Ganymede: A Bit of Everything

The largest of Jupiter's major moons also has the most complex terrain

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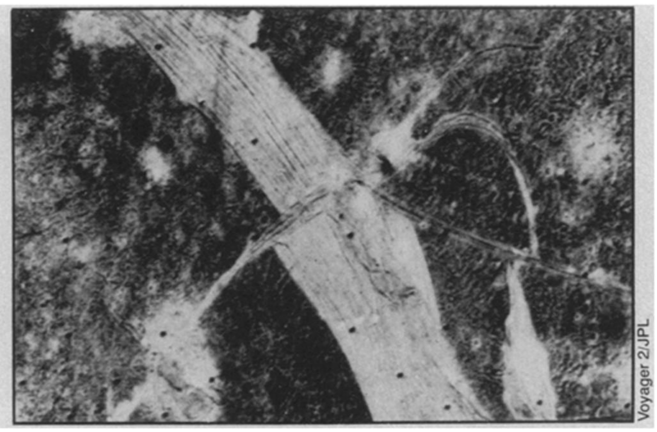
Huge, dark spot on Ganymede (left) is probably ancient impact site. Parallel grooves appear displayed by transverse fault (right), suggesting tectonic activity (see map, 13° lat. by −10° long.).



Viewed as art, the Galilean satellites of Jupiter comprise a diverse gallery. At one stylistic extreme is Io, a kinetic sculpture with its erupting volcanoes, ever-changing surface and manic coloration. At the other end is Callisto, a classic, almost idealized model of a cratered world, unblemished by mountains, valleys or other deviations from the theme. Between them is impressionist Europa, a pale sphere dashed with streaks so flat and intertwined that they look as though they might indeed have been applied with a paintbrush, if not as the abstract drippings of a Jackson Pollack. The other entry is giant Ganymede, larger even than the planet Mercury. And Ganymede is, well, dada.

Dictionary definitions of dada often invoke such terms as anarchistic or irrational, and Ganymede certainly appears in a subjective viewing to have been designed in defiance of the "rules." In some places it is smooth; elsewhere it is as tortured and craggy as the highlands of earth's moon, although even in the roughest spots the ups and downs of the terrain span no more than a few hundred meters. There are craters ringed by wide, bright haloes, presumably of ice overturned from the satellite's thick, frozen crust, yet others nearby in similar terrain show only slight traces of such borders. Most of the craters are relatively small, with few if any in the hundreds-of-kilometers range — except for a huge, dark spot, covering fully a third of its hemisphere and bullseyed with concentric rings, which almost surely resulted from a titanic impact that on a hardrock world would have resulted in a vast basin.

It is not diversity alone, however, that characterizes Ganymede's unusual appearance — Mars, for example, offers a wide-ranging host of terrain types. But Ganymede presents its various facades in what almost appear to be discrete sections, like a model assembled from a collection of mismatched parts. And creating much of that segmented appearance is Ganymede's most unusual feature: a global network of grooves and ridges, branching, weaving and intersecting in bizarre array. And many are not just single lineaments, but families in parallel, with some paths showing as many as 20 grooves and ridges running side by side for tens or hundreds of kilometers.

The map of Ganymede is a strange sight. Viewers have been moved to comparisons ranging from medical photographs to electron micrographs of almost anything. Reproduced on the next three pages, it was drawn by Jay L. Inge of the U.S. Geological Survey's Branch of Astrogeologic Studies, working with a hand-held airbrush from the photos taken last year by the Voyager 1 and 2 spacecraft. The map's latitude-longitude grid as shown is based on spacecraft trajectories and camera angles calculated before the spacecraft encounters ever took place, although better "control points" have since been derived from the photos and will be applied to future editions (the present grid shows errors as large as 10° in both directions).

The map features to which names have been assigned (and approved by the International Astronomical Union) are of three types: Broad areas, or *regiones*, are named for astronomers who discovered satellites of Jupiter. Crater names come from the legendry of ancient Middle Eastern cultures and from the Greco-Roman myth of Ganymede, one of the loves of Zeus (Jupiter). The same source of names has been used for the grooves or *sulci* (Latin for plowings or ditches).

But the existence of nomenclature and coordinates on a map does not mean that Ganymede's features are understood, particularly the grooves, which veteran astrogeologist Eugene Shoemaker of the USGS calls "one of the most aggravating, difficult, exasperating problems I've ever tried to solve." The patterns of the grooves seem to imply all sorts of tectonic activity in the satellite's past — twisting, sliding, stretching — but with a major difference from such activity on the earth. Missing on Ganymede, says Lawrence Soderblom of the USGS, are signs of emergence and subduction, in which new crustal material rises while old plates are driven into and beneath one another. A likely key is that Ganymede appears blanketed not in rock, but in hundreds of kilometers of ice. Solid rock is more dense than liquid magma, so earth's rocky plates sink, Soderblom says, but solid water — ice — will float on liquid water. Shoemaker believes the question is far more complex, possibly involving different "phases" of ice that can form under the tremendous pressure of great depth. A gram of "ordinary" ice, for example, occupies about 1.08 cubic centimeters, Shoemaker says, while a gram of more dense "ice-5," such as might exist several hundred kilometers beneath Ganymede's surface, occupies only about 0.76 cc. If changing temperature conditions prompted a deep ice-5 layer to change to ice-2 (0.86 cc/g) or ice-1, Ganymede's outer layers could have expanded enough to create cracks all over the satellite's surface. But high-pressure ice physics is a virtually new field to most planetologists (including, Shoemaker admits, himself), and Ganymede's surface was not even seen in close-up until 14 months ago. Stay tuned.

Next and last in the series: Callisto. □