NOBLE GASES AND COSMIC-RAY EXPOSURE HISTORY OF WILLARD(B) H-CHONDRITE: A BRECCIA WITH CARBONACEOUS CHONDRITIC INCLUSIONS. A. Inada[1] and K. Nagao[1], [1]Laboratory for Earthquake Chemistry, Graduate School of Science, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan (nagao@eqchem.s.u-tokyo.ac.jp)

Introduction: Willard(b) weighing 12.7 kg was found in New Mexico, USA, in 1934, and classified as H3.5-3.6. Its unique feature is a brecciated texture with small dark clasts [1, 2]. Noble gases were measured for both the dark clast and the host rocks of brecciated lithology. The results show clear differences of noble gas concentrations and cosmic-ray exposure ages between the two phases.

Experimental Method: Sample of dark material was collected from the dark clast by scratching with a needle. Small chips were taken from the brecciated portion hosting the dark clast. Noble gases were extracted from the host rocks by heating stepwisely from 400 to 1750°C (10 steps), while three temperature steps were employed for the clast sample due to its small sample size (2.4 mg).

Results and Discussion: Isotopic ratios of He and Ne from the host samples are dominated by solar wind or SEP components. Concentrations of trapped noble gases are in the range for the gas-rich meteorites Kapoeta and Pesyanoe. In contrast to the host samples, noble gases of solar origin were not observed for the dark material, and its noble gas concentrations and isotopic ratios are similar to those of CI chondrite Orgueil. Cosmic-ray exposure ages calculated for the host and the clast samples assuming 4π-geometry are presented in Table 1. The exposure age for clast (2 m.y.) is much shorter than those for the host samples (9-13 m.y.). The difference between the exposure ages may be explained by an impact of CI-like meteoroide on H-chondrite parent body at the final stage of brecciation and solar-gas implantation. Maximum transit time from the parent asteroide to the Earth should be 2 m.y. In this case, the fragments from the CI-like meteoroide were rapidly mixed with surface materials and buried in relatively deeper part, enough to be shielded from galactic cosmic-rays. The host materials had been exposed to galactic cosmic-rays more than ca. 20 m.y., considering 2π irradiation on the surface of parent body. We did not detect clear excess in ^{131}Xe which would have been produced by secondary neutron capture on Ba during the cosmic-ray irradiation. Hence, heavy shielding condition for the host materials was unlikely. K-Ar ages for the host samples are calculated as 3.9 and 3.7 b.y. adopting average K concentration for H-chondrites. The brecciation might have occurred at around 4 b.y. ago.

Table 1. Cosmogenic ^{21}Ne and ^{38}Ar concentrations and cosmic-ray exposure ages (4π-geometry).

Sample	$^{21}Ne_{cos}$	$^{38}Ar_{cos}$	T_{21}	T_{38}	$T_{average}$
	10^{-9}cm^{3}STP/g		m.y.		
Host1	28	4.3	9.0	8.6	8.8
Host2	40	6.2	13	12	12.5
Clast	4.8	0.61	2.2	1.8	2.0

Production rates (10^{-9}cm^{3}STP/g/m.y.): P_{21}=3.1 and 2.2, and P_{38}=0.50 and 0.34 for the host (H-chondrite) and the clast (CI-chondrite), respectively [3].

References: [1] Grady M.M. (2000) *Catalogue of Meteorites (5th ed.).* [2] Grossman J.N. (1997) *Meteorit. Planet. Sci.*, 32, A159-A166. [3] Eugster O. (1988) *Geochim. Cosmochim. Acta* 52, 1649-1662.