Investigating Trapped Solar Gases in Lunar Meteorite NWA10203

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Introduction: Noble gas components in the lunar samples returned by Apollo missions have been extensively studied (Wieler et al. 2003; Wieler, 2016). However, these returned samples represents only small restricted area of the nearside of the Moon. Therefore, lunar meteorite study is significant to have better understanding of the Moon. In the context of upcoming Chinese Lunar Sample Return Mission, we have started measuring Lunar meteorites to establish a technical and scientific platform for measuring returned Lunar samples. Thus, here we present Helium (He), Neon (Ne) and Argon (Ar) isotopes from Lunar meteorite North-West Africa (NWA)10203. NWA10203 is a feldspathic regolith breccia.

Experimental procedures: We have extracted He, Ne and Ar from two clast and three matrix samples from a slice of NWA 10203, using CO_2 laser by total fusion and step wise heating method. Extracted gases were purified and processed following standard procedures as detailed in Ranjith et al. (2017).

Results and discussion: Measured He is mostly cosmogenic with ($^{3}He/^{4}He$) ~ 0.05-0.1. Measured Ne data is shown in Ne-three isotope diagram, given as Fig. 1, which clearly indicate the presence of the trapped solar wind (SW) in NWA 10203. Based on this diagram, we have inferred a trapped $^{20}Ne/^{22}Ne$ ratio of 12.17±0.16 which could represent fractionated SW composition. In addition, the figure also shows release of trapped Ne towards high temperature in both matrix and clast samples. Interestingly, the cosmogenic Ne release occurs earlier than the trapped Ne. As the SW is surface sited, one would expect release of trapped SW earlier than the volume cited cosmogenic gases. This may indicate that all the trapped gases in low retentive mineral like plagioclase may have lost due to the brecciation process, but cosmogenic gases are still there which got released at low temperature.
Argon released at low temperature is more radiogenic, which indicates that this first release of Ar is from K rich mineral like plagioclase. Like Ne, trapped Ar also released at high temperature, possibly from the high retentive minerals. In addition, release pattern of both cosmogenic and trapped Ar is the similar. This could be due Trapped solar gases which are originally surface correlated may have changed to volume correlated later. This may also indicate the regolith reworking due to brecciation or micrometeorite bombardment. We have used ^{3}He, ^{21}Ne, ^{38}Ar to derive cosmic ray exposure ages T_3, T_{21} and T_{38} respectively, which represents integrated record of both lunar surface irradiation and Moon–Earth transit irradiation. Production rates are estimated based on Hohenberg et al. (1978) and Chen et al. (2017). Cosmic ray exposure ages are estimated for both clast and matrix samples.

Table 1. Cosmic Ray Exposure Ages of Clast and Matrix samples

Sample	T_3 (Ma)	T_{21}(Ma)	T_{38}(Ma)
Clast	9-14	23-29	66-70
Matrix	10-15	26-37	74-81

Lower T_3 and T_{21} than T_{38} may indicate the depletion in lighter noble gases, He and Ne. This may be caused due to degassing activated by the ejection processes from the moon. More information from the recent measurements will be presented during the symposium.

References:
[1] Chen J et al. (2017) *MAPS*, 52(4): 646-655 [2] Hohenberg C. M et al. (1978) *LPSC Proceedings*, 9: 2311-2344) [3] Ranjith, P. M et al. (2017) *PSS*, 146: 20-29. [4] Wieler R. and Heber V.S (2003) *SSR*, 106(1-4): 197-210. [5] Wieler R (2016) *Chemie der Erde-Geochemistry*, 76(4): 463-480.

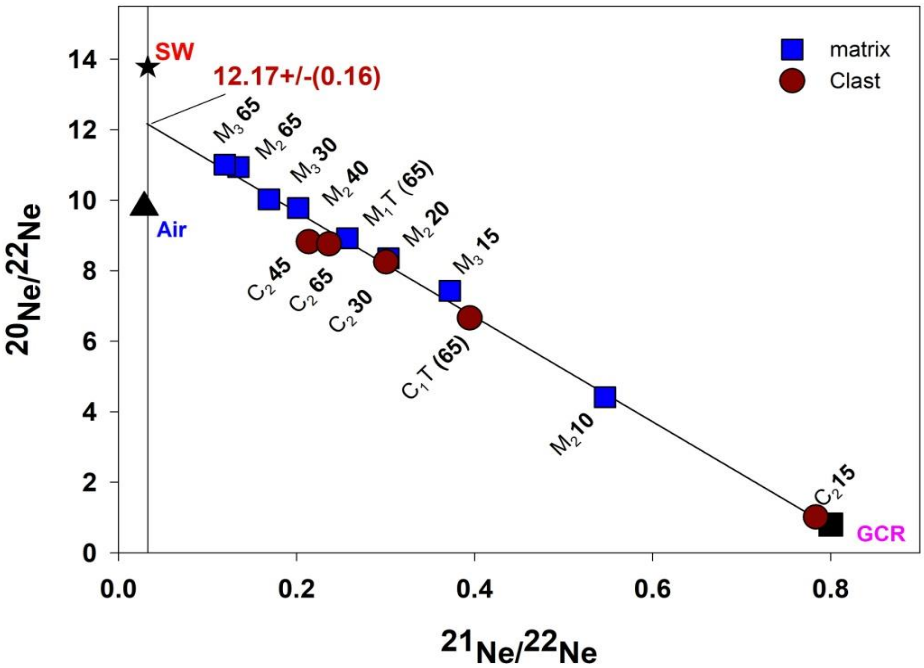

Figure 1.Neon three isotope diagram for all matrix (M) and clast (C) samples. Numbers after C and M shows the percentage of laser power which varies from 10-65%. C_1 and C_2 are two clast samples and M_1, M_2 and M_3 are three matrix samples.