COSMIC-RAY EXPOSURE AGES OF SOME PRIMITIVE ACHONDRITES

S. Li[1], I. Leya[2], T. M. Smith[3], and H. He[3], [1]Center for Lunar and Planetary Sciences, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550081, China, [2]Physikalisches Institut, Universität Bern, Switzerland, [3]State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China.

Introduction: Acapulcoites and lodranites are two groups of primitive achondrites which are considered to originate from a common parent body [1,2]. The detailed mineralogical, chemical, and isotopic studies have revealed that the parent asteroid of acapulcoite-lodranite clan has a multilayered structure [3,4]. Up to now, only about 20 acapulcoite-lodranite clan members have been studied for cosmic-ray exposure (CRE) history investigations [3 and the references therein]. Previous studies indicated the CRE ages of acapulcoite-lodranite clan vary over a narrow range of ages from ~4 Ma to ~15 Ma and most of the reported ages fall between ~4 Ma to ~10 Ma [3, 5]. In order to further understand the parent body breakup history of the acapulcoite-lodranite clan, seven acapulcoite-lodranite meteorites (NWA 2871, NWA 4478, NWA 6484, NWA 6685, NWA 7474, NWA 8118, and NWA 11901) have been selected for CRE age measurement.

Experimental methods: The light noble gases (He, Ne, and Ar) were measured on two fragments with masses of 99.64 and 47.29 mg, respectivly. The isotopic concentrations of light noble gases have been measured by noble gas mass spectrometry at the University of Bern following standard procedures described in e.g. [6, 7]. The noble gases were extracted in one single temperature step at ~1700°C for 45 minutes. The extracted gases were further cleaned via various getters (SAES®) working in the temperature range between room temperature and 280°C. After cleaning, Ar was trapped on an activated charcoal held at the temperature of liquid N_2 and the remaining He and Ne fraction was further purified and inlet into a 90° sector field mass spectrometer. Smilarly, the Ar fraction was expanded into a self-made tandem mass spectrometer.

Results: Here we only report the CRE age of the lodranite NWA 8118. The CRE ages of other selected acapulcoite-lodranite clan meteorites will be reported during the conference. We calculated the production rates of ^{3}He and ^{21}Ne using the same formulas for L ordinary chondrites, which was reported in [8] and [9], respectively. In this study, we did not measure the bulk chemistry of NWA 8118;note that the concentration of target elements producing cosmogenic ^{38}Ar (i.e. Fe, Ca, K) in lodranites are much variable [3], therefore we decided to not calculate the ^{38}Ar CRE age (T_{38}) of NWA 8118. Regarding the 99.64 mg fragment of NWA 8118, the calculated ^{3}He CRE age (T_3) and ^{21}Ne CRE age (T_{21}) are 37.7±11.3 Ma and 39.4±11.8 Ma, respectively. For the 47.29 mg fragment, the calculated $T_3$and T_{21} are 40.9±12.5 Ma and 39.6±12.2 Ma, respectively. The ages are in good agreement; the adopted CRE age of NWA 8118 is 39.4±11.9 Ma. The calculated CRE age is much longer than any reported CRE ages of acapulcoite-lodranite clan members [3 and the references therein].

Conclusions: The reported CRE age of NWA 8118 is a clear indication of a breakup event which happened on the acapulcoite-lodranite parent asteroid ~40 Ma ago. Based on the so far measured acapulcoites and lodranites, we can conclude that their members derived at least from three different breakup events (e.g., at 4-10, ~15, and ~40 Ma ago) on their parent body.

References: [1] Patzer, A. et al. (2004). *Meteoritics & Planetary Science* 39, 61-85. [2] Rubin, A. (2007). *Geochimica et Cosmochimia Acta* 71, 2383-2401. [3] Eugster, O. and Lorenzetti, S. (2005). *Geochimica et Cosmochimia Acta* 69:2675-2685. [4] Li, S. et al. (2018). *Geochimica et Cosmochimia Acta* 242:82-101. [5] Herzog, G. F. and Caffee, M. W. (2014) Cosmic-ray exposure ages of meteorites. In: Treatise on Geochemistry, Second Edition, Vol. 1 (Eds.: Holland H.D. and Turekian K.K.) Oxford: Elsevier. [6] Leya, I. (2013).*Meteoritics & Planetary Science* 48:1401-1414. [7] Li, S. et al. (2017). *Meteoritics & Planetary Science* 52:937-948. [8] Dalcher, N. et al. (2013). *Meteoritics & Planetary Science* 48:1841-1862. [9] Eugster, O. (1988). *Geochimica et Cosmochimia Acta* 52:1649-1662.

Ackowledgements: This work was supported by the West Light Foundation of The Chinese Academy of Sciences and National Natural Science Foundation of China (grant 41473067).. We thank the engineer Hans-Erich Jenni for his support during the noble gas measurements at the University of Bern.