EPSC Abstracts
Vol. 7 EPSC2012-693 2012
European Planetary Science Congress 2012

Geochemistry of Enceladus and the Galilean Moons from in situ Analysis of Ejecta

F. Postberg[1,2], *J. K. Hillier*[2] , *J. Schmidt*[3], , *S. Kempf*[5], *R. Srama*[1]

[1]*Institut für Raumfahrtsysteme, Stuttgart University, Germany;* [2]*Institut für Geowissenschaften, Heidelberg University, Germany;* [3]*IPA, Universität Potsdam, 14476 Potsdam-Golm, Germany;* [4]*LASP, University of Colorado, Boulder, USA*
Postberg@irs.uni-stuttgart.de

Abstract

The contribution of Cassini's dust detector CDA in revealing subsurface liquid water on Enceladus has demonstrated how questions in planetary science can be addressed by in situ analyses of icy dust particles. As the measurements are particularly sensitive to non-ice compounds embedded in an ice matrix, concentrations of various salts and organic compounds can be identified in different dust populations. This has successfully been demonstrated at Enceladus, giving insights in the moons subsurface geochemistry. This method can be applied to any planetary body that ejects particles to distances suitable for spacecraft sensing. The Galilean moons are of particular relevance since they are believed to steadily emit grains from their surfaces either by active volcanism (Io) or stimulated by micrometeoroid bombardment (Europa, Ganymede, Callisto).

1. Enceladus

The unexpected discovery of plumes of water vapour and ice particles emerging from warm fractures in the surface of Saturn's small, icy moon Enceladus raised the question of whether they arise from either a subsurface liquid source or from ice decomposition. Previous compositional analyses, of plume particles injected into Saturn's diffuse E ring, by Cassini's dust detector have already indicated the presence of liquid water[1,2]. Recent analysis of in situ compositional measurements of particles during plume traversals showed that salt-rich ice particles are found to dominate the total mass flux of ejected solids but are eventually depleted in the population escaping into Saturn's E ring[3].

We discuss the consequences of this and other recent results for the processes forming the plume. Previous Cassini observations were compatible with a variety of plume formation scenarios and contributions from "dry" sources (such as ice sublimation or clathrate decomposition) were viable. A plume source dominated by micron-sized salt-rich ice grains, as reported here, eliminates significant contributions from dry, salt-poor sources and severely constrains or rules out non-liquid models in their present form. The recent measurements strongly imply that a salt-water reservoir with a large, but probably non-contiguous or porous, evaporating surface[1,3,4] injects most of the matter forming the plume. The relatively low abundance of insoluble gases[6,7] in the plume is in agreement with a contribution from warm ice sublimation to the gas flux.

2. Galilean Moons

The Galilean satellites are another prime target for this kind of science. During Cassini's 2001 flyby of Jupiter an analysis of tiny grains emitted by Io provided insights into Io's volcanic chemistry[7]. Although they are not as active as Enceladus and Io, in 1999 the Galileo spacecraft also revealed that Europa, Ganymede, and Callisto are enshrouded by icy dust lifted from their surfaces by micrometeoroid bombardment[8]. With suitable instrumentation, it is relatively easy to analyse these particles as samples of planetary surfaces during flybys or from an orbiter[9]. In future missions to the Jovian system the detected particles will be able to be traced back accurately to the point of ejection at the surface. Thus, information on the dust's elemental and molecular composition can be acquired and linked to specific features on the surface. Especially on Europa and Ganymede, resurfacing events and exchange processes with a subsurface ocean could be investigated, with sensitivity for trace compounds unachievable by remote sensing. In a way, microscopic surface samples are brought to the spacecraft and even complex molecules embedded in the ice matrix can be detected unaltered. Galileo and Cassini demonstrated that Io doesn't even need close flybys to investigate its "volcanic ash" [7,10]. As an active satellite distributing its emission all over the Jovian system, Io is of course an easy object for geochemical investigation via dust analysis. The monitoring of Io's dust emission requires neither a specific flyby geometry or specific instrument pointing.

3. Summary and Conclusions

With suitable particle trajectory information, dust detectors on spacecraft, functioning in the vicinity of airless bodies in the solar system, are capable of measuring compositional information which cannot be obtained by any other remote means. This information acts as a valuable probe into surface and subsurface processes, providing insights into past and extant geochemical process within the bodies being studied. Recent results from a successful example, the insight Cassini's CDA has provided into the presence of a briny reservoir in Enceladus are presented here. This discovery illustrates the merit of such instruments in probing other planetary bodies, such as Europa and Ganymede, the targets of missions to the Jovian satellites.

References

[1] Postberg F. et al., *Nature*, Volume **459**, 1098-1101 (2009)

[2] Zolotov, M. Y., *Geoph. Res. Letters* **34**, L23203 (2007)

[3] Postberg F. et al., *Nature*, doi:10.1038 /nature10175, in press (2011)

[4] Schmidt, J. et al., *Nature* **451**, 685-688 (2008)

[5] Waite, J. H., et al., EPSC-DPS 2011-61-4 (2011)

[6] Hansen, C. J. et al., *Geophys. Res. Lett*., 38, L11202, doi:10.1029/2011GL047415 (2011)

[7] Postberg, F. et al., *Icarus* 183, 122–134 (2006)

[8] Krüger, H. et al., Icarus 164, 170–184 (2003)

[9] Postberg, F. et al., Planetary and Space Science, Vol. 59, 1815–1825 (2011)

[10] Krüger, H. et al. *Geophys. Res. Lett*., 30(21), pp.2101-3-1 – 2101-3-4 (2003)