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Simultaneous Extraction of Cosmogenic and Interstellar Radionuclides from Lunar Soil

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Various nucleosynthetic processes contribute to the creation of the chemical elements in the universe. The rapid neutron capture process (r-process) alone produces over half of the elements heavier than iron and is uniquely capable of synthesizing the actinides. Recent r-process events in the solar neighbourhood can leave fingerprints in the solar system, such as the pure r-process radionuclide ^{244}Pu ($t_{1/2}$ $\sim$ 81 Myr). The extraordinary improvements in the ^{244}Pu detection efficiency in recent years made it possible to detect live interstellar ^{244}Pu in deep-sea ferromanganese crusts via AMS — confirming ongoing r-process nucleosynthesis in the solar neighbourhood [1]. We have now extended our search for interstellar ^{244}Pu and also for supernova-produced ^{60}Fe ($t_{1/2}$ = 2.6 Myr) to a different archive, lunar soil. The absence of geological processes leads to the accumulation of radionuclides over much longer time periods, leading to potentially higher signals and enabling mapping of the interstellar influx up to hundreds of millions of years into the past [2,3]. Alongside the search for interstellar radionuclides, we also measured various cosmogenic radionuclides with half-lives in the order of a million years in these lunar samples — suitable to study the samples' exposure histories. The radionuclides ^{10}Be, ^{26}Al, and ^{41}Ca are measured at HZDR in Dresden and ^{53}Mn at the ANU in Canberra. An effective sample preparation method ensuring optimal extraction of all radionuclides from the same sample and simultaneously providing high chemical yields is important here.

This contribution presents a chemical separation procedure based on existing recipes [4,5] to simultaneously extract eight elements from one lunar soil sample. This method was first tested on lunar simulants and then applied on an Apollo 11 soil sample, also investigating different leaching and digestion procedures. Data for 12 lunar soil samples will be presented for all cosmogenic nuclides. Additionally, we will provide insights into preliminary ^{60}Fe data and updates on the quest for interstellar ^{244}Pu.

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Student Submission

Yes

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