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Oceans in the Outer Solar System

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The detection of induced magnetic fields in the vicinity of the Jovian satellites Europa [1,3], Ganymede [2], and Callisto [3] ranges among the most surprising findings of the Galileo mission to Jupiter. The observed magnetic signature cannot be explained by solid ice and silicate rock. It rather suggest s the existence of electrically conducting reservoirs of liquid water beneath the satellites' outermos t icy shells that may contain even more water than all terrest rial oceans combined. The maintenance of liquid water layers at a depth of several tens of kilometers is closely related to the internal structure, chemical make - up, and thermal state of the corresponding satellite interior [4]. The mean densities of Ganymede, Callisto, and Titan, the largest satellite of Saturn, indicate that their interiors are composed of ice and silicates at nearly equal shares by mass, whereas Europa foremos t consists of silicates and metals overlain by a less massive water - ice liquid shell [5,6]. Controlling parameters for subsurface ocean formation are the radiogenic heating rate of the silicate component, additional contributions due to, e.g., the dissipation of tidal energy in case of Europa [7], and the effectivenes s of the heat transfer to the surface [6]. Furthermore, the temperature at which the ice melts will be significantly reduced by soluble substances like salts and/or incorporated volatiles such as methane and ammonia that are highly abundant in the cold outer solar system. Therefore, it is likely that subsurface oceans even may have survived on smaller planetary bodies like, e.g., the Neptunian satellite Triton and large Kuiper belt objects beyond. Several flybys of the Cassini spacecraft will be devoted to searching for tidally induced gravitational signatures of a putative internal water ammonia ocean on Titan that would provide greater flexibility to the satellite's outermos t icy shell [8]. Detection of induced magnetic fields at Titan would be strong indirect evidence for such an ocean [9].

References

[1] M.G. Kivelson et al., *Science* **289** , 1340 (2000).
[2] M.G. Kivelson et al., *Icarus* **157** , 507 (2002).
[3] M.G. Kivelson et al., *JGR* **104** , A3, 4609 (1999).
[4] T. Spohn and G. Schuber t, *Icarus* **161** , 456 (2003).
[5] F. Sohl et al., *Icarus* **157** , 104 (2002).
[6] F. Sohl et al., *JGR* **108** , E12 (2003).
[7] H. Hussmann et al., *Icarus* **156** , 143 (2002).
[8] J. Castillo et al., 33rd *LPSC Meeting,* abstr. # 1989 (2002).
[9] J.S. Leisner et al., *AGU Fall Meeting,* abstr. #SM22B- 4626 (2003).