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Carbonate mineralogy in sediment from Lake Hovsgol and its implications for environmental and geochemical changes of lake water

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Carbonate minerals are one of the important components of sediments. Chemistry of the water is controlled by the reactions of carbonate minerals if these minerals are allowed to form during the sedimentation processes. On the other hand, the mineralogy of the carbonate is determined by the water quality and temperature in lake water. Lake Hovsgol is a semi-closed lake located in the inside of the continent. Because there are little human activities in the vicinity of the lake, it is expected to be sensitive to the environmental and geochemical changes. The one of characteristics of the sediments from Lake Hovsgol is that the sediments are mainly composed of carbonate minerals. Kashiwaya et al. (submitted) analyzed HDP04 core from Lake Hovsgol and showed that HCl soluble fraction, which is attributable to carbonate minerals, tends to increase at glacial periods. This indicates that carbonate minerals are important indicator for environmental changes in Lake Hovsgol. In present study, we examined the detailed carbonate mineralogy of the sediment core (HDP04) with depth to reconstruct the past environment and geochemistry of lake water.

XRD patterns of core sediments with depth up to 57 m of which age is corresponding to 780 kyr B.P. showed that the common mineral phases in sediment are quartz, feldspar, chlorite and illite. In addition, XRD patterns at the depth more than 4.5 m showed the several peaks assigned to various carbonate minerals. The common carbonate phases are calcite (CaCO3) and dolomite (MgCa(CO3)2), but the peaks attributed to the monohydrocalcite (MHC: CaCO3.H2O) are also identified in some samples. MHC is rare mineral in geological environment, because the mineral can only form and be preserved in anomalous geochemical conditions (Taylor, 1975). MHC is much more soluble than calcite and metastable with respect to calcite (Kralj and Brecevic, 1995). The formation of MHC would require the high concentration of dissolved constituents in lake water. The preservation of HMC in geological setting would require low temperature condition, because the transformation rates of metastable phases to crystalline phases are commonly accelerated with temperature. Geochemical modeling by using Geochemist's Workbench showed that present lake water (Hayakawa et al., 2003) is equilibrium with calcite but undersaturated with respect to MHC. In order to form MHC, the calcium concentration in lake water must be twice or three times higher than that of present water. This indicates that the volume of lake water during MHC formation might be at least 2-3 times less that that of present conditions. Because the decrease of water volume in Lake Hovsgol is related to cold periods (Prokopenko et al., 2005), the formation of MHC must be response from cold periods at the area surrounding the lake. The XRD patterns of the sediment at least up to 22 m depth of which age is corresponding to 350 kyr B.P. showed that MHC almost coincidently occurred at glacial period. Moreover, geochemical modeling showed that the pH of solution during HMC formation is calculated to be 8.8 to 8.9 while pH of the present lake is 8.1 (Hayakawa et al., 2003). Even slight changes of pH can strongly influence on the ecosystem and geochemistry in aquatic environment. The estimated difference of pH form carbonate mineralogy indicates that ecosystem and geochemistry of the past lake environment was significantly different from the present environment.

References

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