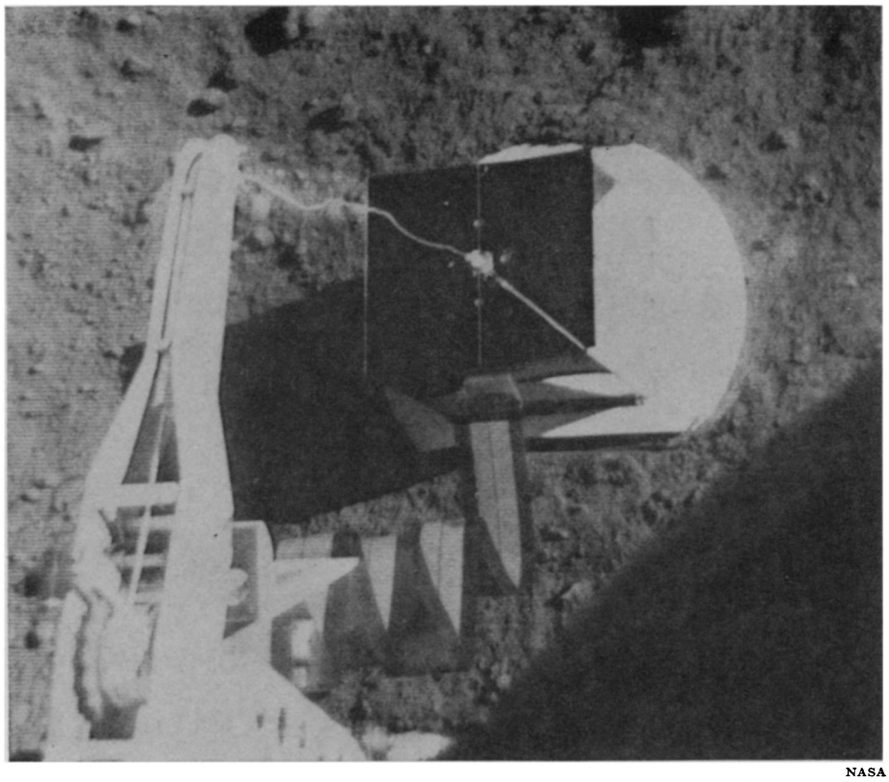
The Earthy Moon

Surveyor 5's automatic chemistry laboratory finds that the moon may be just a chip off the old earth



NASA

Surveyor's robot chemist bounces alpha particles off the rocky moon.

Space scientists have been intrigued for years with the possibility of finding usable oxygen on the moon—not in the lunar atmosphere, since there essentially is none, but in the rocks. As long ago as 1962, Dr. Eugene Konecci, then the National Aeronautics and Space Administration's director of biotechnology and human research, predicted vast lunar processing plants turning out 4,000 pounds of liquid oxygen per month, both for breathing and as an oxidizer for rocket fuel.

An elaborate process developed by the Aerojet-General Corp. in Azusa, Calif., would produce 12 pounds of oxygen per hour from 45 pounds of lunar rock that was first melted in a solar furnace, then processed with methane gas and separated by electrolysis.

Such techniques could prove to be a godsend for future lunar missions, to say nothing of interplanetary flights using the moon as a way station, since they would eliminate the need for carrying tons of oxygen up from earth. All the systems developed so far, however, have been based on a supposition: the existence of oxygen-bearing silicate rocks on the moon. Now the Surveyor 5 spacecraft, which has been on the moon since Sept. 10, reveals it is standing directly over just the kind of rock that would do the job.

More importantly, it greatly strengthens the case for the moon's substance being like a common earthly rock, which would mean that scientists could accurately apply their fund of terrestrial geochemical and geologic experience to the moon. Most of the Surveyor scientists are characteristically cautious about their opinions, fluffing them out with phrases like "the preliminary findings appear to indicate," but Dr. Harold Mazursky of the U.S. Geological Survey feels that three Ranger, five Lunar Orbiter and three Surveyor spacecraft ought to prove something.

The more than 50,000 photos of the moon taken by these various vehicles seem to match the new information from Surveyor 5's automatic chemical laboratory (SN: 9/23), he believes, which clearly points to earth-like rock on the moon. The device is able to analyze only a single microscopically thin layer, four inches in diameter, of the lunar surface, however, and Dr. Mazursky is aware of the risks of generalizing from such a little sample. "The muted roar you hear," he says, "is the limb cracking as I saw it off."

What the lab found, by measuring the characteristic backscatter of alpha particles from six tiny pieces of radioactive curium 242, is a basaltic material containing up to 63 percent oxygen and up to 21.5 percent silicon plus several other elements. Basalt comprises about a fifth of the rock on earth, and can be found almost anywhere, ranging from the palisades along the Hudson River to the plateau of the Colorado; the Hawaiian Islands and Iceland are both made of basalt.

A pair of metallic strips, one of them magnetic, fastened to only one of Surveyor's feet revealed traces of iron on the moon when one of the spacecraft's photos of itself showed some material clinging to the magnetic strip, but not to its nonmagnetic mate. Conspicuously absent, however, or at least in undetectably short supply, was carbon, the basis of earth's organic chemistry. The alpha-scattering device was able to learn only that if there is any carbon at all in the lunar basalt, it makes up less than three percent of the rock's total substance.

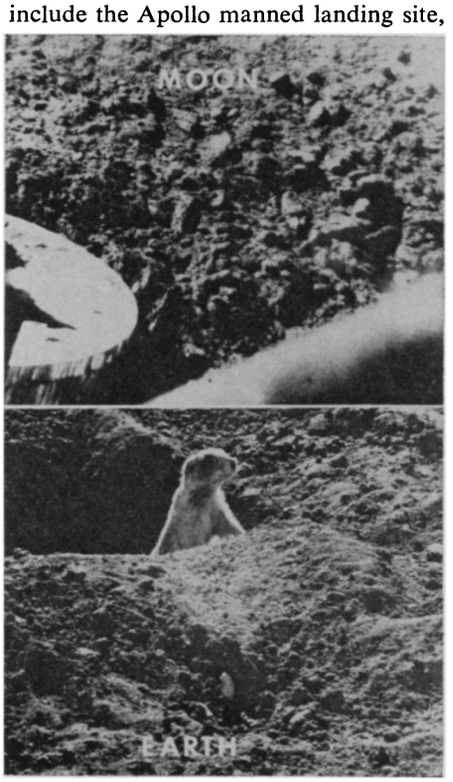
CHEMICAL COMPOSITION OF THE LUNAR SURFACE AT SURVEYOR 5 SITE (PRELIMINARY RESULTS)

ELEMENT	PERCENT OF ATOMS
CARBON	< 3
OXYGEN	58 ±5
SODIUM	< 2
MAGNESIUM	3 ±3
ALUMINUM	6.5 ±2
SILICON	18.5 ±3
SULFUR → NICKEL*	13 ±3
HEAVIER THAN NICKEL	< 0.5
*IRON, COBALT and NICKEL	> 3

Satisfying as it was, the alpha-scatterer has its drawbacks. In the first place, says the experiment's director, Dr. Anthony Turkevich of the University of Chicago, the device can't

detect hydrogen, the most abundant element in the universe. Secondly, although it can identify most of the elements present, it cannot determine the chemical compounds into which they are combined. For both of these reasons, it is difficult to establish the presence of water, at least until the data has all been correlated enabling an exact comparison to be made with a basaltic type on earth.

Surveyor scientists have, however, established the probability that lunar materials have been affected by heat from within the moon itself, possibly from internal radioactivity or compression due to gravity. It is therefore likely that the lunar maria, or seas, which will include the Apollo manned landing site,



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The moon's crumbly, earthy basalt.

were formed by lava flows filling up craters first created by meteor impact. The other, and much less likely, possibility is that the maria resulted from melting due to the meteor impacts themselves.

Another likelihood is that the moon may, like the earth, have a structure consisting of layers, though it may not have an earth-like molten core. "The odds are overwhelmingly in favor" of such a possibility, called differentiation, according to the scientists, although Cornell's Dr. Thomas Gold holds that the differentiation could have taken place in some larger body—such as the earth—of which the moon may once have been a part.

This, in fact, is now the favored theory of the birth of the moon, according to many scientists, and Surveyor 5's findings have added to its weight. "There are three acceptable theories to the moon's origin," according to Dr. Eugene Shoemaker, the Geological Survey's chief astronomer. "One is that it is a double planet to the earth, another that it was captured by the earth's gravity and a third that it split away from the earth millions of years ago. We now have a little more support for the idea that the moon separated away from the earth."

There are two more Surveyors left in the current program. Surveyor 6, equipped with its own alpha-scattering experiment, is tentatively scheduled for next month. Surveyor 7, aimed for early next year, will be equipped with both an alpha-scatterer and a robot shovel like the one that dug trenches in front of the camera of Surveyor 3. It was also recently decided to attach a knob to the top of Surveyor 7's alpha box so that the shovel could nudge it from place to place, thus enabling it to get a more representative sample of its surroundings, all under the eye of the spacecraft's camera. Such nudging is ticklish, NASA emphasizes, however, and won't work if the craft is canted too far over, as Surveyor 5 almost was when it landed with one foot in a crater. ◈

THE NEXT 50 YEARS

The future: still cloudy

"We are fast creating more than the body, more than the mind, more than the spirit can stand." The "we" is man and his creation is runaway technology, of which there was ample evidence at last week's Washington conference on "The Next Fifty Years."

You could breath into a machine and get your lungs full of honest-to-goodness Los Angeles smog. You could step into a booth, called the "Overloaded Eye," hung in sheets of chrome foil with a flashing strobe light in the center. The effect was something like a screaming siren of sight.

Conference planners even let loose a dozen mechanical robot-men, 12 inches high, which clacked and clattered around the exhibits. Every few seconds, knobs pushed out of their breast armor, lit up and chattered away like machine guns.

Reaction to the robot men was both amused and bemused. "They've taken over," said one conference participant. Another leaned down and addressed a robot: "What do you people want?" he asked.

Held by the American Institute of Planners, the conference was the second in a series of three annual international thinkfests, devoted to discovering guidelines for building a decent future global human environment.

The 2,500 planners, scientists, philosophers, authors, clergymen, public officials and youth leaders included such men as French economist and philosopher Bertrand de Jouvenal; Swedish sociologist Gunnar Myrdal, who defined U.S. racial troubles in "The American Dilemma" 20 years ago and Herman Kahn, author of "On Thermonuclear War" and now director of the Hudson Institute in New York.

At the end of the three years, AIP hopes to have sparked enough discussion and gathered enough intelligence to enable democratic societies, particularly the U.S., to start planning their future. But last year's meeting ended in pessimism.

"It was clear," concluded the AIP, "that science is not prepared to deliver answers concerning an optimum environment, nor has man as yet measured optimum environment in his own terms. Further, it was evident that the values by which we might establish priorities to research optimum environment are not understood."

This year the conference focused on values and again there was a strong sense of pessimism, particularly regarding the willingness of democratic peoples to plan their future.

"Planning should not be attempted in an airy optimistic mood," warned Dr. Myrdal. "It must imply strivings against heavy odds. . . . What we need today is not a deceptive hopefulness . . . but the will to grapple with staggering difficulties. We need not the courage of illusory optimism, but the courage of almost desperation."

The United States, where planning has long been a dirty word, faces perhaps the heaviest odds, said Dr. Myrdal, because here the lower strata of people have remained "so inarticulate."

On the international scene, one of the greatest dangers is that the race issue will be infused into the international class struggle between rich and poor, said Dr. Myrdal. The fact is that all the rich nations are white while almost all poor nations are colored.

There was a pervasive feeling throughout the conference that the world faces changes so great they may mean a profound reformation of society. But like all revolutions, its form cannot be comprehended at the start, which is now.

Into the somberness, Hudson's Dr. Kahn brought a "scenario" of the world in 2017, developed with defense analysis techniques.

It appeared to inject a note of scientific sanity and precision—but it was as easy to puncture as the generalities.

Based on the assumption that certain world trends will continue as they have for the past eight centuries, Dr. Kahn