NOBLE GASES IN THE NWA 852/801 CR2 CHONDRITES. D. Nakashima[1], S. Matsuda[1], H. Iio[1], K. Bajo[1], N. Ebisawa[1], and K. Nagao[1]. [1]Laboratory for Earthquake Chemistry, Graduate School of Science, University of Tokyo, Hongo 7-3-1, Tokyo 113-0033, Japan (naka@eqchem.s.u-tokyo.ac.jp).

Introduction: North West Africa (NWA) 852 and 801 are classified as CR2 chondrites [1-2]. The two meteorites contain relatively large chondrules (1 - 2 mm in diameter), FeNi metal, and dark inclusions composed of serpentine and olivine. We measured noble gases in the two meteorites with stepwise heating, which facilitates decomposition of noble gas components with different origins and trapping sites. Laser extraction noble gas analysis was also performed so as to observe microdistribution of noble gases in matrices and chondrules. We found through the noble gas analyses that the both meteorites contain high concentrations of solar wind noble gases (NWA 801 has been found to be a solar gas rich meteorite [3]). This result and petrological similarities suggest that NWA 852 and 801 are the paired meteorites. Here we focus noble gases in the bulk samples and in matrices and discuss the exposure history of the two meteorites. Results of noble gas analysis of the chondrules in NWA 852 and 801 are reported in [4-5].

Stepwise heating noble gas analysis: Bulk samples of NWA 852 (66.3 mg) and 801 (85.2 mg) were heated at from 300 to 1300 °C with 100 °C interval and finally degassed completely at 1800 °C. The extracted noble gases were purified with Ti-Zr getters and separated into four fractions (He-Ne, Ar, Kr, and Xe) with a charcoal trap and a cryogenically cooled trap. The separated four fractions were analyzed with a noble gas mass spectrometer at University of Tokyo (MS-II).

Laser extraction noble gas analysis: Polished sections of NWA 852 and 801 (~ 300 µm thick) were prepared for noble gas analysis. The two polished sections were observed with SEMs (with EDSs) at University of Tokyo so as to search for phases to be analyzed. A Q-switched Nd-YAG laser (1064 nm, 2 kHz pulse) was used for laser ablation of the NWA 852 polished section. The laser diameter was 30 µm (assuming the density of fused matrix is ~ 3 g/cm^3, the fused mass is estimated as ~ 0.6 µg). A Nd-YAG pulse laser without Q-switch was used for laser ablation of the NWA 801 polished section. The laser diameter was 50 µm (in case of 3 g/cm^3, the fused mass is ~ 1.8 µg). Since it is not clear if one fused spot releases detectable amounts of noble gases, five fused spots were made for one measurement. Extracted noble gases were purified with a Ti-Zr getter, and Ne-Xe were trapped by a cryogenically cooled trap. The concentration and isotopic ratio of He were measured with the noble gas mass spectrometers at University of Tokyo followed by analyses of Ne-Xe successively released from the cryo-trap.

Extraction by laser causes elemental fractionation favoring lighter elements, because of low gas retentivity of light elements, especially He [6]. It is necessary to determine extraction efficiencies so that the elemental ratios are corrected. But, “furnace” noble gas measurements of the small samples showed that solar noble gases are heterogeneously distributed in the meteorites (Iio et al. unpublished data), and for this reason the extraction efficiencies cannot be determined.

Results and discussion (bulk): Isotopic ratios of Ne in NWA 852 and 801 indicate that Ne in the two meteorites is dominated by solar and cosmogenic Ne, suggesting that constituents of the two meteorites had been exposed to solar winds on the surface of the parent body (-ies). He isotopic ratios in the lower temperature fractions (< 900 °C) are close to that of solar winds ($^3He/^4He$ = 0.00044; [7]). With increasing heating temperature, the isotopic ratios are elevated, indicative of cosmogenic He (~ 0.2) contribution. The total ^4He concentrations are 3.9 × 10^{-3} cm^3/g (NWA 852) and 6.8 × 10^{-3} cm^3/g (NWA 801), which are higher than that of GRA 95229 (1.4 × 10^{-3} cm^3/g; [8]). The trapped $^4He/^{20}Ne$ ratios of NWA 852 (417) and 801 (515) are close to that of solar winds (~ 500; [7]), suggesting no significant loss of solar He. The trapped $^{20}Ne/^{36}Ar$ ratios of NWA 852 (12.9) and 801 (14.1) are lower than that of solar winds (~ 44; [7]), which is explained by a contribution of primordial ^{36}Ar.

Krypton isotopic ratios of the both meteorites show ^{80}Kr excess in addition to Q like isotopic ratios. The ^{80}Kr excess is indicative of neutron capture reaction on ^{79}Br. Although it is not clear that the neutron capture reaction occurred on the parent body (-ies) or during the transit to the earth, the meteoroid (-s) should have been large enough to moderate the energy of secondary neutrons to the range to induce the neutron capture reaction if during the transit to the earth.

Xenon isotopic ratios in the 400 and 500 °C fractions are close to those of atmospheric Xe. A contribution of Xe-HL is seen around the 800 °C fraction, indicating that presolar diamonds are preserved in the two meteorites. In the higher temperature fractions, Xe isotopic ratios are similar to those of Xe-Q. Solar Xe cannot be observed in the two meteorites.

Thus, similarities of the elemental ratios of trapped light noble gases ($^{4}He/^{20}Ne/^{36}Ar$) and presences of neutron induced ^{80}Kr and Xe-HL in NWA 852 and 801 suggest the two meteorites are paired.

Results and discussion (laser): Isotopic ratios of He and Ne are explained by a mixture of solar and cosmogenic components, which is consistent with the bulk samples.

Measured sites with $^{20}Ne/^{22}Ne$ ratios more than 10 are assigned to solar gas rich portions, while the others are considered to be solar gas poor portions. Concentrations of solar ^{20}Ne and cosmogenic ^{21}Ne in the solar gas rich portions in NWA 852 show a correlation (Fig. 1). Data of NWA 801 are plotted within the range of NWA 852, which implies that the two meteorites had experienced the similar exposure history. This is additional evidence for the two meteorites to be paired. The regression line for the solar gas rich portions is interpreted as a mixing between solar wind and cosmic-ray irradiated grains and unirradiated ones in various proportions [9]. The ordinate intercept corresponds to the concentration of cosmogenic ^{21}Ne produced during the transit to the earth (space exposure), whereas the ^{21}Ne excess from the ordinate intercept corresponds to the concentration of cosmogenic ^{21}Ne produced during the cosmic-ray exposure on the parent body (parent body exposure).

The space exposure age is calculated from the concentration of cosmogenic ^{21}Ne produced during the space exposure (~ 1.9×10^{-8} cm^3/g; Fig. 1), the chemical composition of matrices (the average chemical composition of CR chondrite matrices is applied; [10]), and the production rate (assuming the average shielding; [10]). The derived space exposure age is ~ 9 Ma, which is comparable with those of the solar gas free CR2 chondrites (7 - 8 Ma; [12]).

The point “A” (Fig. 1) has a cosmogenic ^{21}Ne excess of ~ 7.7×10^{-8} cm^3/g. Here we assume that the excess is the concentration of cosmogenic ^{21}Ne produced during the parent body exposure, although there might be a solar gas rich portion with a higher excess (there are also solar gas poor portions with higher excesses). The ^{21}Ne production rate is obtained from the chemical composition [10] and the elemental production rate at the shielding depth of 40 g/cm^2 [13], where the production rate reaches a maximum. The lower limit of the parent body exposure age is estimated as ~ 57 Ma.

Constituents of NWA 852/801 would have been exposed to solar winds and cosmic-rays for more than 57 Ma on the surface of the parent body, and the meteoroid fell onto the earth after the transit time of ~ 9 Ma.

References: [1] Russell S. S. et al. (2002) *Meteoritics & Planet. Sci., 37,* A157-A184. [2] Connolly H. C. et al. (2007) *Meteoritics & Planet. Sci., 42,* 1647-1694. [3] Svetina M. et al. (2009) in preparation. [4] Matsuda S. et al. (2009) this volume. [5] Nakashima et al. (2009) this volume. [6] Nakamura et al. (1999) *GCA, 63*, 241-255. [7] Grimberg A. et al. (2008) *GCA, 72,* 626-645. [8] Scherer P. and Schultz L. (2000) *Meteoritics & Planet. Sci., 35,* 145-153. [9] Nakashima D. et al. (2006) *Meteoritics & Planet. Sci., 41*, 851-862. [10] Weisberg M. K. et al. (1993) *GCA, 57,* 1567-1586. [11] Schultz L. and Freundel M. (1985) *In Isotopic ratios in the solar system* (ed. Centre National d’Etudes Spatiales), pp. 27-33. [12] Svetina M. et al. (2003) *GCA, 67,* A461. [13] Leya I. et al. (2001) *Meteoritics & Planet. Sci., 36,* 1547-1561.

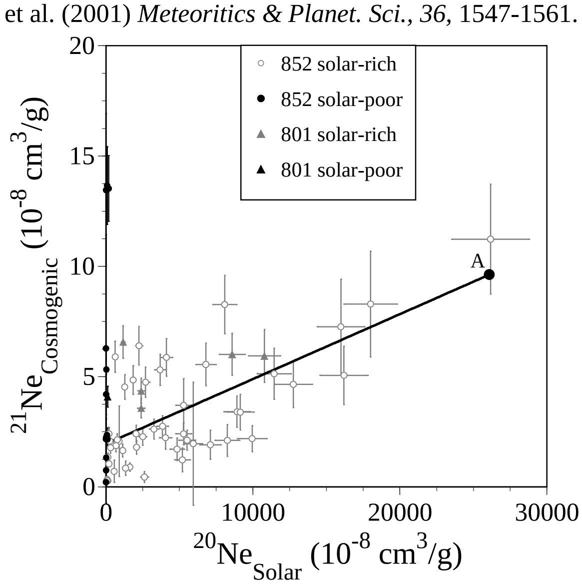

Fig. 1: The relationship between concentrations of cosmogenic ^{21}Ne and solar ^{20}Ne in matrices of NWA 852 and 801. The solid line is the correlation line for the solar gas rich portions of the two meteorites. The point ”A” is defined by the highest solar ^{20}Ne concentration.