Microscale mineralization pathways in surface sediments: A chemical sensor study in Lake Baikal

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ABSTRACT: We used an array of ion-selective electrodes (oxygen [O_2], hydrogen [H^+], carbonate [CO_3^{2-}], calcium [Ca^{2+}], ammonium [NH_4^+], and nitrate [NO_3^-]) with a micromanipulator to study mineralization processes in the surface sediments in Lake Baikal. Concentration profiles at submillimeter resolution were measured in sediment cores from four depths (160-1,400 m) in the South Basin. Oxidation rates of organic carbon (C) estimated from O_2 and NO_3^- profiles measured in March and July 2001 ranged between 2.2 and 4.9 mmol C m^{-2} d^{-1}. The characteristic shape of the O_2 profiles allowed separation of oxidation of organic carbon from reoxidation of reduced compounds at the oxic-anoxic boundary. Of the benthic carbon turnover, 60-75% was metabolized through oxic respiration and 11-28% through anoxic mineralization. The remainder (12-14%) was due to denitrification. Carbon dioxide (CO_2) profiles calculated from O_2 agreed well with those from pH and CO_3^{2-}, supporting the concept that oxic respiration was the prevailing mineralization pathway. Alkalinity balance calculated from flux rates of reduced compounds and bicarbonate (HCO_3^-) calculated from pH and CO_3^{2-} profiles showed that the sediment was a sink for alkalinity. The flux rates in the range of 0.13-1.0 mmol m^{-2} d^{-1} were caused by buffering the hydrogen ions (H^+) generated from reoxidation processes of reduced compounds. Potential dark CO_2 assimilation by chemoautotrophic bacteria in the sediment was 0.03-0.1 mmol C m^{-2} d^{-1}. Because of the long O_2 exposure time of 25-2,500 yr, however, only 3-14% of the initially settled organic carbon was finally buried in the sediments, forming the paleolimnological record of Lake Baikal.

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