aerospace

SATURN 4-B IMPACT

Puzzling ion clouds

Two lunar surface experiments left on the moon by Apollo 12 astronauts last year have supplied puzzling data on ion clouds resulting from the impact of the Saturn 4-B stage into the moon.

About 17 seconds after the impact, the solar wind spectrometer and the lunar ionosphere detector began registering the presence of ionized gas. The gas apparently arrived in three distinct clouds. The particles had energies of 35 to 50 electron-volts. The bulk of them arrived from the north and northeast of the monitoring site, even though the impact was 135 kilometers to the west.

The event poses several questions, such as how what was probably a neutral gas became ionized; how the gas traveled from the impact site to the instruments, and how the gas was accelerated to the high energies observed. The principal investigators for the two monitoring instruments were Drs. Conway Snyder of the California Institute of Technology's Jet Propulsion Laboratory and John Freeman of Rice University.

Dr. Freeman suggests two hypotheses. One is that the gas bubble from the impact first traveled about 50 kilometers vertically upward and encountered the solar wind and later the ultraviolet from the sun, both of which could have ionized the gas. If the gas traveled farther upward, the ions could have been picked up and accelerated by the interplanetary electric field.

His second hypothesis is that in the interaction of the neutral gas and the solar wind a bow shock was created. In this case, the ions would be of shock front origin.

As for the origin of the gas itself, Dr. Freeman suggests that it could have been solar wind gas trapped in the lunar soil and released by the impact.

MAGNETISM

Moon's internal temperature

The magnetometer left on the moon by the Apollo 12 crew immediately detected a localized magnetic field of about 35 gammas (SN: 3/14, p. 269). However, the instrument also supplied other kinds of data that took longer to interpret.

After a year of study, Dr. Charles P. Sonett of the National Aeronautics and Space Administration's Ames Research Center and principal investigator for the instrument, has made some preliminary conclusions.

In the moon's outer crust, says Dr. Sonett, the temperature is estimated to rise by two or three degrees per kilometer depth. (This causes the lunar electrical conductivity to increase by a factor of about one million in going from the surface to a depth of 200 kilometers.)

The present evidence from the data, says Dr. Sonett, "is that we are dealing with a moon whose core temperature is some 800 to 1,000 degrees C." The heat flux of the moon is about two-tenths to three-tenths of a microcalorie per square centimeter per second, or about a sixth to a third that of the earth.

If Dr. Sonett's numbers are the final results, says Dr. Frank Press, Chairman of the Lunar Panel of the Lunar Planetary Missions Board, "nowhere in the moon—as long as the temperature is lower than 1,000 degrees—is there molten rock. And if the measurements were within 500 kilometers of the moon's core," says Dr. Press, "then most of the moon is solid."

Nor, says Dr. Press, is there any evidence so far of lunar water as ice or bound in minerals. He describes the moon, from the preliminary results, as a cold body having a thick and strong lithosphere in which no partial melting has taken place.

SEISMOLOGY

Strains on the moon

The Apollo 12 seismometer has been recording identical events each month at the time the moon is closest to the earth (SN: 8/1, p. 96). These, says Dr. Gary Latham of Columbia University's Lamont-Doherty Geological Observatory and principal investigator for the seismometer, are believed to be moonquakes triggered by the tidal strain. The most active zone has been located about 120 miles southeast of the Apollo 12 site, very near some well-developed rilles.

Scientists do not know whether the rilles are depressions created by hot magma flows, or large cracks caused by internal shifts. If the rilles are fractures, says Dr. Latham, then when the moon bulges because of the tidal strain the fractures may slip and cause moonquakes. Since the slippage appears to be always in the same direction, it is very likely that there is an additional source of strain accumulating in the moon. What this source is, says Dr. Latham, "is a very exciting problem."

He offers several possibilities. It may be that the ellipsoidal shape of the moon is gradually settling back into a more spheroidal shape as the moon recedes from the earth about one-half inch per year. Or the moon may be expanding very slightly as a result of radioactive materials releasing heat within the moon.

GEOCHEMISTRY

Water from lunar soil

Lunar geologists have speculated for some time about the possibility of using lunar soil to produce water and oxygen on the moon. This capability would be needed to supply permanent lunar bases. But until last week no one had actually designed the process.

Ten scientists at NASA's Manned Spacecraft Center in Houston are now seeking patent rights on what Dr. Robin Brett, one of the inventors, calls a very simple process. The apparatus uses a mirror to focus the sun's rays on a container of lunar soil, heating the soil to between 1,150 and 2,400 degrees F. Hydrogen, supplied originally from earth, is introduced into the container and reduces oxygen atoms present in iron oxides, such as the iron titanium oxide called ilmenite, to form steam. Then to get oxygen, the steam is passed through an electrolysis cell which separates the hydrogen and oxygen. The hydrogen may be recirculated a number of times.

The process has been tested with simulated lunar soil. If it proves practical, the inventors claim that moon dwellers could produce a pound of water from 100 pounds of lunar soil. If the iron-bearing oxides were first concentrated magnetically, the predicted yield would increase to nearly 14 pounds of water from 100 pounds of soil.