First lunar farside samples from Chang'e-6 mission analyzed

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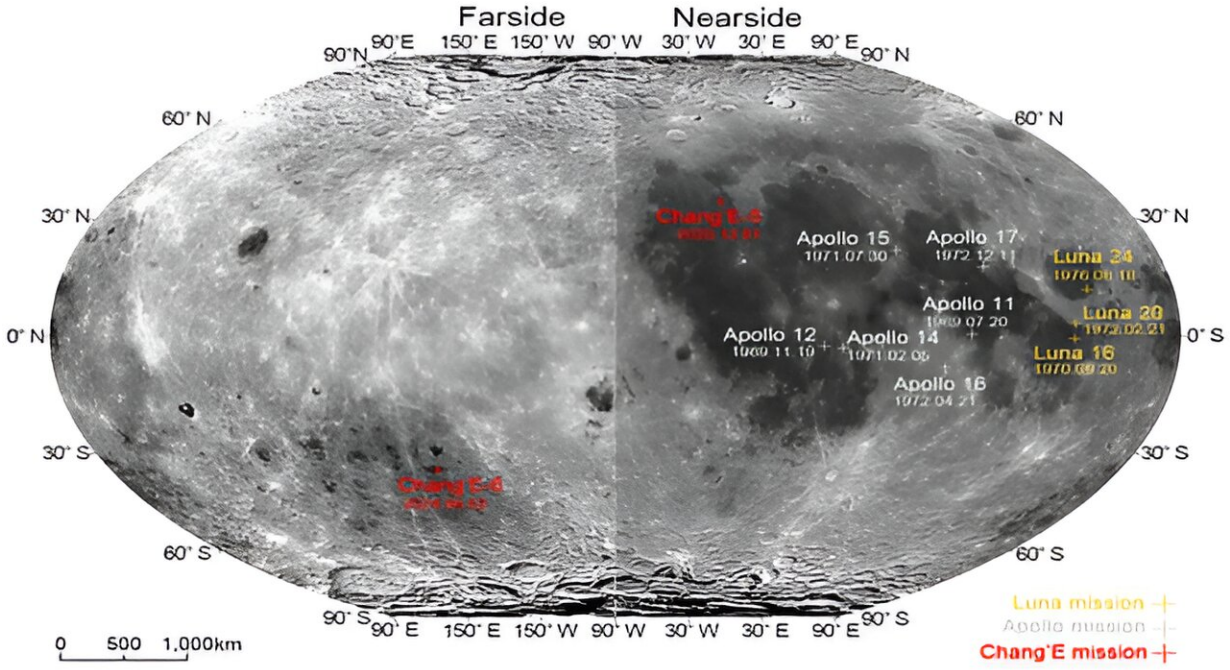

The Topographic Map illustrates the landing sites of the Chang'E Missions, Apollo Missions, and Luna Missions. Credit: NAOC

A team of Chinese scientists has studied the first lunar farside samples brought back by the Chang'e-6 mission. The findings mark a significant milestone in lunar exploration science and technical exploration capability. The study was published in *National Science Review* on Sept.

16.

"As the first samples collected from the moon's far side, these samples will provide an unparalleled opportunity for lunar research," said Prof. Li Chunlai from National Astronomical Observatories of the Chinese Academy of Sciences (NAOC), one of the corresponding authors of this study.

The samples help to advance the understanding of several key aspects of lunar science, including the moon's early evolution, the variability of volcanic activities between the nearside and farside, the impact history of the inner solar system, the record of galactic activity preserved in the lunar weathering layer, the lunar magnetic field and its anomalies and duration, and the composition and structure of the lunar crust and mantle.

The samples were gathered from the lunar surface using drilling and scooping techniques. The team analyzed their physical, mineralogical, petrographic, and geochemical properties. The analysis showed that the collected samples reflect a mixture of "local" basaltic material and "foreign" non-mare material. The rock fragments are mainly basalt, breccia, and agglutinates. The primary constituent minerals of the soils are plagioclase, pyroxene, and ilmenite, with very low olivine abundance. The lunar soil in the samples is mostly a mixture of local basalts and non-basaltic ejecta materials.

The lunar surface is divided into three very distinct geochemical provinces based on variations in geochemical characterization and petrologic evolutionary history. These are the Procellarum KREEP Terrane (PKT), the Feldspathic Highland Terrane (FHT), and the South Pole-Aitken Terrane (SPAT).

"These local mare basalts document the volcanic history of lunar farside,

while the non-basaltic fragments may offer critical insights into the lunar highland crust, South Pole-Aitken impact melts, and potentially the deep lunar mantle, making these samples highly significant for scientific research," said Prof. Li.

"These insights are expected to lead to new concepts and theories regarding the origin and evolution of the moon, and refine its use as an interpretive paradigm for the evolution of the terrestrial planets," added Prof. Li.

Adding together the lunar samples gathered from the six Apollo missions, three Luna missions, and the Chang'e-5 mission, a total of 382.9812 kg of lunar samples have been collected. These lunar samples have provided scientists with critical information on the formation and evolutionary history of the moon. "Returned lunar samples are essential to planetary science research, as they provide key laboratory data to link orbital remote sensing observations to actual surface ground truth," said Prof. Li.

The samples have contributed to the development of hypotheses, such as the moon's giant impact on early Earth's origin, the lunar magma ocean, and the Late Heavy Bombardment. These earlier studies of lunar samples, all of them collected from the lunar nearside, have significantly advanced the discipline of planetary science. "Nearside samples alone, without adequate sampling from the entire lunar surface, especially from the farside, cannot fully capture the geologic diversity of the entire moon. This limitation hampers our understanding of the moon's origin and evolution," said Prof. Li.

Scientists gained the much-needed farside lunar samples when the Chang'e-6 mission collected 1,935.3 grams of lunar samples from the South Pole-Aitken Basin on June 25, 2024.

The lunar samples collected from the nearside by the Apollo, Luna, and CE-5 missions included samples from the PKT and the FHT. Until now, no samples had been collected from the unique SPAT on the lunar farside. Scientists believe the South Pole-Aitken Basin was formed 4.2 to 4.3 billion years ago in the Pre-Nectarian period. It is the largest confirmed impact basin in the solar system.

More information: Chunlai Li et al, Nature of the lunar farside samples returned by the Chang'E-6 mission, *National Science Review* (2024). DOI: 10.1093/nsr/nwae328

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