Natural attenuation of zinc by the sediment layer in Majuro Atoll

*Lisa Ito[1], Yoshio Takahashi[1]

1. Department of Earth and Planetary Science, School of Science, The University of Tokyo

The sediments of Majuro Atoll, Marshall Islands, consist of bioclastic materials, including foraminifera and coral reef debris. The sedimentary depth profiles of elements showed that various elements were enriched in the upper layers of the islands of Majuro Atoll including heavy metals such as zinc (Zn) and copper (Cu). Carbon-14 dating revealed that the sedimentation of the upper layer was completed before 1670 and 542 cal BP in Laura and Calalen, respectively. The enriched elements could be categorized by their origins: (a) terrestrial elements transported as dust (aluminum (Al) and rare earth elements (REEs)); (b) anthropogenic elements (Zn and Cu); and (c) elements supplied by seabirds (phosphorus (P)). The total amount of Al supplied to sediments for ca. 2000 years was similar to those estimated from (i) total (dry + wet) depositions of Al in aeolian dust and (ii) Al in deep-sea sediments in the Central Pacific.
These results suggested that Al in Majuro Atoll was of airborne origin. The enrichment factors (EFs) of the elements normalized to Al concentration of continental crust showed that REEs were also transported as dust. The EFs of Zn and Cu were greater than 21.1 and 5.45, respectively, suggesting that Zn and Cu were mainly of anthropogenic origin. The speciation analysis of Zn and Cu by K-edge X-ray absorption near-edge structure (XANES) showed the presence of Zn–Cu alloys originated from industrial products. It was also revealed that Zn was enriched in the surface due to anthropogenic emission after urbanization on Majuro Atoll and fixed by carbonate and phosphate at the upper layer, which inhibits migration of Zn into the deeper layer and its release to the groundwater and coastal water.
Hence, the fixation of heavy metals at the surface prevents their exposure to aquatic organisms and residents via fresh groundwater in the island.

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