Galileo probes structure of Jovian moons

Halfway through its 2-year Jovian tour, the Galileo spacecraft has taken a peek at Jupiter's four largest moons. Gravitational and magnetic field maps, along with standard images, are allowing scientists to probe Ganymede, Io, Europa, and Callisto from the inside out. Galileo scientists recently released new information on three of these moons.

The craft confirmed that Ganymede has a magnetic field, making it the only moon known to have one (SN: 7/20/96, p. 37). The evidence includes a surge in electromagnetic emission that researchers heard as soaring whistles and hissing static when the craft passed through ionized gas around Ganymede. The signals indicate that the moon sports a magnetic field large enough to deflect that of Jupiter.

A gravitational map, deduced from the motion of the craft as it orbited Ganymede, reveals that the moon has a dense core. Taken together, the new findings indicate that Ganymede has a three-layered structure. Its core consists of molten iron, whose internal circulation generates the magnetic field. A rocky mantle surrounds the core, and a thick shell of ice forms Ganymede's exterior.

The presence of a molten core reflects an episode of heating well after Jupiter and its moons were born, argues Gerald Schubert of the University of California, Los Angeles. He suggests that Ganymede initially consisted of a uniform mixture of material. Later, the gravity of Jupiter and the other large moons distorted and flexed Ganymede, producing heat that melted and separated out the iron-rich constituents. More recently, the moon's orbit changed and the distortions lessened. The melting could not have happened just as Jupiter formed, notes Schubert, because the core would have had time since then to cool and resolidify, eliminating the magnetic field.

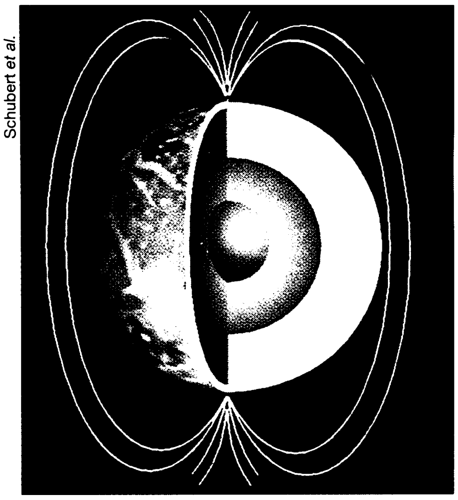
John D. Anderson of NASA's Jet Propulsion Laboratory in Pasadena, Calif., notes that Ganymede is structurally akin to volcanically active Io, which lies closer to Jupiter. "If you stripped away the icy shell from Ganymede, it would look very much like Io," he notes.

The Galileo team describes their studies in the Dec. 12 NATURE. At a NASA press briefing, Kelly Bender of Arizona State University in Tempe unveiled the first images of Callisto, the coldest, outermost moon. They show bright regions of material, as if older and darker ice had slumped downhill and exposed more pristine ice underneath.

At last month's American Geophysical Union meeting in San Francisco, Galileo researchers also reported that Callisto appears to have no magnetic field and a uniform composition. Callisto may reside too far from Jupiter for heating to have altered its structure. Some theorists suggest that this icy moon represents what the other large Jovian moons looked like soon after their formation.

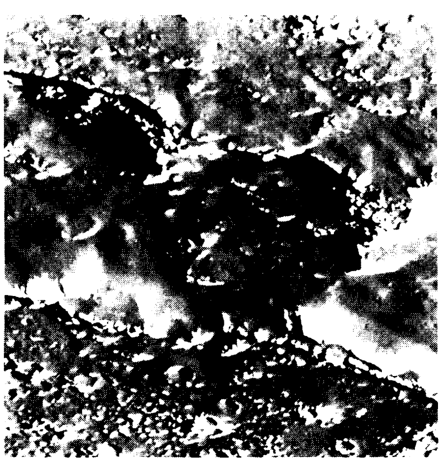
Finally, a new image of Europa shows evidence of volcanic activity. Any heat source that could generate volcanoes would also melt ice. Therefore, the volcanism makes scientists more confident that Europa has an ocean beneath its icy exterior. *—R. Cowen*

Schubert *et al.*



Ganymede's three layers: molten metallic core, rocky mantle, and icy shell.

JPL/NASA



A chain of craters on Callisto.

Tumor offers unsafe home for cell's genes

Cells inside a tumor have trouble catching their breath. Though tumors secrete chemicals that trigger new blood vessel formation, these cancerous masses grow faster than their blood supply. Consequently, cells deep within the solid mass face a serious lack of oxygen, a condition known as hypoxia.

By counting mutations in genes that were added to mouse cancer cells, researchers have now discovered that the oxygen-poor environment of a tumor can cause DNA damage. This finding may explain, in part, why tumor cells gradually accumulate multiple gene mutations and chromosomal abnormalities and thus why tumors tend to become more malignant with time.

The new study, conducted by Toni Y. Reynolds, Sara Rockwell, and Peter M. Glazer, all of Yale University School of Medicine, appears in the Dec. 15 CANCER RESEARCH.

To monitor the frequency of DNA damage within a tumor, the investigators turned to a bacterial gene called *supF*. They inserted multiple copies of this gene into mouse cancer cells. The group then either grew those cells in dishes filled with an oxygen- and nutrient-rich solution or injected the cells into the flanks of mice and allowed tumors to develop.

Many weeks later, the researchers removed the bacterial genes from the dish-grown cells and from the mouse tumors and inserted them back into bacteria. Under the test conditions, bacteria that received a normal *supF* gene generated blue colonies, while those getting a mutated gene produced white ones. The experiments showed consistently that cells grown in a tumor had about five times as many *supF* mutations as cancer cells raised in a dish.

To examine what aspects of tumor environment might trigger mutations, the researchers again grew mouse cancer cells in dishes but deprived the cells of almost all oxygen. Like their counterparts grown inside mouse tumors, these hypoxic cells experienced an increased frequency of *supF* mutations, says Glazer.

This "profound result" adds to the growing link between hypoxia and tumor development, notes Amato J. Giaccia of Stanford University School of Medicine. In the past year or so, Giaccia and his colleagues have shown that the oxygen-poor environment within a tumor favors the survival of cells possessing a mutated form of *p53*, a gene that normally regulates cell growth and division (SN: 4/6/96, p. 216). Now, says Giaccia, the Yale group has shown that hypoxia actively encourages mutations, perhaps even those that alter *p53*.

How the tumor environment, or more specifically hypoxia, harms DNA is unclear. The low oxygen content of tumor cells may somehow damage genes directly, or the mutations may be a secondary result. For example, hypoxic cells experience a rise in internal acidity, much as a runner's muscles build up lactic acid when they have used up all available oxygen. This increased acid content may directly injure DNA or may impair the enzymes used to correct DNA mutations, says Glazer.

He and his colleagues are now examining whether cell acidity influences mutation frequency. *—J. Travis*