AOGS 2006

New Understanding of the Saturnian Satellite System from Cassini: The Story Being Told by the Icy Satellites

DENNIS MATSON[1], JULIE CASTILLO[1], TORRENCE JOHNSON[1], JONATHAN LUNINE[2], CHRISTOPHE SOTIN[3]

[1] *JPL/CalTech, Pasadena, CA, USA*

[2] *Lunar Planetary Lab, University of Arizona, AZ, USA / INAF-IFSI, Rome, Italy*

[3] *LPGN, Universite de Nantes, France / JPL CalTech Pasadena, CA, USA*

This presentation reviews some of the main results on the Saturnian satellites, inferred from the wealth of information provided by the Cassini spacecraft. Since its arrival in the Saturnian system in July 2004, Cassini performed close flybys of all the medium-sized Saturnian satellites. The icy geology of these satellite surfaces records the history of the system. Less immediately visible is what is happening below those surfaces. A revolution is occurring in the study of satellite interiors and dynamics. The satellite densities are now known within a few percents. High-resolution imaging also enables better understanding of the nature of the geological features observed at the surface of the satellites as well as providing the shapes of their geoids. An absolutely stunning Cassini discovery at the South Pole of Enceladus is a large hydrothermal region, complete with geysers. Expelled with the water are N2, CH4, and other products. These indicate that high temperatures (i.e., $\sim$500-800 K) exist in the interior, and are involved in the hydrothermal circulation that is thought to reach down, through cracks, into the upper level of Enceladus' rocky core. In general, however, thermal models based on the density data combined with the latest material thermal properties indicate that the satellites interiors (including Enceladus) have been very cold throughout most of their history, and do not offer the conditions suitable for significant endogenic activity and surface geological processes. The crucial question arises of whether it is possible for the satellites to develop significant heating and tidal dissipation. When our present understanding of materials is applied, including frequency-dependent rheological models, the satellites have a heat deficit compared to our expectations which were raised by a cursory examination of their surface morphologies which definitely indicate much past activity. This heat shortage can be palliated by including short-lived radiogenic species (e.g., chiefly 26Al and 60Fe). In the past, the problem with using short-lived radiogenic species is that nobody knew how much to include in the models. Now that we know the age of Iapetus, we can assume the same for the other satellites and, thus, all of the activity levels are specified and no free parameters remain. Multidisciplinary models (e.g., coupled thermal, dynamical, geological models) including short-lived radiogenic species provide better matches to the geological observations, and, have solve several riddles, such as the origin of Enceladus' warm hydrothermal zone and geyser, or satellite, dynamical evolution, especially the despinning of Iapetus. Also, the sensitive dependence of the models upon 26Al allows us, for the first time, to make use of high-resolution radiochronometry in dating some elements of the Saturnian system. This work was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under NASA contract.