SPACE SCIENCES

Jonathan Eberhart reports from Houston at the Lunar and Planetary Science Conference

Io off and on

The spectacular volcanoes on Jupiter's moon Io, a scientist has tentatively concluded, may be a sometime thing, with eruptions taking place only about 10 percent of the time. Those active periods, however, suggests Guy J. Consolmagno of the Massachusetts Institute of Technology, may be thousands of years long.

The currently favored explanation for the energy source of Io's volcanism is "tidal heating," energy generated by gravitational wrenching of the tidally raised bulge on the side of Io that always faces Jupiter. The gravitational forces shift because Jovian satellites outside Io (Europa and Ganymede) pull Io's otherwise circular orbit into an ellipse.

But Io's volcanoes have seemed to be too hot. The authors of the tidal-heating idea (who predicted its presence even before the Voyager 1 spacecraft discovered the eruptions) calculated that, averaged over Io's lifetime, the satellite should be putting out no more than 800 ergs of energy per square centimeter per second, and probably more like 400 or less. Yet Io's heat flow has been measured to be in the range of 1,000 to 2,000.

Consolmagno's suggested resolution for the quandary came from a computer model of Io's thermal evolution, beginning with its very formation. After Io came together, or accreted, it began to heat up, though the initial version of the model indicated that the heat would rapidly escape by convection to the surface of the still-solid object. "After about half a million years," Consolmagno says, "the damn thing re-froze on me." He then modified the model to include the chemical changes that would have been produced by the heat, notably the deposition of a kilometers-thick layer of sulfur on the surface. The sulfur would have acted as an insulator, efficiently keeping the heat inside until the temperature rose enough to melt rock to within 10 km of the top.

This melting, Consolmagno says, would result in explosive eruptions of sulfur for a time, but the eruptions would also release enough heat to space that after a while the region immediately beneath the volcanoes would cool off, and the eruptions would stop. The tidal stresses would continue to generate more heat, however, and in time more eruptions would occur (though probably far from the regions of the previous ones, which had most recently received a cooling).

The result would be that Io would alternate between emitting the vast amounts of heat that have been measured and sealing most of the heat inside. The volcanoes, according to Consolmagno, "serve to expel in a short period of time the heat that had been building up over a period 10 times as long." If so, it means that the Voyager spacecraft was simply lucky to visit Io when the satellite happened to be "going off," though Consolmagno estimates the length of the active phases to be "less than 15,000 years"—which could encompass roughly the age of civilization. (One question raised by Consolmagno's model is why the eruptions would start and stop all over Io at about the same time.)

A different idea, at least for further study, was posed several months ago by Rick Greenberg of the Planetary Science Institute in Arizona. It too calls for Io's "ons and offs" to be global, but on a vastly different timescale, with only a handful of on-off cycles in the satellite's lifetime. Perhaps, Greenberg reasons, the tidal heating itself varies. As the forced eccentricity of Io's orbit leads to energy dissipation and melting, he reasons, Io becomes less rigid, making its tidal bulge more free to grow. This in turn leads to a reduction in the orbit's eccentricity, which could conceivably reduce the tidal heating enough to, in effect, "turn off the burner." As the satellite cools and resolidifies, its orbital eccentricity increases again, and a new heating cycle begins. (Charles Yoder of Caltech has yet another idea — that Io only recently reached the orbital resonance with Europa that "pumps up" the eccentricity in the first place.)

NASA to establish cosmic dust lab

The National Aeronautics and Space Administration's Johnson Space Center in Houston, home base for Apollo moonrock samples and Antarctic meteorites, will soon take on the care of another category of extraterrestrial material: cosmic dust. By about June 1, says JSC lunar and planetary division chief Michael Duke, the center will be the site of "the only laboratory dedicated to all facets of cosmic dust study"—preservation, typing, distribution and even some of the actual analysis.

Cosmic dust particles, typically from 1 to 100 microns in diameter, are collected on oil-coated plates mounted to high-altitude aircraft. The idea has been around since the early 1960s, says Duke, but it was the mid-1970s before analysis techniques became sophisticated enough to spot the tiny particles (the total known "crop" weighs a few *millionths* of a gram) and distinguish them from other materials such as aluminum oxide particles left in the atmosphere by rocket exhausts.

The optimum altitude for collecting them seems to be about 60,000 feet, says Duke, which is above the levels at which other particles might confuse the issue but low enough for the density of the atmosphere to slow down incoming cosmic dust grains so that they accumulate in significant numbers. Most of the collecting to date has been done with a U-2 aircraft, but NASA will soon begin using a converted B-57, whose greater payload will enable the dust collectors to remain in place even when the plane is being used for other purposes. This will nearly triple the annual collecting time, Duke says, and new collector plates promise more than five times the combined area of those on the U-2.

The cosmic dust laboratory will be a small room, only a few meters on a side, rated as a "Class 100 clean room." A filtration system and other safeguards will ensure that the room's air exposes the particles to no dust particles larger than 0.3 microns, and no more than 100 smaller ones per cubic foot of air.

The poles of old Mars

Three spots on the surface of Mars, all of them within 15° of the equator, show signs of once having been at the poles, according to Peter H. Schultz and A.B. Lutz-Garihan of the Lunar and Planetary Institute in Houston. The implication of these possible "paleo-poles," says Schultz, is that redistribution of the planet's mass by internal activity shifted the crust.

Viking spacecraft photos from orbit, he says, show the regions to have curved valleys like those in the present polar caps, "pedestal craters," whose shapes suggest that they formed in now-vanished ice, and signs of laminated terrain reminiscent of the present caps' familiar layering, which could indicate cyclic climate changes.

The present poles represent a stable position established after the formation of the huge Tharsis rise, the scientists report, while the proposed paleo-poles (A, B and C on the map, by increasing age) existed after, during and before a no-longer-evident mass redistribution associated with the volcanic Elysium region, a fourth of the way around the planet. If crustal volcanics are due to a mantle plume that is fixed relative to the Martian spin axis, the authors suggest, the proposed polar wandering can also account for the northwest trend and age sequence of the line of huge volcanoes along the Tharsis ridge.

Schultz and Lutz-Garihan