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Modern accumulation rates of biogenic silica in Baikal bottom sediments: significance of diatom species composition

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Abstract

The modern distribution of biogenic silica (SiO_{2biog}) in Baikal surface (0–0.2 and 0–0.5 cm) sediments, its mass accumulation rates (MAR), and the processes responsible for this distribution were studied. The contents of SiO_{2biog} were determined in samples from 87 stations evenly distributed throughout the lake water area. These data were used to calculate the MAR of SiO_{2biog} and compile SiO_{2biog} and MAR distribution maps. The maps showed that the MAR varies significantly throughout the study area. Its highest values have been established in North Baikal. In Central and South Baikal the MAR values are much lower, and the minimum values are observed in the Selenga shoal. This MAR distribution pattern is consistent with the distribution of frustules of *Aulacoseira baicalensis* endemic diatoms throughout the surface sediments. Compared with other modern diatom species, this one has the most massive and heaviest frustules, which undergo the least dissolution when settling. This suggests that the above species plays a leading role in the accumulation of biogenic silica in modern Baikal bottom sediments, whereas the role of thin-walled species is minor because of their small mass and partial or complete dissolution in water on settling. Dilution of the sediments with terrigenous material is less significant for the SiO_{2biog} accumulation.

Keywords: Biogenic silica; mass accumulation rates; diatom plankton; species composition; production; Lake Baikal

Introduction

Diatoms are the main supplier of biogenic silica into Baikal bottom sediments (Votintsev, 1955, 1961, 1967; Votintsev et al., 1975; Vykhristyuk, 1979, 1980); therefore, it was suggested that diatom production and opal concentrations in the sediments are mutually related. That is, the content of SiO_{2biog} in the lacustrine sediments reflects changes in diatom production. This permits one to use opal concentrations in Baikal sediments as an indicator of the lake productivity changes in various geologic epochs (Bezrukova et al., 1991; Colman et al., 1995; Granina et al., 1993; Qiu et al., 1993). Since a change in lake productivity is a consequence of environmental and climatic changes, biogenic silica is one of important indicators used to interpret paleoclimatic Baikal sediment records (Baikal Drilling Project Group, 1998, 2000; BDP-99 Baikal..., 2005; Colman et al., 1995; Grachev et al., 1997, 1998; Karabanov et al., 2000a, 2000b, 2001, 2004; Khursevich et al., 2001; Prokopenko et al., 2001; Williams et al., 1997, 2001). But concentrations of substance in sediments not always reflect its actual supply and accumulation because of its possible dilution with terrigenous material. Therefore, it is more correct to use the values of absolute masses (Lisitsyn, 1991; Strakhov, 1947) or flows (mass accumulation rates (MAR)) (Maeda et al., 2002; Rea et al., 1993). The MAR of sediment component are a spatial-temporal characteristics permitting a quantitative estimation of the accumulation intensity ignoring the dilution effect. In order to get a true idea of SiO_{2biog} accumulation in modern Baikal sediments, it is important to calculate the flows (MAR) of SiO_{2biog} in three lake basins differing in morphology and diatom productivity and to elucidate whether opal concentrations in the bottom sediments depend on the diatom productivity.

Granina et al. (1993) and Karabanov et al. (1997) noted that it is more correct to use the MAR rather than the concentrations of opal. But the absence or scarcity of data on sedimentation rates and the dry bulk density of sediment did not permit calculation of MAR for entire Baikal. Today there are many literature data on the isotopic age of Baikal sediments (Colman et al., 1996; Edgington et al., 1991; Kuptsov and Bogdanov, 1991; Mackay et al., 1998; Nakamura et al., 2003); also, new data on the dry bulk density of the bottom sediments appeared (Colman, 1994). This permits a

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