HABITABILITY POTENTIAL OF CERES, A WARM ICY BODY IN THE ASTEROID BELT.

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Large, low-density C-type asteroids are abundant in the main belt. The most prominent of these objects is the dwarf planet Ceres, which presents an advanced stage of evolution. Ceres is almost twice as large as Enceladus, and both objects contain more than 50% of water in volume [1]. Although asteroids cannot benefit from tidal heating like outer planet satellites, their proximity to the Sun provides an everlasting supply of energy. Astronomical observations and geophysical modeling indicate that Ceres is likely to be differentiated. This implies that at least during part of its history, Ceres' interior could contribute to the evolution of habitable conditions on its surface. Recent ground-based observations indicate the presence of brucite and magnesite at the surface of Ceres, which is consistent with pervasive hydrothermal alteration [2]. The origin of such activity is still unclear. The presence of these hydrous alteration phases may be linked to one, or several, episodes of hydrothermal activity inside the asteroid during which time the chemical and physical conditions may have been favorable for development of organic and/or biochemical precursors. This is of particular relevance to astrobiology because large water-rich asteroids have been suggested as reservoirs of water and organics which could have been transported to Earth during its evolution.

Warm surface temperatures may promote the preservation of a deep liquid layer, if the water shell contains second-phase volatile impurities and hydrated minerals [3]. Indeed, even if Ceres were "frozen," i.e., its interior were in thermal equilibrium with its surface, then its internal temperature would still reach at least 180 K in low-latitude regions. Although the presence of liquid water at high latitudes is unlikely because polar temperature is estimated to be about 130 K, the presence of seas at the equator cannot be ruled out until detailed modeling is undertaken. In any case, these conditions offer a context suitable to endogenic activity involving the exchange of material between the interior and the surface. The temperature and chemical gradients could permit the global cycling of materials, which is key to maintaining sufficient dynamism to sustain a habitable environment.

The many questions raised by astronomical observations of Ceres will hopefully be answered by the *Dawn* Mission that will visit the protoplanet in 2015. The *Dawn* Mission is instrumented with the capability to measure composition and constrain internal properties and geological evolution. This information will help better assess the astrobiological potential of the dwarf planet.

We will present a range of possible models for Ceres for some key habitability parameters, both chemical and physical, based upon our current understanding of that object. Then we will discuss how the Dawn Mission will provides constraints on the internal structure of the Dwarf planet and implications its past and present habitability potential.

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References:

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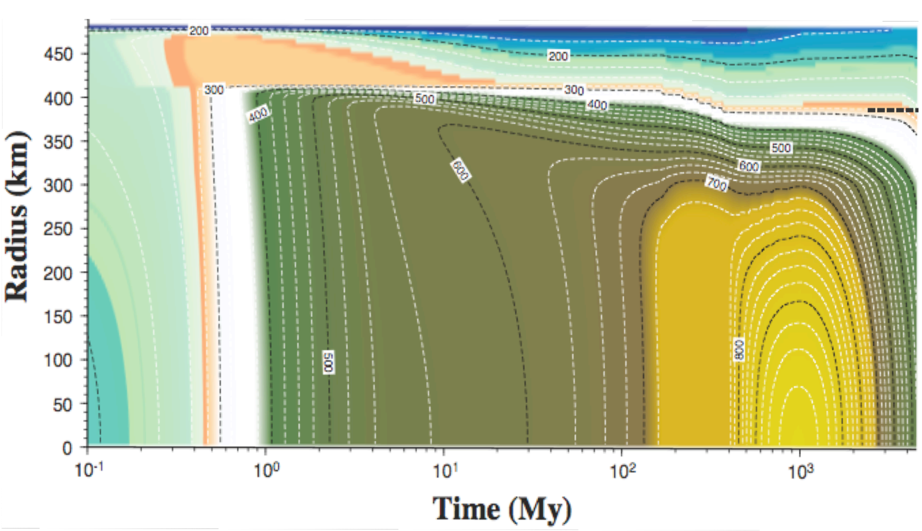

Example of thermal evolution model for Ceres [3]. This case assumes a time of formation of 3 My after the production of calcium-aluminum inclusions. It shows rapid melting leading to full differentiation. The long-term preservation of a deep ocean depends on the freezing temperature of the icy shell, a function of the concentration and nature of second-phase impurities part of the original material, or resulting from hydrothermal leaching of the rock phase.