Smooth sailing: Unlike artist's drawing, Pioneer 10 saw no Texas-sized asteroids—just grains of sand.

The asteroid belt: Not as much material as expected

In space, at least, the optimists have won again. The Pioneer 10 spacecraft has just navigated successfully what had been considered the most hazardous leg of its one-billion-kilometer trip to Jupiter—the asteroid belt (SN: 11/11/72, p. 310).

Last week space physicists and engineers monitoring Pioneer 10 presented their preliminary findings on the asteroid belt. They concluded that it offers little hazard to spacecraft.

The scientists knew Pioneer 10 would not pass close to any of the larger asteroids (the closest it came to one was 6 million kilometers). The big unknown had been the smaller particles ranging in size from a thousandth of a millimeter to one millimeter. Even though they are small, their velocities are high and they could do damage.

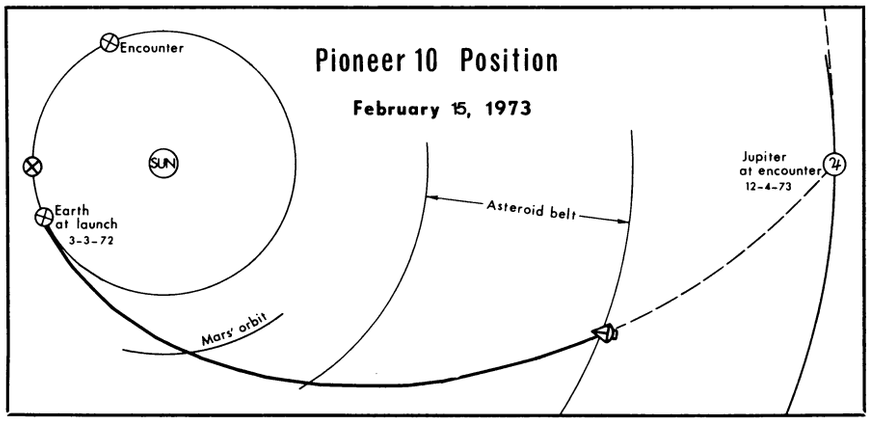
The results indicate there is not nearly as much material in the 430-kilometer-wide belt as thought, and there is surprisingly little of the smallest dust particles expected to be prevalent as a result of collisions of larger asteroids. The findings also suggest that the distribution of particles in space from earth to and through the belt depends on their size. The smallest particles were more numerous closer to the sun; medium-sized particles were distributed evenly from earth orbit to and through the belt; and the largest particles were more numerous at the densest region of the belt at about 2.8 astronomical units. (One astronomical unit, or a.u., is equal to the distance between earth and sun.)

Martha Hanner of Dudley Observatory in Albany, N.Y., analyzed the smallest particles to determine the origin of the gegenschein—sunlight reflected off dust at the anti-solar point. She found no concentration of the particles in the asteroid belt, but she did find the number of particles fell off as Pioneer 10 moved away from the sun. If there ever were the small particles in the belt, solar radiation reradiated off them would slow them down; they would then be pulled into the sun. The implication is that most of the smallest particles seen are cometary debris rather than ground-up asteroids.

There was, however, an increase in the largest particles—one-tenth millimeter to one millimeter. Robert K. Soberman of General Electric saw about 75 particles in all.

The origin of the asteroid belt is still a mystery, but the hunches are growing stronger that it is probably a planet that never formed. "It may be difficult to form a planet in that no-man's-land (between the rocky terrestrial planets and the gaseous outer planets)," says John H. Wolfe of NASA's Ames Research Center. The total debris of the belt would not make a planet as large as the moon.

Wolfe reported on the interplanetary medium and on the interstellar wind composed of hydrogen and helium entering the solar system. Of special interest were the solar streamers emitted from the sun during the August flares (SN: 9/16/72, p. 181). By the time the solar material had reached Pioneer 10 in the middle of the belt, the veloc-



Illustrations: NASA

Almost there: Pioneer 10 has completed 70 percent of its journey to Jupiter.

ity had dropped by a factor of two, the density had increased and the temperature had increased by a factor of two. Wolfe thinks this was the result of the interaction of the streamers as they bumped into the slower-moving solar plasma.

A surprise to Wolfe was where he saw the interstellar material entering the solar system—on the plane of the ecliptic at a right ascension of 240 degrees. This is about a 15-degree difference from measurements taken in 1968, and 15 degrees, in cosmic terms is a lot, he says. The measurements could be in error, or the interstellar medium could be a lot more turbulent than thought.

Three instruments on Pioneer 10 monitor cosmic rays. One surprise is how little the flow of low-energy rays changes as the spacecraft moves away from the sun. The variation was far less than expected. Frank B. McDonald of the Goddard Space Flight Center had expected to see 50 to 60 percent more of the low-energy cosmic rays. What he saw was about a five percent increase per a.u. This suggests, he says, that the solar effects go out much farther than thought. "At three a.u. the solar influence should have been negligible."

His most laudable comments, however, were about the spacecraft, built by TRW Inc. "I feel this spacecraft represents one of the most outstanding achievements of our space program."

Jupiter, as seen from the spacecraft, is now about one-tenth the size of the sun as seen from earth. Pioneer 10 will begin taking measurements of the planet Dec. 3. "God, OMB [Office of Management and Budget] and Congress willing, we will continue this exploration for the rest of the century," says John Naugle, head of space science at NASA. Pioneer 10 will continue sending back signals to earth until it has reached the orbit of Uranus at 20 a.u. in 1979.

Pioneer 11, the backup to Pioneer 10, is scheduled for launch in April. □

Map of Mars

Last summer when SCIENCE NEWS reproduced on two pages a detailed map of Mars prepared from Mariner 9 photographs (SN: 8/12/72, p. 104), a number of readers expressed a desire to obtain the map. At that time it had not been printed in quantity and was unavailable. Last week the U.S. Geological Survey announced that the map is now available for purchase.

Send 75 cents to: U.S.G.S. Distribution Section, 1200 South Eads St., Arlington, Va. 22202. Ask for "Shaded Relief Map of Mars."

Making the deuterium fit the big-bang theory

The recent discovery of deuterium in interstellar space gives cosmologists a severe problem. It appears from the measurements that the relative abundance of deuterium to hydrogen lies in the range between 1 in 33,000 and 1 in 2,000. Since stars do not produce deuterium (in fact they use it up) any of it found floating in space is assumed to be a relic of a period early in the history of the big bang during which deuterium was formed.

The quoted figures on the deuterium abundance are compatible with a big-bang theory of the origin of the universe, but just barely. They would require a universe with a very low density, a density about the same as that now observed. Cosmologists, however, have been unwilling to believe that the matter seen is all the matter in the universe. To have things like clusters of galaxies hang together and to give the universe itself a closed curvature, a large amount of unseen matter must be present. The usual way of getting this is to postulate clouds of dark matter in intergalactic space. But the present deuterium abundance values would not permit the existence of such

Did lunar volcanism end 3 billion years ago?

Evidence seems to be mounting in favor of a moon that has been relatively inactive for the last 3 billion years. That is the general consensus of some geologists studying the returns from Apollo 17. The Taurus-Littrow site was thought to be an area where both old and very young material—perhaps younger than a billion years—would be found (SN: 11/25/72, p. 346).

Now Oliver Schaefer of the State University of New York at Stony Brook has announced the age of the famous orange glass (SN: 1/6/73, p. 7) found at Shorty crater. It is 3.71 billion years old. The age is a disappointment. "It can now be reasonably stated," he said last week, "that volcanism on the moon was a phenomenon which ended about 3 billion years ago." Schaefer, Liaquat Husain, Gerald Barber and Theodore Ludkewitz, all of Stony Brook, have dated returns from all the Apollo sites. For the Apollo 15 mare basalts, for example, they obtained ages of from 3.25 billion to 3.40 billion years.

The Stony Brook group also dated a basalt returned from the mare near Shorty crater. Its age is 3.76 billion years.

The orange glass formed part of the ring around Shorty crater. At the time of discovery, geologist-astronaut Harrison Schmitt commented that it looked like a fumarole alteration (SN: 12/23/72, p. 414). A fumarole on earth is a gaseous vent that occurs in volcanic regions during the last phases of volcanism. The gas comes through the vent and alters material around it in a zoned fashion. The orange glass was thought to be part of that alteration. Now Schmitt's hypothesis seems unlikely.

"I don't see how it [the orange glass] could be the result of a fumarole," says William C. Phinney, head of the preliminary examination team at NASA's Manned Spacecraft Center in Houston. "The orange glass is not related to the surrounding material. It is a beast entirely unto itself."

The orange glass was brought to the surface about 30 million years ago. That is the exposure age—the length of time the material has been on the surface—calculated by the Stony Brook group.

How the material was formed 3.71 billion years ago, probably in a layer in the moon, and got to the surface only 30 million years ago is an intriguing problem. "It's a very unusual situation," says geologist Farouk El Baz, now of the Smithsonian. He says Shorty crater is the result either of explosive volcanism which brought up the orange glass or of a low-velocity impact explosion which also brought up the glass. The crater lacks all the characteristics of usual impact craters.

"It's strange, whatever it is," says Phinney.

The last hope, perhaps, of finding very young material lies in the age-dating of the dark mantling material from the site. El Baz thinks this dark mantle was extruded after the major volcanic filling of the area. The dark material has been distributed to scientists, and the age-dates may be available in time for the Fourth Lunar Science Conference, March 5-8 at Houston.

But Phinney and others at Houston think the dark mantling will not turn out to be young. "It'll probably be about the same age," he told SCIENCE NEWS. The material is strikingly similar in chemical composition to the Apollo 11 basalts. They dated about 3.7 billion years old.