Apollo renaissance

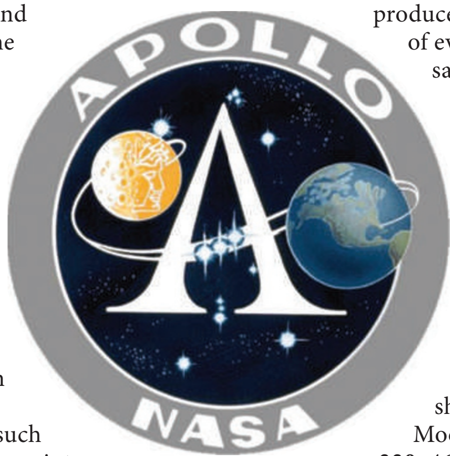
Forty years ago, the Apollo missions brought unprecedented knowledge of the Moon. After a lengthy period of hibernation, the material recovered in the late 1960s and early 1970s is back in the limelight.

The rock samples and data collected during the Apollo missions have regained popularity over the past few years, in line with a rising interest in studying the Moon. More of the Moon's secrets are sure to be unveiled as scrutiny of the decades-old material with more sophisticated techniques and faster computers continues.

Seismic data collected during the Apollo programme between 1969 and 1972 suggest that the lunar mantle is partially molten at its base, above a fluid outer and a solid inner core, in a set-up that is not dissimilar to that on Earth (*Science* doi:10.1126/science.1199375; 2011). About 60% of the core's volume is inferred to be liquid, a valuable constraint in the light of the paucity of data and consequent uncertainties.

The re-evaluation of the data gathered by seismometers on the Moon's near side also suggests that the interior of the Moon contains only a low fraction of volatile elements. This conclusion is in line with the idea that volatile elements, such as hydrogen, sulphur and chlorine, would have escaped to space when the Moon formed in a violent event: the most likely scenario suggests that a large planetary body hit the Earth and excavated the material that was to become the Moon. During the explosion, volatile elements would have been released to space, leaving lunar material devoid of hydrogen, and hence water.

A study in this issue, using different but equally old material from the Apollo programme, however, concludes that water has played a role in the Moon's history. These analyses suggest that comets that hit the moon shortly after its formation are the most likely source of the water found in lunar rocks (page 79). A group of papers had reported glimpses of water, detected at the lunar surface (*Science* **326,** 562–572; 2009), and significant water content has been proposed for the lunar mantle, too (*Nature* **454,** 192–195; 2008; *Nature* **466,** 466–469; 2010). But whether any water in the Moon's interior was inherited from Earth and retained throughout the Moon's formation has been a puzzle.

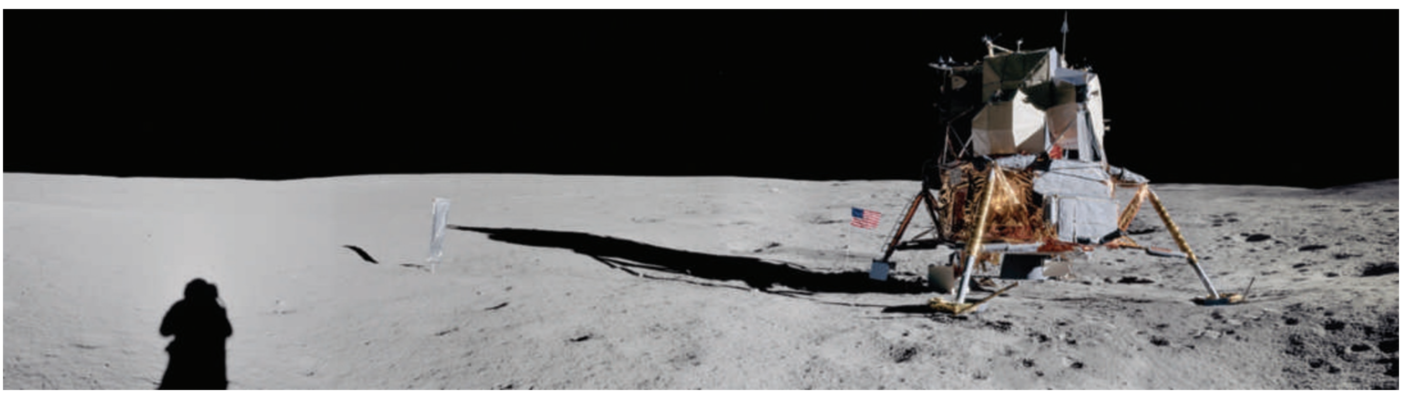


It turns out that the isotopic signature of the lunar hydrogen differs markedly from that of water found on Earth (see page 79). Instead, the ratios of deuterium to hydrogen resemble values measured for comets, such as Hale–Bopp, and thus point to delivery from comets. If so, the water must have been added after lunar and terrestrial material were separated in the Moon-forming impact.

Neither the seismic analyses nor the isotope studies would have been technically possible when the lunar samples were returned to Earth. And by the time the technology had advanced, the attention of planetary scientists had turned to Mars and other planets. The shift in focus was in part a consequence of one of the main conclusions of the Apollo programme — that the Moon's surface and mantle were dry and therefore less interesting.

Space programmes in an ever-widening range of countries — including India, China and Japan — have contributed to the renewed focus on lunar exploration in recent years. Together with the programmes by more established space agencies, these efforts have produced a growing body of evidence that Earth's satellite is not devoid of water. One of the latest developments in this respect, reported in a group of papers, was the detection of water in debris released from the Moon's surface, when a rocket was deliberately crashed into a permanently shadowed crater on the Moon (*Science* **330,** 463–486; 2010).

The possibility of a wet Moon has enticed scientists working on other planets to take a closer look at the Apollo material — almost half a century after US president John F. Kennedy announced the goal of sending an American to the Moon in May 1961. Such longevity is rare in modern science. The planetary sciences, with missions so pricey that data collection can be as infrequent as once every few decades, showcase how historical samples and data can be turned into a treasure trove. ❐



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