COSMIC-RAY EXPOSURE AGES OF BRACHINITES AND BRACHINITE-LIKE ACHONDRITES. S. P. Beard[1], D. Weimer[2], H. Busemann[2], C. Maden[2], T. D. Swindle[1], [1]Lunar and Planetary Laboratory, University of Arizona, Tucson AZ 85721 (spbeard@lpl.arizona.edu), [2]Institute of Geochemistry and Petrology, ETH Zurich, Clausiusstrasse 25, 8092 Zurich, Switzerland.

Introduction: Though there should be plentiful sources of olivine from the mantle regions of differentiated chondritic bodies, only a few types of meteorite classes are dominated by olivine. One such type, are the brachinites, which are a small group of achondrites that have a poorly-understood history. The majority of studies on brachinites have focused on petrology and bulk chemistry [1,2,3], with little focus on chronology. The goal of this work is to use noble gas mass spectrometry to understand the exposure history of a suite of 16 brachinites. Furthermore, for the first time we aim at providing a systematic study of ^{4}He and ^{40}Ar gas retention ages and of the potentially present trapped heavy noble gases in these samples.

Cosmic-ray exposure (CRE) ages measure the time since a meteorite ejected from its proximate parent body resulting from an impact or break-up event. Analysis of CRE clusters was used in addition to oxygen isotopic measurements to support the idea that the howardites, eucrites, and diogenites (HED) meteorites originated from the same parent body [4] as well as e.g. demonstrating a common break up event among acapulcoites [5].

Methods: Brachinites/brachinite-like samples in this study are Ramlat as Sahmah 309, North West Africa 595, North West Africa 1500, North West Africa 3151, North West Africa 4518, North West Africa 4874, North West Africa 4876, North West Africa 4882, North West Africa 4969, North West Africa 6077, North West Africa 6474, North West Africa 6962, North West Africa 7297, North West Africa 7605, North West Africa 8777, and North West Africa 10637. The 16 samples were divided into two aliquots (as permitable by available mass; ranging from 8-95 mg; average ~46 mg) in order to have their noble gases (He, Ne, Ar, Kr, and Xe) measured. Gas measurement followed established methods [6] and were measured on the custom-built sector-field noble gas spectrometer at ETH Zurich, named "Albatros".

Samples were placed in an all metal sample holder maintained in vacuum above a furnace that was continuously preheated to ~300-400 °C. Gas extraction involved dropping the sample into a Mo crucible increasingly heated to ~1750 °C for ~30 minutes. The gas was purified of reactive gases such as hydrocarbons, water, etc. by a series of SAES^{TM} getters that were maintained at various temperatures up to 250 °C. The gas was then measured in two or three stages, depending on the suitability of measuring all Kr/Xe isotopes for each sample (determined by results of the first aliquot measured for all He and Ne isotopes in the first step, and all Ar and main isotopes of Kr and Xe in the second step). Argon, Kr, and Xe were separated from He and Ne by freezing them onto activated charcoal which was cooled by liquid nitrogen. This allowed for the measurement of He and Ne. The heavy noble gases were separated using two cold traps (-125 °C and -196 °C) to separate Ar from Kr and Xe when sufficent Kr and Xe were expected. Some samples contained enough argon to overload the multiplier. When this happened, an additional step was added to the procedure to dilute the amount of Ar in order to have reliable measurements of the ^{36}Ar/^{38}Ar measured in ion counting mode. The Albatros mass spectrometer uses a Faraday cup (for gas at high pressure) as well as a counting mode multiplier (for gas at lower pressure). The effect of doubly charged interferences was monitred by measuring the amount of ^{40}Ar and CO_2 background in the He and Ne portion of analysis. In general, these interferences were negligible.

Mass fractionation was monitored by measuring a series of calibrated gas mixtures of known composition throughout the experimental duration. Blank corrections were applied to sample results by replicating the sample measurement procedure on Al foil 'beads' originating from the same source of foil used on samples.

^{21}Ne ages were calculated using the production rates reported by [7] with modifications for 4π exposure and assuming a 40 g/cm^2 shielding for all samples. The target chemistry was taken as an average of the bulk chemistry of brachinites reported in [8].

Results: Figure 1 is a histogram that shows the distribution of the **preliminary** ^{21}Ne ages, which range from 8-39 Ma. Of the 13 samples in which two aliquots were measured, 11 of them agree in age (within ~10%). The ages of one sample did not agree and therefore was not included in the figure (RaS 309: ~14 Ma and ~30 Ma). Most samples' ^{38}Ar results show a significant portion of a trapped component, which needs further analysis.

Discussion: These preliminary results are expected to change since they do not include the separation of trapped and cosmogenic components mostly for Ar and -for a few cases- for Ne (although the isotopes considered here are dominated by the cosmogenic component) and are currently assigned a general shielding depth. Also, more sophisticated models predicting cosmogenic production rates for ^{3}He, ^{21}Ne and ^{38}Ar in dependence of the $(^{22}Ne/^{21}Ne)_{cosmogenic}$ shielding

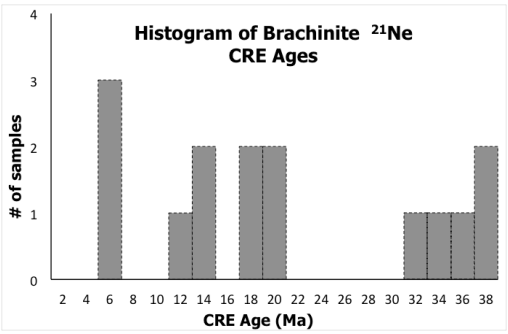

Figure 1: ^{21}Ne ages for 15 brachinite and brachinite-like achondrites.

indicator as well as the sample chemisty [9] will be used. However, we have confidence from the fact that almost every samples' aliquots showed good agreement. The histogram of ^{21}Ne ages does not show any definitive clustering, but also does not show a flat distribution. Most noteably, there are three samples that fall into the 6 Ma bin.

Our next steps are to make the appropriate corrections for occasionally present trapped Ne and Ar, to determine ^{3}He and ^{38}Ar CRE ages, to determine and fully reduce the Kr and Xe data to assess the non-neglible trapped heavy noble gas content of some samples and determine bulk ^{4}He and ^{40}Ar gas retention ages. Future work will also include argon-argon analysis of these samples. Additional splits of the same samples analyzed in this work have already been irradiated and are now in lab preparations for analysis. The combination of the CRE and Ar-Ar ages will give us new insights into the relationships among these meteorites.

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