Callisto: a Living Planet

...Strong Evidence

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References: All scientific information in this document is from (a) **www.jpl.nasa.gov/galileo** web site or (b) **JPL's Galileo Listserve** (To subscribe, e-mail JPLNews@jpl.nasa.gov with the message "subscribe galileo".) or (c) **National Geographic** September 1999 in an article about the Galileo project or (d) **Scientific American** (Feb 2000 iirc) in an article by Torrence Johnson, head of the Galileo Team. The underlying premise that there is a planet in our solar system with nonbreathing life, and other scientifically unverified solar system information, can be blamed squarely on **The Urantia Book**, pages as noted. All photographs by the **Galileo Spacecraft**, all illustrations courtesy of **JPL-NASA**

Which World Could it Be?

We are told that Mars would be a sub-breather world if it were inhabited, and Venus would be peopled by superbreathers. Mercury and Luna are certainly lifeless: Ours is the only world in the inner solar system with much water. Saturn's orbiting world Titan is an atmospheric world which would house mid-breathers. (Titan is probably the third planet "currently suitable for inhabitation" in our solar system (The Urantia Book (TUB) P173-d)). Anything beyond Saturn is certainly too far from the sun.

This leaves only Jupiter's family of four secondary planets. These four virtually airless worlds are just now being explored in much more detail than ever before, by the Galileo space probe's Jupiter-orbiting mission, extended for its fifth glorious year through the year 2000. Forget Star Trek's "Five Year Mission" - Galileo is real and a miracle more wonderous than "2001 a Space Oddessy", which it so nearly duplicates in date as well as location!

*Left to right, Jupiter's Family of Secondary Planets: **Io, Europa, Ganymede** and **Callisto**. Note Callisto's richness of color compared to its grayish near-twin Ganymede. Callisto has about 2/3 of the land area of our own world, but none of its ocean area.*

Innermost Io orbits within Jupiter's Van Allen belts in a radiation environment that would be quickly fatal to life, among many other extreme hostilities. It has aroused immense interest because of its continuous volcanic activity, which is no doubt a harbinger of its upcoming disintegration by tidal disruption in "the next few million years". (TUB P.658-b)

Europa seemed a most likely choice, as it seems certain it has a deep ocean of water under its planet-wide ice cover, and we are familiar with life developing in water. One discomforting feature of Europa as a life sphere was its small size, slightly smaller than our own moon. But other readers besides myself have speculated that it just about had to be the one, and no doubt scoured the pictures on the JPL-NASA website (www.jpl.nasa.gov/galileo) looking for signs of inhabitation. But we might infer that life probably doesn't start underwater on airless worlds from the statement that says it usually does on *atmospheric* worlds (TUB P.560-b), and a recent NASA study that says there'd be no way to energize underwater life where there is no significant sunlight on an airless world, and Europa's ice cover plus the distance from the sun probably makes it pretty dark down there. Perhaps Europa's ocean will freeze solid when its tidal friction partner Io is gone.

The surface of Ganymede seems frozen and dead from the Galileo photos. But it also has had its devotees among Urantia Book students as the life world c andidate. Its chief attractiveness was that it is the largest of these four small worlds, and it has very interesting geology, so to some it seemed the most likely to have life conditions.

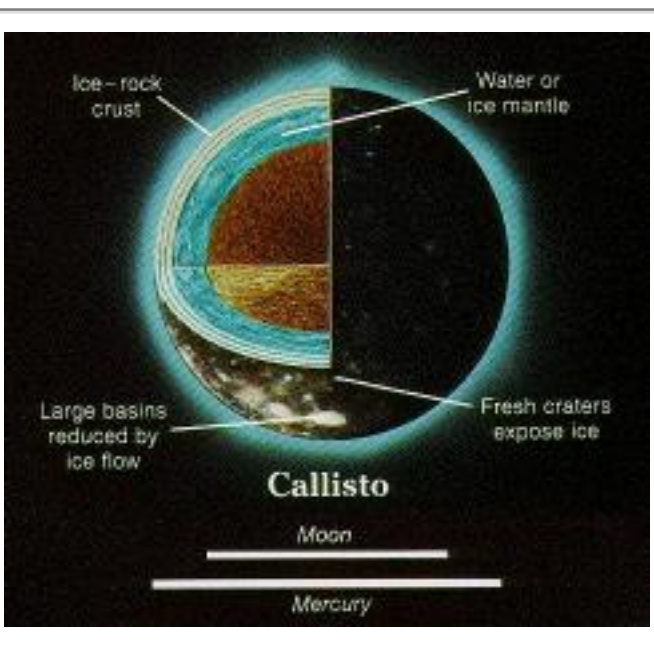
At first Callisto seemed much like its twin in size, Mercury: a boring place where nothing special could possibly have happened, an undifferentiated amalgamation of craters, ice and rock. But Galileo did dutifully make a few relatively close passes at Callisto with its instruments humming.

Protection: Magnetic Field, Ozone Layer

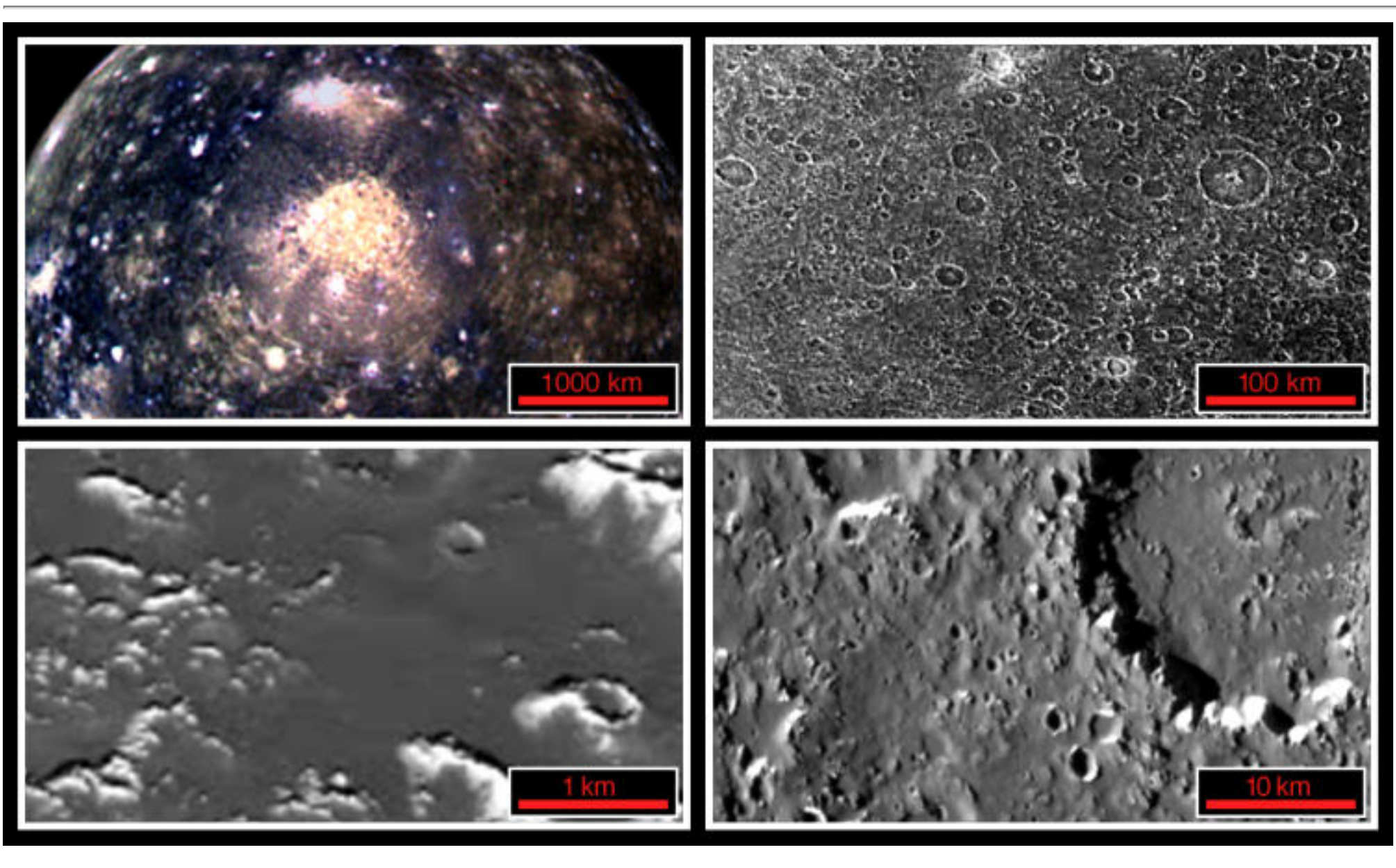
Much to scientists' surprise, in fact unnoticed until long after the readings, Callisto turned out to have a magnetic field. This means that instead of being jumbled stuff all the way to the center as expected, Callisto, in common with Ganymede, must have a rocky core with a layer of circulating salt water or other conductive fluid, less of an ocean than a fluid mantle. Callisto's magnetic field resembles what is seen when a hollow copper sphere (or in this case Callisto's conductive salt water mantle) is subjected to a changing magnetic field (ie Jupiter's rotating field). The electric currents induced magnetically into the conducting layer produce their own magnetic field that exactly counters the imposed field.

The ozone ionosphere is generated by ultraviolet light striking the surface and splitting oxygen from the hydrogen in the ice molecules. Two oxygen molecules will combine to form oxygen gas, O2, and again UV energy can zap a third onto it for O3, ozone.

Together, these provide protection to shelter life from UV radiation and solar particles as they do on our world.



While everyone, both in the Urantia reader community and at JPL-NASA, seemed to be scrupulously ignoring Callisto, Galileo scientists nevertheless noticed a mystery, which seems to have gone largely without comment until very recently. In the close-up views, it was evident that there were few craters beneath about half a mile in size, in fact, few visible small-scale surface details at all, not even rocks. A dark material covered the landscape, leaving only larger crater rims and other peaks exposed. This matter appears to move. Planentary geologist Ronald Greeley said "The surface is being eaten away and blanketed by soft, fluffy stuff." and the vanishing ice theory "As the ice sublimates and is lost, all that is left is the dirt." (National Geographic, P.139): But they are at a loss to explain why it should happen on Callisto but not Ganymede. For that matter, why should such a process so completely smooth or obscure the smaller surface features? Grasping at straws for a rational explanation, they've speculated a static charge "fluffing up" the surface material. Can any dirt, rock powder or gravelly grit really qualify as "soft, fluffy stuff"? And what unknown energy that occurs nowhere else could cause or maintain a static charge millenium after millenium? The Galileo team themselves feel that none of the explanations so far is satisfying.



Four views of Callisto, at global, continental, regional and local sizes, showing the obscuration of small craters, rocks and other surface details by an unknown"soft, fluffy" and "dark" material

Life Chemistry

A NIMS (near infrared mapping spectrometer) reading had previously riveted my attention. The Galileo team had noted sulphur and *carbon*, the basic element of life, as features of the Callistan surface spectrum. Callisto may the only world besides Earth where carbon readings other than in atmospheric gasses are mentioned.

Recently it was revealed in more detail that there have been four unusual absorption spectra features in addition to the expected water ice and hydrated minerals, near a wavelength of four microns:

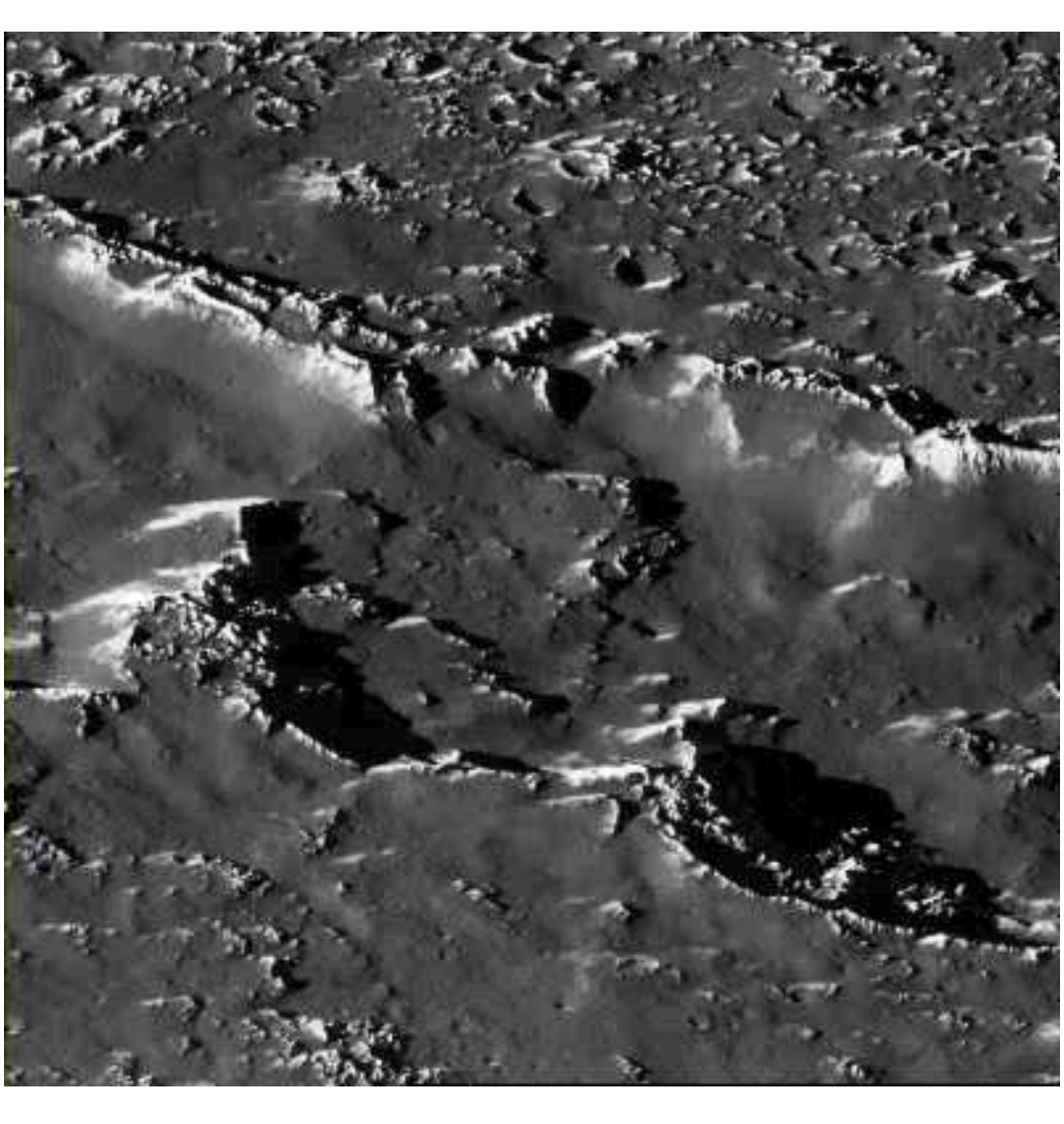
(1) Carbon Dioxide "trapped in the surface". (or perhaps existing as a chemical in living tissue?) There is also a carbon dioxide "exosphere" - a tenuous atmosphere.
(2), (3) These would seem to be sulphur, which could have been blown into space by Io's volcanos, or originated locally, and may or may not be an important part of Callistan life chemistry.
(4) This wavelength, considered by JPL scientists to be the strangest, and with good reason, corresponds to that absorbed by carbon-nitrogen bonds - the chemistry of organic life.

In fact, the lines are similar to laboratory spectra of complex organic molecules termed "tholins" by Carl Sagan. Tholins are thought to resemble organic material in the solar nebula; clouds of interstellar ice grains have comparable spectra. For life, these are some of the most important materials.

The existance of the exosphere is also very interesting. It ought to be lost as ultraviolet radiation from the Sun breaks the carbon dioxide (CO2) molecules into ions and electrons to be swept away by Jupiter's magnetic field. This indicates an ongoing flux of CO2 into the atmosphere. Although the scientists suggest outgassing from the surface, a more likely scenario is that it is given off as a waste product of living organisms, as it is on our planet. This CO2 might be utilized by plants (and animals?) in photosynthesis much as the trace of CO2 in our own atmosphere is.

Evidence for Forests

"Soft, fluffy stuff", organic compounds: could it be vegetation? Unfortunately, the highest resolution pictures are around 20 meters, 65 feet, per pixel or worse (above picture, close-up "Local" view with "1KM" bar). This seems to be too coarse to make out the individual components of the landscape material, as it should be if it were vegetation. PIA00514, below, resembles nothing so much as a forested landscape. I thought, Oh for color photos!, Oh for a closer view!



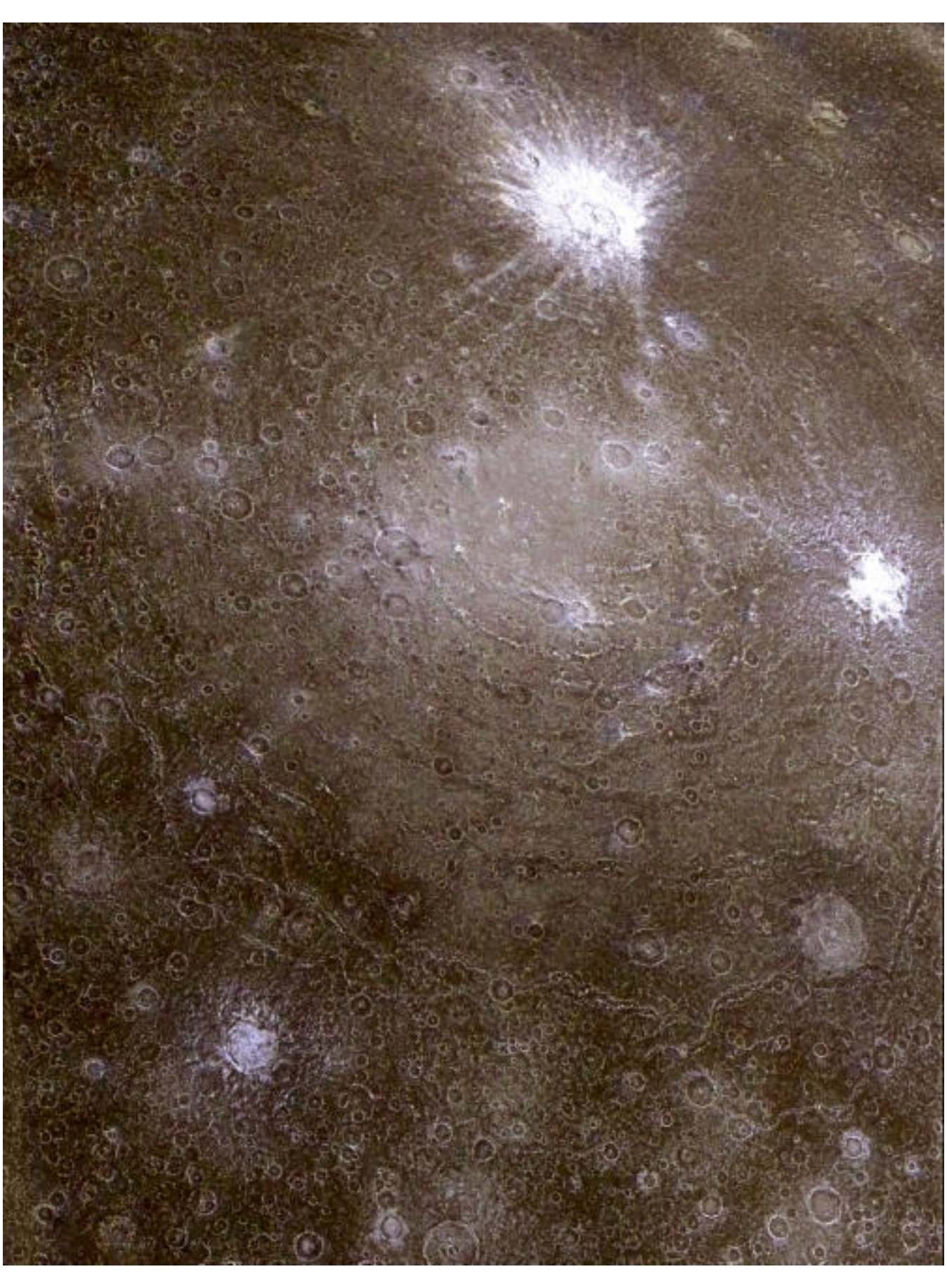
What is the nature of the dark material obscurring Callisto's landscape details except on steep or icy slopes? (each image pixel is around 30 meters, 100 feet, square)

Scanning the Callisto images again, the key was the three or four large-scale color pictures, in particular PIA00562, a continental-scale mosaic view of the Asgard "bullseye" region. It was immediately obvious: Large dark-green patchy regions of Callisto have the appearance of being heavily forested! Other areas show a subtle light lime green: "grasslands"? "scrub brush"? a different family of trees? Anyone who's looked down from a jet over the mountains at 40,000 feet will be familiar with such an appearance of forests from great altitude. Since they cover surface details so effectively, at least in the areas where the close-up views were taken, it would seem that very large bushes or else trees are the order of the sphere. There is more green in PIA00562 than in most space shuttle views of the earth's land areas.

In PIA00562, "Low-resolution color data were combined with a higher resolution mosaic to produce this infrared composite image". What this means is that I'm not completely sure these are natural colors, though I believe they are intended to be. In some of the global images said to be more-or-less natural color, there are hints of green, though nothing so strong as PIA00562. But even if it turns out that these 'greens' are actually another color, I maintain it looks very much like regions of vegetation.

The entire conjecture could, of course, be entirely wrong, reader beware! (<--universal disclaimer - good on any planet! :-) But vegetative cover seems a much better explanation for the lack of surface detail thanthe other conjectures, and I find the close-up pictures and PIA00562 convincing. The green color could conceivably be geological zones rather than trees, indicated by its pattern around Asgard, but it may also be that that owing to underlying geological mineral patterns trees grow well there.

No one even dreamed that such a thing could be, not on cold, cratered, airless and apparently liquidless Callisto, so we didn't recognize the familiar aspects of the scene.



PIA00562, The Asgard Region of Callisto. In this continental-scale mosaic, the lower left appears more straight down, while the curve of the planet's surface bends away to an oblique view towards the top right. Note the patches of green, a color not found in landscapes anywhere else in the solar system except on our own world.

Other Mysteries

Another mystery noted by the scientists is what appears to be erosion in areas of different elevations, especially crater rims sliding or collapsing down into the bottoms at points, these "mud"-flows even spreading out for two kilometers. While the process is unknown, it indicates something active has been at work, and there seems little reason to doubt that it still is today.

Also noticed by the Galileo team are what appear to be pits, of unclear origin. Not all are circular, and they seem distinguished from craters by their lack of rims. Are they "mudslidden" craters, craters partly covered by vegetation, or something man-made, such as open pit mines, or even just clearings in the trees? Could this be our first direct evidence of human activity on another planet?

I have no idea of the chemistry or biology that would activate life on an airless sphere with a surface climate of 120 degrees absolute (-195 Celsius, -320 Fahrenheit). How the first primitive microbes and organisms could move around and spread in an environment with no evident liquid to drift in is beyond me, but perhaps there is hidden low-freezing-point liquid we can't see; maybe softening the soil as evidenced by the "mudflows". And perhaps primitive life there is only active in the heat of the mid-day sun (the day is about 17 of ours, curiously about the same as Saturn's planet, Titan) and hibernates the rest of the time. But it seems there are two temperature zones for life "much colder" than ours as well as two "much warmer" (TUB P. 562-c).

Regardless, TUB says life on non-breather worlds is radically different than on atmospheric worlds, and so is its heat regulation (TUB P.563-564). Perhaps animal life differentiates from plants at a later evolutionary stage - plants or seeds sprout legs and start to creep around. After all, it would seem that non-breathers get some of their energy intake from photosynthesis.

Whatever types of animals there are, there will be none that fly or make sound since there is no air. To us, eerie silence. Physically, the people would be around ten feet tall, very spindly, and slow moving, in accord with the weak gravity, one eighth of ours (evidence: TUB, P.562-b).

Light energy from the rather distant sun is only four percent as strong as in our region, but it is not diluted by an atmosphere and clouds. The trees or bushes are likely to be very tall and spindly, spreading their leaves and branches widely in their quest for light. Not only is there the light gravity, but additionally there is no wind to brace against. They may (or may not) also be very slow growing by our standards. (But they are, seemingly, green!) With the long day and dull sunlight, perhaps the more advanced plants have learned to move their leaves to keep them pointed at the sun.

The Urantia Book says that the advancing races on airless worlds must do much to protect themselves from [micro-] meteorites (TUB P.563-d), and one wonders how they survive to become advanced. Perhaps dense forest or brush cover forms a protective shield for the animals and early human races.

Airhead Ideas

That pretty much covers the essentials. Here are some of my own geographic observations and speculations. No doubt some of them are wrong.

First, altitude as a factor in plant growth on Callisto. One would anticipate that altitude would have no meaning on an airless world, but there is actually some atmosphere of tenuous ozone and carbon dioxide.

But, without other atmospheric gasses to carry it aloft, the ozone, along with the carbon dioxide, may possibly be a quite thin layer near the ground. This could mean that the higher the elevation, the less ozone above it, and the harsher the radiation from the sun. The ozone is, then, generated on the exposed higher bare-ice peaks and drifts down the slopes into the lowlands. This might help to explain why higher crater rims and other peaks are so clear of vegetation: there is a height above which it can't grow owing to UV radiation. Also it is possible the plant life utilizes the tenuous carbon dioxide for photosynthesis, just as here, and it could also thin quickly with altitude.

But I am a layman and have no real idea how high the atmospheric layers might extend. It is just as likely that the slopes are simply too steep, or that they are composed, as they appear to be, mainly of hard, infertile ice-rock in which plants can find no sustenance.

Now back to PIA562 and Asgard. (The center of Valhalla is the big yellowish "lump" in the global images.) The zone towards the center of the Asgard 'Bullseye' seems to have little ground cover. It would seem Asgard and Valalla were formed by huge meteor strikes which broke through to the mantle, causing a tremendous upwelling of water from the mantle. They may have struck earlier in Callistan history when the crust was thinner than today. The series of concentric troughs or crevasses around these two huge structures bespeak of surface shrinkage as these areas cooled and solidified. (Although, a few of the rings near Asgard's center appear to be raised, instead.) Some Valhallan meteor rays may be from the central yellowish material being thrown out by later, smaller meteors whose craters lie within the Valhalla center. Valhalla's ring structure is immense, occupying the major portion of one hemisphere.

If the ozone layer is indeed thin, it would drift away from the lighter materials in the Asgard/Valhalla central regions toward denser ground even if they were not elevated, as such lighter crustal zones would no doubt tend to be. There would be a double effect causing the evident stunting of plant growth revealed in the picture: lack of ozone protection and the impoverished soil, composed mainly of up-welled mantle ice. This idea is supported by the presence of many smaller craters and the concentric rift valleys whose floors seem much greener than the surrounding plains: (a) the elevation is lower and so there would be more ozone, and (b) underground minerals are more exposed. Meteors and comets would also add their own new minerals.

From these geologic or meteoric events may also be taken a theory of why Callisto and not Ganymede was suitable for life implantation. Callisto, being smaller, only had local regions where the segregation of the planet's inner layers involved the surface beyond an early date, and it cooled sooner, so mostly the surface retained the original rich minerals brought to it by meteoric and cometic accretion. On larger Ganymede, major portions of the surface, if not all of it, became involved and most of the heavier minerals sank into the planet, leaving mainly unfertile ice "rock" in the surface layers. This is the undoubted case on Europa, warmed by tidal friction, where even today meteors seem to break through the thin ice sheet and end up uselessly under the ocean. It is estimated that 20% of Callisto's surface is ice versus 50% on Ganymede. Euro pa must be close to 100%.

A separate factor in Callisto's habitability may be that it is the only Jovian world outside Jupiter's plasma torus, a giant donut shaped ring of charged particles orbiting Jupiter, originating in Io's volcanos and affected by Jupter's magnetic field. Whether this is significant I'm not sure.

Many large Callistan craters are glaringly white with no apparent ground cover. Perhaps these apparently blighted zones were caused by comets composed mainly of ice. Or, the heat generated by such large impacts melted the ice in the soil, or the object broke through to the planet's water "mantle", causing the other minerals to sink and leaving bright, unfertile ice at the surface.

It may be speculated that the Callistans must surely find their neighboring worlds much more environmetally friendly than we do ours, perhaps even livable. Ganymede and Europa are of similar gravity and in the same temperature belt as Callisto, and have similar sorts of magnetic fields and ionospheres. Since they are non-breathers, there is no atmospheric requirement.

On the other hand, it is very unlikely they will come to visit us on our world. What with its hellish heat, crushing gravity, blinding lighting, its toxic pressurized gas envelope, and the fact that it is 3/4 covered with molten rock, their scientists may well assume that the third planet could not possibly be inhabitable by any conceivable form of life.