Clues to extraterrestrial material in old sedimentary rocks: A case study on helium-3 from the Permian/Triassic boundary

*Naoto Takahata[1], Tetsuji Onoue[2], Mitsutaka Miura[3], Yuji Sano[1], Yukio Isozaki[4]

1. Atmosphere and Ocean Research Institute, the University of Tokyo, 2. Faculty of Advanced Science and Technology, Kumamoto University, 3. Graduate School of Science and Technology, Kumamoto University, 4. Department of Earth Science and Astronomy, the University of Tokyo

Helium is suitable to detect extraterrestrial material in marine sediments as well as platinum group elements such as iridium because helium is much enriched in extraterrestrial matter compared to the Earth’ s surface. In this study we tried to detect extraterrestrial material in old sedimentary rocks collected from the Permian/Triassic (or P/T) boundary section. Becker et al. (2001) reported an anomaly in ^{3}He trapped in fullerene from P/T boundary rocks in Japan and China, which in turn suggested a possible extraterrestrial impact as the cause of the P/T boundary mass extinction. However no one have ever found evidence for extraterrestrial ^{3}He after their finding. Although the approach of using the ^{3}He signature appears promising, their results are doubtful. We checked their finding using new samples collected from a better P/T boundary section.
We collected pelagic deep-sea sediments in the ancient Pacific Ocean (Panthalassa Ocean) in the Mino Belt, central Japan. Layers we collected the sediments include the P/T boundary section. Much higher ^{3}He/^{4}He ratios (up to 150 R_a; 1R_a = the atmospheric ratio) were observed at the extraction temperatures of 750-950 degree Celsius in bulk samples and acid-insoluble residues. These high ^{3}He/^{4}He ratios may infer existence of extraterrestrial helium carried in fullerenes or interplanetary dust particles. Bulk ^{3}He concentrations we obtained from Mino section samples are enough higher than the detection limit and relatively higher below the P/T boundary. This is the first report on distribution of extraterrestrial ^{3}He across a large P/T boundary section. Based on sedimentation rate calculated from zircon ages, influx of extraterrestrial material was estimated. It may have increased to more than ten times higher during a hundred of thousands of year before the P/T boundary, which is equivalent to the influx at the K/Pg boundary because of long duration. This increase may have caused global cooling leading to mass extinction.

Reference: Becker et al. (2001), Science, 291, 1530-1533.

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