

that not only was the moon *not* ever a part of the earth, but indeed that most of earth's continents were once part of the moon. Starting with a virtually ignored paper published in 1955 by an obscure German girls' school teacher, Dr. Alfven paints a pretty lively picture of primordial earth.

As the moon sped by from spaces unknown, he says, earth's gravity caught it and swung it into a retrograde orbit, moving around earth in the opposite direction than it does now. Then, as gravity tried to get the two bodies into a balanced relationship, the moon moved up over the poles instead of more nearly over the equator. Tides were five miles high, and rolled around the earth in six hours, "polishing" the globe. The moon, looking twice as big as it does now, dominated the heavens.

Then, says Dr. Alfven, came the most dramatic event in the history of the earth: the moon reached what is called the Roche limit and broke apart. More than half of the moon may have plunged to the earth, Dr. Alfven believes, an event which could explain why the earth's crust is considerably less dense than its core.

But where did the moon come from? The same place as Mars. The moon was once a planet, Dr. Alfven says, and condensed out of the same "cloud" as Mars, while the Earth, Venus and Mercury form another "genetic group."

If, as Dr. Urey and others believe, the moon is older than the earth's estimated 4.5 billion years, the riddle of its birth may hold the key to even bigger questions, such as the origin of the solar system.

### What's It Made Of?

It may not be exactly a goldmine, but silver, platinum, diamonds and a host of other materials have all been indicated on the moon by one study or another. Depending on whether or not there have been volcanic eruptions on the moon, other possibilities include metals such as iron, nickel, cobalt, copper, aluminum, magnesium, titanium, mercury and zinc; other elements such as phosphorous, carbon, sodium, potassium, sulfur, iodine and chlorine; and even water.

Water is a special case. The moon could hold twice the world's riches and water would still be more important to anyone on it. Volcanic rocks often have up to 10 times the water found in other basic rocks (in part because the time during their formation when water could have escaped is shorter). Astronauts will thus be in luck if there turns out to have been volcanic activity in the geologically recent past.

Arguments over what the moon is made of, however, can't hold a candle to the pet theories that clash on just what the surface looks like. Despite painstaking analysis of thousands of

lunar photos, scientists still vie with one another as strongly as before.

There is no evidence of "moon dust" or that the moon is honeycombed with caverns, as some scientists have suggested, says Dr. Eugene Shoemaker, a geologist. "Absolute nonsense," says Cornell's noted Dr. Thomas Gold, who firmly believes that there is a definite dust layer, fluffed up into myriad "fairy castles" by the continual impact of micrometeoroids. Miles beneath the lunar crust there may be a layer of ice and dirt, Dr. Gold believes, which may have implications for life on the moon.

NASA's Dr. John O'Keefe thinks the moon is largely covered with ash flows, while Soviet expert B.J. Levin believes they are lava flows. Dr. Evan Walker of the University of Miami has described a layer of granular particles ranging from 65 to 500 feet deep. Dr. Urey calls the surface "soft and spongy," while Dr. Kuiper calls it "crunchy." Or it may be "fuzzy" (Dr. Charles Warren, U.S. Geological Survey). Or hard, or pebbly, or gritty, or bouldery, or silt-like (miscellaneous scientists).

Millions of dollars and hundreds of scientific minds have devoted more than half a decade to discovering the moon's secrets. But it will take a lot more asking to satisfy anyone of the answers.

### End of an Era

SEVERAL THOUSAND engineers, scientists and technicians at Cape Kennedy noted the closing of an era last week as they watched Gemini 12, the last of its kind, poised above launch complex 14. At the same time, the second U.S. Lunar Orbiter was nestling in toward its picture-taking orbit around the moon, and somewhere below it the amazing Surveyor 1 was again talking back to its mentors on earth.

Surveyor, to everybody's surprise, continued to respond to commands from earth and to deliver data, even long after it was no longer able to deliver pictures.

Unlike its predecessor, Lunar Orbiter 2 would not be looking out for Surveyor's landing spot. It would, however, have more than a dozen areas to look at, possibly including the one where Ranger 8 crashed 21 months before. In addition, changes in its orbit would provide information about the moon's gravitational field, which is "sufficiently non-uniform" to affect the path of any lunar satellite.

Surveyor 3 (No. 2 failed—see chart p. 420) is due to be launched in mid February and may be the first of several equipped with drills, probes or scrapers that will reach down into the lunar surface and retrieve samples. A robot chemical laboratory called a mass spectrometer will analyze the samples and transmit the results to earth

### AERONAUTICS

## Bug-Eyed Airplane Bugs Pilots

A BUG-EYED jet fighter is being flown by pilots who have no way to see out except through a periscope.

Obviously such indirect viewing has its disadvantages—one periscope-peering test pilot misjudged his speed so badly that he almost attempted a full 180-degree turn while taxiing across the runway at 150 miles per hour—but he may have to learn to like it for the supersonic transports and space rescue missions of the future.

Huge space-going gliders called lifting bodies, now being designed for rescue or as earth-to-orbit ferries, will build up too much heat from re-entry to use ordinary windshields.

A current test model, which goes nowhere near orbit, needs three layers of inch-thick glass filled with a continuous flow of cooling gas to withstand the heat. In a space-going version, windshield weight would be prohibitive.

To test a possible substitute, an F-104 Starfighter was fitted with a binocular periscope ending outside the cockpit in two bulbous "eyes."

The half-dozen NASA pilots who flew it were "pretty apprehensive" about the periscope before they tried it, said William H. Dana, co-director of the project, who doubles as a testpilot himself. After a few flights they unanimously decided it could be gotten used to, but there are problems.

Biggest complaint has been the need to look away from the eyepieces in order to check instrument readings.

The exaggerated stereo effect of the periscope has caused pilots to "consistently" level off too high in landings.

Vibration on the ground caused "severe loss of vision," and the system was virtually useless at night. Lack of side vision hampered all circular approaches to the runway, and the need to stay glued to the eyepieces drew complaints.

To improve visibility and side vision, the researchers are now outfitting a second plane, a C-47 "Gooney Bird," with a system using ground-glass viewing screens instead of eyepieces. This will allow pilots to move their heads normally, and consult instruments with minimal eye movement. The wrap-around screens will stretch as much as 100 degrees to the side.

The system has also been suggested as a possible aid to supersonic transport aircraft. Both SST designs currently in competition have pivoted "droop-snoots," which swing down so pilots can see over the plane's long nose.