I-Xe Dating of Meteorites Including Ancient Solar Wind Noble gases

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During the formation of planets from nebula gas and dust in the early solar system , the activity of the primordial sun increased at a certain period, and a large amount of nebula gas was blown away from the planet formation region by the strong solar wind. Since then, the solar wind irradiated the forming planetesimals and it is considered that breccia meteorites formed at the surface layer of planetesimals took abundant solar wind in themselves. In this study, I-Xe ages of Zag (H36) and Northwest Africa 801 (CR2) (NWA 801) meteorites which are breccia meteorites were determined in order to clarify when the solar wind blew nebula gas away by a comparison between I-Xe age and the amount of solar wind derived noble gases. About 20 mg fragments of Zag and NWA801 meteorites irradiated with neutrons at the Kyoto University research reactor were heated stepwisely in vacuum at temperatures ranging from 650 to 1800 to release xenon isotopes, including naturally occurring radiogenic ^{129}Xe derived from ^{129}I and ^{128}Xe produced from ^{127}I by (n, β) reaction in the reactor. After purifying the noble gases extracted at each heating step, xenon isotope ratios were measured using a magnetic-sector-type mass spectrometer VG3600 The obtained ^{129}Xe/^{128}Xe ratios of the samples after corrections for low temperature alteration and trapped component were converted to relative I-Xe ages by comparing with ^{129}Xe/^{128}Xe ratio of the Shallowater meteorite standard which has absolute age of 4.5633±0. 0004 billion years [1] and was irradiated with neutrons together with the samples.
The Zag meteorite is composed of light and dark portions. According to Bajo [2], the light portion is older and has less solar wind noble gases . The dark portion, on the other hand, has younger age and more solar wind noble gases. This suggests that the light portion was formed before the nebula gas was blown away, and the dark portion was formed after that. Although our new I-Xe ages are associated with relatively lager errors compared to those reported in [1] due to less neutron fluence to produce ^{128}Xe the light portion was systematically older (4.561±0.013 and 4.558±0.013 billion years) than the dark portion (4.554± 0.009 and 4.551±0.006 billion years) and less enriched in solar wind noble gases by an order of magnitude, which are consistent with the previous research. The weighted mean of I-Xe ages of the light and dark portions are 4.557±0.004 and 4.550±0.002 billion years (errors are 95% confidence levels), respectively, suggesting that solar nebular gas dissipation would have occurred between these ages. The NWA 801 meteorites had younger I-Xe age (4.549±0.012 billion years) and large amount of solar wind noble gases , which is similar to the Zag meteorite. However, due to the large uncertainty, more data with higher precision (i.e., higher neutron fluence) are required to constrain the timing of solar nebular gas dissipation.
References:[1] J. D. Gilmour et al., Meteorit. Planet. Sci. 41, 19 (2006). [2] Bajo, K. Doctoral Dissertation, The University of Tokyo, 2010

Keywords: I-Xe dating, meteorite

