Productivity-induced lacustrine bedded chert formation in the Eocene Green River Formation

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Rhythmically alternated beds of chert and shale, also called as bedded chert, are commonly observed in marine sedimentary rocks. Recent studies revealed that changes in bed thickness of chert represent orbitally-paced variations in marine productivity and silicate weathering rate (Hori et al., 1993; Ikeda et al., 2017). On the other hand, bedded cherts are occasionally found in lacustrine deposits. Previous study interpreted that formational mechanism of lacustrine bedded chert is linked to the interplay between silica dissolution in alkaline lake waters and its precipitation due to the conversion of lake water’ s pH (e.g. Hesse, 1989). Some studies suggested that the pH of saline and alkaline lake water could have changed by the freshwater input (Eugster, 1967; Eugster 1969). Other study implied that the metabolic processes of cyanobacteria modified the pH of lake water and influenced to the silica precipitation (Behr and Rohricht, 2000). However, convincing evidence of chertification mechanism in lacustrine deposits have not been clarified yet.

In order to elucidate the formation mechanism of lacustrine chert, the present study examined a lacustrine bedded chert succession in the Eocene Green River Formation in northern Utah, USA. We have conducted detailed field survey in the Indian Canyon section in northern Utah. Bedded cherts occur in shallow lake level stage and alternated with dolomite beds with every 5–10 cm in thickness. Elemental mapping by Scanning X-ray analytical microscope (SXAM) reveals that the Ca concentration in dolomite layer, while Si concentration in chert layer, with sharp boundary coincide with lithofacies boundary. Elemental distribution also shows that alternation of chert and dolomite occur in every 1–2 cm in thickness. In addition, fluorescent microscopic inspection reveals that the distribution of Si concentration coincides with the dense accumulation of spherical organic matter. These spheres show the brightest fluorescence carbon shell with similar size (30–40 μm). The morphology of these spherical organic matter resembles to green algae, such as *Botryococcus braunii*, which are also abundantly preserved in the Green River Formation. Occurrences of algal organic matters in chert layer imply that deposition of algal organic matter could be related with the formation of lacustrine chert.

It is noteworthy that the lake water alkalinity of the Green River Formation is considered to be high (pH>9) because of extensive volcanic activity around Colorado Plateau. These lines of evidence suggested that silica precipitation is possibly caused by decreased pH due to the decaying organic matter (increasing CO_2 and/or organic acid) in sediment pore water. Deposition of organic matter can be related to changes in the lake algal productivity. Given that sedimentation rate of the formation in Indian Canyon section is estimated as ca. 10–15 cm/kyr (Smith et al., 2008), observed chert occurrence (1–2 cm and 5–10 cm) yields 67–200 and 333–1000 year’ s cyclicities. Therefore, periodic occurrences of chert beds in the Green River Formation are possibly linked to the centennial-scale changes in the lake algal productivity.

Keywords: lake sediments, Eocene, productivity, chert, silica, pH

