NOBLE GAS STUDY OF UNGROUPED ACHONDRITE GRA 06129

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Introduction: GRA 06128 and 06129 paired achondrites display an unusual mineralogical feature distinct from any known meteorites. They are characterized by a high abundance of Na-rich plagioclase [1]. Zeigler et al. [1] suggest that the two meteorites are chemically similar to brachinites. We measured noble gases in GRA 06129 by total melting and stepwise heating to understand the formation history of this meteorite and to compare the noble gas compositions with those in brachinites.

Results and discussion: The samples show high $^{40}Ar/^{36}Ar$ ratios ~10000 and high concentrations of ^{40}Ar (1.7 - 2.0) × 10^{-4} cm^3STP/g. K-Ar ages are estimated as 4.3 - 4.5 Ga from the ^{40}Ar concentrations and K content of 0.25 wt% [2]. Interestingly, the high $^{40}Ar/^{36}Ar$ ratios and high concentrations of ^{40}Ar are observed constantly in the 1000, 1300, and 1800 °C fractions, although radiogenic ^{40}Ar in most meteorites is generally released at low temperatures (<1000 °C). Kr isotopic compositions show excesses of $^{80,82}Kr$ derived from neutron capture on $^{79,81}Br$, in addition to spallogenic Kr and atmospheric contamination. Moreover, isotopic ratios of Xe exhibit ^{129}Xe excess. Thus, Kr and Xe isotopic ratios are indicative of the presence of volatile elements such as Br and I, consistent with the petrologic observation [2]. Detection of ^{129}Xe excess (2.2 × 10^{-11} cm^3STP/g) suggests early formation of GRA 06129 before ^{129}I extinction.

Like GRA 06129, the two brachinites, Brachina and Eagles Nest, show ^{129}Xe excesses, however, the excesses are higher (7.8 - 35 × 10^{-11} cm^3STP/g; [3, 4]) than that in GRA 06129. Brachinites contain Ar-rich trapped noble gases [3, 4]. On the other hand, trapped noble gases are not seen in GRA 06129.

He isotopic ratios appear to be mixtures of cosmogenic He and radiogenic ^{4}He. Ne isotopic compositions are mostly cosmogenic, and demonstrate contribution of Ne produced via Na-spallation [5]. This is consistent with the results that the meteorite is composed mainly of Na-rich plagioclase [1]. Cosmic-ray exposure ages (T_3 and T_{21}) are calculated from concentrations of ^{3}He (4.0 - 6.9) × 10^{-9} cm^3STP/g and ^{21}Ne (7.8 - 8.2) × 10^{-9} cm^3STP/g. Production rates for ^{3}He (1.5 × 10^{-8} $cm^3STP/g/Ma$) and ^{21}Ne (2.7 × 10^{-9} $cm^3STP/g/Ma$) are calculated using the formulae for eucrites [6], the assumed average shielding parameter ($^{22}Ne/^{21}Ne$ = 1.11), and the chemical composition [2]. The ^{21}Ne production rate from Na is included in the calculation using the production rate ratio $P^{21}_{Na}/P^{21}_{Mg} = 0.67$ [7]. T_3 and T_{21} are estimated as 0.27 - 0.46 Ma and 2.9 - 3.0 Ma. The shorter T_3 than T_{21} would be caused by ^{3}He loss induced by solar heating.

References: [1] Zeigler R. A. et al. 2008. Abstract #2456. 39th LPSC. [2] Arai T. et al. 2008. Abstract #2465. 39th LPSC. [3] Ott U. et al. 1985. *Meteoritics* 20:69-78 [4] Swindle T. D. et al. 1998. *MAPS* 33:31-48. [5] Vogel N. et al. 2004. *MAPS* 39:767-778. [6] Eugster O. and Michel Th. 1995. *GCA* 59:951-970. [7] Huneke T. C. et al. 1972. *GCA* 36:269-301.