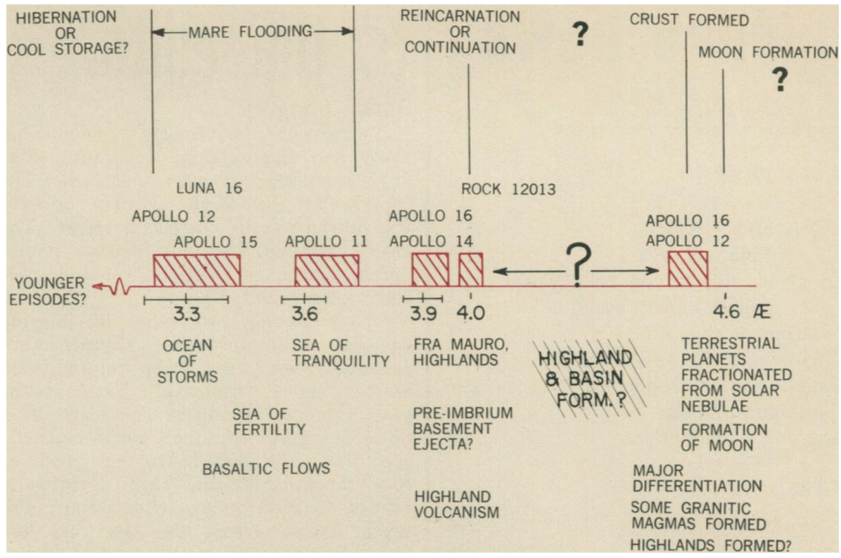
Filling in the gaps in lunar evolution



Davida Daemon from Wasserburg and Papanastassiou

Reconstructing lunar evolution, Wasserburg plots dates of moon rocks and soil from all the moon missions. "It's a lousy way to date a planet," he says.

"The moon is now teaching us extraordinary things—like what the early history of a planet is." Gerald J. Wasserburg, Oct. 27, 1972.

A group of lunar scientists gathered last week in Washington for a mini lunar science conference to summarize current knowledge about the moon, present recent findings from Apollos 15 and 16 and hopes for Apollo 17. The lunar quest seems to have reached a new plateau. Many primary questions have been answered, and second-generation questions are being posed. "And the moon is now giving us answers we don't have questions for," says Gerald J. Wasserburg of the California Institute of Technology.

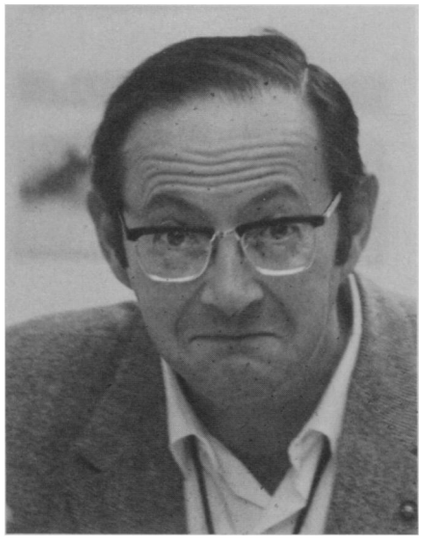
Some of those answers are coming from analyses of Apollo 16 data. The Apollo 16 Descartes site was in the Central Highlands, thought to be part of what is left of the lunar crust (SN: 7/1/72, p. 12). Some geologists had hoped to find rocks there unchanged since the crust formed, dating around 4.6 billion years old. Wasserburg reported results of two samples he, D. A. Papanastassiou and colleagues at Caltech dated. Sample 68415, an igneous rock rich in plagioclase, had a rubidium-strontium age of 3.84 billion years. The second sample, 65015, was not as straightforward. Most of the rock material indicated a crystallization age of 3.93 billion years, but some of the individual crystals were between 4.40 billion and 4.48 billion years old. This would indicate the time for the initial crystallization of the rock before most of it crystallized again at 3.93 billion years.

The sample is high in radioactive elements similar to one other old rock, 12031 from Apollo 12, which crystallized initially at 4.5 billion and again at 4.0 billion years.

Oliver Schaeffer of the State University of New York at Stony Brook presented argon 39-argon 40 ages on several Apollo 16 samples that ranged in age from 3.98 billion to 4.25 billion years.

What to make of these ages is the problem. Paul Gast of the Manned Spacecraft Center pointed out that Apollo 14 rock ages had also tended to cluster around 3.84 billion and 3.93 billion—perhaps indicating two distinct wide-range events. It is not likely these are dates for formation of the highlands. Instead Wasserburg thinks the dates indicate a widespread melting and recrystallization in the highlands between 3.80 billion and 3.95 billion.

According to Leon T. Silver of Caltech, the "permanently shadowed soil" (SN: 4/29/72, p. 276) collected at the Apollo 16 site shows a much higher volatile lead content than other soil collected. The shadowed area served as a "cold trap" for lead that had been volatilized (SN: 1/1/72, p. 12). He also reported a widespread occurrence of the component high in radioactive elements that some call KREEP(UTH) (for high potassium, rare-earth elements, phosphorus, uranium and thorium). Orbital measurements indicate it is concentrated in the Oceanus Procellarum. But Silver says debris of this material is found all over the Apollo 15 and 16 sites as well, and is not of local origin. What is the relationship between this component, and the anorthositic highlands and the ancient crust? Wasserburg thinks the radioactive material could be remnants of the top layer of that old crust.



Caltech

Wasserburg: No query for the answer.

The two old rocks and the soil that consistently dates 4.6 billion years old leave no doubt the moon has primitive material somewhere. It may even be older than expected. An Apollo 16 anorthosite (60015) has strontium in it older than that found in meteorites.

There are several obvious gaps in this chronology. The youngest rock dated is 3.16 billion years old. Has the moon been inactive since then? What happened between about 4.2 billion and 4.6 billion years ago? Did the crust heat from accretion, melt, disgorge layers and cool off only to be remelted again from internal radioactive heat 500 million years later?

It is the hope that Apollo 17 will fill in the gaps. Harrison (Jack) Schmitt, geologist-astronaut of the last moon mission, thinks he has a good chance of bringing back material younger than 3.16 billion years and older than 4.2 billion years. If not, the gaps will remain until answers can be found in the rocks stored in Houston. □