

Cryovolcanisms on Solar System bodies: Observations, importance, and future perspectives

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Cryovolcanos are volcanos on icy planetary bodies, erupting liquids and vapors of volatiles (e.g., water, ammonia, methane, and carbon dioxide) from subsurface water reservoirs or oceans. In the Solar System, geologically-active icy moons (e.g., Enceladus, Titan, and potentially Europa) and icy dwarf planets (e.g., Ceres and Pluto) are known to possess cryovolcanisms in the past or even today.

Cryovolcanos are unique windows to reveal the physico-chemical states of the subsurface oceans of the icy bodies, which is essential to understand the thermal evolution and habitability. Morphology of cryovolcanos would be a key to constrain the physical properties (e.g., viscosity and density) of liquids in the subsurface water reservoirs. Chemical compositions of erupting materials would provide information on volatile and salt compositions of the liquids. Eruption of volatiles (e.g., methane and nitrogen) could be also a major source of atmospheric gas species and thus could have affected the surface environments.

Despite such importance, the nature of cryovolcanisms, such as formation mechanisms and eruption styles, is largely unknown. Since pure liquid water is denser than that of ice, dissolved gas species in cryolava would play a key role for its eruption through bubbling and a consequent decline in the bulk density. Dissolved gas/salt in the liquids also controls the viscosity of cryolava. Such importance of dissolved species in cryovolcanisms implies a potential similarity in the role of volatiles in silicate volcanisms on rocky planets, such as Earth. Here we review recent observations of cryovolcanos on the Solar System icy bodies by spacecrafts. We then discuss the possibility of and future perspectives for development of comparative researches between cryo- and silicate-volcanisms in the Solar System.

Keywords: icy bodies, Solar System exploration, cryovolcano