論文内容の要旨

論文題目

Geological study on saturnian small satellites:
Implications to ephemeral cryovolcanism of Enceladus
(土星系小型衛星に記録されたエンセラダスの火山活動)

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The cryovolcanism of Enceladus should have been less active than at present otherwise the global shape of the satellite would display significant clues indicative of such a high discharge rate over billions of years. However, the exact estimate of the duration of current cryovolcanism is almost impossible from geological observations of Enceladus alone because its high activity erases previous records. For this reason, I study small satellites near Enceladus rather than directly study the surface of Enceladus; I focus on the interaction between these satellites and the E-ring because Enceladus generates plumes composed of gas and particles, which forms Saturn's tenuous E-ring. I have identified diverse evidence indicating that the E-ring particles accumulate on the small satellites, such as Helene, Telesto, Calypso, Methone, and Pallene, which have received little attention by science community until now. Nevertheless, high-resolution images of the satellites have been obtained during the past decade through the Cassini mission. Especially, nearly the entire surface of Helene has been imaged in high-resolution, which enables me to preform detailed investigation of its geological features. Based on the images of Helene, I have developed a shape model, measured the distribution of craters, and examined geological features. As a result, I find that the E-ring particles have accumulated preferentially on the leading hemisphere of Helene, which results in the deficiency of small craters as well as the development of numerous streaky depressions formed by mass movement. Furthermore, I find that Telesto, Calypso, Methone, and Pallene have spherical shapes with unusually smooth surfaces, which can also be explained by the accumulation of the E-ring particles. Finally, I conclude that the ages of the E-ring deposits on the small satellites are likely to be at most 100 Ma. This collectively indicates that the cryovolcanic activity currently occurring on Enceladus is ephemeral.