NOBLE GAS DATA ON UREILITES FROM THE LYBIAN, OMANI, AND MOROCCAN DESERTS.

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Introduction: Ureilites are an interesting group of achondrites since they share features of both, fractionated igneous rocks and of primitive meteorites [1]. Particularly interesting is their record of primordial noble gases, which occur in elemental concentrations and isotopic compositions similar to those in carbonaceous chondrites. The main carriers of such gases are presumably carbonaceous materials (e.g., graphite, diamond, amorphous carbon), whose origin is not entirely understood in the context of ureilite petrogenesis. We have undertaken a study of the noble gas records in ureilites with the goals of constraining the origin of their primordial gases, the host phase(s), and the relationship of these gases to phase Q, the carrier of primitive gases in chondrites, and the cosmic rays exposure histories. Here we present first results on 8 ureilites from the deserts of northern Africa and Oman, 5 of which were measured for noble gases for the first time.

Samples: Eight ureilites were analyzed for noble gases. The samples were found in the hot deserts of Lybia (DaG 084, DaG 319, DaG 340, and HaH 126), Oman (Dho 132, JaH 422, and JaH 424), and Morocco (NWA 5928, provisional name). Most samples consist of normal ureilites and range in weathering grade from W2 to W4. Only 2 samples are petrographically distinct: DaG 319 is a polymict breccia and JaH 422 is an impact melt breccia.

Results and Discussion: Concentrations of the noble gases He, Ne, and Ar were obtained on bulk samples in the mass range ~50-90 mg by one-step pyrolysis at 1700˚C. He and Ne noble gases in most cases are dominantly cosmogenic; using average values for the trapped and cosmogenic components in ureilites and chondritic meteorites [2-5], the cosmogenic component represents ca. 95% of the total Ne (Fig. 1). The exceptions are DaG 340, Dho 132, and JaH 422. Dho 132 lies on a mixing line between the average cosmogenic and a trapped component, either air or primordial Ne (Ne-U, [2]). However, JaH 422 and DaG 340 appear to plot below such mixing line, especially JaH 422. Previous results on DaG 340 [6] are consistent with ours. Literature data on ureilites [7] show considerable scatter and some of the points seem to reflect mixing with an end-member with lower ^{20}Ne/^{22}Ne than air. It is unclear what the component for this mixing could be. One possibility is fractionated Ne-U during impact melting for the case of JaH 422, but the degree of fractionation would imply strong losses of Ne as well as of Ar, which shows no such fractionation (see below). In addition, the frequency of such Ne isotopic compositions does not appear to correlate with sample petrogenesis. Further tests such as stepwise heating analyses and/or etching of samples like JaH 422 could help further resolve this low ^{20}Ne/^{22}Ne end-member component.

All samples have consistently low ^{40}Ar/^{36}Ar values indicating that Ar is mostly primordial in composition (Fig. 2). Despite weathering effects on all samples, the air component in these samples is negligible with the exception of DaG 084. This is a rather unusual result since hot-desert meteorites tend to have high ^{40}Ar abundances [8]. DaG 084 clearly deviates from the rest in that it has higher ^{40}Ar/^{36}Ar and lower ^{36}Ar/^{38}Ar ratios. The sample analyzed had a greater proportion of fusion crust than the other samples, which may contribute more atmospheric gases, particularly ^{40}Ar, although the hand specimen does not look particularly more weathered. The Ar data show that this sample consists of a mixture between air and the cosmogenic component, with some excess radiogenic ^{40}Ar but very little contribution of the trapped primordial Ar. It is however unclear why or how this sample appears to have lost its Ar trapped component. The calculated abundance of radiogenic ^{40}Ar is in the same order as that for the other ureilites analyzed here (~10^6 ccSTP/g).

Ne-21 Exposure Ages: The production rate of ^{21}Ne can be derived from physical model calculations [9] for meteoroids of with radii between 10 cm and 85 cm using the average bulk composition of ureilites [10]. The calculated exposure ages are in the range of 4 to 27 Myr, with no apparent clustering (Fig. 3). The component deconvolution and exposure age calculation for the samples DaG 340 and JaH 422 is more complicated; using a trapped component (either air or Ne-U) greatly overestimates the amount of cosmogenic ^{22}Ne and, therefore, yields anomalously high ^{22}Ne/^{21}Ne$_{cos}$ values. Instead, using a lower ^{20}Ne/^{22}Ne end member seems more appropriate. Taking the lower limit of the purely cosmogenic trend (^{21}Ne/^{22}Ne ~ 0.8), a line can be fitted through the data points, yielding ^{20}Ne/^{22}Ne ~ 7.4 but a cosmogenic value of ^{22}Ne/^{21}Ne that is too low. Instead, taking the overall trend of all literature values as lower limit, the best ^{20}Ne/^{22}Ne value is ~ 9 (Fig. 1). With this adopted value, both DaG 340 and JaH 422 yield low exposure ages (6 and 3 Myr, respectively). DaG 340 could also be fitted with the air $^{20}Ne/^{22}Ne$ composition, but the exposure age increases significantly (~13 Myr).

References: [1] Goodrich C. A. (1992) Meteoritics 27, 327-352; [2] Göbel R. et al. (1978) JGR 83, 855-867; [3] Ott U. et al. (1984) Meteoritics 19, 287-288; [4] Busemann H. et al. (2000) MAPS 35, 949-973; [5] Wieler R. (2002) In Noble Gases in Geochemistry and Cosmochemistry (ed. D. Porcelli, C. J.Ballentine and R. Wieler), pp. 125-170; [6] Scherer P. et al. (1998) LPSC XXIX, #1383; [7] Schultz L. and Franke L. (2004) Noble gas data compendium. MAPS 39(11), online; [8] Scherer P. et al. (1994) In Noble Gas Geochemistry and Cosmochemistry (ed. J. Matsuda) pp. 43-53; [9] Leya I. and Masarik J. (2009) MAPS 44, 1061-1086 [10] Mason B. (1979) In: Data of Geochemistry, 6th Edition [11] Cosarinsky et al. (2009) GCA 73, A245; [12] Scherer et al. (1999) LPI Cont. 997, 72-75; [13] Bogard D.D. and Garrison D.H. (1994) LPSC XXV, 137-138; [14] Herzog G.F (2003) In Treatise on Geochemistry, Elsevier, pp. 347-380.

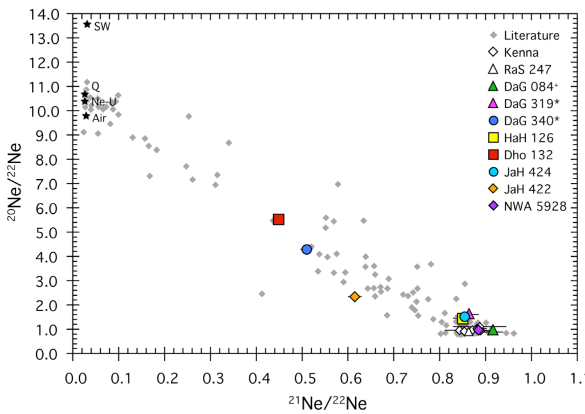

Fig. 1 Ne 3-isotope plot. Most samples have mostly cosmogenic Ne, with the exception of DaG 340, Dho 132 and JaH 422, define a mixing line with a trapped component, either Ne-U, air or even a lower $^{20}Ne/^{22}Ne$ component. Uncertainties are 1σ. Literature data from [7] and Kenna and RaS 247 from [11]. SW: solar wind. $^{+}$Sample measured by [12]. *Samples measured by [6].

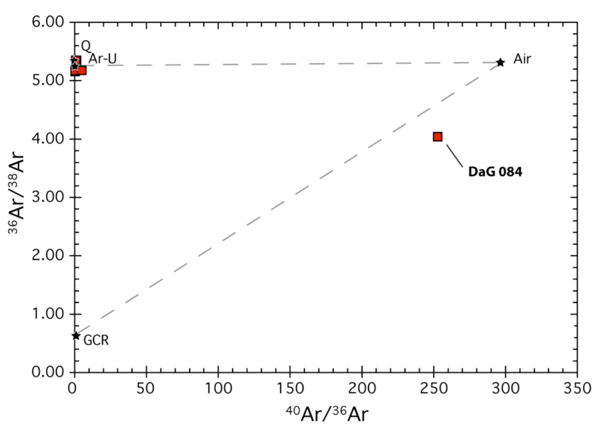

Fig. 2. Argon 3-isotope plot. The Ar in most samples is clearly dominated by the primordial component. DaG 084 is the only exception, with a high abundance of ^{40}Ar probably from air contamination by weathering and probably also a cosmogenic component. GCR: galactic cosmic rays; Ar-U: ureilite primordial trapped component [13].

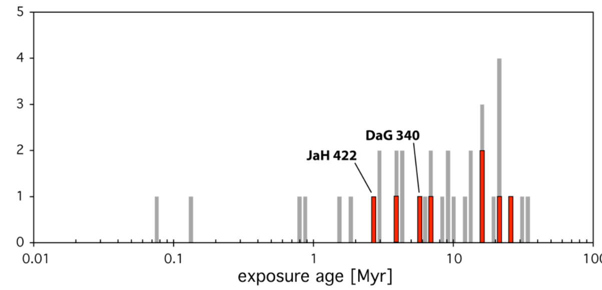

Fig. 3 Cosmic ray exposure ages based on the production of ^{21}Ne. Age resolution is approximately 15%. Literature data (in gray) are from [1, 14 and references therein].