

GEOPHYSICS

Craters Found on Mars

► **ASTRONOMERS ARE** speculating whether the surfaces of other bodies in the solar system, besides earth's moon and Mars, are covered with craters from meteorite strikes.

The surface of Venus may never be revealed, because of its cloud cover.

The other planets, such as Mercury and Jupiter, also have their secrets—now. However, these should be uncovered when future space probes photograph, then eventually land on, their surfaces.

The Mariner 4 photographs of Mars, man's first close-up pictures of another planet, revealed the totally unexpected fact that the Martian surface, like earth's moon, is peppered with craters.

The Martian craters are from two to five billion years old, the first examination of the pictures taken by Mariner 4 on July 14 has shown. All of earth's surface features—even the great mountain ranges—are only a fraction of that age.

The craters on Mars were made by meteorites slamming into the surface as were the few known on earth and the many photographed on the moon by the Ranger lunar probes.

The 75-mile diameter of the largest crater photographed by Mariner 4 is the clue to its ancient age. The largest crater on earth, known positively to have been made by meteorite impact, near Flagstaff, Arizona, is slightly less than a mile in diameter.

SPACE

Unmanned Launch Studied

► **THE RUSSIANS** who built the Zond 3 solar probe, launched on July 18 from an unmanned orbiting space station, apparently solved one of the biggest problems confronting the designers of the U.S. Voyager Mars landing capsule, scheduled for a mission in 1971.

The problem is that of launching one unmanned space vehicle from another unmanned space vehicle. The first Voyager flight, now tentatively set for 1969, will be a relatively simple flyby mission, but two years later a spacecraft will be launched from earth containing a robot landing capsule intended to set itself down on the Martian surface and make the first on-the-spot search for life on another planet.

The Soviets have revealed very few details of their current achievement, so U.S. scientists can only guess about how Zond 3 was fired from its 13-ton orbital launch pad. Either the spacecraft was launched remotely, by human controllers on the ground, or it followed a preset, automatic procedure, operating entirely in response to timers, relays, light-sensitive switches and on-board electronic computers.

Voyager must perform a similar feat, but if the landing capsule is going to send back any useful data from the surface, it must land softly enough to leave its delicate

equipment intact. Since Mariner 4 revealed the Martian atmosphere to be as thin as that almost 20 miles above the earth, a simple glider would be practically impossible.

Some present designs call for a landing capsule weighing almost as much as the spacecraft carrying it. In Boeing's design, 3,000 of the lander's 5,000 pounds will be used for the retrorocket system.

Launching space vehicles from other space vehicles will be a vital space flight technique in the future, and Voyager will be the United States' first try. For any long-duration manned flights such as trips to Mars or other planets, launching from orbit is almost a necessity to keep space vehicles from becoming unmanageably large. Lifting a payload from the surface of the earth requires a much bigger booster than does launching the same load from orbit.

If space travel ever becomes common on a large scale, with many passengers traveling in huge "space liners," such vehicles will almost certainly be assembled in orbit with component parts flown up to orbit via much smaller shuttle craft.

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For the same reasons, they also believe that Mars has never had sufficient water to form streams or fill oceans since that time. Water in these amounts would have caused severe erosion, as happens on earth.

Another conclusion the scientists have reached is that there are very likely no tremblors or other surface-wrenching jolts on Mars, unlike earth. The lack of internal activity is consistent with the absence of a significant magnetic field on Mars as was determined by Mariner 4 observations.

If the Martian surface is truly in its primitive form, as is now believed, that surface may prove to be the best, perhaps the only, place in the solar system still preserving clues to how life originated, traces of which have long disappeared from earth.

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SPACE

Orbiting Fuel Tanks To Service Spacecraft

► **"CURB SERVICE"** for spaceships—refueling in orbit and departing without ever landing on earth—may be a necessity for the lengthy interplanetary missions of the future.

A cone-shaped "tanker" much like an enlarged Gemini capsule, containing a fuel-filled "bladder," could orbit the earth for as long as four months while waiting to dock with a thirsty spacecraft, said L. L. Morgan of the Lockheed Missiles and Space Company.

With the spacecraft in one orbit and the tanker following beneath it in another, the tanker could be guided up to perform the refueling maneuver, either automatically or by remote control, perhaps from an orbiting space station. The last few critical feet between the vehicles would be covered under the watchful eye of a TV monitor, permitting men to take over in an emergency.

After refueling was completed, the tanker could "back away" from the spaceship by firing one of 18 sets of engines (arranged about like those on a Gemini capsule and designed to permit control in any direction), and then fall harmlessly in the ocean.

Mr. Morgan suggested a 115-mile circular orbit for the tanker, and a 300-mile orbit for the space-going "customer."

One kind of spacecraft, however, would get special treatment. The huge Saturn V rocket, already charged with getting the first Americans started on their flight to the moon in 1970, needs a huge tank of liquid hydrogen, so big that a simple cone shape would be unmanageable. Mr. Morgan suggested a rigid cylindrical shell, reinforced at the ends with partial cones.

A rigid outer shell would first of all provide increased protection from meteoroids, and in addition would reduce the amount of insulation needed to keep the liquid hydrogen from becoming heated and turning back into a gas.

One of the biggest problems in tanker design is sloshing of the fuel, which could knock the tanker against the spaceship. Mr. Morgan told the second annual meeting of the American Institute of Aeronautics and Astronautics in San Francisco.

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