NOBLE GAS STUDY OF NEW ENSTATITE SAU 290 WITH HIGH SOLAR GASES.

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Introduction: A new enstatite(E) chondrite, Sayh al Uhaymir 290 (SaU 290, nicknamed SaU 30R) was found in Adam County, Oman, by Rainer and Claudia Bartoschewitz, 2004, February 13th and November 6th. They found this new E chondrite on the gravel plateau of Miocene fresh-water limestone of Milddle Fars group, during the natural science expedition. SaU 290 was recovered as broken 64 pieces, the total mass of 1.796 kg, within a distance of 10 m approximately. SaU 290 will be officially named in the Meteorite Bulletin, 2005 [1]. It is classified as an E 3 anomaly enstatite chondrite, microbreccia, weathering grade W2.

Chondrite groups commonly contain trapped noble gas, called Q gas [2, 3], while some E chondrites contain Ar-rich noble gases as well, which are different from those in ordinary and carbonaceous chondrites in elemental ratios of $^{36}Ar/^{84}Kr/^{132}Xe$ (e. g., [4] etc.). Although Ar-rich gas is favored in ^{36}Ar, He and Ne relative abundances are significantly lower than those of solar gas. According to [5], chondrules in E chondrites are one of the possible trapping phase for the Ar-rich noble gases.

Noble gas analyses was performed at Laboratory for Earthquake Chemistry, the University of Tokyo. SaU 290 shows very high solar noble gas concentrations, which suggest brecciated structure inside. In this work, we will report the noble gas concentrations and isotopic ratios, cosmic-ray exposure ages and its relationship with weathering.

Experimental Method: SaU 290 was analyzed by using the mass-spectrometric system (modified-VG 5400 / MS-II). 0.0110 g of SaU sample was prepared for total melting experiment at the temperature of 1800 °C, in order to extract the noble gases.

Extracted gases at each temperature were purified using Ti-Zr getters heated at 750ºC. At first He and Ne were separated from Ar, Kr and Xe by retaining the heavier noble gases on a charcoal trap held at liquid N_2 temperature. After isotopic compositions of He and Ne were measured, the Ar, Kr and Xe were desorbed from the charcoal trap followed by separation using a cryogenic-trap and their isotopic compositions were determined.

Sensitivities and mass discrimination correction factors of the mass spectrometer were determined by measuring a known amount of atmosphere (e.g., 5×10^{-4} cm^3STP). Mass discrimination for $^3He/^4He$ ratio was determined using a ^3He and ^4He mixture with $^3He/^4He$ $=1.71\times10^{-4}$. The blank levels for ^4He, ^{20}Ne and ^{40}Ar were negligible, considering the amount of noble gas released from the SaU 290 specimen.

Results and Discussion: The elemental and isotopic compositions of noble gases in the SaU 290 E chondrite is presented in Table 1. Figure 1 shows the elemental abundances of heavy noble gases in SaU 290. The observed elemental ratios of $(^{36}Ar/^{132}Xe)_{trapped}$ and $(^{84}Kr/^{132}Xe)_{trapped}$ for this meteorite is 350 and 2.23, respectively, which falls above Q gas. This indicates that SaU 290 contains Ar-rich gas and/or solar noble gas in addition to Q gas.

Ne-three isotope diagram of SaU 290 enstatite is plotted in Figure 2. The Ne isotopes of SaU 290 are close to solar wind Ne, with the highest $^{20}Ne/^{22}Ne$

Table 1. Isotopic ratios of concentrations of He, Ne, Ar, Kr and Xe in SaU 290 enstatite

^{3}He	^{4}He	^{3}He/^{4}He	^{20}Ne	^{21}Ne	^{22}Ne	^{20}Ne/^{22}Ne	^{21}Ne/^{22}Ne	^{36}Ar	^{38}Ar	^{40}Ar	^{38}Ar/^{36}Ar	^{40}Ar/^{36}Ar
10^{-9} cm^{3}STP/g			10^{-9} cm^{3}STP/g					10^{-9} cm^{3}STP/g				
125.2	347480.6	0.000360 ± 0.000040	1550.7	8.1	119.6	12.9609 ± 0.2341	0.06808 ± 0.00049	906.7	170.9	10202.5	0.18847 ± 0.00044	11.2519 ± 0.0373

^{84}Kr	^{78}Kr/^{84}Kr	^{80}Kr/^{84}Kr	^{82}Kr/^{84}Kr	^{83}Kr/^{84}Kr	^{86}Kr/^{84}Kr
10^{-12} cm^{3}STP/g					
5757.9	0.005357 ± 0.000338	0.035947 ± 0.001434	0.17882 ± 0.00502	0.18333 ± 0.00499	0.28655 ± 0.00621

^{132}Xe	^{124}Xe/^{132}Xe	^{126}Xe/^{132}Xe	^{128}Xe/^{132}Xe	^{129}Xe/^{132}Xe	^{130}Xe/^{132}Xe	^{131}Xe/^{132}Xe	^{134}Xe/^{132}Xe	^{136}Xe/^{132}Xe
10^{-12} cm^{3}STP/g								
2586.7	0.007057 ± 0.001527	0.005248 ± 0.001084	0.08846 ± 0.00899	1.06791 ± 0.03072	0.16512 ± 0.00685	0.8073 ± 0.0157	0.3693 ± 0.0108	0.3071 ± 0.0119

among E chodnrites. For the comparison, we plotted the literature data of Y-791790, Y-793225, Y-8414, ALH-77295 and Pillistfer from [6] and ALHA77295 from [7]. SaU 290 and ALHA 77295 contain solar Ne. Y-793225, Y-8414 and Pillistfer are mostly cosmogenic components, while Y-791790 is the mixture of cosmogenic, Q and Ar-rich gases [5, 6].

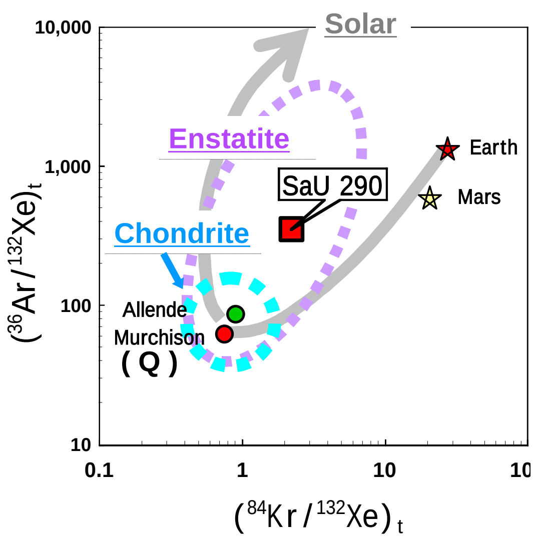

Figure 1. Elemental abundances of Ar, Kr and Xe in SaU - 290 enstatite. Data of Allende and Murchison (Q) are from Wieler et al.,1991, 1992. Earth and Mars (Ozima and Podosek, 2002 [8]).

Generally He in chondrites is a mixture of radiogenic, cosmogenic, and trapped (primordial) He. The isotopic ratio of ^{3}He/^{4}He for SaU 290 is 0.000360, which is virtually identical to that of solar wind (4×10^{-4}). This He isotope ratio is also consistent with the presence of solar gas. If we consider the all ^{4}He determined for SaU 290 is solar He, the ^{4}He/^{20}Ne ratio is 225, which is also close to solar value [8].

Concentrations of cosmogenic ^{3}He, ^{21}Ne and ^{38}Ar, and their production rates, cosmic-ray exposure ages are shown in Table 2. For the calculation of cosmogenic ^{21}Ne, we used the values, $(^{21}Ne/^{22}Ne)_{trapped}$ =0.033 of Solar Wind [8], $(^{21}Ne/^{22}Ne)_{cosmogenic}$ =1.11 of average chondritic value [9]. And $(^{38}Ar/^{36}Ar)_{trapped}$ = 0.188 and $(^{38}Ar/^{36}Ar)_{cosmogenic}$ = 1.5 are used for the calculation of cosmogenic ^{38}Ar in SaU 290. Production rates of ^{3}He, ^{21}Ne and ^{38}Ar , abbreviated P_3, P_{21} and P_{38}, were calculated using the formulae proposed by [9], inserting 1.11 of $(^{22}Ne/^{21}Ne)_{cosmogenic}$ in the correction factors for shielding depth and the correction factors for target elemental compositions. The calculated cosmic-ray exposure ages, T_3, T_{21} and T_{38} are 7.8 m.y., 13.7 m.y. and 11.7 m.y., respectively. The short T_3 exposure age may have resulted from diffusion loss of ^{3}He [10]. And the short exposure age T_{38} may be caused from heterogeneity [11] or weathering effects [6], [12].

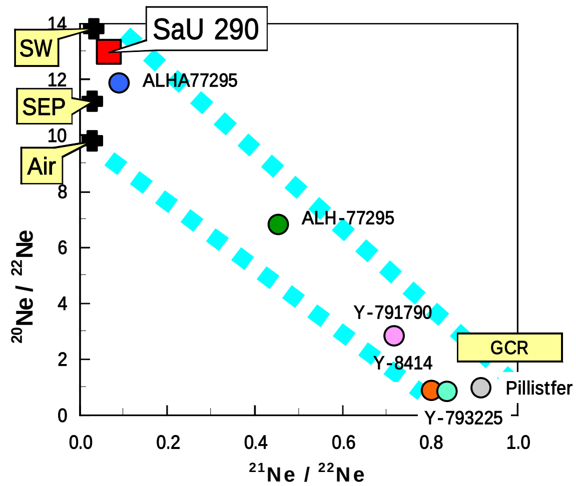

Figure 2. ^{21}Ne/^{22}Ne vs ^{20}Ne/^{22}Ne diagram. SaU 290 shows the highest data of ^{20}Ne/^{22}Ne. Data of Y-791790,Y-793225, Y-8414, ALH-77295 and Pillistfer from Okazaki et al., 2000. Data of ALHA77295 from Wieler et al., 1985.

References: [1] Bartoschewiz R., personal communication. [2] Wieler R. et al. (1991) *GCA*, *55*, 1709-1722. [3] Wieler R. et al. (1992) *GCA*, *56*, 2907-2921. [4] Crabb J. and Anders E. (1981) *GCA*, *45*, 2443-2464. [5] Okazaki et al. (2001) *Nature*, *412*, 795-798. [6] Okazaki R. et al. (2000) *AMR*, *13*, 153-169. [7] Wieler et al. (1985) *LPS XVI*, 902-903. [8] Ozima M. and Podosek F. A. (2002) Noble Gas Geochemistry, 2nd edition, pp286. [9] Eugster O. (1988) *GCA*, *52*, 1649-1662. [10] Park et al., (2003) *GJ*, *37*, 639-648. [11] Bogard D. D. et al., (1983) *EPSL*, *62*, 132-146. [12] Patzer A. and Schultz L. (2001) *Maps*, *36*, *947*-961.

Table 2. Cosmogenic ^{3}He, ^{21}Ne and ^{38}Ar concentrations and cosmic-ray exposure age of SaU 290 enstatite

^{3}He	^{21}Ne	^{38}Ar	$(^{22}Ne/^{21}Ne)_c$	P_3	P_{21}	P_{38}	T_3	T_{21}	T_{38}
10^{-9} cm^{3}STP/g				10^{-9} cm^{3}STP/g/m.y.			m.y.		
125.09	43.57	4.825	1.11	1.613	0.319	0.0411	7.8	13.7	11.7

(Chemical composition was assumed as EL)