Global view of Io's volcanic activity suggests that tidal heating is concentrated within its upper mantle

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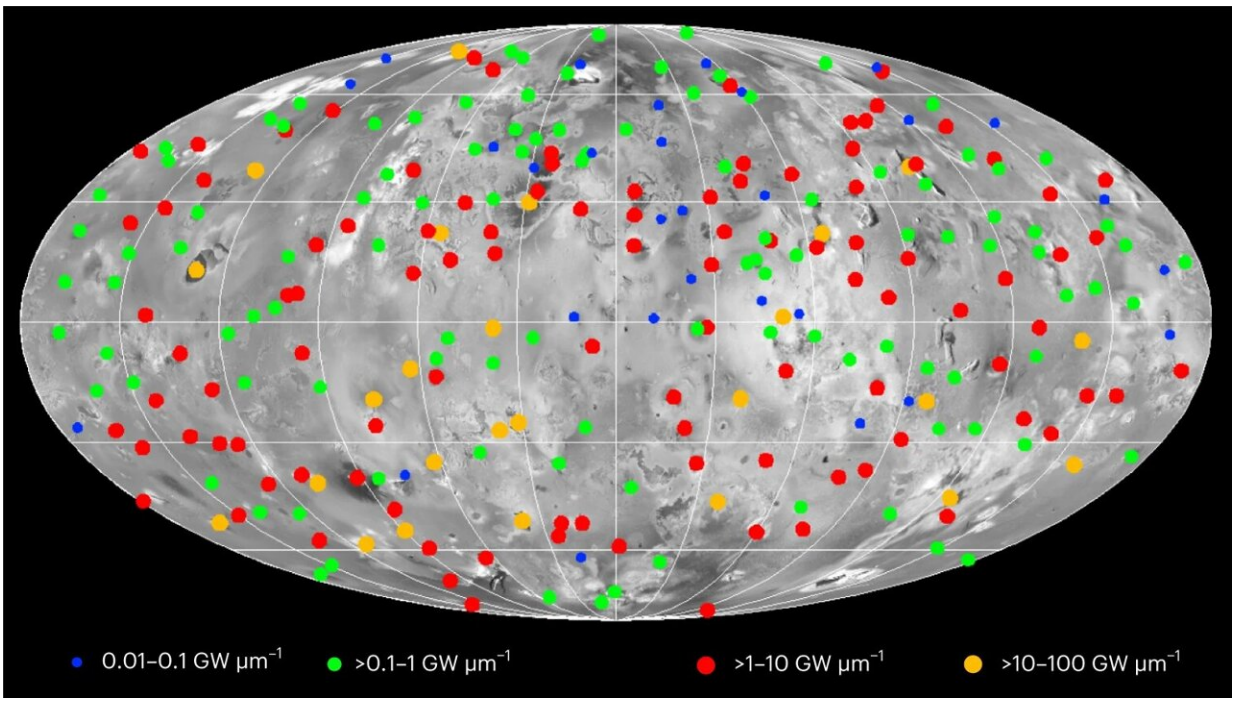

Hot spot detections. The maximum, unsaturated 4.8 μm (M-band) spectral radiances from 266 hot spots identified in Juno JIRAM data obtained from March 2017 to July 2022, using data from orbits PJ5 to PJ43 grouped by order of magnitude. The larger the symbol, the greater the 4.8 μm spectral radiance. This is an equal-area Mollweide projection centered on 180° W, 0° N. The grid size is 30°. 4.8 μm is a wavelength sensitive to the thermal emission from young, hot lava on the surface of Io[20]. Our hot spot detection numbers and distributions (Tables 1 and 2) differ substantially from those of ref. [17]. Credit: *Nature Astronomy* (2023). DOI: 10.1038/s41550-023-02123-5

A team of volcanologists and planetary scientists from NASA's Jet Propulsion Laboratory, California Institute of Technology, the University of Arizona, and Arizona State University has found via study of a newly created global view of Io's volcanic activity that its tidal heating is likely concentrated within its upper mantle. In their study, reported in the journal *Nature Astronomy*, the group analyzed data from sensors measuring heat emission from the closest of Jupiter's innermost moons.

Prior research has suggested that Io, one of Jupiter's moons, is the most volcanically active object in the solar system. Its surface is covered with caldera and red rivers of molten rock. Scientists would like to know the source of the heat driving this activity but have been unable to find the evidence they need.

They suggest the ultimate source is Jupiter's gravity—it exerts a changing pull on the moon due to changes in the distance of the moon from the planet. This results in friction in the moon's rocky material, resulting in heat production. What they do not know is whether the heat originates deep within the moon or closer to its surface. In this new effort, the researchers report evidence that suggests it is the latter.

Up until recently, most of the data regarding heat emission from Io have been focused on its equator—data from probes that passed near the moon and Earth-bound instruments have given scientists a lot of data for the moon's midsection but very little about its poles. Such data is needed, the research team notes, to learn more about where the underground heat is coming from.

In 2016, the Juno spacecraft began orbiting Jupiter around its poles, giving researchers studying Io a way to learn more about heat emanating

from its poles, as well. The research team on this new effort was able to combine the new data with the old to create a global heat map for the entire moon.

They were able to map 266 volcanic hotspots and found that the moon was emitting 60% more heat along its lower latitudes than its higher latitudes—a characteristic of the moon that suggests the heat responsible for much of the volcanic activity is located just below the surface. If that is the case, the researchers suggest, it could mean that Io has a soft upper mantle or even a molten ocean beneath its crust.

More information: Ashley Gerard Davies et al, Io's polar volcanic thermal emission indicative of magma ocean and shallow tidal heating models, *Nature Astronomy* (2023). DOI: 10.1038/s41550-023-02123-5