Distribution and Origin of Helium, Neon, and Argon Isotopes in Apollo 12 Samples by *In Situ* Analysis with a Laser-Probe/Mass-Spectrometer

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Abstract

Distributions of the relative isotopic abundances of helium, neon, and argon were measured *in situ* by laser-probe/mass-spectrometric analysis of Apollo samples: 12070,67 (fines and individual gabbro, basalt, feldspar, and glass fragments); 12018,24 gabbro (interior and exterior surface); and 12010,13 breccia (interior and exterior of matrix and vein of fine-grained material). On a scale of 10^{-3} to 10^{-5} g, the distributions of helium, neon, and argon isotopes in these samples are highly variable. The maximum abundances of these gases are located (1) in rocks within 30 μ of the pitted "top" surface (that surface exposed to solar irradiation), (2) in loose fines on the lunar surface, or (3) in veins of fine-grained material within rock breccias.

The relative abundances of the helium, neon, and argon isotopes from the "top" surface (< 30 μ) of 12018,24 are equivalent to the isotopic abundances measured in the lunar fines 12070,67 and are consistent with an origin by solar-wind implantation. A comparison of the ratios of helium, neon, and argon isotopes from these samples with the ratios determined on the fine-grained vein material of 12010,13 and on the previously analyzed fine-grained vein material of Fayetteville and Kapoeta meteorites shows that the He^3/He^4 is 30% less in the meteorites than in the lunar samples. Furthermore, although the He^4/Ne^{20} from Kapoeta is consistent with the lunar results, the He^4/Ar^{36} is a factor of 3 higher, whereas the relative abundances of isotopic helium, neon, and argon from Fayetteville are not equivalent to the lunar results.

Cosmogenic gases, isotopically similar to the gases produced in achondritic meteorites by galactic cosmic-ray bombardment, have been located in the interior of the lunar samples.