Review on "A post-Galileo view of Io's interior"

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Io is known as the object having the most active volcanism in the solar system. Locked in a resonant orbit around Jupiter, it circles the planet twice as often as Europa. The incredible forces that it is subjected by Jupiter and the other Galilean satellites cause it to strech and heat up. Since the predictions of this extreme geological activity, scientist have been interested in figuring out what kind of precesses rule Io's interior. This paper presents a pausible model for Io's structure based on results from Galileo's flyby.

During the Voyager flyby era in the late seventies an initial model for this satellite's interior was suggested. It was proposed that Io had a crust a few kilometers wide which was constantly streched by tidal forces. The tidal heating would completely melt the mantle and mainly sulfur and basaltic magma was released into the surface via volcanic eruptions. Alterations were made to this model in order to allow for the existance of large mountains in Io which could not be supported by a thin crust. It was then suggested that this moon was made of a thick solid silicate crust (30 km or more) on top of a slightly melted mantle from which most of the heating was coming from. This is what was commonly agreed on prior to the Galileo flybys. After analyzing Galileo images between 0.4 and 21 microns, the authors present a model which is closer to the views in the seventies than prior to the mission. They expect Io to have a molten Fe-Sulfur core roughly half the size of the moon, a mantle that is nearly half molten near the crust and a thinner crust of about 13 km. New Galileo images indicate much higher temperatures for the lava than previously expected, close to 1900K at some locations. This shows that silicate lavas are continually erupting into the surface since sulfur vaporizes at about 700K. The color of the images also suggest that these lavas are made of ultramafic materials (low percentage of Si, high on Mg and Fe). If Io has been as active since its formation its interior would be highly differenciated and the crust low density by now. Then there could not be any high-melting-temperature lavas present. This means that the crust has to be continually recycled back into the mantle. As new material is pushed in, the cold crust is compressed and mountains are formed. These extreme compressions slow down the rise of magma from the mantle, so it is possible to have close to half of it molten, in contrast with the pre-Galileo views of a nearly solid mantle. The authors used a thermodynamic model to estimate the melt fraction on Io's mantle as function of lava temperature, in order to arrive to their 30-60 percent molten mantle claim. Galileo's magnetometer experiment showed an absence of magnetic field for Io which would indicate that its core is not convecting. Two features seen on Io's surface called plumes and paterae might be supported by their picture. Plumes are caused by material being spewed 100-200 km high above the surface and paterae are depressions filled with lava. Magma rising towards the crust can heat up volatiles right underneath the crust that could escape through vents creating plumes. Paterae could be created as the intruding magma unroofed small sections of the crust. This model, although controversial, seems be able to explain Galileo data.

Keszthelyi et al. A post-Galileo view of Io's interior. Icarus 169, 271-286. 2004