LUNAR METEORITE SAU 300 – NOBLE GAS ISOTOPES

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The new lunar meteorite Sayh al Uhaymir 300 (SaU 300) is classified as regolithic granulite breccia based on its petrology and chemistry [1,2,3]. The characteristic features indicate a high temperature metamorphic event, which produced the granulite breccia texture of this meteorite. A chip weighing 100.9mg from the meteorite has been measured for noble gases at the Laboratory for Earthquake Chemistry, Univ. of Tokyo by a stepwise heating method: 600, 800, 1000, 1200 and 1800°C.

It showed a maximum release at 1000°C, whereas other noble gases were mostly released at 1800°C. At the 600 and 800°C, Ne isotopic ratios are interpreted as a mixture between terrestrial atmospheric and cosmogenic components, but at the higher temperatures trace amount of SEP-Ne, [^{20}Ne] ~1×10^{-7} cm^{3}STP/g, was recognized as the plots on a SEP-cosmogenic mixing line (Fig. 1). Solar wind Ne as indicated in [5] could not be identified. Regolith breccias generally trap solar wind (SW) and solar energetic particles (SEP). By the later thermal metamorphism, less energetic SW-particles should have been removed. Cosmogenic ^{3}He, ^{21}Ne and ^{38}Ar concentrations are 0.3, 0.70, 1.5 $\times10^{-8}$ cm^{3}STP/g. The increasing concentrations of heavier isotopes indicate that heavier noble gases show longer apparent exposure ages, because production rates generally become smaller for heavier isotopes.

The observations noted above are consistent with the petrological features: most of noble gases had been lost when granulitic texture was produced on the Moon, and trace amounts of noble gases strongly retained in some minerals remain in this meteorite. The noble gas release profile suggests that the temperature was about 1200°C. From the above discussion, the cosmogenic ^{21}Ne and ^{38}Ar should be partly the products by cosmic-ray irradiation on the Moon prior to the thermal event. Accordingly, the concentration of cosmogenic ^{3}He and its production rate of ~1.5×10^{-8} cm^{3}STP/g/Myr gives an upper limit on a transit time of SaU 300 from the Moon to the Earth as 0.2 Myr. Concentrations of radiogenic ^{4}He and ^{40}Ar are respectively 220 and 1400×10^{-8} cm^{3}STP/g. Adopting the concentrations of U (0.22 ppm), Th (0.46 ppm) and K (510 ppm), U/Th-He and K-Ar ages were calculated as 0.055 and 2.9 Gyr, respectively. The much younger U/Th-He age should have been resulted by strong He-loss during the thermal metamorphism. Because the radiogenic ^{40}Ar should have been lost partly at the thermal event, real crystallisation age bust be older than the calculated K-Ar age.

Similarities are observed for Dhofar 026, which is confirmed as the first lunar metamorphic meteorite and classified as anorthositic granulite breccia [4,6]. The ancient regolith seems to have undergone thermal metamorphism to about 1000°C or more.

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