Phosphate mineral formation in Lake Baïkal sediments and implications for paleoclimate

[1]Fagel N.,[2] Alleman L.Y.,[2] André L., Cloots R., Hatert F., Juvigné E. & Renson V.,

1. Geology Department, Clays and Paleoclimate, University of Liege, 4000 Liege, Belgium. E-mail: nathalie.fagel@ulg.ac.be
2 Department of Geology, section of Petrography and Mineralogy, Royal Museum for Central Africa, Tervuren, 3080, Belgium. E-mail: lalleman@africamuseum.be; landré@africamuseum.be

The more than 20 million years old Lake Baikal sedimentary record provides a good climate archive. While most paleoclimate reconstructions are mainly based on biotic proxies, we tested in this study other minerogenic tracers. In particular, it was suggested that the formation of authigenic and/or diagenetic phosphate minerals in Baïkal sediments underlines transitions from glacial to interglacial periods (Deike et al., 1997). The phosphate mineral formation previously evidenced (Müller et al., 2002) may be sensitive to suspended sediment concentrations: glacial periods are characterised by high detrital discharge, interglacial intervals are marked by low detrital supply but high biogenic sedimentation. Phosphate minerals were observed in Baïkal sediments from recent to 65 kyr BP. Their abundance was related to the sedimentation rate, the phosphate enrichment layers being particularly common on low sedimentation site, i.e., the Academician Ridge. Major and trace elements have been analysed by ICP-AES and ICP-MS on four cores drilled on topographic hills, in the southern basin (Posolsky bank, CON01-604), in the central part (Academician Ridge, VER98-1-3 and VER98-1-14) and in the northern basin (Continent Ridge, CON01-603). The geochemical signature is consistent with the occurrence of Mn-Fe-phosphate minerals. For instance P_2O_5 reaches up to 3% wt. relative to a mean value of 0.3 in the background sediment, MnO_2 presents an enrichment factor up to 6. There is no associated enrichment in any of the trace elements measured at the same levels. In the sediments, those P-Mn-Fe rich levels are related either to sparse millimetric dark concretions or to a layer (or a group of layers) defined by an alignment of numerous concretions but there is no so-called crusts. The concretions, isolated by >63 μm sieving, present a lamellar morphology. They are identified as Fe-phosphate phases with a variable proportion of Mn. The powder diffraction diagram is consistent with vivianite, a mineral that has been previously characterized in lacustrine sediments worldwide, including Baïkal. However, its precise formation process is not yet fully understood. Dean et al. (2002) emphasize that the occurrence of phosphate minerals in Elk lake (USA) is indicative of the paleo-productivity of the water-column. For Deike et al. (2002), phosphate crusts mainly accumulate under slow sedimentation conditions. We discuss the paleo-environmental implications of the occurrence of phosphate minerals in sediments. By studying the distribution of the phosphate concretions in sedimentary columns characterised under different sedimentary conditions, we would like to point up the implications of phosphate minerals for paleoclimate reconstruction.

References

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