

## Marking the Fifth Anniversary of the Discovery of Enceladus's Plumes

**Enceladus as an Active Moon;  
Bern, Switzerland, 14–18 June 2010**

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In commemoration of the fifth anniversary of the discovery of Enceladus's plumes, a group of about 2 dozen specialists gathered at the International Space Science Institute (ISSI) in Switzerland (<http://www.issibern.ch/teams/ActiveEnceladus>) with the goal of advancing understanding of the nature of Enceladus and its unusual phenomena. Speakers at the meeting noted that Enceladus is much more exciting than even their wildest expectations for it more than 20 years ago when the Cassini-Huygens mission to Saturn was conceived, in the 1980s, several years after the Voyager flybys.

Cassini revealed the surprising activity of the icy moon Enceladus, which is ejecting plumes of water vapor and ice grains from its anomalously warm south polar region. During the flyby of Enceladus on 17 February 2005, the Cassini magnetometer observed magnetic effects caused by Enceladus's plumes. Alerted by these stunning measurements, the Cassini investigators focused in on Enceladus during subsequent flybys and obtained the presently known facts about

the plumes and the large south polar thermal anomaly.

The weeklong meeting was held at ISSI in Switzerland. This was an interdisciplinary workshop with participants who are in the relevant fields of science: optical remote sensing, magnetic fields, magnetospheric plasma, and in situ measurements. Attendees included both observationalists and theoreticians who covered the geological, astronomical, and fields-and-particles sciences. The intense discussions explored the limits of scientific knowledge and the geophysical and geochemical implications for Enceladus and the several roles it plays in the Saturnian system. This small, erupting satellite is also the source of most heavy ions in the magnetosphere and the supplier of material to the E ring of Saturn. In addition, it is a driver for the dynamics of the magnetosphere.

Participants discussed in situ sampling of the plume by the Cassini Ion and Neutral Mass Spectrometer and Cosmic Dust Analyzer that obtained the first direct measurements of the composition of material from the interior of an icy satellite. Surprisingly, salts were present in the small particulate, icy ("dust") grains, giving evidence that at some

time, either now or earlier, aqueous processes occurred on Enceladus. The simultaneous presence of a relatively small amount of volatile gases in the plumes suggests that pristine ices and clathrates, relatively unprocessed thermally, may also be involved in the plumes and geothermal activity.

Cassini has discovered that the intensity of the insolation alone does not determine whether liquid water can exist. The eruption of water vapor and ice crystals in plumes of Enceladus proves this. Thus, under the right conditions, liquid water can exist at great distances from the Sun. That means that exobiologically interesting environments in the universe can occur over a much larger range of distances from stars than previously thought, meeting participants noted.

The participants concluded that many more discoveries would come from the Cassini mission. However, important questions about Enceladus have already arisen that require compositional and other measurements that are clearly beyond the capabilities of Cassini's instruments. A number of advanced studies have been started to address these issues, to define not only the desired instruments but also the vehicles needed to use them effectively.

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## Volcanology Curricula Development Aided by Online Educational Resource

**Using On-Line Volcano Monitoring Data in College and University Courses:  
The Volcano Exploration Project: Pu'u Ō'ō (VEPP);  
Hawaii Volcanoes National Park, Hawaii, 26–30 July 2010**

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Volcanic activity is an excellent hook for engaging college and university students in geoscience classes. An increasing number of Internet-accessible real-time and near-real time volcano monitoring data are now available and constitute an important resource for geoscience education; however, relatively few data sets are comprehensive, and many lack background information to aid in interpretation.

In response to the need for organized, accessible, and well-documented volcano education resources, the U.S. Geological Survey's Hawaiian Volcano Observatory (HVO), in collaboration with NASA and the University of Hawai'i at Manoa, established the Volcanoes Exploration Project: Pu'u Ō'ō (VEPP). The VEPP Web site (<http://vepp.wr.usgs.gov>) is an educational resource that provides access, in near real time, to geodetic, seismic, and geologic data from the active Pu'u Ō'ō eruptive vent on Kilauea volcano, Hawaii, along with background and context information. A strength of the

VEPP site is the common theme of the Pu'u Ō'ō eruption, which allows the site to be revisited multiple times to demonstrate different principles and integrate many aspects of volcanology.

To support use of the VEPP Web site, a weeklong workshop was held at Kilauea volcano. The 25 participants from the United States and Canada represented a diverse cross section of higher learning, from community colleges to research universities, and included faculty who teach introductory non-major classes (both large and small), laboratories, discipline-specific upper division courses, and graduate seminars. Workshop goals were for participants to learn how to interpret volcano monitoring data, become proficient in the use of the VEPP Web site, provide feedback on content and organization of the site, and create teaching modules that integrate the site into college and university geoscience curricula.

By the end of the workshop, the VEPP site had been modified based on participant feedback, and about 20 new volcanology teaching modules that incorporate the Web

site were created and made publicly accessible via the VEPP workshop section of the National Association of Geoscience Teachers (NAGT) Web site (<http://www.nagt.org/nagt/vepp/activities.html>). Each teaching module has been peer reviewed and contains a description of learning goals, context for use, instructions, methods to assess student learning, and ancillary materials (e.g., handouts, grading rubrics). Anyone hoping to incorporate active learning and hands-on experiences in teaching volcanology is encouraged to browse these modules for activities appropriate for their class size and level. It is expected that this collection of ready-to-use teaching exercises will save instructors time and result in more dynamic and effective teaching practices.

Log-in information for the VEPP Web site (<http://vepp.wr.usgs.gov>) is distributed for educational use only and is available by contacting Michael Poland (see below).

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