High-resolution chemostratigraphy of Fe–Mn crusts by LA-ICP-MS

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Ferromanganese (Fe–Mn) crusts occurred in submarine environment are chemical sedimentary rocks composed mainly of Fe–Mn oxides[1]. Previous leaching experiments and bulk chemical analyses[2] indicated that elements in Fe–Mn crusts are distributed into Mn–oxide phase, Fe–(oxyhydr)oxide phase, carbonates, and detrital materials. Several studies discussed paleoceanographic environments from chemostratigraphy of Fe–Mn crusts because Fe–Mn oxides take various elements from ambient seawater[3]. However, previous approaches based on bulk chemical analysis and EPMA mapping are severely limited in spatial (time) resolution and number of measurable elements, respectively.

Here, we show elemental mapping images of major and trace elements including rare-earth elements in Fe–Mn crusts from the western Pacific Ocean, analyzed by femto-second laser ablation ICP-MS (Thermo, iCAP Q). The laser beam was about 30 μm in diameter and 10 Hz repetition rate which scanned over sample surface along the growth direction of Fe–Mn crust at 80 μm/s, and space between adjacent scaned lines was 80 μm. Elemental concentrations were calculated from analysis of hand-pressed standard materials of JMn-1 and Nod-P-1 (issued by GSJ and USGS, respectively) and normalized into 100% of major element oxides.

The high-resolution elemental mapping images show clear column structures with high Mn concentration and gaps between the columns that are filled with Fe-(oxyhydr)oxide, detrital elements, and some phosphate grains. Titanium correlates with Mn, even though Ti has generally been considered to be distributed in Fe–(oxyhydr)oxide phase[2]. In addition, Ti, Ni and U show stripe pattern. We will discuss these characteristic elemental distributions corresponding to the structure, from a perspective of chemostratigraphy in Fe–Mn crusts.

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