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A Giant Leap for the Geosciences

GSA Speaking of Geoscience

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Fifty years ago, 600 million people breathlessly watched a live television broadcast during which astronaut Neil Armstrong took humankind's first steps on the surface of another world—an achievement that many still consider one of humanity's greatest feats. The first lunar landing is all the more impressive when you contemplate that it occurred just eight years after our nation's first space flight—Alan B. Shepard Jr.'s 15-minute suborbital "pop-up"—and less than seven months after Apollo 8's thrilling initial voyage around the Moon.

Astronauts Neil Armstrong and Buzz Aldrin, pictured here, spent 2.5 hours exploring the Moon's surface during the Apollo 11 mission. Image credit: NASA

Armstrong's first, tentative steps on the dusty lunar surface on 20 July, 1969 were the culmination of many converging factors. These included President John F. Kennedy's inspiring leadership; massive budget appropriations totaling $25 billion—about $153 billion in 2018 dollars; years of dedicated work from an estimated 400,000 engineers, technicians, scientists, mechanics, pilots, support staff, and other professionals; and numerous technological advances, including computers with integrated circuits and the invention of new materials such as Teflon, which our society continues to benefit from.

As "lunatics" around the globe prepare to celebrate Apollo 11's golden anniversary, I think it's instructive to also reflect on the Apollo program's monumental scientific accomplishments. These include tangible discoveries that have revolutionized our understanding not only of the Moon, but also the Earth and the rest of the solar system.

Chief among these is a better understanding of how the Moon formed. Prior to the Apollo program, there were three competing theories: the co-formation hypothesis, which suggested the Earth and Moon simultaneously coalesced from the same mass of interstellar dust and gas; the capture hypothesis, which argued that the Moon, after accreting at the same time as the rest of the solar system but in a different location, was later captured by Earth's gravity; and the giant impact hypothesis, which posited that about 4.5 billion years ago the Moon condensed out of the debris thrown up after a Mars-sized object (named Theia) smashed into the proto-Earth.

Although many lines of evidence are consistent with the giant impact hypothesis, for years scientists failed to find the difference in isotopic ratios that numerical models predicted should exist between lunar and terrestrial samples to reflect the Moon's greater proportion of Theia-derived material. It wasn't until five years ago, when scientists first measured a significant difference between the Moon's and Earth's oxygen isotopic ratios in basalt samples from three Apollo landing sites, that planetary scientists really coalesced around the giant impact hypothesis. Many additional scientific discoveries have led to a much more sophisticated understanding of the Moon's age, composition, internal layering, and evolution, including the formation of the lunar highlands from a great magma "ocean" and the Mare (the so-called "seas") from huge impact craters that later filled with dark lava flows.

But just as important as these discoveries are the intangible scientific benefits, in particular how the lunar landings and associated space race inspired many geoscientists. These include Tanya Atwater, a Professor Emeritus at the University of California–Santa Barbara and this year's recipient of the Penrose Medal, GSA's highest honor, for outstanding, original contributions that mark a major advance in the science of geology. The "Mother of Plate Tectonics" told me in a 2013 interview that the launch of Sputnik changed an entire generation of careers, including hers. "When I was a kid," she said, "there was all this science fiction: Guys were zooming off in spaceships and walking around on the Moon and planets. We assumed it really was fiction, so when humans put Sputnik into orbit, that seemed astonishing, and it made me think that science could do anything." So instead of pursuing a career as a commercial artist, Atwater switched to science.

Brown University's James W. Head III, the 2015 recipient of the Penrose Medal and numerous additional honors, told me in a 2017 interview that his illustrious career in planetary geology began when he responded to an ad that consisted of a full-page photo of the Moon with a single line of text that read, "Our job is to think our way to the Moon and back." He leapt at the chance to work at Bellcomm, Inc., an organization whose sole purpose was to offer technical advice to the Apollo program, and

eventually helped select some of the Apollo landing sites and train NASA astronauts in geology.

As NASA prepares to unveil a stash of never-before-studied Moon rocks brought back by the Apollo 17 astronauts and to implement the ambitious Artemis Program, whose stated goal is “to send the first woman and the next man to the lunar South Pole by 2024,” we can only hope this next generation of Moon exploration will inspire similarly talented people to pursue careers in geology.

That will be another small step for a (wo)man—and a giant leap for the geosciences.

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