SIGNIFICANT DEPLETION OF ARGON-RICH NOBLE GASES IN THE NINGQIANG CARBONACEOUS CHONDRITE DURING EXPERIMENTAL AQUEOUS ALTERATION

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Introduction: Ar-rich noble gases are a main component of primordial noble gases in unequilibrated ordinary chondrites and some classes of anhydrous carbonaceous chondrites [e.g., 1]. The Ar-rich gases are characterized by the high $^{36}$Ar/$^{132}$Xe and $^{84}$Kr/$^{132}$Xe ratios relative to Q gas [2]. Recently it is reported that the Ar-rich gases are removed by light HF/HCl etching, like solar wind noble gases, and thus suggested that they locate in the amorphous rims around fine-grained olivine and pyroxene [3]. On the other hand, the Ar-rich gases are minor in carbonaceous chondrites that experienced aqueous alteration [e.g., 4]. In order to understand the relation between the abundance of Ar-rich gas contents and the degree of aqueous alteration that meteorite experienced in their parent bodies, we performed an experimental aqueous alteration on Ningqiang. A piece weighing 0.3g was crushed into µm-sized particles and kept in liquid water at 200°C for 10 and 20 days. Natural Ningqiang sample and altered ones soaked for 10 and 20 days were analyzed for mineralogy by X-ray diffraction and for noble gases by stepped pyrolysis.

Results and Discussion: Mineralogical analysis shows that the natural sample consists of olivine, low-Ca pyroxene, magnetite and troilite. Olivine, low-Ca pyroxene and troilite contents were reduced in the sample altered for 10 days, while phyllosilicate and hematite formed. Noble gas analyses show that the experimental alteration for 10 days removed 90, 72 and 61% of $^{36}$Ar, $^{84}$Kr and $^{132}$Xe, respectively, whereas lesser proportion (28%) of $^{20}$Ne was removed. The $^{36}$Ar/$^{132}$Xe and $^{84}$Kr/$^{132}$Xe ratios were reduced from 220 and 1.3 to 59 and 0.9, respectively, whereas $^{20}$Ne/$^{132}$Xe ratio was increased from 31 to 57. Calculated $^{36}$Ar/$^{132}$Xe and $^{84}$Kr/$^{132}$Xe ratios of noble gases removed by the alteration are 323 and 1.5, respectively, and are in the range of Ar-rich gases in enstatite chondrites [5] and ureilites [6]. These indicate that the Ar-rich gases are located in materials that are very susceptible to weak aqueous alteration brought about by the neutral water. In contrast, the noble gases remaining in the sample are close to Q gas in the elemental compositions. This indicates that Q gas in phase Q is much more resistant to aqueous alteration than the Ar-rich gases. In the sample altered for 20 days, mineralogy and noble gas signatures are basically similar to the 10-day sample, indicating that most of the Ar-rich gases were lost by aqueous alteration within 10 days. Our results suggest that major portion of primordial noble gases were lost from primitive hydrous asteroids during low-temperature aqueous alteration.