. Abundance of the heavy elements is key to formation models. Although the water-ammonia ocean would prevent a measurement of O and N, that would not be detrimental, as the noble gases (Ar, Kr, Xe, Ne, He) and their isotopes, C, S, as well as D/H, GeH4, AsH3, PH3, and CO will be adequate, and they can be accessed by probes at pressures less than 20 bars. References: [1] Ness et al, Science 233, 85,1986 and Science 246, 1473, 1989; [2] Hubbard, in Uranus, Neptune, NASA CP 2330, 291, 1984, and Podolak, et al., 1991, in *Uranus* (J. Bergstralh, et al., eds.),

Univ. of Arizona Press. pp 48–49.1991[3]; [3] Goncharov, et al., Phys. Rev. Ltrs., 94, 125508, 2005; [4] de Pater, et al., 1991, Icarus, 91, 220; [5] Baines, K, Hammel, H, 1994, Icarus, 109, 20 ; [6] Atreya et al. Water-ammonia ionic ocean on Uranus and Neptune – clues from H2S ice cloud? AGU Mtg. Dec 2005; [7] Atreya, SK, and Wong, AS, pp121-126, in "*Outer Planets*", T. Encrenaz, et al., eds, Springer, 2005.