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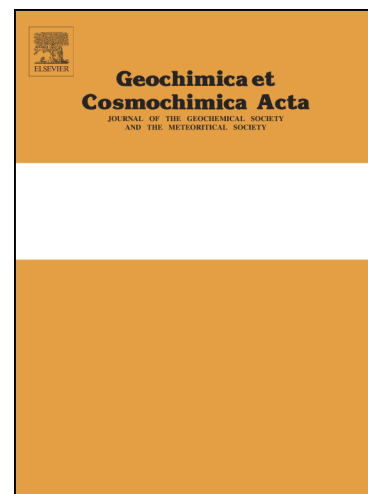
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## Stepwise heating of Lunar anorthosites 60025, 60215, 65315 possibly reveals an indigenous noble gas component on the Moon.

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Despite extensive effort during the last four decades, no clear signature of a lunar indigenous noble gas component has been found. In order to further investigate the possible occurrence of indigenous volatiles in the Moon, we have re-analyzed the noble gas and nitrogen isotopic compositions in three anorthosite samples. Lunar anorthosites 60025, 60215 and 65315 have the lowest exposure duration (~2 Ma) among Apollo samples and consequently contain only limited cosmogenic (e.g. <sup>124,126</sup>Xe) and solar wind (SW) noble gases. Furthermore, anorthosites have negligible contributions of fissiogenic Xe isotopes because of their very low Pu and U contents. As observed in previous studies (Lightner and Marti, 1974; Leich and Niemeyer, 1975), lunar anorthosite Xe presents an isotopic composition very close to that of terrestrial atmospheric Xe, previously attributed to "anomalous adsorption" of terrestrial Xe after sample return. The presumed atmospheric Xe contamination can only be removed by heating the samples at medium to high temperatures under vacuum, and is therefore different from common adsorption. To test this hypothesis, we monitored the adsorption of Xe onto lunar anorthositic powder using infrared reflectance spectroscopy. A clear shift in the anorthosite IR absorbance peaks is detected when comparing the IR absorbance spectra of the lunar anorthositic powder before and after exposure to a neutral Xe-rich atmosphere. This observation accounts for the chemical bonding (chemisorption) of Xe onto anorthosite, which is stronger than the common physical bonding (physisorption) and could account for the anomalous adsorption of Xe onto lunar samples.

Our high precision Xe isotope analyses show slight mass fractionation patterns across <sup>128-136</sup>Xe isotopes with systematic deficits in the heavy Xe isotopes (mostly <sup>136</sup>Xe and marginally <sup>134</sup>Xe) that have not previously been observed. This composition could be the result of mixing between an irreversibly adsorbed terrestrial contaminant that is mostly released at high temperature and an additional signature. Solar Wind (SW) Xe contents, estimated from SW-Ne and SW-Ar concentrations and SW-Ne/Ar/Xe elemental ratios, do not support SW as the additional contribution. Using a  $\chi^2$  test, the latter is best accounted for by cometary Xe as measured in the coma of Comet 67P/Churyumov-Gerasimenko (Marty et al., 2017) or by the primordial U-Xe composition inferred to be the precursor of atmospheric Xe (Pepin, 1994; Avice et al., 2017). It could have been contributed to the lunar budget by volatile-rich bodies that participated to the building of the terrestrial atmosphere inventory (Marty et al., 2017).

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