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Ultrasensitive Xenon analysis of eucrites to investigate the evolution of the early Solar System

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The nine stable isotopes of xenon record time-sensitive information that can be used to unravel Solar System evolution. Xenon isotopic signatures of planetary bodies are diagnostic of specific processes and events, and reflect mixtures of multiple sources [1]. These include Xe from nucleosynthetic components, Xe from decay of ^{129}I, ^{238}U, and ^{244}Pu, and Xe from spallation and secondary neutron capture reactions when samples containing light rare earth elements and barium are exposed to cosmic rays [1]. One of the readily available sources of information for studying the evolution of the solar system are eucrite meteorites, which are considered to originate from the asteroid 4 Vesta [2]. In our study, we will analyse the xenon isotopic composition of eleven eucrites to better understand the behaviour of Pu, U, Ba and I during the igneous differentiation of 4 Vesta. This will provide insights into the early evolution and geochemistry of volatile reservoirs of terrestrial planetary bodies. We also aim to provide new Xe-Xe cosmic ray exposure ages to test the hypothesis that the cosmic ray energy spectrum has varied over the last 50 Myr, as well as to determine closure ages to xenon loss in the early solar system. New Xe-Xe ages will be combined with existing Kr-Kr exposure ages [3] to determine if anomalous and the main groups of eucrites originated from different parent bodies or during different impact events. This will help to refine the grouping of eucrites. Paired step-heating analyses of unirradiated and thermal neutron irradiated material of both main group and anomalous eucrites will be performed using the RELAX mass spectrometer [4]. Here, we present new data from unirradiated eucrites, discuss xenon isotopic signatures, and outline future directions of this research.

[1] Gilmour et al., 2006, MAPS, 41, 19–31; [2] Scott et al., 2009, Geochim. Cosmochim. Acta, 73, 5835 – 53; [3] Strashnov et al., 2013, Geochim. Cosmochim. Acta 106, 71-83; [4] Crowther et al., J. Anal. At. Spectrom., 2008, 23, 938–947.