NOBLE GASES OF ENSTATITE CHONDRITES, MELT ROCKS AND AUBRITES. J. Park[1,2,3], K. Nagao[4], J. Choi[4], J. M. Baek[4], C. Park[4], J. I. Lee[4], M. J. Lee[4], G. F. Herzog[2], L. E. Nyquist[5], M. K. Weisberg[1,3,6], D. S. Ebel[3,6], J. S. Boesenberg[7], J. S. Delaney[8], B. D. Turrin[8], and C. C. Swisher III[8]. [1]Kingsborough Comm. Coll., Brooklyn, NY 11235, USA (jisun.park@kbcc.cuny.edu), [2]Dept. Chem. & Chem. Biol., Rutgers Univ., Piscataway, NJ 08904, USA, [3]Amer. Museum of Natural History (AMNH), NY, NY 10024, USA, [4]Div. Polar Earth-System Sci., Korea Polar Res. Inst.(KOPRI), Incheon 21990, Korea, [5]XI/NASA Johnson Space Center, Houston, TX 77058, [6]Dept. Earth and Environmental Sci., Graduate Center, City University New York, New York, USA, [7]Dept. of Geological Sciences, Brown University, 324 Brook Street, Providence, RI 02912, [8]Dept. Earth Planet. Sci., Rutgers Univ., Piscataway, NJ 08904, USA.

Introduction: We selected a set of enstatite metorites (chondrites and achondrites) for studies of noble gases as part of a broader study to constrain their thermal and collisional histories. The enstatite meteorites are of interest partly because they are the only chondrites with bulk oxygen (as well as Cr, Ti, Ni, and Zn) isotopic compositions similar to those of Earth and Moon, suggesting a genetic relationship [e.g., 1].

We chose 6 meteorites for study (Table 1). The anomalous melt rocks (E7) could have formed by impact melting on the surface of the EH or EL parent asteroids; or by reprocessing of a portion of the E chondrites' parent asteroids at depth [2]. Bosenberg et al [2,3] observed that EL chondrites have compositional similarities to senstatite chondrites that have been melted and /or metamorphically recrystallized. In this study, we explore the connection between aubrites, unequilibrated (EH3, EL3) and equilibrated (EL6), enstatite chondrites and enstatite chondrite melt rocks and their pre- and post-accretional histories. Toward this goal, we carried out combined studies of noble gas analyses, ^{40}Ar/^{39}Ar age dating and radionuclides of ^{10}Be, ^{26}Al, ^{36}Cl) to provide information on geochronological evolution, such as formation age, impact age and cosmic ray exposure ages.

Table 1. Samples list.

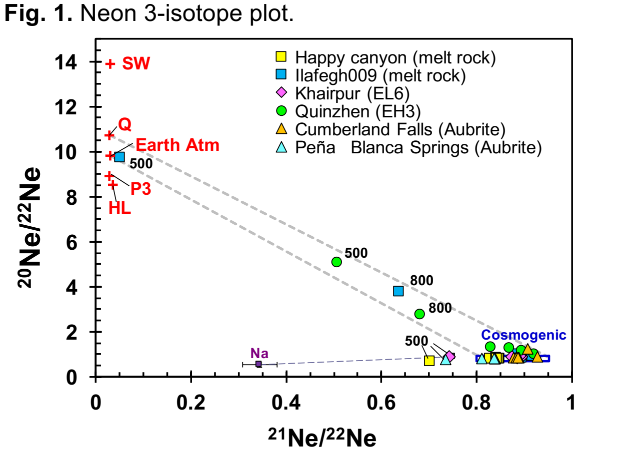
Sample	classification	mass (mg)	Reference (AMNH #)
Happy Canyon	E7, melt rock	30.51	#4454
Ilafegh 009	E7, melt rock	26.5	#4757
Khairpur	EL6	35.64	#473
Qingzhen	EH3	32.33	#4653
Cumberland Falls	Aubrite	24.16	#664
Peña Blanca Springs	Aubrite	25.87	#4852

Experimental methods: *Noble gases.* Six samples with masses between 24 and 36 mg were preheated at 150 °C for 24 h and then degassed stepwise at temperatures of 500, 800, 1000, 1300 and 1800 °C for 30 minutes. He, Ne, Kr, Xe, and Ar were measured with a mass spectrometer, VG-5400, originally modified at the University of Tokyo and now transferred to Korea Polar Research Institute (KOPRI) [4]. Sensitivities and mass discrimination correction factors were determined by measuring aliquots of atmospheric Ne, Ar, Kr, and Xe and separately standardized mixtures of ^{3}He and ^{4}He.

Ar-Ar analyses (Noble gas lab, Rutgers Universit) and cosmogenic radionuclides (Chem lab, Rutgers, and PRIME lab, Purdue University) are an ongoing project and will be available by the LPSC meeting.

Results and discussion:
^{3}He/^{4}He ratios. We examined the ^{3}He/^{4}He ratios for evidence of the presence of He acquired at an early stage of Solar System history, before the completion of deuterium burning in the Sun. Such He is expected to have a ^{3}He/^{4}He < 3.62 x 10^{-4}, the value deduced for the Outer Convective Zone (OCZ) of the Sun from the Genesis measurements [5]. However, the data indicate that ^{3}He is mostly cosmogenic.
Ne isotopes. A neon 3-isotope plot [Fig. 1] shows mostly cosmogenic components with terrestrial contamination restricted to the low-T releases from Quinzhen and Ilafegh 009.
^{40}Ar/^{39}Ar ages. ^{40}Ar/^{39}Ar measurements are in progress. Our interest for the ^{40}Ar/^{39}Ar study is that it would provide valuable information for understanding the chronological history and heating events. The reported ^{40}Ar/^{39}Ar ages [Fig. 2] for Abee, Khairpur, Quinzhen, Ilafegh, Happy Canyon, etc. are generally

Fig. 1. Neon 3-isotope plot.



4.2-4.5 Ga, but with a few young ags ~2 Ga. Bogard et al [6] reported that most enstatite chondrites show evidence for substantial recoil redistribution of ^{39}Ar, but nevertheless determined ages in the range between 4.50–4.54 Ga. Hopp et al. [7] also reported ^{40}Ar/^{39}Ar ages of 4.49 ± 0.01 Ga for 6 samples of EL5 and EL6, 4.45 ± 0.01 Ga for EL3 and 4.53 ± 0.01 Ga for EH impact melt LAP 02225. Two samples of Sahara 97096 (EH3) and EET 96135 (EH4/5) show obvious ^{40}Ar loss with a young age of ~2 Ga, possibly due to a late thermal event. Noble gas data for the Norton County enstatite achondrite, aubrite [8] indicate from the CRE age of ~115 Ma the possible pre-irratiation of the aubrite parent body .

*Xe isotope*s (Fig. 3) The data cluster near the composition expected for the Q-component [9] and show mixing of Q and atmospheric gases with only minor contributions of solar Xe. Some excess ^{136}Xe is due to the addition of Xe-HL, carried by presolar diamonds [10] or of ^{244}Pu-fission Xe to a mixture of Q and atmospheric gases.

Heavy trapped noble gases. Elemental ratios of trapped ^{36}Ar, ^{84}Kr, and ^{132}Xe in subsolar-gas-carrying enstatite chondrites [11] are shown in Fig. 4. Enstatite chondrites seem to be divided into two groups, subsolar-gas-carrying and subsolar-gas-free based on Ar, Kr and Xe studies [11]. Okazaki et al [12] found very high concentrations of ^{36}Ar in chondrules of enstatite chondrite Y-791790, and suggested that certain chondrules were carriers for this component, which may have been derived from solar gas implanted into chondrule precursors during the T-Tauri phase of the Sun [11]. The noble gas implantation would have occurred in fine grains of the precursor materials of the chondrules rather than in the chondrules themselves. Further investigations of chondrules containing gases of solar-origin will help to determine whether they trapped noble gases during the T-Tauri stage of the sun. Extreme enrichments, if any, might suggest implantation close to the early sun as well as an enhanced flux of solar gases.

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Fig. 2. Summary of ^{40}Ar/^{39}Ar ages of enstatites and aubrites in the literatures.

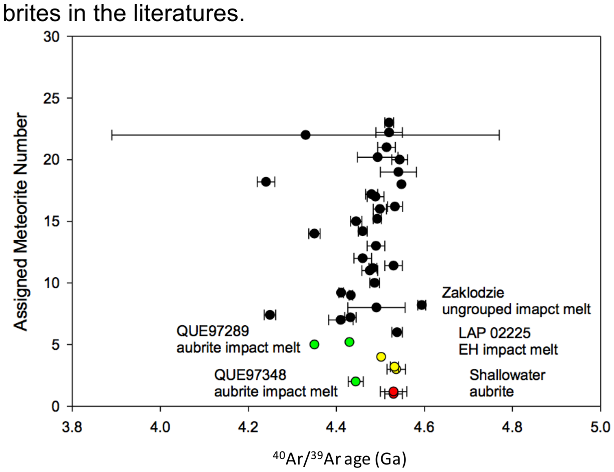

Fig. 3. ^{136}Xe/^{132}Xe *vs.* ^{130}Xe/^{132}Xe for Aubrites and Enstatites.

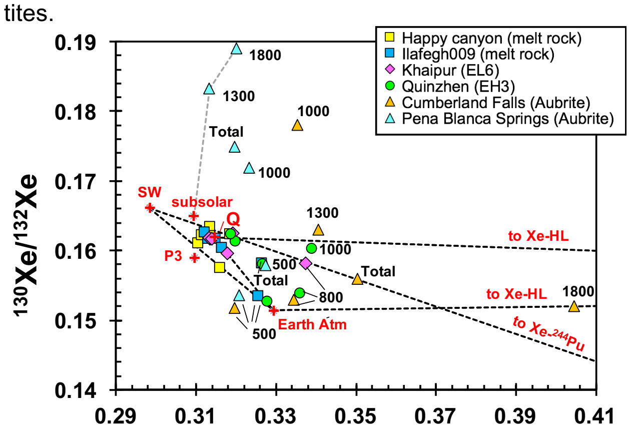

Fig. 4. ^{84}Kr/^{132}Xe *vs.* ^{36}Ar/^{132}Xe for Aubrites and Enstatites.