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A type of cryomagmatic differentiation on icy satellites from clathrate hydrates fractional crystallization

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We suggest that the formation of clathrate hydrates from an aqueous magmatic chamber enriched in gasses and dissolved ions will result in the differentiation of the cryomagmas into the icy satellites.

Aqueous cryomagmas with some gasses and salts are suitable to exist in some icy satellites such as Europa, Enceladus or Triton. During the evolution of these magmas, fractional crystallization of different minerals by cooling should occur, including clathrate hydrates of the gases. The effects of the sulfates, which presence in Europa is supported by spectroscopy, and the ammonia, proposed to be present in Triton or Enceladus, in the aqueous cryomagma are similar. Both compete with clathrate hydrates for the water. But the evolution of the differentiation process will depend on which is the first hydrate which is formed in the interior of the planetary body (based on the pressure and temperature conditions for the phases stability). Formation of clathrate hydrates removes water from the original solution. So if the solution also contains salts, there will be a higher concentration in ions as soon as the clathrates are formed. The clathrates crystals would be separated from the more concentrated brine magma by density. If the destruction of the clathrate layer occurred by any movement or fracturation, clean water ice could ascend through the brine to higher levels. Crystallization of gas hydrates generally would cause expansion of the assemblage if water ice is a crystallizing phase, so that would cause tensional stresses on surrounding ice, and it might also drive fracturing, and then drive expulsion of the liquid.