Limnol. Oceanogr., 52(5), 2007, 1824–1837
© 2007, by the American Society of Limnology and Oceanography, Inc.

Sources and sinks of methane in Lake Baikal: A synthesis of measurements and modeling

M. Schmid[1]
Swiss Federal Institute of Aquatic Science and Technology (Eawag), Seestrasse 79, CH-6047 Kastanienbaum, Switzerland

M. De Batist
Renard Centre of Marine Geology, Department of Geology and Soil Science, Ghent University, Krijgslaan 281 s.8, B-9000 Ghent, Belgium

N. G. Granin
Limnological Institute of the Siberian Division of the Russian Academy of Sciences, P.O. Box 4199, Irkutsk 664033, Russia

V. A. Kapitanov
Institute of Atmospheric Optics, 1, Akademichesky Avenue, Tomsk 634055, Russia

D. F. McGinnis
Swiss Federal Institute of Aquatic Science and Technology (Eawag), Seestrasse 79, CH-6047 Kastanienbaum, Switzerland

I. B. Mizandrontsev
Limnological Institute of the Siberian Division of the Russian Academy of Sciences, P.O. Box 4199, Irkutsk 664033, Russia

A. I. Obzhirov
Pacific Oceanological Institute, 43, Baltiyskaya Street, Vladivostok, 690041, Russia

A. Wüest
Swiss Federal Institute of Aquatic Science and Technology (Eawag), Seestrasse 79, CH-6047 Kastanienbaum, Switzerland

Abstract

We studied the methane (CH_4) budget of Lake Baikal, the most voluminous lake in the world and the only freshwater body with known occurrences of methane hydrates in the sediments. CH_4 concentrations were measured in water samples taken during six expeditions between October 2002 and June 2004; these expeditions covered the entire lake volume. A one-dimensional model was applied to (1) estimate the large-scale vertical CH_4 fluxes within the South Basin of Lake Baikal, (2) determine the exchange with the atmosphere, and (3) constrain the CH_4 inputs from seeps and mud volcanoes to the deep water. Fluxes were generally several orders of magnitude below previous estimates. The annual internal source of CH_4 to the pelagic surface mixed layer was roughly estimated to be 40 Mg CH_4. A large part of this input diffuses downwards and is consumed in the water column, with a CH_4 residence time of about 4 yr. The input of CH_4 from deep gas seeps and mud volcanoes is less than a few 10 Mg CH_4 yr^{-1}, most of which is oxidized before reaching the surface. The net CH_4 flux between the atmosphere and the main waterbody distant from shallow areas is negligible and not significantly different from zero. However, occasional high CH_4 concentrations, both in the surface water and in the atmosphere, indicate that the region near the Selenga delta is a local CH_4 source to the atmosphere. CH_4 fluxes in the Central Basin are very similar to those in the South Basin, whereas in the North Basin, the shallow CH_4 sources are weaker.

[1] Corresponding author (martin.schmid@eawag.ch).

Acknowledgments

We thank the captains and crews of RV *Vereshchagin* and RV *Titov* for their hard work during so many surveys; A. Ageev, V. Blinov, V. Druzhinin, R. Gnatovsky, A. Salyuk, M. Schurter, and O. Vereshchagina for their invaluable support in the field work; and I. Tyryshkin and Y. Ponomarev for their assistance in the design of the methane gas analyzer. Finally, the constructive input from two reviewers helped to improve the clarity of the manuscript.

This project was supported by the INTAS grant 2001-2309 (multidisciplinary study of natural gas seeps in Lake Baikal–MULTISGAS). The water temperature measurements were supported by the EU-project CONTINENT (High-resolution CONTINENTal paleoclimate record in Lake Baikal: A key-site for Eurasian teleconnections to the North Atlantic Ocean and monsoonal system; EVK2-CT-2000-00057).