V Reunión de Ciencias Planetarias y Exploración del Sistema Solar (CPESS5)

CHARACTERIZATION OF FLUID EVOLUTION WITHIN ICY MOONS IN PRESENCE OF CLATHRATES

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Introduction: Deposits of hydrated salts detected on Europa and Ganymede have been suggested to have an endogenous origin. We propose that the presence of CO_2 clathrates may have a starring role on the ascent of briny fluids to the surface. P-T conditions beneath these moons' surfaces are suited to form CO_2 clathrates. Since gas hydrate formation consumes water, the presence of other solutes as salts in the liquid phase suffers variations. Such changes in solutes concentration produce the differentiation of fluids by density changes which may affect to icy crust stability and fracturing [1].This work shows the results of the experimental simulation of the evolution of fluids from the pressurized interior of Europa and Ganymede in presence of CO_2 clathrates (in phase sI: $CO_2{\cdot}5.75H_2O$) employing different techniques as Raman spectroscopy, thermodynamical variables recording and mineral textures analysis. The $MgSO_4$-CO_2-H_2O ternary system has been selected as an approach of the geochemistry of the fluids [2, 3, 4]. Higher pressures are reached in Ganymede's ocean, making possible the presence of CO_2 high-pressure clathrates. The pressure range of stability is from 0.8 to 1 GPa [5]. Their different stoichiometry ($CO_2{\cdot}2H_2O$) [6] could imply different effects during the moon's evolution.

Methodology: The experiment is conducted in a high pressure-volume chamber. It is equipped with a thermocouple and a pressure transducer for monitoring the thermodynamical evolution of the system. It has a sapphire window, which allows both optical examination and Raman Spectroscopy. The chamber is filled with the aqueous solution 17% wt. $MgSO_4$ and saturated by bubbling CO_2. Clathrates formation begins at 273 K and 3.3 MPa and is maintained until salt hydrates precipitate. Afterwords, the chamber is heated in order to reach clathrates dissociation. There are two observation perspective modes in the experiment: one is to study the vertical profile of the system, and the other is from above the surface as we were able to observe the moon remotely.

In order to perform the experiment at Ganymede's ocean conditions, the study is conducted employing a sapphire anvil cell and Raman microscopy.

Results and discussion: Salting out produced by sI clathrates is quantified (Fig. 1): when clathrates form, $MgSO_4$ concentration increases in the remnant fluid until reaching firstly saturation and then it drops when salt hydrates precipitate. According to the phase diagram, CO_2 clathrate stability regions pass through the $MgSO_4$+H_2O binary system eutectic and peritectic points. Consequently, the hydrates which precipitate are epsomite ($MgSO_4{\cdot}7H_2O$) and meridianiite ($MgSO_4{\cdot}11H_2O$) and it is confirmed by Raman spectroscopy. After clathrate dissociation, all phases return to the solution and $MgSO_4$ concentration recovers its initial value (Figure 1).

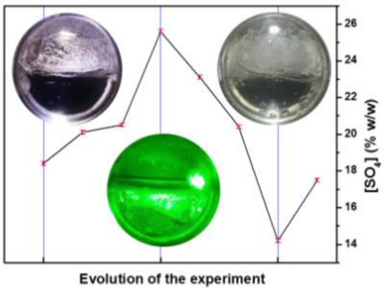

Figure 1: $MgSO_4$ concentration along clathrate formation and dissociation processes.

Salting-out induced by presence of clathrates may lead the differentiation of fluids within the icy moons. Gas-rich fluids can be distilled from clathrate dissociation. Plume geological activity would be triggered by these fluids, similarly than those mechanisms suggested for Enceladus [7].

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[1] Muñoz-Iglesias, V. et al., ***Geochim. Cosmochim. Acta*** 125, 466-475, 2014. [2] Khurana, K. K. et al., ***Nature*** 395, 777-780, 1998. [3] McCord, T. B. et al. ***Science*** 280, 1242-1245, 1998. [4] McCord, T. B. et al. ***Science*** 292, 1523-1525, 2001. [5] O. Bollengier, O. et al. ***Geochim. Cosmochim. Act.*** 119, 322-339, 2013. [6] Hirai et al., ***JCP*** 133, 124511, 2010. [7] Waite, J. H. et al., ***Science*** 311, 1419-1422, 2006.