Environmental changes and heavy metal pollution across the Anthropocene in Uranouchi Bay, Kochi, Japan

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The inner bay is a place where environmental changes caused by nature and human activities are recorded in detail. In particular, since the Industrial Revolution, the record of human impact on the global environment has been preserved, and a new geological age called the Anthropocene has been proposed (Crutzen and Stoermer, 2000). There are only a few examples of continuous analysis of seafloor sediments before and after the Anthropocene, such as the analysis of Ise Bay in the vicinity of an industrial area (Toh et al., 1982). The purpose of this study is to examine the environmental changes during the intervening period of the Anthropocene recorded in the marine sediments of Uranouchi Bay, located in the central part of Kochi Prefecture, a rural area less affected by the industrial zone. In particular, the transformation process of organic matter and changes in the concentration of heavy metals were investigated.

Uranochi Bay is a sedimentary bay with a narrow mouth and a long, narrow topography of 12 km from east to west, where fish farming is actively conducted.

The seafloor surface sediments of Uranai Bay were collected in March 2021 by a diver who pushed core pipes directly into the bay at the back and center of the bay. One of the two core samples taken at each location was subjected to non-destructive analysis (X-CT, MSCL) and elemental composition analysis using a digital image, XRF core scanner (ITRAX) after half-splitting. The other was cut at 1 cm intervals in the depth direction and kept frozen. The other was cut into pieces at 1 cm intervals in the depth direction and stored frozen, then freeze-vacuum dried to powder form for analysis of organic matter (EA-IRMS) and dating (γ -ray spectrometer).

From X-ray CT and magnetic susceptibility, the sediments in the inner (U-1) and middle (U-3) bay were silty mud, and the density of the core samples gradually increased from the seafloor surface to the depth. ITRAX and dating showed that heavy metal elements (Cu, Zn, Ni) increased from about 18 cm below the core surface (1964) in the inner part of the bay (U-1) and from about 36.5 cm below the core surface (1954) in the central part of the bay (U-3). In the center of the bay (U-3), the increase was observed from about 36.5 cm below the core surface (before 1954). The values before the change in heavy metal elements and the current values increased by almost twofold. Mn, an indicator of redox, decreased from about 14 cm (estimated 1977) in the inner part of the bay and from about 34 cm (1954) in the middle of the bay, suggesting that the seafloor environment has become more reductive since that time. Br, an indicator of marine organic carbon, increased from about 25 cm (1953) in the inner part of the bay and from about 45 cm (1922) in the middle of the bay, suggesting that those derived from phytoplankton increased. The TOC and C/N ratios increased from about 25 cm in the inner part of the bay and about 45 cm in the middle of the bay, respectively, and the stable isotope ratios (δ^{13}Corg., δ^{15}Norg.) changed accordingly. The average sedimentation rate was 1.7 as fast in the inner part of the bay (U-1, 9.7 m depth) as in the middle of the bay (U-3, 19 m depth), suggesting that the onset of changes in heavy metals and organic matter was different due to differences in seafloor topography, basin area and sedimentation rate.

Keywords: Anthropocene, Heavy metal pollution, Organic matter, Environmental changes, Inlet bay

