# Formation Processes and Anthropogenic Influences for Sediments in Majuro Atoll

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Atolls only 1~3 m above sea level are vulnerable to natural disasters and climate change. In spite of such conditions, people have lived in the Majuro Atoll in Marshall Islands for more than 2000 years (Yamaguchi et al., 2009). The life styles in this island have changed dramatically by the modernization. For example, the use of motor vehicles has been increased. Especially in an isolated island, sediments originally composed of coral gravel and foraminifera are easily affected by human activities such as cultivation of crops and well for drink water etc. Therefore, condition of sediments could be proper index of human impact. In particular, when they use modern industrial products, heavy metals contained in the products can be emitted and accumulated in the sediments. However, the influence of these contaminants on the reef island remains unclear. In this study, we focus on the changes of physico-chemical conditions of soil depending on the depth according to time series variation in Majuro and Arno Atolls, since atolls can be an appropriate model site to evaluate anthropogenic impacts.

Dating of each depth was conducted by radiocarbon ($^{14}C$) measurement for foraminifera using accelerator mass spectrometry (AMS) and Bayesian age-depth Models. X-ray fluorescence (XRF) and Inductively-coupled plasma mass spectrometry (ICP-MS) analyses were conducted to measure the elements in each layer. X-ray absorption fine structure (XAFS) analysis was also done to examine the detailed chemical form. Also microbeam X-ray Computed Tomography (CT) was used to estimate porosity of foraminifera at different depths.

Dating results showed that rapid sedimentation was likely to occur in each island in atoll in the early stage of the formation. The concentration of toxic elements such as Zn, Cu, and Pb increased sharply around 50 cm depth that are considered to be emitted after the original sedimentation of biological remains such as coral gravel and foraminifera. This result correlated with that of total organic carbon (TOC) from the same depth. The concentration of rare earth elements (REEs) also increased around the same depth and negative cerium anomaly became smaller at shallower depth. However, only Mg increased as the depth increased or as the porosity of foraminifera decreased. XRD analysis showed that magnesian calcite has decreased in the upper layer of the sediments, which suggested the selective dissolution of Mg from magnesian calcite near the surface. Bulk and μ-XAFS analyses showed that (i) Zn exists as Zn-rich particles such as as ZnO and ZnS, which are considered to be a tire wear and (ii) chemical species of Fe is ferrihydrite. Taking them into consideration, adsorption of heavy metals on ferrihydrite and/or humic substances inhibit release of heavy metals to aqueous phase even though the atoll was made of porous materials, where water easily flows out from the island by rainfall or tide. XAFS analysis also revealed that aluminum is present either as kaolinite or muscovite. These results show contribution of terrigenous material.

The original sediments of atolls is $CaCO_3$ contained in biological remains without heavy metals. Therefore, atolls can be appropriate model site to examine the chemical form and amount of elements emitted by anthropogenic effects and to assess the impact of modernization as our studies.

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