Picturing a new world: Views of Ganymede

Sliced and diced by grooves, faults, and fractures, it's as if someone had hacked at the surface of Ganymede with a meat cleaver. That's the surprising view of the surface of Jupiter's largest moon revealed by the Galileo spacecraft when it flew within 830 kilometers of this icy body on June 27, capturing features never before imaged in sharp detail.

The pictures, released by NASA last week, cover just 0.02 percent of Ganymede's surface and mark the beginning of the craft's 18-month grand tour of Jupiter and its four largest moons. On future visits, Galileo is expected to view Ganymede at even higher resolution. Nonetheless, these first images, revealing structures as small as a football field in two equatorial regions of the giant moon, "turn our previous thinking upside down," says James W. Head, a member of the Galileo imaging team at Brown University in Providence, R.I.

For 17 years, he notes, ever since the Voyager craft took the first flyby snapshots of Ganymede, parts of the moon that looked smooth were assumed to be young, recently resurfaced by icy eruptions. But Galileo images of a bright region on Ganymede called Uruk Sulcus show that some smooth areas are heavily cratered and splintered by fractures. "Some regions that we thought were the youngest are the oldest," says Head.

Tectonic activity—the movement of adjacent layers of crust—"has sliced [the surface] up so much that we can't even see old craters and signs of volcanic activity in some areas," he adds. The chopped-up terrain suggests that the moon was considerably hotter and more active in the past than planetary scientists have thought, Head says.

The fractures hint that Ganymede may once have possessed a subsurface ocean.

JPL/NASA

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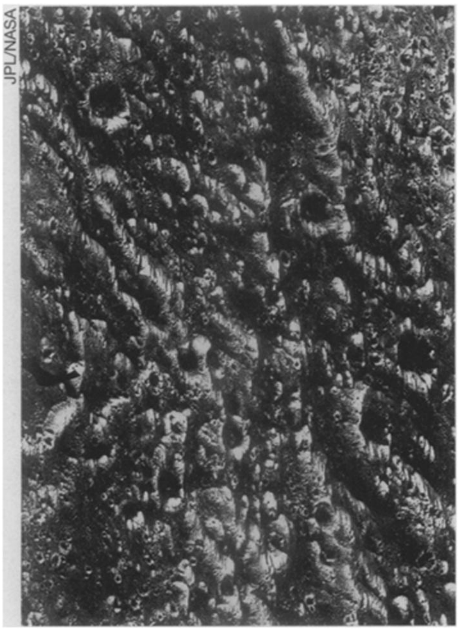


Galileo image of Uruk Sulcus shows old, heavily cratered terrain (top) and linelike features that cut through the region (lower left). Pictured area measures 55 by 35 km.

Ironically, says Head, the widespread fractures may also be obliterating compelling evidence of an underground ocean—namely, the smooth areas that would have been created by eruptions of water ice.

Although nothing about the images "screams out for having an ocean down there," says Galileo investigator Robert T. Pappalardo of Brown, he and Head say that another finding may lend credence to the idea. Margaret G. Kivelson of the University of California, Los Angeles reports that Galileo's magnetometer detected a magnetic field about one-fortieth the strength of Earth's emanating from Ganymede.

This weak field, she says, could arise in one of three ways: molten iron flowing at Ganymede's core; a briny ocean still circulating beneath the icy crust (SN: 7/6/96, p. 8); or solid material carrying the remnant of a much stronger magnetic signal from the past. Gravity mapping of Ganymede, scheduled for Galileo's next flyby on Sept. 6, may determine whether the moon indeed has an iron core.

During its tour, Galileo is likely to discover many more surprises, says Head. Flying back from the Galileo data center, the sleep-deprived geologist pored over the Ganymede images that he had spread across his tray table, ignoring the in-flight movie. Asserts Head: "There ain't many movies that can compete with these images, you can bet on that." — *R. Cowen*

Deep furrows dominate this view of Ganymede's Galileo Regio. The area measures 64 km by 46 km.

Sticking tough with new hydrogen bonds

Hydrogen, the simplest element, can still spring a few surprises.

Researchers have now identified a previously unnoticed type of bonding between two hydrogen atoms belonging to different molecules. "This is a new type of intermolecular interaction," says chemist Robert H. Crabtree of Yale University. Crabtree and his collaborators describe their discovery in the July Accounts of Chemical Research.

The existence of the conventional hydrogen bond has long been recognized. In a water molecule, for example, a hydrogen bond links a hydrogen atom of one water molecule and the oxygen atom of another molecule. This bond forms because, within a water molecule, a strong covalent bond ties each of the two hydrogen atoms to the oxygen atom, leaving the hydrogen atom positively charged and the oxygen atom negatively charged.

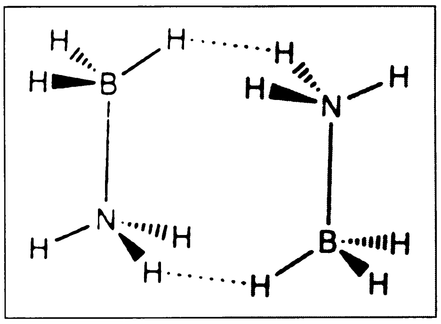
Crabtree and his coworkers have found that in certain molecules, hydrogen atoms can have different charges. In amine borane (H_3BNH_3), for instance, the hydrogens linked to the boron atom have a negative charge, while those linked to the nitrogen atom have a positive charge. Thus, some of the hydrogens of one molecule are attracted to those of another molecule.

The researchers call this type of interaction a dihydrogen bond. The presence of such bonding can strongly influence a substance's melting point and other physical characteristics. Amine borane melts at 104°C, whereas ethane (H_3CCH_3), which has an analogous structure but features no dihydrogen bonding, melts at -181°C.

"Dihydrogen bonding leads to strong adhesion," Crabtree says.

Robert H. Morris of the University of Toronto in Ontario has also identified molecules with dihydrogen bonding. It's likely that there are other cases in which these forces exist, but they haven't yet been recognized, he says. — *I. Peterson*

Crabtree *et al.*/J. Amer. Chem. Soc.



In this pair of amine borane molecules, attraction between a boron-linked hydrogen of one molecule and a nitrogen-linked hydrogen of the other produces a strong intermolecular bond (dotted lines).