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Pressure effects on aqueous solutions of interest to the Europa's ocean. Simulation experiments.

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Abstract

Laboratory experiments simulating the conditions of the potential ocean of Europa satellite are being performed.

We are simulating processes of gas dissolution and fractional crystallization in aqueous salt-rich cryomagmas, and analyzing in situ the changes in some physical-chemical parameters.

1. Introduction

There are some indirect evidences of the presence of an ocean in the interior of Europa, but there are no direct data about its characteristics yet. This objective should be explored in the future missions to the Jupiter system. However, simulation experiments can provide some knowledge about the aqueous reactions and processes that can be expected at oceanic conditions. The information that we already have about the materials at the surface [1], the geochemical models of the satellite [2, 3], and the geophysical models about the internal structure [4, 5], are used for setting up the experiments.

We consider a range of pressures from 1 to 1800bar for our experiments. Composition of the aqueous solutions is mainly sulfate-rich, but CO_2 gas, chlorides and sulfuric acid are other solution compounds.

Previous published theoretical models about the geochemical equilibria of salty [3] and acid solutions [6] shows how the precipitation sequences of minerals at subzero temperatures should be. The pressure dependence on both, the geochemical equilibria, and chemical constants of these systems has been also studied theoretically in [7].

We are using binary and ternary systems with similar compositions than [6] for doing precipitation experiments. Salt mixtures with gases are being utilized to study the solubility at high pressure and the crystallization of gas clathrates from the electrolyte solutions [8].

2. Methods and equipment

Two different high pressure chambers located at Centro de Astrobiología, Madrid, are available for making these experiments: 1) HPPSC (High Pressure Planetary Simulation Chamber), which maximum working pressure is 3000bar, the sample volume is 10ml, and has four ports for making different in situ analysis. 2) MPPSC (Moderate-high pressure Planetary Simulation Chamber), which maximum working pressure is 300bar, the volume is variable up to 50ml due to a mobile piston, and has a window for spectroscopic measurements. Both chambers are made of stainless steel and have automatic control system for temperature and pressure. Raman spectroscopy and ultraviolet spectroscopy have been the main techniques used during the experiments.

3. Results

The work is still in progress.

We made cuantitative studies from raman spectroscopy about the solubility of CO_2 in salty solutions at high pressure. In Fig.1 is shown the depence of the CO2 solubility in a 5% MgSO4 solution with pressure. This analysis have been done for differnt concentrations of sulfate.

Solubility data has been used to study the crystallization of clathrates in electrolyte solution. These particular results will be explained in [8].

pH variation during the fractional crystallization of the aqueous solutions has been measured and compared to the theoretical pH evolution.

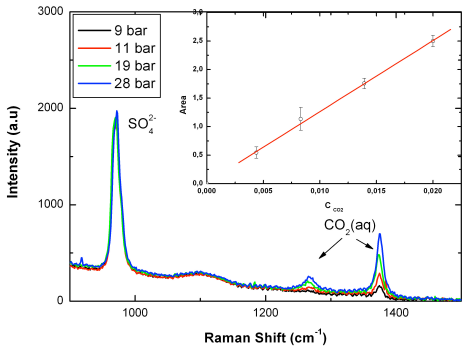

Fig. 1. Raman spectra of aquous solution at 5% MgSO4 at different pressures. The inset show the linear fit obtained between the CO2 concentration in the solution with the raman peak area.

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