

The He isotopic ratios in old terrestrial atmosphere: On the effect of human industrial activity

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Sano et al. (1989) indicated that the He isotopic ratio in air has changed from the value measured by Mamyurin et al. (1970) and Calarke et al. (1976), suggesting the addition of 4He in the air caused by the human industrial activity. However, Lupton and Graham (1991) denied it from their measurements. Recently, Person-Wickmann et al. (2001) reported the small excess of 3He in historical slags processed in 1500AD. Thus it is still in debate whether there is a temporal variation of atmospheric $3\text{He}/4\text{He}$ ratio or not. It is very important if human industrial activity like burning of fossil fuels gives effect on the variation of He isotopes in the air.

We have examined the He isotopic ratios in old Chinese and Japanese porcelain on the idea that the old air could be preserved in voids in old porcelain. We used eight samples and measured the He, and Ar isotopes and their elemental abundances by crushing and by fusion.

There was no correlation between $3\text{He}/4\text{He}$ ratios and $38\text{Ar}/36\text{Ar}$ ratios, indicating that there is no effect of isotopic mass fractionation effect at the trapping. The $4\text{He}/36\text{Ar}$ ratios are high in many porcelain samples, but no correlation with $3\text{He}/4\text{He}$ ratios, indicating that there is an elemental fractionation but no isotopic fractionation.

The following conclusions have been obtained.

- (1) The $3\text{He}/4\text{He}$ ratios in porcelains shows slightly high values compared to the present value in air.

About 1400AD $R/R_a = 1.10 + 0.03$

About 1700AD $R/R_a = 1.05 + 0.02$

Thus, it is likely that the $3\text{He}/4\text{He}$ ratio in old atmosphere was higher than the present value.

- (2) The radiogenic 4He was also degassed in some porcelain samples which were supposed to be baked in low temperatures. In this study, the He ratios in Japanese old porcelain were lower than those in Chinese old porcelain, suggesting that the baking temperature of Japanese old porcelain was lower than that of Chinese one.