Possible sources of non-solar Xe, Ar in lunar soils

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Surface-correlated noble gases implanted in lunar soils are known to contain parentless radiogenic components such as ^{40}Ar, ^{129}Xe and fission Xe [1] that are not thought to be attributable to the solar wind (SW). These components have been assigned a lunar origin: Radiogenic components produced in the lunar interior were degassed to the transient lunar atmosphere, and some of these degassed noble gasses were re-implanted to the lunar surface together with SW [2]. However, this degassing hypothesis requires an untenably high degassing efficiency of radiogenic noble gases from the lunar interior. We therefore inferred that the parentless radiogenic noble gases may have been imported from extra-lunar source(s), and suggest that “pollution of the Sun by planetesimals/planets” inspired by recent studies on extra-solar planetary system [3] could be responsible for these parentless radiogenic noble gases.

Radiogenic noble gas isotopes such as ^{40}Ar, ^{129}Xe, ^{244}Pu-fission Xe will be relatively enriched in a volatile-depleted planet because they were initially trapped in solid planetary bodies as "metallic" parent elements ^{40}K, ^{129}I, ^{244}Pu. From a comparison of Xe fluxes between SW and planet pollution, we concluded that the planet pollution of two Earth masses in the Sun proposed by Murray et al. [4] could account for non-solar Xe in lunar soils, provided that (1) planet pollution lasted for a few hundred Ma or less and (2) a few percent of the polluted Xe was entrained in SW. However, ^{40}Ar in lunar soils appears to be too large to be attributable to planet pollution alone. It is interesting to speculate that if the geomagnetic dipole field were absent or much weaker in the early history of the Earth, the issue being still matter of a debate, there would be significant ion loss from the atmosphere as inferred from the case of Mars [5]. Some of these escaping ions may be trapped on lunar soils. The closer distance of the Moon to the Earth in the earlier time [6] would also enhance the capture of these escaping ions by the Moon.

References

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