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Not My Fault: Celebrating 50 years of lunar geology

Lori Dengler/For the Times-Standard
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On July 20, 1969 I was living in Berkeley. I had just completed my first quarter of grad school in the Berkeley geophysics program after unsuccessful attempts to fit into Scripps and the University of Chicago. Like many Americans, I listened to the lunar landing on an AM radio. At the time, I didn't think a lot about what would be learned from landing on the moon. I was just caught up in the excitement of what seemed a nearly unobtainable feat.

Going to the moon and coming back. And it wasn't just Armstrong, Aldrin and Collins who returned, but 47 pounds of moon rock and soil, the first extraterrestrial material collected off the planet. Far more valuable that gold or diamonds, the box of samples held keys to questions about the moon and solar system that remote sensing could not answer.

A lot was known about the moon before Apollo 11 landed. In the decade before, the Soviet Union and the U.S had launched nearly 70 uncrewed missions to the moon. Some were landers, some flybys and some orbiters. Two-thirds were failures, either during launch, in transit, crashing on landing, or communication and telemetry errors. But by the mid 60s, a general picture had emerged from the shape of the moon, gravity and topographic variability.

The rocks that Armstrong and Aldrin dropped into a box, plus the scoops of dust and soil Armstrong added as an afterthought to provide a little padding to the rocks, would be the first samples to fill in the details. Critical information such as age, composition and texture could only come from had samples. Every Apollo landing mission would continue to add to the collection. The last lander, Apollo 17, brought back 243 pounds, bringing the total Apollo haul to 840 pounds.

First results from the lunar samples came in the early 1970s. The rocks were almost all igneous (formed from the cooling of molten rock) and very very old. The few samples that weren't igneous were breccias (conglomerations of broken bits of igneous rocks formed by impacts) and dust/sand particles from the breakdown of the igneous rocks. Igneous rocks are the easiest to estimate dates for – the breakdown of small amounts of radioactive isotopes provide an atomic clock. The ages of rock from the six Apollo landing sites range from about 3.2 to 4.4 billion years.

At the time of the Apollo landing, scientists were debating the origin of the moon. There were several competing hypotheses: the two bodies could have been formed together, the moon may have been captured early on in the history of the solar system, or a large body (Mars size or larger) had collided with the young earth, creating a monster debris field around the earth that quickly coalesced into the moon. Analyses of the moon rocks showed a composition nearly identical to that of the earth and most planetary scientists now favor some version of the impact scenario.

NASA has kept a very careful watch on its moon rock collection (see the Science News link below). The Apollo 11 samples were quickly quarantined (as were the astronauts) to both protect earthlings from possible moon contaminants and vice versa. Most of the samples would end up at NASA's Johnson Space Center in Houston where they are kept at uniform pressure and temperature in a nitrogen-sealed environment. About 50,000 samples have gone to research labs all over the globe, but nearly 80% of the collection has yet to be touched.

The initial analyses of the Apollo rock collection suggested a body with no water. There were no hydrated minerals in the samples and this was consistent with the consensus at the time that the moon was a dry world. But analysis techniques have changed in the past fifty years and in the 2000s a team used an ion microprobe, an instrument that only became available for research purposes in the 1980s, to analyze some of the Apollo samples. They found water trapped in tiny volcanic glass beads. More recent uncrewed missions this century, including ones from China, Japan and India, have confirmed the presence of water, although the amount and distribution is still being debated.

There was an unexpected bonus to the Apollo rock samples. They helped to identify another source of lunar material that had been previously unrecognized – meteorites. The overwhelming majority of meteorites originate in the asteroid belt. Most have characteristics that put them in several recognized categories. But a few have unusual mineral signatures that don't seem to fit with the majority. In the 1980s, a meteorite found in Antarctic was analyzed and compared to the Apollo samples. The composition showed a perfect match. 371 meteorites have now been identified as having come from the moon, providing a more widely distributed source of moon rocks for analysis.

It isn't just the Apollo hand samples that contributed to the study of lunar geology. Apollo 12, 14, 15, and 16 astronauts deployed seismographs at their landing sites. The instruments sent data back remotely to earth and operated until 1977. The instruments detected moonquakes – small seismic events believed triggered by tidal forces and impacts. The data was used to determine the internal structure of the moon. Like earth, the moon has a core, an outer core, a mantle and a crust.

The legacy of the Apollo missions continues and all future lunar missions, whether remote or with crews will be based on the foundations built fifty years ago.

Note: more about the NASA moon rock repository and the science behind the collection in Science News - https://www.sciencenews.org/article/nasa-apollo-anniversary-moon-rocks-preservation

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