NOBLE GASES RELEASED BY CRUSHING FROM HAPPY CANYON E-CHONDRITE;

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The Happy Canyon (HC) enstatite (E-) chondrite is an impact-melt breccia formed probably from the EL-chondrite parent body [1]. We analyzed it (weighing 0.310 g) for crush-released noble gases. Considerable amounts of trapped Ar, Kr and Xe, and radiogenic ^{129}Xe were released. Twelve percent of bulk Xe [2] appeared by triplicate steps of crushing; one step of crushing consists of 100x pounding. The amounts of gases released at each step of crushing are essentially constant, suggesting that greater portions of trapped gases could be released by more extensive crushing. The isotopic ratio of Xe is approximately solar except for ^{129}Xe. The ^{129}Xe/^{132}Xe ratio is 3.8, being constant at each step. Elemental ratios are largely fractionated compared to the bulk composition [2]: ^{36}Ar / ^{84}Kr / ^{132}Xe = 31.9 / 0.68 / 1.

Helium and Ne are mostly cosmogenic, but ratios of crush-released cosmogenic He, Ne and Ar to those for the bulk [2] are low: 4.2×10^{-4}, 7.6×10^{-4} and 1.5×10^{-3} for ^{3}He, ^{21}Ne and ^{36}Ar, respectively. The lower release of lighter cosmogenic gases suggests a gas loss by terrestrial weathering. ^{3}He/^{4}He is actually identical with that for the bulk, but ^{21}Ne/^{22}Ne is considerably lower than that for the bulk, indicating preferential crush-releasing from Na-rich phases. Release of radiogenic ^{40}Ar is also low, 3.1×10^{-3} relative to the bulk. Both cosmogenic gases and radiogenic ^{40}Ar are in-situ products in minerals, thus they are released from the surface newly formed by crushing. The preferential release of trapped gases, therefore, indicates that they do not reside in crystal lattices but at places that are easily destroyed by crushing, such as microbubbles. This interpretation that considerable parts of trapped gases are contained in microbubbles can give a partial solution of a long-standing problem in noble gas cosmochemistry of E-chondrites, i.e., lack of correlation between trapped gases and petrologic type [2, 3], although we need crushing experiments of other E-chondrites.

Isotopic ratios of Xe determined so far for E-chondrites are enriched in heavy isotopes compared to solar Xe [2, 3]. The bulk E-chondrites are expected to contain fissiogenic Xe from ^{244}Pu [2]. The ^{134}Xe/^{132}Xe and ^{136}Xe/^{132}Xe ratios (Fig. 1) determined in this work are solar [4] within experimental errors, indicating that E-chondrites trapped solar-type Xe.

Impact-melting of HC took place ca. 4.566 Ga ago and the I-Xe age was established, therefore the I-Xe system was closed, during crystallization of the molten portion [1]. A considerable fraction of radiogenic ^{129}Xe (i.e., 4.1% of that for the bulk) was crush-released.

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This is a lower limit of radiogenic ^{129}Xe contained in microbubbles because more steps of crushing could give more gas release. Note the great difference in the crush-released fraction between radiogenic ^{40}Ar and ^{129}Xe, that is, 0.32% vs 4.1% at face value. This suggests that the cruch-released ^{129}Xe is not in-situ decayed ^{129}Xe in the HC meteorite but inherited ^{129}Xe which was accumulated prior to the impact-melting. Likely the inherited ^{129}Xe was mixed with trapped gases and occluded in microbubbles by the impact-melting 4.566 Ga ago. The inherited ^{129}Xe could not correlate with ^{128}Xe produced by neutron-capture on ^{127}I. The fraction of neutron-captured ^{128}Xe which correlated with radiogenic ^{129}Xe is 29.1 % for HC [5].

The trapped $^{36}Ar/^{132}Xe$ ratio is extremely low (31.9) for the crush-released gas. The ratio is 84 for the HC bulk and ranges 70 to 2660 for other E-chondrites [2]. Large enrichment of Xe in the crush-released gas of HC can be interpreted by the fractionation hypothesis in microbubbles [6] with the bubble density of 2×10^{-5} cm^3/g.

References: [1] McCoy, T.J. et al. (1995) Geochim. Cosmochim. Acta 59, 161-175. [2] Crabb, J. and Anders, E. (1981) Geochim. Cosmochim. Acta 45, 2443-2464. [3] Wacker, J.F. and Marti, K. (1983) Earth Planet. Sci. Lett. 62, 147-158. [4] Eberhardt, P. et al. (1972) Proc. Lunar Sci. Conf. 3, 1821-1856. [5] Kennedy, B.M. et al. (1988) Geochim. Cosmochim. Acta 52, 101-111. [6] Takaoka, N. (1994) Noble gas geochemistry and cosmochemistry, ed. Matsuda, J., Terra Sci. Publ. Co. Tokyo, p. 23-29.

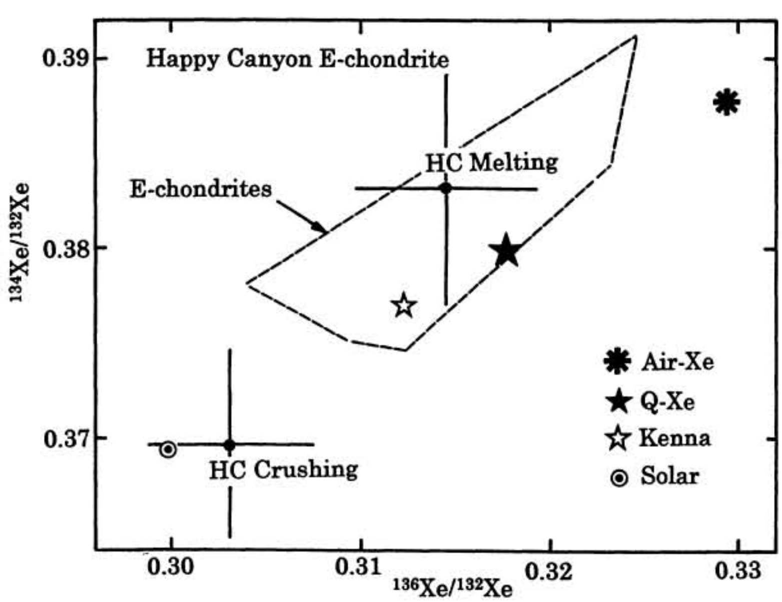

Fig. 1. Heavy Xe isotopes crush-released from HC.