PHYSICAL SCIENCES

Jonathan Eberhart and Janet Raloff report from the meeting in Miami Beach of the American Geophysical Union

A mascon on Mars

One of the significant early spacecraft discoveries about the moon was the identification of "mascons," or mass concentrations, in the lunar crust. They are believed by some researchers to have been formed by meteorite impacts in the relatively low-density crust, leaving craters that are then filled in by denser lava flows. The density may have been further enhanced from beneath by a "rebound effect" causing mantle material to rise into the crust beneath the crater. Such features are rare, or at least hard to identify, on the still-evolving earth. But a just-completed analysis of data from the Viking 2 orbiter now reveals what William L. Sjogren of Jet Propulsion Laboratory calls "our first Martian mascon."

It is located in the northern hemisphere of Mars, at the site of a well-worn (and thus presumably aged) basin named Isidis Planitia, centered at 12°N by 271°W. The mascon's discovery — by its presence as a gravitational "high" that is also a topographic "low" — was made possible only last October, when the spacecraft's orbit was changed to bring it as close to the surface as 300 kilometers, with the orbit also at a sufficiently high inclination to the equator and with the low point on a radio line-of-sight to earth. The low periapsis was necessary because the mascon creates such a subtle perturbation, amounting to only 0.00006 of the primary gravitational field. In terms of the mascon's effect on the material beneath it, says Sjogren, it produces an excess downward pressure, or loading, of about 1,000 kilograms per square centimeter.

It may be the only mascon in the Martian northern hemisphere (at least to the 60°N latitude limit of the data), Sjogren adds, but it is not yet known whether there are others in the south. That will have to wait until the orbiter's low periapsis crosses into the southern hemisphere in late July — or perhaps until the next mission to Mars, possibly a decade from now. The reason is that Viking orbiter 2 may be about to run out of steering gas (SN: 4/1/78, p. 197), unless its dwindling supply can be husbanded for a few more months of operation.

The methane boom?

The loud and mysterious "booms" reported in recent months (SN: 3/25/78, p. 181) — and explained by some researchers as sonic booms from aircraft — may instead be a symptom of a widespread process that could represent a major potential energy source, according to Thomas Gold of Cornell University. At least some of the booms, he says, do not correlate with aircraft flight times, and may be explosions of methane gas released from the depths of the earth's crust. Deep enough wells, Gold says, while they may be expensive and difficult to drill, "may tap into virtually limitless supplies" of methane.

Gold believes that "a substantial fraction" of carbon-containing gases released from the earth's interior is in the form of methane. Although carbon dioxide is a more likely form to emerge from volcanic vents, he says, "thermodynamic considerations indicate that methane is favored when the pathway is a cool fault line," such as created by the fracturing of deep rocks from subterranean stresses. Such fracturing "can only take place when a high-pressure gas is present that can hold open the fractures and allow sudden slippage." The resultant outgassing, he says, may be responsible not only for the reported booms, but also for such phenomena as "earthquake lights" (ignited by sparks in the flowpath to the surface), vast areas of bubbles at sea and such "recognized" earthquake precursors as changes in electrical conductivity and ground-water levels.

"Although the amounts that must have come to the surface on an average per year are only a few tens of millions of tons — not enough to make any dent in the fuel problem — there is good reason to believe that one can learn to tap into regions where the deep gases have begun to force their way to the surface," Gold says. Although the required new technology may pose substantial problems, he adds, "having once achieved it, there is the hope of abolishing the fuel shortage altogether."

Earthquakes and nuclear power

The risk that an earthquake will occur "equal to or in excess of" the maximum intensity that New York's Indian Point nuclear-power plants are designed to withstand, is 10 times higher than previously estimated by Nuclear Regulatory Commission seismologists, say Yash P. Aggarwal and Lynn R. Sykes of Columbia University. Assuming reactor lifetimes of 40 years, the risk that an intensity seven quake (on the Modified Mercalli scale) will occur is "about 5 to 11 percent," they say; NRC placed the risk at 0.5 percent. And the chance that even greater quakes will occur is "about two percent," they say.

With data from a recently installed seismic network, they established precise locations for 33 small quakes, since 1962, on or near the Ramapo fault. NRC's hypothesis that the Ramapo is dead "appears tenable only in the near absence of local instrumental data," they say. Historical accounts show three quakes of intensity 7 (the last in 1927) during the past 250 years. Although they "cannot be unequivocably associated with a specific fault," the Columbia scientists say in the April 28 SCIENCE that "evidence" exists for a link with the Ramapo.

A major Ramapo branch, the Thiells fault, runs within a mile of the Indian Point reactors, they say. And they cite an unpublished 1975 report that an individual fault, "possibly of the Ramapo system ... passes beneath reactor unit 3."

NRC hearings "brought out ... problems about the applicability of existing federal regulations to sites in the East," they say. A fault is considered "capable" of causing quakes only if it is shown to have moved during the past 500,000 years or if instrument data show a direct correlation between "macroseismicity" and the fault, they say. But it is difficult to measure whether Ramapo's 150-million-year-old rocks have moved recently, they say. And the term macroseismicity is neither defined by NRC regulations nor used commonly by seismologists, they say.

NRC's Carl Stepp says reactors are generally overdesigned with "two or three orders of magnitude" better construction than is needed, especially in major reactor parts like the containment vessel.

Earthquakes and tidal cycles

In recent years scientists have considered the possibility that small changes in the earth's rotation can play an important role in triggering earthquakes. Now T. R. Visvanathan, a geologist at the University of South Carolina's Union campus, has correlated changes in the earth's rotation, attributable to tidal forces of the sun and moon, with historical records of quakes in the Charleston-Summerville region of South Carolina. He found earthquake cycles corresponding to: the lunar anomalistic period (interval between successive moon-earth perigees) of about 27.5 days, the synodic period (interval between "new" moons) of about 30 days, the earth year, and the nine-year precession of the lunar-perigee point. There also appears to be a 90-year earthquake-activity cycle he says.

These correlations, he says, indicate that if an important quake occurs in the study area over the next 10 years, it will happen between 1979 and 1983. And its intensity will not exceed 7 on the Modified Mercalli scale (measured from 1 to 12), he says. More than a quake-prediction tool, these correlations may provide clues as to what causes earthquakes, he says.