

Gas hydrates as a potential protector of subsurface oceans in icy worlds

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Subsurface oceans in icy worlds are most interested research targets in astrobiology. The presence of a subsurface ocean is suggested for many outer Solar System bodies, such as the Jovian icy satellite Europa, the Saturnian icy satellite Enceladus, and the icy dwarf planet Pluto. The major premise for life to appear in an such ocean is the long-term existence of the ocean. Previous theoretical studies have pointed out that there are two options for an ocean to avoid freezing: production of a large amount of heat inside the body due to tides and/or large depression of freezing point of the ocean due to an inclusion of a large amount of impurities. Both options, however, are unlikely to explain the current presence of a subsurface ocean in Pluto. Recently, we recognized a new generic mechanism for an ocean to avoid freezing: a layer of gas hydrates on the ocean can act as a strong thermal insulator. This mechanism not only theoretically explains the presence of Pluto's ocean but also indicates that even a less-heated icy body can also possess a subsurface ocean for a long time depending on the condition. Thus, there would be more long-term subsurface oceans than previously thought.

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