Roman CCS White Paper

Title: Study of volcanic analogues in the Solar System

Roman Core Community Survey: *High Latitude Wide Area Survey*

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Abstract: The geological activity in the solar system had different evolution in different bodies but some of the most active are IO, Enceladus, and Earth. In this paper we propose to observe and compare the volcanic activity and the volcanoes evolution after the heavy bombardment between Earth, Io, and Enceladus. Learning this information, we can extrapolate to exoplanets.

1. Introduction

The heavy bombardment was the process in which leftover planetesimals bombarded other objects in the late stages of solar system formation. Water may have come to Earth by of icy planetesimals.

The geological activity in the solar system had different evolutions in different bodies but some of the most active are IO, Enceladus, and Earth, with it the life evolution on our planet. Applying what we have learned about the interior of Earth to other planets tells us how their interiors are. Smaller worlds cool off faster and harden earlier but in the case of some Moons of the Solar System the activity continues.

A world can have a magnetic field if charged particles are moving inside. Three requirements are needed: Molten interior, Convection and Moderately rapid rotation.

Io is a world in constant activity. IO belongs to the biggest planet in the solar system Jupiter. The creation of the lava seen erupting from multiples volcanoes in Io is because it is continuously stretched and squeezed. Io is the most volcanic celestial object that is in our solar system (Fig.1).

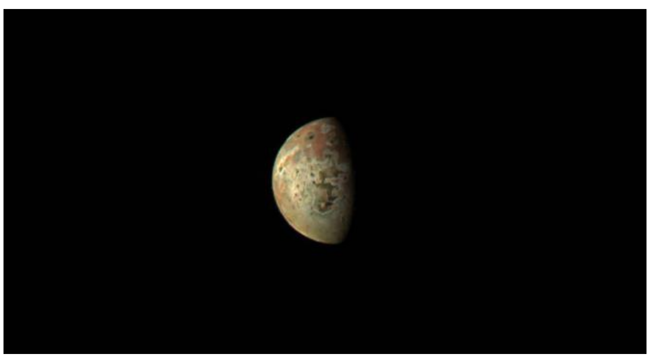
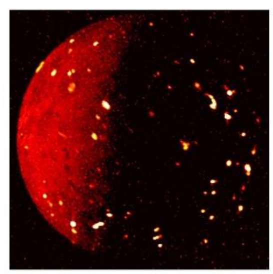

Fig. 1. NASA images. Io observed in infrared on the right, in optical band at the left.

Enceladus is an ocean moon from Saturn. Scientists thought it had liquid water oceans under a frozen shell, ejecting sprays of the ocean out into space. This object reflects a lot of sunlight, the surface temperature is extremely cold, around minus 330 F. This moon orbits Saturn at 238,000 kilometers. During a flyby trip of Cassini in 2005, a magnetic field around Enceladus due to electric currents generated by the interaction of atmospheric particles and the magnetosphere of Saturn was detected [1].

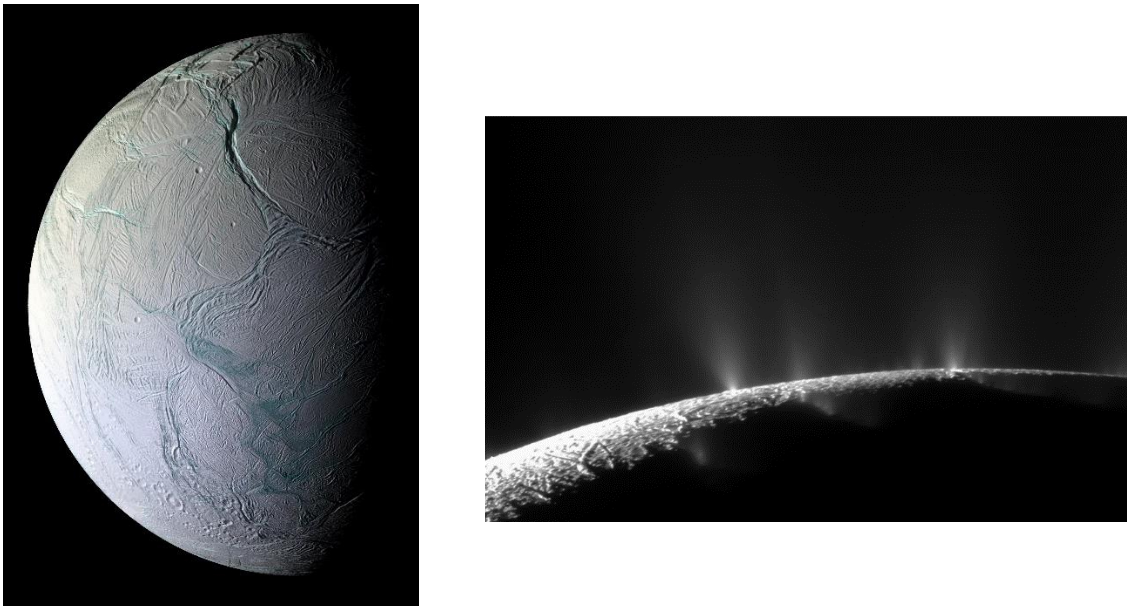

Fig. 2. Enceladus observed in different missions using Cassini. At the left is the image of Enceladus; Right: Plumes over Enceladus. Images from NASA [2, 3]

During the Cassini mission at Saturn from 2004 to 2017, it flew through the plume and E ring multiple times. Scientists found that the ice of Enceladus contains minerals and organic compounds including the ingredients for amino acids. In a paper Postberg et al. [4] published Phosphorus was found inside icy particles ejected into space by the small plume of Enceladus, it is a building block for DNA.

We can compare volcanic activity and the volcanoes evolution after the heavy bombardment between Earth, Io, and Enceladus. Using the evolution stages on Earth we can predict similar phases on Enceladus and IO using machine learning.

We are also interested in knowing the heat source on Enceladus from the surface to the level of condensation in the atmosphere.

2. Instrumentation

Using the Roman Telescope that will be launched in 2027, we can compare and complement the observations and information with the Juno Mission, the JWST MIRI and the radio broadcasts (NASA Radio Jove with students) to reach our goal: Study of volcanic analogues in the Solar System in more detail.

Using information from Juno, JunoCam, the JIRAM (Jovian InfraRed Auroral Mapper) spacecraft, SRU (Stellar Reference Unit) and MWR (Microwave Radiometer) we can study IO volcanoes and how volcanic eruptions interact with Jupiter's magnetosphere and auroras.

The Roman Telescope will observe from 0.48-2.30 Mm (blue to NIR, S band and K band-290Mbit). The Wide Field Instrument (WFI) is a 300.8 megapixel multiband visible near IR. The telescope will operate in a field of view of 0.28 square degrees, more than 100 times that of Hubble's imaging cameras. We propose to use the Roman Telescope to observe Io and Enceladus in NIR to complement the information from the other telescopes and study the volcanoes in more detail.

3. Conclusions

Using the Roman Telescope that will be launch in 2027, we can compare and complement the observations and information about the active volcanoes in our solar system with the Juno Mission, the JWST and radio emissions (Radio Jove of NASA with students) to reach our goal and we can extrapolate the information to exoplanets.

4. References

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