The role of volatiles in volcanism on Io

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Sulfur and sulfur dioxide volatiles play a significant role in the volcanism on Io, the innermost of the large moons of Jupiter. However their abundance appears to vary greatly from one location to another, for reasons that are as yet poorly understood. At Pele the volatiles are abundant enough to drive plumes which carry material hundreds of kilometers above the surface. At Loki their abundance is smaller yet the activity, while less violent, may still be strongly influenced by volatiles. In the foundering-lava-lake-crust model for recurrent activity, developed by Rathbun, the volatiles and their vesicles provide the required buoyancy for the crust and therefore control the timing of the eventual foundering. Volatiles may also act to modify the temperature distribution we see with thermal infrared measurements. We have been conducting a detailed analysis of spacecraft data to quantify the amount and the role of the volatiles at these and other sites.

At Loki numerous small bright features, which for historical reasons are colloquially known as bergs, are distributed across the dark patera surface. Modeling of colors in the best available images (from Voyager I) shows that small parts of the patera are bare basalt but much of the background patera is covered by 20 to 40 percent sulfur, with the exact coverage depending on assumed sulfur grain size. At the bergs, most of which are only partially resolved, coverage is at least 33 percent, probably ranging up to 100 percent. The bergs may in fact be fumarole deposits on the basalt crust. However the largest bergs appear to survive successive resurfacings, which implies they represent something less ephemeral than simple surface deposits, and are perhaps higher standing kipuka.

In addition to Pele and Loki, we are analyzing the volatile distribution at other hot spots such as Tupan. Tupan shows an overall morphology similar to Loki, with a central island and one straight margin. However rather than showing bright bergs in a dark patera it shows a more complex pattern which varies across the patera. However a detailed analysis of the reflectance shows that sulfur is abundant on many of the surfaces within the patera.