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Experimental determination of salt partition coefficients between aqueous fluids, ice VI and ice VIIÂ : implication for the composition of the deep ocean and the geodynamics of large icy moons and water rich planets

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The potential habitability of extraterrestrial large aqueous reservoir in icy moons and exoplanets requires an input of nutrients and chemicals that may come from the rocky part of planetary body. Because of the presence of high pressure (HP) water ices (VI, VII, etc.) between the liquid ocean and the silicates, such interactions are considered to be limited in large icy moons, like Ganymede and Titan, and water rich exoplanets. In the case of salty-rich oceans, recent experimental and modeling works have shown that aqueous fluids can be stable at higher pressures [1, 2]. This can ultimately allow direct interaction with the rocky core of icy moons. This effect is nevertheless limited and for larger bodies such as water rich exoplanets with much higher pressures in their hydrosphere, HP ice should be present between the rocky core and a putative ocean.

Salts are highly incompatible with low pressure ice Ih, but recent experimental work has shown that alkali metal and halogen salts are moderately incompatible with ice VII, that can incorporate up to several mol/kg of salts [3, 4, 5]. As far as we know, no similar study has been done on ice VI, a HP ice phase expected inside large icy moons.

We present here the first experimental data on the partition coefficient of RbI salt between aqueous fluids, ice VI and ice VII using in-situ synchrotron X-Ray single crystal diffraction and X-Ray fluorescence mapping (ESRF - ID-27 beam line [6]). Our experiment enable us to observe a density inversion between ice VI and the salty fluid, and to measure the values of salt partition coefficients between the aqueous fluid and ice VI (strongly incompatible) and ice VII (moderately incompatible). Using the volumes determined with X-Ray diffraction, we were able to measure the density of salty ice VI and ice VII and determine that salty ice VI is lighter than pure H_2O ice VI.

These results are very relevant for the study of water rich planetary bodies interior because the partition coefficient will enable the computation of the chemical evolution in the deep ocean during the cooling of the hydrosphere. These results are also very important for the high pressure ice mantle dynamics as they show the great effects of dissolved salt on the ice phases densities and therefore the potential role of convecting ice to feed the overlaying ocean with life-sustaining chemicals.

References

[1] Journaux B, Daniel I, Caracas R, Montagnac G, Cardon H. Icarus. 2013; 226:35-63.

[2] Vance S, Brown JM. Geochimica Cosmochimica Acta. 2013; 110:176-89.

[3] Frank M, Runge C, Scott H, Maglio S, Olson J, Prakapenka V, et al. Physics of the Earth and Planetary Interiors. 2006; 155 :152-62.

[4] Frank MR, Aarestad E, Scott HP, Prakapenka VB. Physics of the Earth and Planetary Interiors. 2013; 215:12-20.

[5] Klotz S, Bove L, Strässle T, Hansen T, Saitta A. Nat Mater. 2009; 8:405-9.

[6] Mezouar, M. et al. Journal of Synchrotron Radiation. 2005; 12, 659-664.