Paleoenvironmental evolution and diagenesis of the Miocene Onnagawa Formation from mineral and elemental fluctuations

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Middle to Late Miocene (16.0-5.3Ma) marks one of the three major cooling steps during Cenozoic. In this cooling event, siliceous sediments with high organic contents were widely deposited along the North Pacific margins, which has been attributed to enhanced primary productivity and/or preservation of diatoms. The Miocene Onnagawa Formation represents the deposition of those siliceous sediments in the northern Japan Sea. It was reported that siliceous rocks in the Onnagawa Formation showed meter-scale rhythmical bedding reflecting fluctuations in productivity of diatoms and flux of terrigenous materials. Furthermore, it was also reported that parts of highly siliceous rocks in the Onnagawa Formation showed centimeter-scale black bands. However, the age and the cause of their occurrence has not been understood.

We executed construction of a continuous lithologic columnar section, collection of samples at 20 cm intervals, and performed mineralogical and geochemical analyses with X-ray diffraction (XRD) and X-ray fluorescence (XRF) in the process of cyclostratigraphy for the precise dating of the Onnagawa Formation. Here we mainly present the XRD and XRF data.
The obtained columnar section is 130 m in thickness and divided into 5 lithologic units. It briefly displayed a calcareous part, a muddy part, and a siliceous part from the bottom to the top. Our samples were taken from the siliceous part in the uppermost ~60 m-thick interval (62-121 m interval from the bottom). The XRD data clearly indicate that most of the siliceous samples consist mainly of opal-CT, which derives from biogenic opal, and some taken from 62-66 m interval contain no opal-CT but are enriched in quartz. It suggests that the stratigraphic interval locates in the transition of silica diagenesis between “opal-CT zone” and “quartz zone”. The peak position of opal-CT in the XRD data also shows that the lower part underwent silica diagenesis more strongly than the upper, which is consistent with no occurrence of opal-CT and the increase in quartz at the lowest part. Furthermore, it was confirmed that the m-scale rhythmical bedding reflected the abundance in biogenic silica. We will discuss the paleoclimatic significance of fluctuations of biogenic silica and other elements, and the influence of silica diagenesis using the XRD and XRF data.

Keywords: biogenic silica, the Onnagawa Formation, Miocene cooling, silica diagenesis, XRD, XRF

