NOBLE GASES IN A PRIMITIVE ACHONDRITE NORTHWEST AFRICA 3250.

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Introduction: NWA 3250 is a primitive achondrite that consists of olivine (58 %), low-Ca pyroxene (38 %), and accessory plagioclase, taenite, troilite and chromite [1]. The previous studies indicated that the oxygen isotope composition plots on the bulk CR chondrite field and is close to those of some other primitive achondrites (e.g., NWA 011 and 6901) and equilibrated CR chondrites (e.g. [2]). From mineralogical and petrological investigations, a close affinity among NWA 3250, 2994, 3100, 6901, 6921, 7317 and 8548 has been suggested [3-6]. NWA 2994 and 3100, in which relict chondrule signatures were found, have been identified to be highly equilibrated and metasomatized CR6 chondrites, and Tafassasset to be CR7 chondrite [7]. These results imply that the large scale thermal heating has occurred at the CR chondrite parent body. However, current observations for these meteorites are not straightforward and detailed scenario about the parent body(ies) is still unclear. In this study, we conducted noble gas analyses for two small fragments separated from a specimen of NWA 3250 in order to obtain additional information for chronology such as cosmic-ray exposure ages and gas retention ages as well as primordial noble gas indication.

Noble gas measurement: Noble gases were measured with a MM5400 sector-type mass spectrometer at Kyushu University. The first sample #1 (3.7 mg) was heated at 700 and 1750 ℃ and the second sample #2 (3.7 mg) at 900 and 1750 ℃, respectively, for gas extractions. Extracted gases were purified by Ti-Zr getters, and then noble gases were separated in He-Ne, Ar and Kr-Xe fractions, each of which was introduced into the mass spectrometer.

Result and discussion: The results of noble gases in the two samples are mostly consistent with each other with some exception. Remarkable differences are observed in concentrations of ^{3}He, ^{4}He and nucleogenic Xe isotopes. Helium and Ne are dominated by cosmogenic component plus radiogenic ^{4}He. The concentrations of cosmogenic ^{3}He are 0.57 and 1.0×10^{-6} cm^{3}STP/g, those of ^{21}Ne are 1.2 and 1.0×10^{-7} cm^{3}STP/g, and the measured ^{22}Ne/^{21}Ne ratios are 1.174 ± 0.107 and 1.068 ± 0.062 for #1 and #2, respectively. The low ^{22}Ne/^{21}Ne ratio of #2 implies heavier shielding, though unfortunately the uncertainty of #1 is large to discuss. Assuming the average bulk chemical compositions of the probably paired meteorites (NWA 2994 and 3100) and a temporal shielding condition (somewhat heavier shielding; at 40 - 50 cm depth in a meteoroid with 50 cm in radius), the production rates of ^{3}He and ^{21}Ne are calculated using elemental production rates given in [8], from which we obtained cosmic-ray exposure ages of 31 and 56 Ma for T_3, and 31 and 37 Ma for T_{21}, respectively. Preliminary the average of T_{21}, 34 Ma, is considered as the cosmic-ray exposure age of NWA 3250. In previous works for CR chondrites and a possibly related primitive achondrite group (brachinites/-like), the cosmic-ray exposure ages range in <1 - 12 Ma with a cluster of 5 - 7 Ma for CR2 [9] and 3 - 50 Ma for brachinites/-like [10], respectively. The exposure age of Tafassasset (proposed as CR7) is 76.1 ± 15.2 Ma [10]. Equilibrated meteorites tend to have longer cosmic-cray exposure ages, however, numbers of measured samples belonging to these classes are still limited.

The sample #1 contains large amounts of radiogenic ^{4}He and ^{129}Xe, and fission $^{129-136}$Xe; but #2 does not (the concentration of ^{4}He is about one sixth and fission Xe has not been detected). The isotopic compositions of Xe also show more abundant cosmogenic Xe in #1 than #2. This is likely because the former sample included phosphate mineral. Trace amounts of merrillites were reported for NWA 2994 and 3100, though it is unknown for NWA 3250, presence of such mineral can simply explain observed cosmogenic and fission Xe. The excess ^{134}Xe/^{136}Xe ratio is preliminary calculated to be 0.96 ± 0.28 after the correction of cosmogenic and trapped Xe components, which agrees with the ratio of 0.939 from ^{244}Pu-derived fission (c.f., 0.818 from ^{238}U-derived fission). There may be small contribution from ^{238}U fission as well. Many of CR chondrite-related equilibrated meteorites (including CR6, 7 and primitive achondrites) show old formation ages by short lived nuclides such as Mn-Cr, Al-Mg and Hf-W systems (e.g., [11] and references therein). Our result on NWA 3250 also suggests that extinct nuclides ^{129}I ($T_{1/2}$ = 15.7 Ma) and ^{244}Pu ($T_{1/2}$ = 80 Ma) must have been alive at the time of Xe closure and that the ^{244}Pu-Xe age is obtained as 107 ± 24 Ma before Angra dos Reis based on the calculation we applied to eucrites [12], where the target element ratio for cosmogenic and the trapped Xe composition is customized to chondritic; the age is slightly changed but not sensitive to them.

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