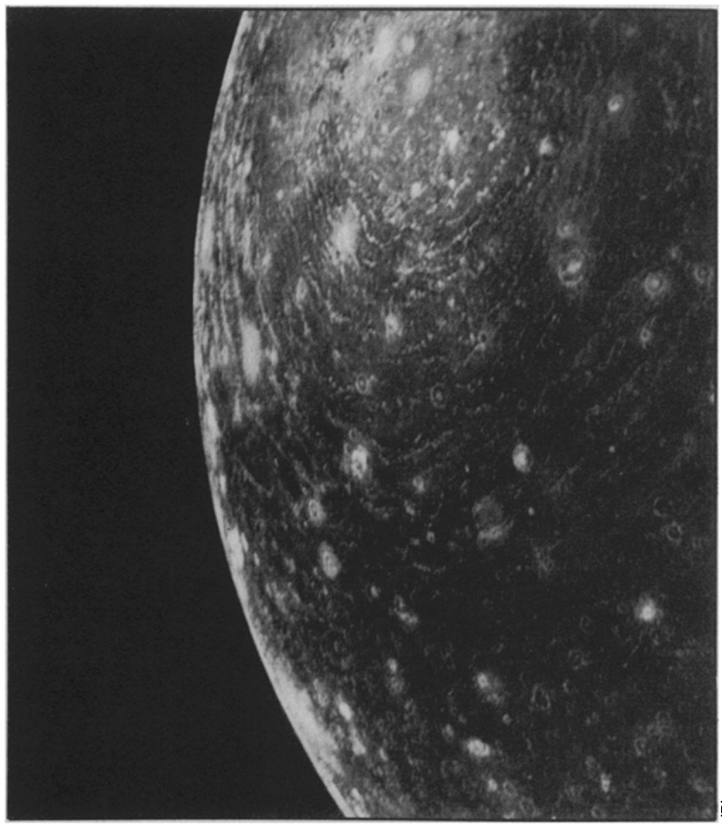
Callisto: Craters, Craters Everywhere

The most "normal-looking" of Jupiter's big moons still has scientists scratching their heads

BY JONATHAN EBERHART



JPL

Bright, concentric rings mark Valhalla, the huge feature on Callisto photographed by Voyager.

Volcanically resurfaced Io, nearest of the Galilean satellites to Jupiter, seems to have preserved not a single one of the meteorite impact craters so familiar on earth's moon. Careful peering at Europa reveals no more than eight hiding among its long, linear markings. Ganymede shows a more respectable number amid its curious patterns of parallel grooves and ridges, but on outermost Callisto, impact craters are truly the name of the game — for, as the map on the following pages shows, there is almost nothing else.

The map, based on the Voyager 1 and 2 spacecraft photos taken last year, was hand-drawn with an airbrush by Patricia M. Bridges of the U.S. Geological Survey's Branch of Astrogeologic Studies in Flagstaff, Ariz. As with the other Galilean satellite maps that have appeared recently in these pages, not all of Callisto's surface is shown, and many parts appear blurrier (coarser resolution) than others. Both of these limitations result from the incomplete photo coverage (the south pole was not seen at all) and the fact that the pictures were taken from a wide range of distances, but the map is not likely to be appreciably improved until the Galileo spacecraft returns to the Jovian system no earlier than 1986. Even so, it does provide a near-global impression of the motif that bedecks this single-mindedly crater-ridden world.

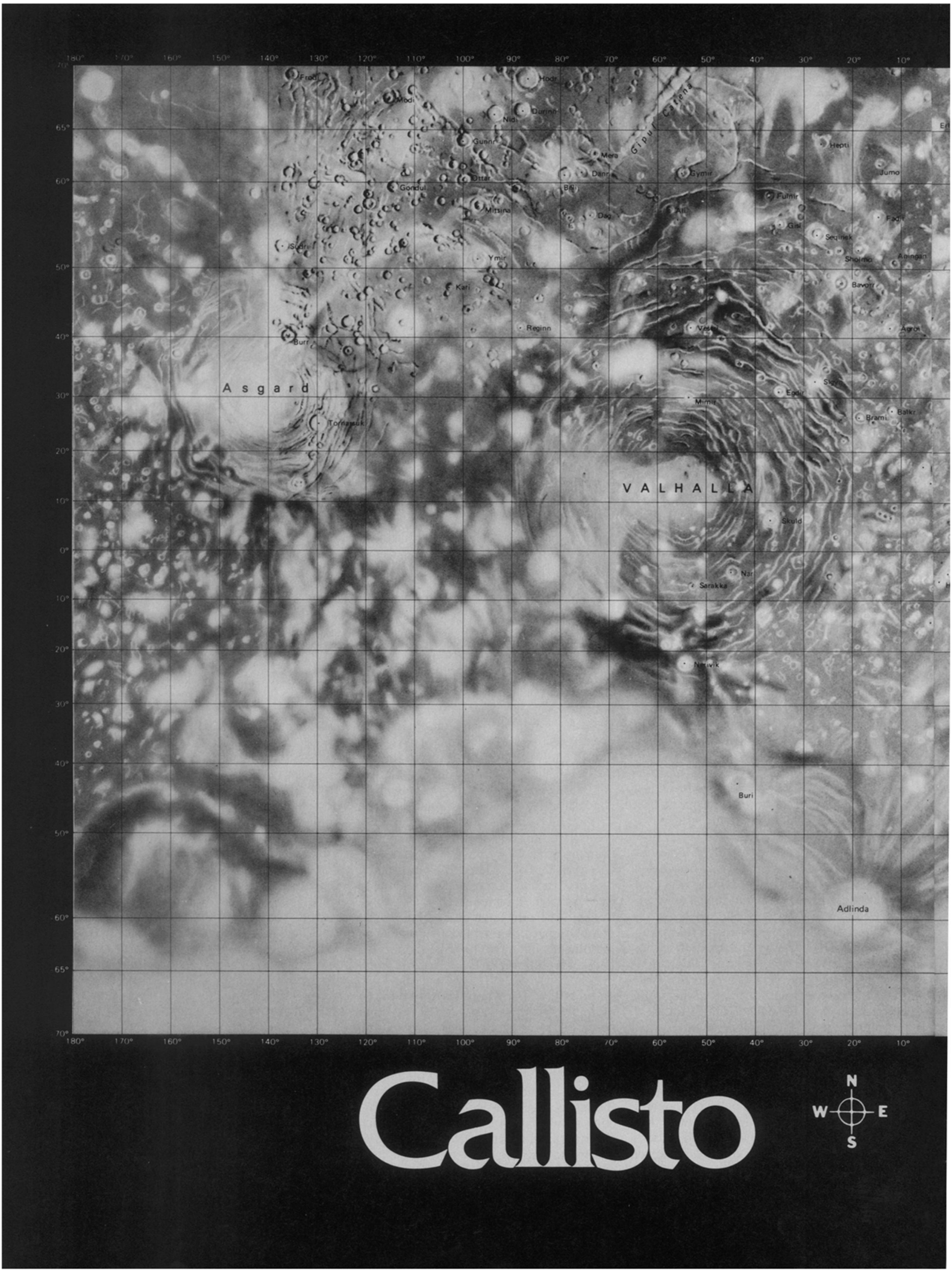
In the spectacular company of the other Galileans, Callisto could easily be written off as merely the monotonous one. But some researchers feel that this plain sister may in fact be a Cinderella world with a valued attribute: a surface virtually unchanged since the early days of the solar system. It has long been a widespread opinion that much of the cratering now visible on the solar system's planets and satellites was produced during a "great bombardment" some four billion years ago, when far greater numbers of rocky chunks were around to do the damage. But earth and Mars, for example, have since eroded much of the evidence; earth's moon poured forth seas of lava to cover it up. Among the Galilean satellites, Io's facade changes as you watch, and smooth Europa, too, seems to have erased much of its history. Ganymede carries the scars of many impacts, but its myriad grooves seem to have formed more recently than most of the craters (few craters overlie the grooves), implying that tectonic activity may have distorted the ancient record. Callisto, however, may exhibit a surface unaltered since its primordial pounding.

The grounds for this belief, suggested by Patrick Cassen of the NASA Ames Research Center and colleagues (SN:10/6/79, p. 233), are that Callisto is slightly smaller than Ganymede and may have a substantially less massive core. This could have meant that the internal heat of the young Callisto was less than Ganymede's, so that tectonic thrashings might have ceased before the great bombardment ended; Ganymede, on the other hand, might have kept churning long enough to disturb the cratering record.

In addition, Ganymede shows a number of faint, ghostly crater-like forms that some planetologists are now calling "palimpsests," which recent studies suggest may be the results of impacts into an ice layer that was once floating on a softer, possibly liquid layer beneath. Callisto, though it too is an ice-blanketed world, shows few if any such features, which could mean that its crust froze earlier in its history so that the impacts took place in solid, stable ice — the same surface that is still on display.

Callisto's impact features run the gamut of sizes, from those too small for Voyager's cameras to see (which means smaller than about 2.5 kilometers) to a huge, concentric-ringed structure that could just about encompass the contiguous United States. Officially named Valhalla (Callisto nomenclature comes from Scandinavian legendry), the structure could remind the casual observer of another gigantic feature, Orientale basin on earth's moon. But Callisto is a very different world. While Orientale has three principal concentric rings surrounded by radial streaks of ejected material, Valhalla has numerous rings and no such streaks. The rings of Orientale essentially are circular mountain ranges; Valhalla's are little more than bright streaks against a darker background. Valhalla, in fact, is scarcely a basin at all, lacking the topographic depression that would exist on a hardrock world. On a smaller scale, the reverse can be true. Craters in rock often have a central peak, formed when the terrain rebounds from the blow of an impact; but on iceworlds such as Callisto, central pits are more common, due to melting of the ice by the heat of the blow. Even for experienced planetologists, the Jovian iceworlds have meant going back to basics.

For more of the photos and maps of the solar system's wonders, see p. 348. □


Callisto
N
W
E
S
Asgard
VALHALLA
Adlinda
Fröd
Hodr
Modi
Durinn
Niði
Gunnr
Mera
Gipul Catena
Hepti
Jumo
Dann
Gymir
Gondul
Ottar
Bil
Fulnir
Mitsina
Dag
Aii
Gisl
Fadir
Seginek
Sholmo
Abingan
Skirn
Ymir
Bavorr
Kari
Reginn
Vzedi
Agrot
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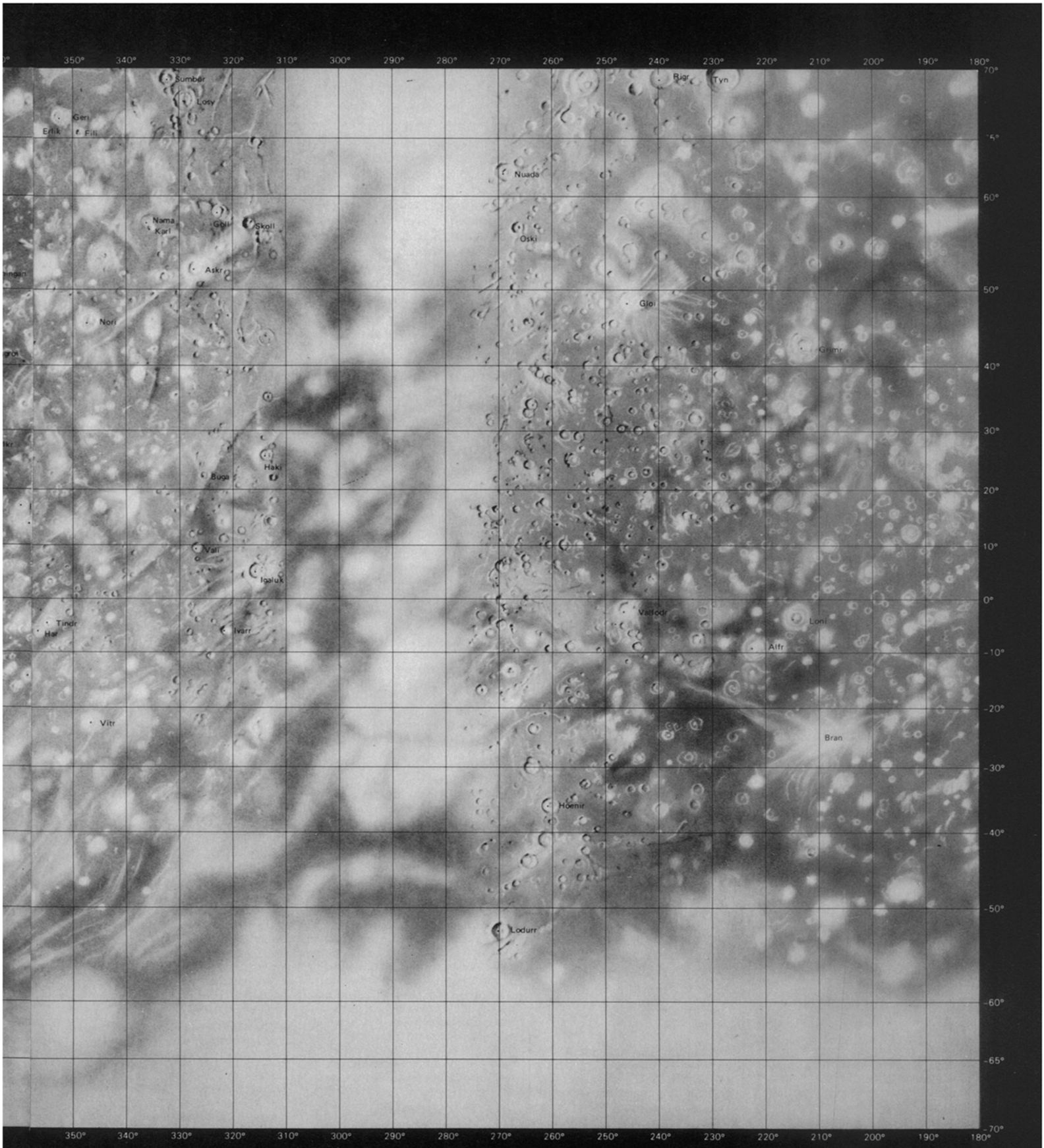
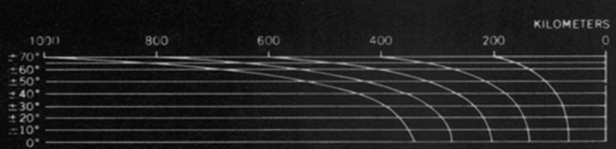
Skuld
Nar
Sarakka
Nerivik
Buri





Map of Callisto, outermost of Jupiter's four Galilean satellites, shows one of the solar system's most heavily cratered surfaces, including huge, concentric-ringed features but with almost no vertical relief. Drawn from Voyager 1 and 2 photos by the U.S. Geological Survey's Branch of Astrogeologic Studies at 1:25,000,000 scale, map is shown here at 1:34,000,000. Diameter of Callisto, refined in calculating coordinate grid, is 4,820 ± 20 kilometers.