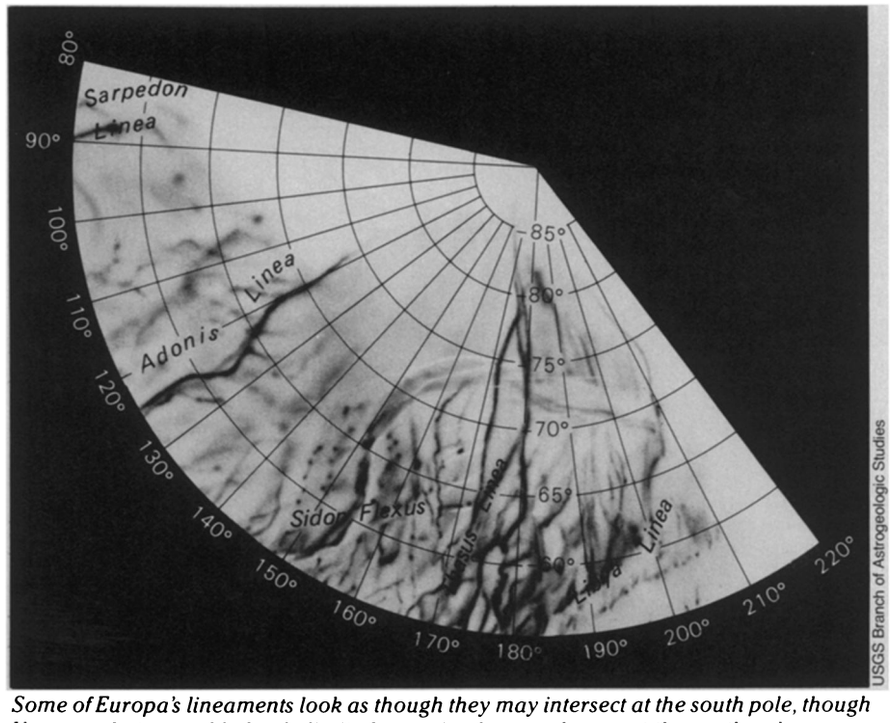
Europa: Tracings in the Ice

The myriad lines that crisscross its surface look almost painted on

BY JONATHAN EBERHART



Some of Europa's lineaments look as though they may intersect at the south pole, though Voyager photos enabled only limited mapping here and none at the north pole.

Making a map of a map would seem to be a redundant endeavor, and although the object in question is certainly no mere map — it is an ice-clad ball of rock nearly as large as earth's moon — it does have that appearance. Like a particularly convoluted roadmap, its light-colored surface is laced with a tangle of dark lines, long ones and short, some straight, others curved or segmented, some embellished with light streaks that run along their centers. And, maplike, the lines are flush enough with the terrain to appear almost printed on, departing no more than 100 to 200 meters from the skin of a globe more than 3,100 kilometers through.

Or, for those whose thoughts frequently extend beyond the earth, there is another possible association: "I was struck by the fact," says Jay L. Inge of the U.S. Geological Survey, "the first time we looked at it, that we'd finally found Lowell's canals." Yet Sir Percival Lowell, noted astronomer of yesteryear, was interpreting (erroneously) markings he believed he could see on the surface of Mars. Inge, with the Survey's Branch of Astrogeologic Studies in Flagstaff, Ariz., was indulging in a bit of mock *déjà vu* with Europa, second-innermost of the four major moons of Jupiter. But Europa resembles the real Mars no more than it does any other body in the solar system yet studied in similar detail.

And it was Inge's task to draw the map, part of a growing series of extraterrestrial chartings that also includes parts or all of earth's moon, Mercury and Mars. Working at a scale of 1 to 25,000,000 (1 cm = 250 km), he used an airbrush, following the Voyager 1 and 2 spacecraft photos that are the only existing views of the Galilean satellites' spectacular surfaces. Though the photos may more directly represent Europa's reality, the map represents the terrain free of the potentially misleading influences of shadow, distortions from the imaging system, and brightness differences that sometimes appear when a given area is photographed at varied lighting angles. In one important sense, however, the limitations of the photos are deliberately included: The photos were taken over a wide range of distances from Europa, which results in some of the pictures being considerably less sharp than others (resolution is also affected by differences in the relative movement between the rotating satellite's surface and the spacecraft). Where the photos are blurrier, Inge rendered the map that way, because drawing surface features more sharply than they actually appear—even if presumably similar features are better photographed elsewhere on Europa — could be risking substantial errors with such an alien terrain.

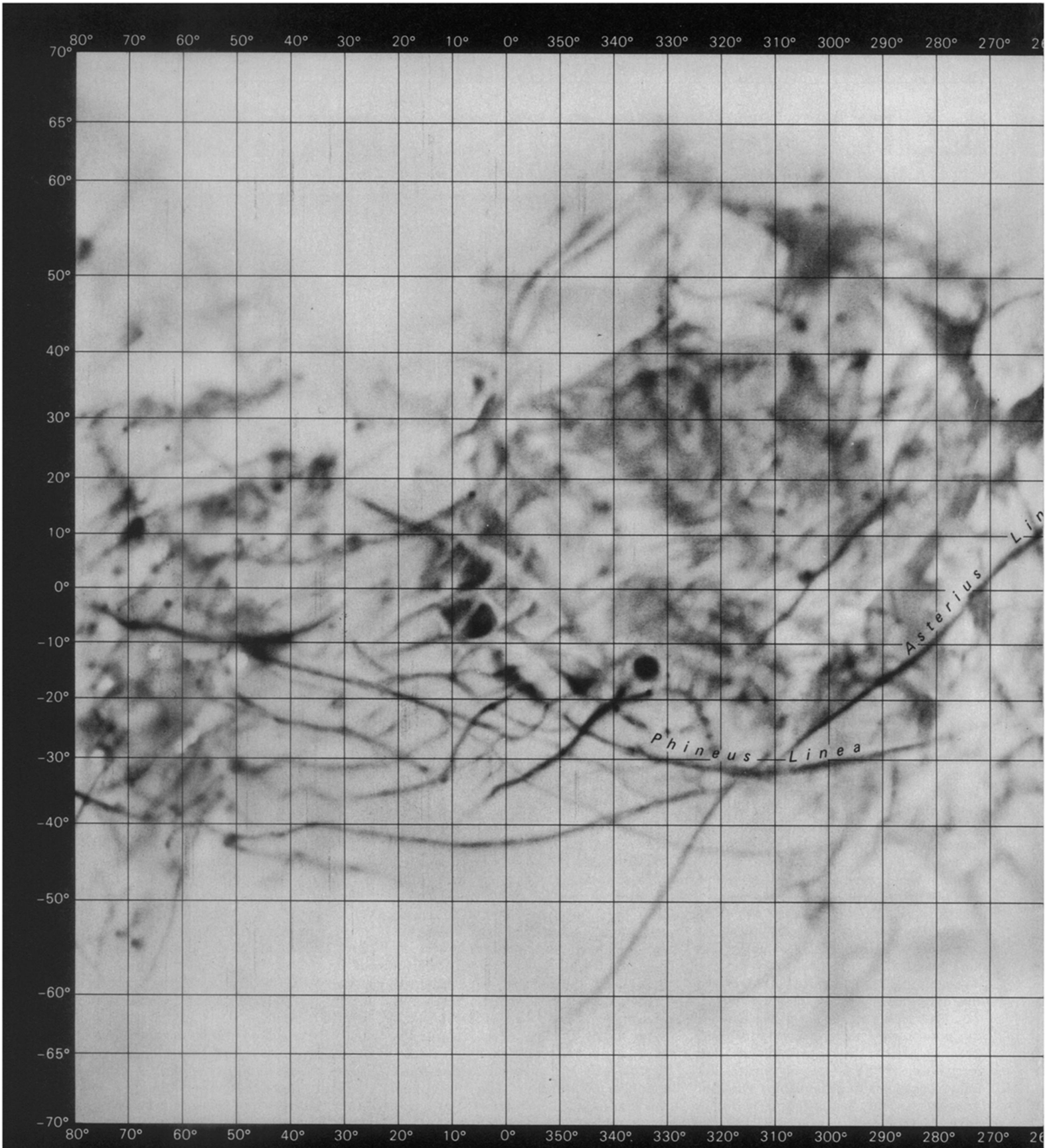
Nonetheless, the streaks are there, regardless of what they may turn out to look like when sharper photos become available in the future. They seem to be cracks in the icy crust, but their origin is uncertain. One idea is that they may have been caused by the stresses of tides raised by Jupiter (also the favored explanation of Io's volcanism). In that hypothesis, the "tidal bulge" on the side of Europa that always faces the planet is essentially pushed in and out as the satellite's elliptical orbit takes it nearer and farther from Jupiter. In addition, the bulge is pulled from side to side, as its tendency to face Jupiter throughout its elliptical journey results in its rotating sometimes faster, sometimes slower than Europa's overall constant rotation rate.

But many of the features appear many tens of kilometers wide, wider than tidal proponents think can be explained by that mechanism alone. Some of the Voyager scientists have suggested that wide cracks (the features have been estimated to cover 5 to 15 percent of the surface) could have been created if Europa's ice crust was generated by the "outgassing" of liquid water from the interior. As the water layer froze from the top down, the idea goes, the new ice could have been cracked by the pressure of new liquid pushing up from beneath.

Not all of the cracks, however, necessarily resulted from the same process. Close looks at the Voyager photos indicate that some features cross others at characteristic 45° angles, suggesting that they resulted from torsional stresses, says Lawrence Soderblom of the U.S. Geological Survey, while in other cases this aspect is lacking. Also, he says, from the ways in which some of the streaks cross over and under one another, "it's clear that you can divide these things into families with different ages."

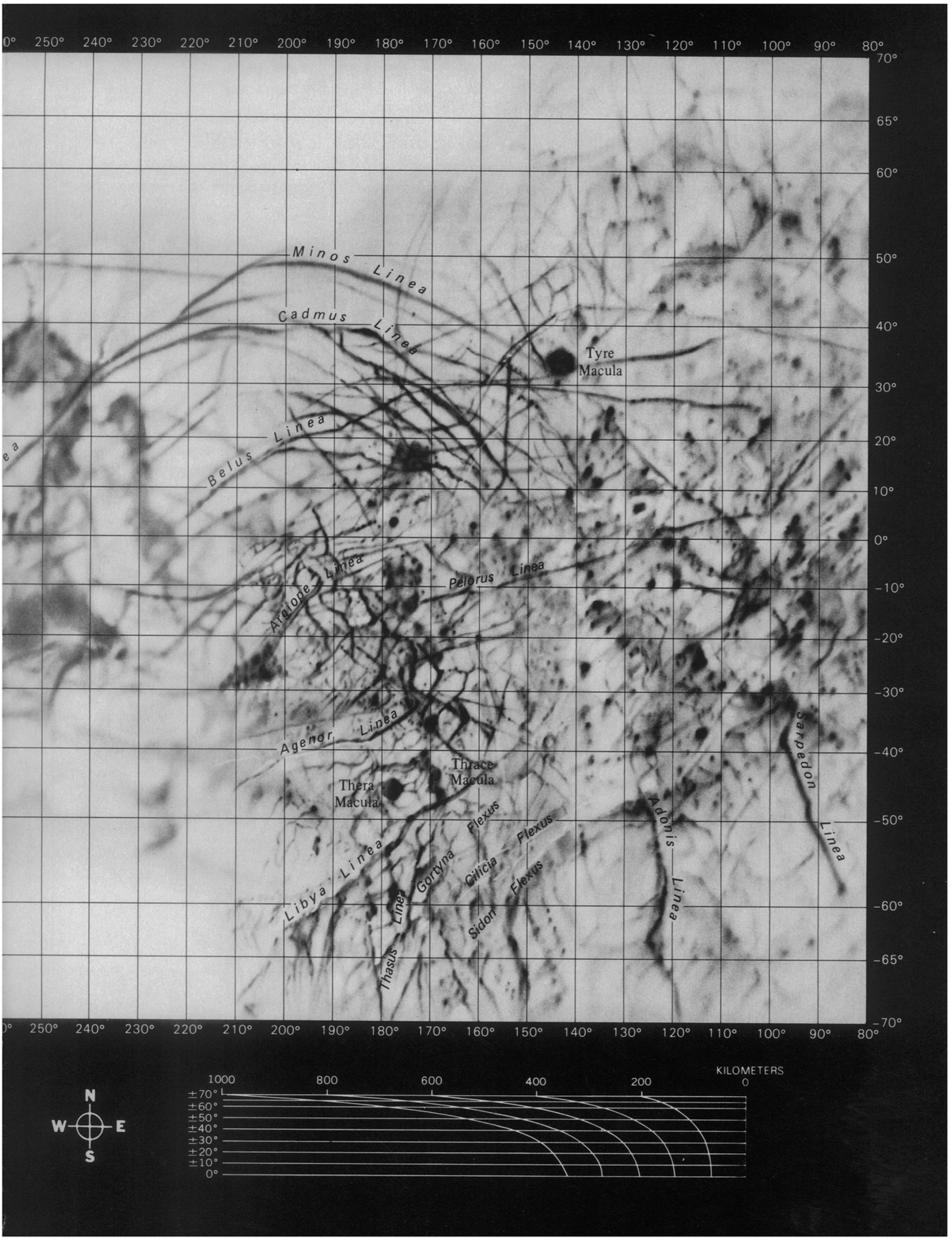
The cartographer, however, has other concerns. The latitude-longitude grid on the new Europa map (overleaf) is based on pre-flight predictions of the spacecraft trajectories and camera angles, and could be off by as much as 10° in longitude and 5° in latitude. Accurate "control points" calculated from the photos will be used to improve the grid over the next few months. Additional names may also be assigned to the map, based, like the existing ones, on the myth of Europa, one of the loves of Jupiter.

Next: Ganymede. □



Europa

Map of Europa, second nearest to Jupiter of the planet's four large Galilean satellites, shows numerous linear features, some of which are thousands of kilometers long but which barely ripple the icy surface. Prepared from Voyager 1 and 2 photos by the U.S. Geological Survey's Branch of Astrogeologic Studies, map is a 1:25,000,000 scale. Refined diameter of Europa is 3,126 ± 20 km.


0° 250° 240° 230° 220° 210° 200° 190° 180° 170° 160° 150° 140° 130° 120° 110° 100° 90° 80°
70°
65°
60°
50°
40°
30°
20°
10°
0°
-10°
-20°
-30°
-40°
-50°
-60°
-65°
-70°
Minos Linea
Cadmus Linea
Tyre Macula
Belus Linea
Argione Linea
Pelorus Linea
Agenor Linea
Thrace Macula
Thera Macula
Sarpedon Linea
Flexus
Flexus
Flexus
Libya Linea
Gortyna
Cilicia
Sidon
Thasus Linea
Adonis Linea
KILOMETERS
1000
800
600
400
200
0
±70°
±60°
±50°
±40°
±30°
±20°
±10°
0°
N
W
E
S