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Geologic Map of Europa Highlights Targets for Future Exploration

Differentiating between a mountain range and a huge crack sometimes can be difficult, said planetary scientist Alex Patthoff. At least it's difficult when you're trying to identify features on a tiny moon nearly 600 million kilometers away.

This is just one of the obstacles Patthoff, a researcher at the Planetary Science Institute in Tucson, Ariz., and a team of scientists faced as they spent weeks poring over images of Jupiter's moon Europa to create the first global geological map of its surface. Patthoff and his colleague Erin Leonard first presented the research in October 2017 at the Geological Society of America's annual meeting in Seattle, Wash., and again at the 2017 AGU Fall Meeting in New Orleans, La.

Destination: Europa

At 3,100 kilometers in diameter, Europa is the smallest of the Galilean moons, which also include Callisto, Io, and Ganymede. It's one of the few moons in the solar system suspected of having a global ocean underneath an ice shell—a boon for scientists looking for life beyond Earth. Europa may even host geyser-like plumes similar to those on Saturn's moon Enceladus.

Europa's surface also seems relatively young: Although the other moons are pockmarked with craters, scientists see barely any on Europa's surface. This absence of craters could mean that its surface continuously forms anew, thus making Europa a geologically active world.

The Voyager spacecraft first revealed Europa's strange, red-streaked surface in 1979; the Galileo mission then discovered the internal ocean. Since then, scientists have wanted to return. NASA already has plans: In the 2020s, it intends to send an orbiter called Europa Clipper to the icy moon. And someday, it would really like to send a lander, but that dream is entirely hypothetical at this point.

But before we can send an orbiter or a lander, scientists need to know where to point the spacecraft to collect data, which means they need a map. Now they have one.

> "Most of the weirdness, for me at least, rises from the complexity of the surface."

Mapping Ice

To create the map, the researchers stitched together more than 100 images from the Voyager and Galileo missions to form a mosaic and then spent weeks identifying and categorizing surface features. These features include cracks, ridges, impact craters, regions called "chaos" where the icy surface seemed turbulently disrupted and uneven, and more.

Some problems arose—like trying to differentiate between a ridge and a crack, Patthoff said. Light sometimes plays tricks on the brain—a ridge can cast a shadow dark enough that it looks like a crack, for instance.

The finished map "really shows how the tectonics of the band structures and the chaos regions interact with each other at a global scale," said David Senske, the deputy project scientist for the Europa Clipper mission.

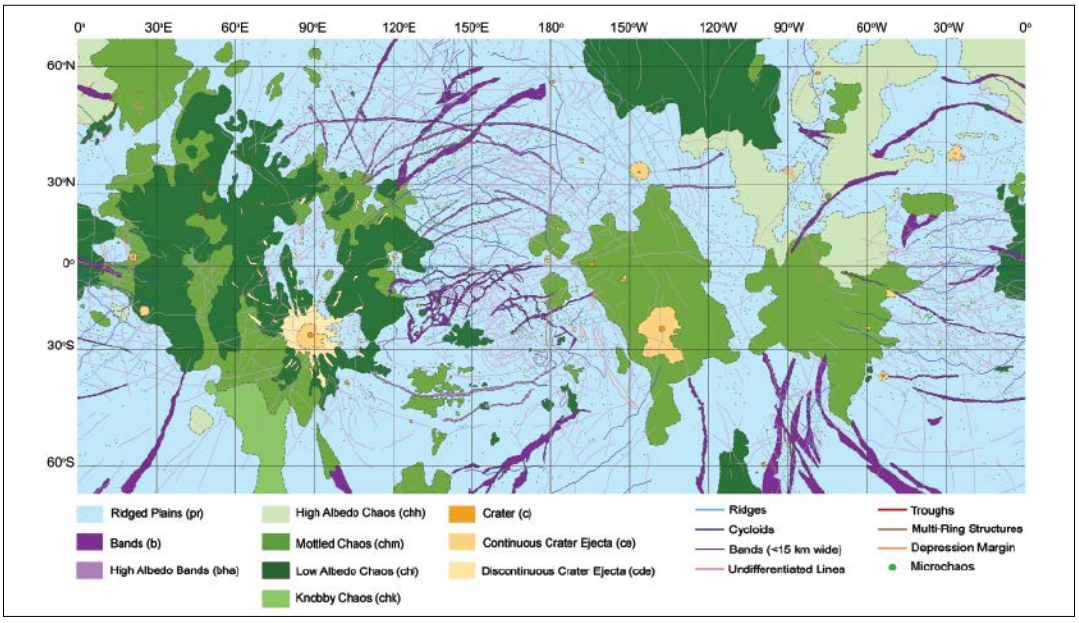
Global View

The global view allowed the mappers to start formulating more and more questions: Why are some features smooth lines and others jagged? What creates the chaos terrain? How does the internal ocean interact with the icy crust?

"Most of the weirdness, for me at least, rises from the complexity of the surface," said Leonard, who is a graduate student at University of California, Los Angeles and coauthor on the research. "I had only studied one region of Europa in depth, so the wide variety of features and the intense complexity of the surface were a bit shocking once I started looking at Europa's entire surface in detail."

One question Europa scientists hope to answer, among many, is, How thick is the moon's icy crust? A 20-kilometer-thick crust of ice could imply that convection occurs beneath the surface and no direct interaction takes place between the internal ocean and the surface. If the crust is just a few kilometers thick, however, the internal ocean could be interacting directly with the surface, creating the features spotted by Voyager and Galileo.

Now, armed with a shiny new map, scientists can target locations for future study to start answering their many questions.



Scientists created this map by stitching together more than 100 images of Europa's surface from the Voyager and Galileo spacecraft, then manually identifying key features. For polar projections, read the full article on Eos.org at http://bit.ly/EuropaGeoMap. Credit: NASA/Erin Leonard, Alex Patthoff, and Dave Senske, building on work by Ron Greeley, Thomas Doggett, and Melissa Bunte

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