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Introduction: As icy bodies may provide habitable conditions, Ceres, as the closest such body, deserves further scrutiny [1]. Other icy bodies are at much larger distances and require longer travel times. Also, Europa, one of the highest priority astrobiology targets is exposed to high-radiation fluxes which make any in-situ investigation very challenging. Ceres' density means that the dwarf planet likely consists less than half of rock with the rest being lighter material, ice or (salty) water [2]. Ceres may well have accreted during the first 5 Myr of the solar system. Based on the heat of accretion and the presence of radio-isotopes, it is thought to have differentiated into a rocky core and an ocean [3].

Environmental Conditions: The early conditions in that ocean must have involved sources of chemical energy resulting from this differentiation and therefore the conditions might have been suitable for the origin of life - especially if the putative ocean was in direct contact with rocky mantle material. The hydrothermal vents implicated for the origin of life on Earth, rich in H_2, CO_2 and iron [4], might be expected to occur at Ceres as well. Indeed, life may still exist there today, and models developed for Europa of simple ecosystems in a dark subsurface ocean may apply (e.g.[5]) . After the accretion phase, Ceres cooled, and with it the internal ocean likely cooled as well and partly froze, especially in the polar regions [6]. The larger volume of ice caused an internal pressure [1,7], thus enabling icy volcanism. The (lighter) ice layer under the polar regions must have extended these regions to float on the denser ocean and to exert stresses in the crust.

Icy volcanism could well have occurred through cracks in the crust, whereby ocean water was ejected through the colder upper layers of the crust. That ocean water must have partially frozen while ascending to the surface, equilibrated with the dissolved salts, and the brine was eventually deposited on the surface. Biosignatures from putative life in the ocean could be present in these ejecta from icy volcanism. The detection of recent or ongoing volcanism is therefore essential and the presence of any water vapor plumes would indicate the places where to look. The timescale of Ceres' thermal evolution is still uncertain. It appears that plumes of water vapor that have been detected indicate either sublimation of surface ice or active icy volcanism. Plumes of water vapor have been detected with the HIFI instrument on Herschel [8], with localization at two dark areas: "Piazzi", in the middle of Vendimia Planitia and close to crater Dantu; and an area within Hanami Planitia and close to crater Occator. The latter crater exhibits white spots on the crater floor (Fig. 1), probably composed of natrite (anhydrous Na_2CO_3) with some admixture of ammonium salts, NH_4Cl or NH_4HCO_3 [9].

Conclusion: These spots, likely being deposited by icy volcanism from a liquid layer within Ceres, are a location where biosignatures from Cerean life may be found. The salts likely indicate that the inferred subsurface ocean is not acidic, and may in fact provide habitable conditions. A lander should be designed to analyze the deposited ices from the cryovolcanism below the radiation-reworked surface, as it may contain building blocks of organic macromolecules, and possibly even cellular components or fossils of organisms.

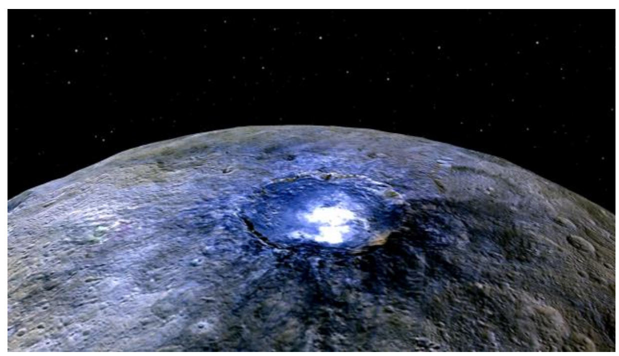

Fig. 1. White spots in Occator crater on Ceres, a potential promising landing site (Image credit of NASA).

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