COSMIC-RAY EXPOSURE AGE AND PREATMOSPHERIC SIZE OF THREE RECENT FALLS (L6)

T. M. Smith[1], S. Li[2], P. M. Ranjith[1], F. Su[1], J. Gattacceca[3], ASTER Team[4], and H. He[1] [1]State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China, [2]Center for Lunar and Planetary Sciences, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550081, China, [3]Centre Européen de Recherche et d'Enseignement de Géosciences de l'Environnement (CEREGE), UM 34 CNRS-IRD, Aix-Marseille Université, Technopôle de l'Environnement Arbois-Méditerranée, 13545 Aix-en-Provence, France, [4]G. Aumaître, D. L. Bourlès, and K. Keddadouche.

Introduction: Over the past months, three L6 chondrites falls have been observed; Mangui from China, Ozerki in Russia, and Viñales in Cuba. The Mangui meteorite fell in the Yunnan Province, China at 9:43 pm on June 1st, 2018 [1]. Based on recent calculations, the meteorite entered Earth's atmosphere with an angle of 55.3±2.5°, from southeast to northwest, resulting in a strewn field of ~12 km long [2]. Up to now, more than 1000 individuals or fragments have been identified, with masses ranging from 0.04 g to ~1280 g, the total mass being ~50 kg. Mangui has been classified as a L6 ordinary chondrite, with a shock stage S4-S5 [1,2]. The Ozerki meteorite (L6, shock stage S4-S5) fell in Russia on June 21, 2018, 20 days after Mangui. Based on models, the total number of specimens has been estimated to be ~100 individuals, for a total mass of ~7 kg. Search campaigns are still ongoing, and more masses are expected to be found. Finally, the Viñales meteorite (L6, schock stage S3) fell in Cuba on February 1st, 2019. In the following days, several hundred of individuals have been collected by locals. Here we study the cosmic-ray exposure (CRE) history of two individual samples of Mangui, Ozerki, and Viñales by measuring cosmogenic radionuclides and noble gases, produced in space by galactic cosmic rays (GCRs). We are especially interested in the CRE age and the preatmospheric size of the meteoroid, the latter could help to better understand the disruption mechanisms during the atmospheric entry. Based on the short time interval between the different observed falls, similar petrographic types, and the similar shock characteristics, we expect these three meteorites to have a similar exposure history and therefore to be paired.

Experimental methods: The cosmogenic noble gas concentrations (^{3,4}He, ^{20,21,22}Ne, and ^{36,38,40}Ar) and isotopic ratios in the meteorite samples have been measured by pyrolysis, using a NOBLESSE © noble gas mass spectrometer at the noble gas laboratory of the Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS). In addition, targets for the cosmogenic radionuclides ^{10}Be, ^{26}Al, ^{36}Cl, and ^{41}Ca have been prepared for two Mangui samples and will be measured at the Centre d'Enseignement et de Recherche Européen des Géosciences de l'Environnement (CEREGE), Aix-en-Provence (France), host of the French national 5MV Accelerator Mass Spectrometry ASTER facility [3].

Results: Here we present only the results obtained on Mangui; Ozerki and Viñales could not be measured at the time of the abstract deadline. First, the preatmospheric size of Mangui has been determined using the measured cosmogenic (^{22}Ne/^{21}Ne)$_c$ ratios and the calculated cosmogenic ^{3}He$_c$, ^{21}Ne$_c$, and ^{38}Ar$_c$ production rates, as described in [4]. Based on this, we estimate the preatmospheric radius to be in the range of ~30-35 cm. Second, we calculated the preatmospheric mass using the empirical relation given in [5]. We calculated a preatmospheric mass of ~109 kg, which, when considering an average bulk density of 3.29 g/cm^3 gives a preatmospheric radius of ~20 cm; this is relatively consistent with the ~50 kg mass so far recovered. The CRE age has been calculated using the concentrations in cosmogenic ^{21}Ne$_c$, and ^{38}Ar$_c$, later labelled T_{21} and T_{38}, as described in e.g. [6]. The CRE ages vary between ~0.5-0.9 Ma, in agreement with the ^{26}Al-^{21}Ne CRE ages. We observe the common trend $T_{21}<T_{38}$; the T_3 age is much lower, and consistent with significant He diffusive losses, thus suggesting Mangui might have suffered severe heating after the breakup from its parent body and during its travel to Earth. We estimate the diffusive losses to be ~54-75%. In addition, we will compare the calculated CRE ages with the ^{36}Cl-^{36}Ar and ^{10}Be-^{21}Ne dating schemes [7], ^{36}Cl and ^{10}Be being not yet available at the time of the abstract submission. Finally, the gas retention age was determined using both radiogenic ^{4}He$_r$ (T_4) and ^{40}Ar$_r$ (T_{40}). The calculated T_4 and T_{40} retention ages range between ~4-12 Ma and ~88-108 Ma, respectively, suggesting a severe thermal and impact history. The CRE history of Ozerki and Viñales will be presented at the conference.

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