

Cryovolcanism, a critical review

*Kei Kurita¹

1. Earthquake Research Inst., The University of Tokyo

Volcanoes are surface manifestation of internal activity of planets and satellites. In planetary explorations the primarily available data source would be the surface images so that the volcanoes identified on the surface are unique window into the interior. This argument is particularly significant in icy bodies of the outer solar system because exploration data are so limited except for the surface images. Up to now several types of surface morphology have been considered as a product of cryovolcanism. In this presentation I will focus on the general aspects of the cryovolcanism in comparison to the silicate volcanism and would like to emphasize the significant role of hydrate phase in cryovolcanism.

Similarities and dissimilarities between cryovolcanism and silicate volcanism: There exist a lot of similarities between ice and silicate minerals such as the rheological properties and the melting relationship. The depression of the melting point in the existence of accessory components in both systems should play an important role in promoting differentiation. The critical difference is the pressure dependence of the melting temperature and the density contrast between liquid and solid phase. Since water magma is not buoyant in the icy lithosphere this density reversal requires special mechanism for driving water magma to the surface. This situation is, however similar to the continental basalt volcanism. In the icy satellites the stress field in the outer lithosphere plays an important role. Both exogenetic origin such as tidal forcing and endogenous origin such as thermal stress and volume change driven by phase change would be

Significant role of hydrate phase in cryovolcanism: Hydrate is a common phase in the multicomponent system including H₂O. It is stable at higher pressure so that it should be an important constituent phase while it decomposes near surface. This may result in explosive behavior because the decomposition is associated with generation of gas phase. Although a lot of combination of the components form various hydrate phases, there exist two planetologically significant end-members, CO₂ hydrate and CH₄ hydrate. These two have contrasting nature in terms of the density, which would cause different evolution path in the material differentiation.

Keywords: cryovolcanism, hydrate