First-Look Maps of Saturn's Moons

Almost nothing was known about Jupiter's Galilean satellites — Io, Europa, Ganymede and Callisto — before the Voyager 1 spacecraft visited them in March of 1979, even though they are so big that Galileo himself discovered them (hence the name) through his primitive telescope in the early 17th century. The moons of Saturn are nearly twice as far from earth, and, with the exception of Titan, far smaller than any of the Galileans, so it is hardly surprising that still less information existed about them in the astronomical record.

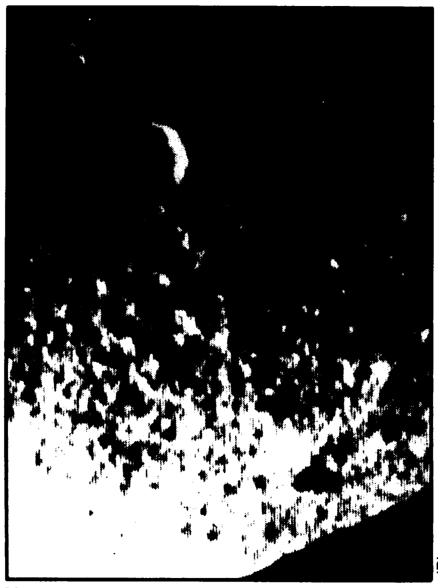
Last November, Voyager 1 flew through the Saturnian system to begin setting the record straight, a task that will continue when Voyager 2 flashes by late this coming August. Voyager 1's cameras were frustrated by the dense atmosphere of Titan, but revealed the strangely varied crater sizes of Rhea, widespread wispy streaks on Dione, a vast crack extending a fourth of the way around Tethys, one of the deepest known craters in the solar system on little Mimas, and more.

Now many of the photos have been used to prepare maps of the above four moons, just as was done for the Galilean satellites (see SN 117:251, 283, 315, 345). Drawn by artists at the U.S. Geological Survey's Branch of Astrogeologic Studies in Flagstaff, Ariz., they attempt to present the satellite surfaces free from camera-angle distortions, shadow effects and other potentially misleading influences. The maps are still preliminary — precise positions of surface features are still being refined, names for them have not yet been approved by the International Astronomical Union, and Voyager 2's additional photocoverage is months away — but they provide the first near-global looks at the solar system's most recently explored members.

They were drawn by airbrush, freehand, working directly from the Voyager 1 photos. Where the photos seem blurrier or lower in resolution, the maps have deliberately been rendered the same way in order to prevent possibly erroneous extrapolations with the exotic terrain. Planetary cartography chief Ray Batson pointedly prefers non-geologists as his artists, in fact, to minimize any possible tendency to make the alien landforms look like more familiar features on earth.

The map of Rhea — or at least of all the parts that were photographed with sufficient resolution (the cutoff point was about 40 kilometers per line pair) — appears on pages 108-109 and the cover of this issue of Science News. Dione, Tethys and Mimas will appear in upcoming issues.

"Callisto," one researcher observed after seeing the first Galilean-satellite photos, "may well turn out to be the most heavily cratered body in the solar system." Indeed, it showed virtually nothing else — no mountains, no crevasses, just craters, shoulder to shoulder. But Rhea seems to be more crater-ridden still, with the characteristic ring-walls sometimes cutting across one another as though there was simply not enough room for all the meteorites, large and small, that struck it.


JPL

Voyager 1 photo of heavily cratered Rhea was used in mapping the satellite's surface.

Strangely, according to Laurence Soderblom of the USGS, parts of Rhea look as though the largest chunks were missing from the meteorite mix that hit everywhere else (SN: 11/22/80, p. 325). One interpretation of this, he says, could be that those parts were smoothed over by internal activity following the great meteorite bombardment believed to have done most of the solar system's cratering some four billion years ago, so that the smooth areas now preserve evidence of a later bombardment by a different batch of objects that lacked the biggest pieces.

Soderblom's view is not unanimous among the Voyager scientists, and it raises the question of what would produce the heat necessary for internal activity in a body that is mostly ice and less than half the size of earth's moon. There are also a few large, smooth areas still visible on Rhea (one is centered at about 5°N by 30° on the map), not unlike the lava-filled maria on earth's moon, though it has been suggested that solid ice could, over time, simply have "flowed" back to fill them in.

Voyager 2 will not add a great deal to the existing Rhea photo-coverage, since it will pass nearly nine times as far from the satellite as did Voyager 1. But even the photos now in hand, barely three months old, will, like the map, yield more information as researchers spend more time studying their latest planetary horizons.

Next: Dione. □

Council turns down Peru quake forecast

In its first major action, the year-old National Earthquake Prediction Evaluation Council has rejected a prediction by two U.S. government scientists that a series of large earthquakes will occur in Peru beginning in June 1981.

The evaluation, completed following a meeting of the two scientists and the 12-member council held Jan. 26 to 27, came at the request of the Peruvian government. According to reports received at the U.S. Geological Survey in Reston Va., when news of the prediction was made public in Peru last year, there was general alarm and a scramble to make airline reservations to leave the country. The episode points out the delicacy required in issuing earthquake predictions and raises questions about the responsibility of scientists making such forecasts.

Brian Brady of the U.S. Bureau of Mines and William Spence of the U.S. Geological Survey, both in Denver, Colo., outlined their forecast at a meeting on earthquake prediction held in San Juan, Argentina, on Oct. 20. The scientists could not be reached for comment, but earlier news accounts reported that the predictions were based on a method called the "inclusion collapse theory." According to this theory, inclusions are areas of deeply buried rock that have become weakened by cracking and that eventually give way in an earthquake. The scientists believe that such inclusions have developed in the oceanic plate that descends along the coast of Peru, and that a precursory pattern of tremors has occurred in the region. Because of the size and position of the proposed inclusions, Brady and Spence forecast that a magnitude 7.5 to 8.0 event would occur on or about June 28, a magnitude 9.2 quake about Aug. 10 and a magnitude 9.9 event about Sept. 16. (The scientists used the Kanamori scale, which includes the energy released in low-frequency tremors. A major 1960 quake in Chile measured 8.3 on the Richter scale, 9.6 on the Kanamori.) The predicted epicenters are all near Lima.

The council, which was created by law in 1977 and met for the first time last year (SN: 3/1/80, p. 136), responded, "...nothing in the observed seismicity data, or in the theory insofar as presented ... lends substance to the predicted times, locations, and magnitudes of the earthquakes. The council regrets that an earthquake prediction based on such speculative and vague evidence has received widespread credence outside the scientific community."

Among the objections to the predictions voiced by the council and other earthquake researchers interviewed by SCIENCE NEWS are inconsistencies in the data and in the predictions themselves, the "unrealistic" detail of the predicted magnitudes, times and locations and the fact that the theory has not been reviewed and published in the scientific literature. They add, however, that the region is very active seismically and has been identified as having the potential for a large quake. Even so, the council stated, "...none of the members of the council would have serious reservations about being present personally in Lima at the times of the predicted earthquakes." □

A larger role for opiate receptors

When Candace Pert and Solomon Snyder of the Johns Hopkins Medical Institutions reported in 1973 the first evidence for opiate receptors in the brain, it was a landmark finding, since it not only indicated that the brain has neural receptors for morphine but led the way to the discovery of the brain's own natural "morphine," the enkephalins (SN: 11/22/75, p. 327).

But research into the opiate receptors is just beginning, it seems. Pert (who is currently with the National Institute of Mental Health in Bethesda, Md.) and colleagues are now finding that the opiate receptors seem to be involved in much more than the mediation of pain relief. Apparently, they are involved in the filtering of sensory stimuli into the brain.

In the September PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, Pert and Miles Herkenham of NIMH described a simple method for visualizing drug and neurotransmitter receptors in the brain. And in the same paper they reported evidence that opiate receptors coincide within the visual, auditory, olfactory and somatic nerve circuit of the brain and that these opiatergic pathways lead to the limbic area of the brain, which is known to be involved in the processing of emotions. These findings suggested that the receptors control incoming sensory information and that this sensory information is ultimately processed in the limbic area of the brain. In fact, the receptors may even place incoming sensory information in an emotional context along a pleasure-pain continuum.

And in a paper now in press with SCIENCE, Pert, along with NIMH colleagues Michael E. Lewis, Mortimer Mishkin, Evgeni Bragin, Roger M. Brown and Agu Pert, reports that the opiate receptors are not only present in the brain's sensory circuits but that the receptors increase in number as they progress along these nerve pathways, ultimately ending up in the limbic area of the brain. So the receptors may very well be involved in the processing of sensory stimuli in the brain. In fact, Candace Pert and her team suggest that the opiate receptors may work in reverse as well — that is, convey emotional messages from the limbic area to the sensory nerve circuits. This way, they say, "emotional states essential for individual and species survival could influence which sensory stimuli are selected for attention." □

Clues to anxiety: The inosine difference

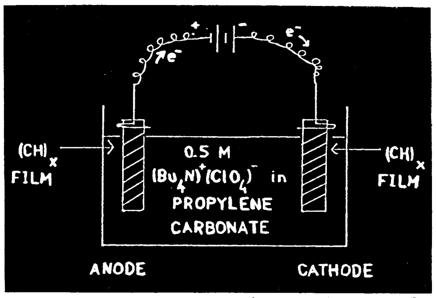
Scientists recently mapped out specific areas in the central nervous system for the benzodiazepines, a group of chemical compounds used to reduce anxiety. Several naturally occurring inhibitors have been found for the most widely used of those compounds: diazepam, otherwise known as Valium. These natural chemicals, one of which is named inosine, bind to the same spots in the brain that Valium does. Large doses of inosine prevent seizures in mice, serving the same function as smaller doses of Valium. The effects of inosine, which is part of the purine group, have now been further defined by researchers at the National Institutes of Health. Jacqueline N. Crawley and colleagues report in the Feb. 13 SCIENCE that when mice placed in cages with lit and darkened sections are given Valium, they overcome normal fears of bright light and venture into the lighted cage areas. But when the mice are given moderate doses of both inosine and Valium, the inosine blocks the effects of Valium and the mice stay in the dark.

Why does inosine inhibit Valium's effects in low doses and mimic the tranquilizer in high doses? Scientists do not know, but results so far suggest that inosine is involved in moderating emotional states and anxiety-related behaviors. "We want to determine a natural substance that is involved in anxiety," says one of the researchers, Paul J. Marangos. "We feel that the purines are good candidates for further research." Human applications, such as the control of anxiety by regulating the brain's large supply of inosine, are still years away. Researchers first must clarify inosine's effects on mice, pinpoint the binding site where inosine and Valium interact and make the jump from animal behavior models to human anxiety. □

A salt and battery without any metals

In research that pushes the electric car one space closer to the road, scientists have developed a lightweight, rechargeable storage cell that involves no free metal or metal ions — an organic battery.

Operation of this battery, designed by Alan G. MacDiarmid and colleagues of the University of Pennsylvania at Pittsburgh, depends on the behavior of the simplest possible organic polymer, polyacetylene, which is composed of carbon-hydrogen units or $(CH)_x$. Polyacetylene, an organic semiconductor, can act as either an electron source or an electron sink. Moreover, upon losing or receiving electrons, its ability to conduct electrons increases about 10^{12}, achieving the conductivity prowess of metals.



MacDiarmid et al.

During charging, Bu_4N^+ migrates to the cathode, and ClO_4^- migrates to the anode.

Its ability to donate and receive electrons, coupled with its metallic conductivity, makes polyacetylene the stuff of battery electrodes. Two thin pieces of polyacetylene film, about one-tenth millimeter thick, are immersed in a solution that contains tetrabutylammonium perchlorate in the organic solvent propylene carbonate. The tetrabutylammonium perchlorate is a salt that dissociates into the tetrabutyl ammonium (Bu_4N^+) and perchlorate (ClO_4^-) ions. These two ions play a special role when the battery is being charged.

The battery is charged by connecting one polyacetylene strip to the negative terminal of another battery, the other strip to the positive terminal. The strip attached to the negative terminal of the outside battery acts as the sink, accepting electrons; the strip attached to the positive terminal of the outside battery acts as the source, donating electrons. To keep the net charge of this system neutral during charging, explains MacDiarmid, the Bu_4N^+ ions "snuggle up" to the now negatively charged polyacetylene electrode — the electron acceptor, or cathode. Likewise, the ClO_4^- ions move to the positively charged electrode — the electron donor, or anode.

When discharging, this process is reversed: The electrode strip that had accepted electrons now loses them, and the electrode strip that had donated electrons