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Dynamics of dissolved and bubbled methane in Lake Youngrang and Hwajinpo, Korea

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Introduction

The limnological characteristics of coastal lakes were studied at some brackish lagoons along the eastern coast of Korea (Heo et al., 2001, 2004a, 2004b; Kwon et al., 2005). Lake Youngrang and Lake Hwajinpo are eutrophic lakes estimated for nutrients (Heo et al., 1999).

A large part of methane is produced by bacteria in anaerobic environments during the decomposition of organic matter, and the main substances of such methanogenesis are thought to be H_2+CO_2, ethanoic acid, and other organic acids (Barder, 1979; Koyama et al., 1979). River water and littoral sediment have been identified as the sources of methane in Lake Biwa (Murase et al., 2003). The redox cycles of manganese and iron in the oxic-anoxic boundary layers were observed in Lake Fukami-ike (Yagi & Shimodaira, 1986; Yagi, 1993, 1997). An accumulation of particulate manganese (PMn) and an associated decrease in dissolved organic carbon (DOC) were observed at the transition zone of the oxic-anoxic boundary layers (Yagi, 1986,1997). These facts seem to suggest that the DOC decrease involves the consumption of DOC as an electron donor by bacteria catalysis for the reduction of MnO_2. The present study was undertaken to clarify the mechanism of seasonal changes in particle and dissolved methane, manganese, iron and DOC in two brackish lakes in Korea.

Methods

Sampling

In our study, the two brackish lagoons, Lake Youngrang (St. 1, 2) and Lake Hwajinpo (St. 1, 2, 3) , on the eastern coast of Korea were selected as monitoring sites (Fig. 1). Water samples were collected in glass syringes with hand pump at depth intervals of 25 cm to 100 cm. These observations were made in August and September, 2005 and October, 2006 in the respective lakes.

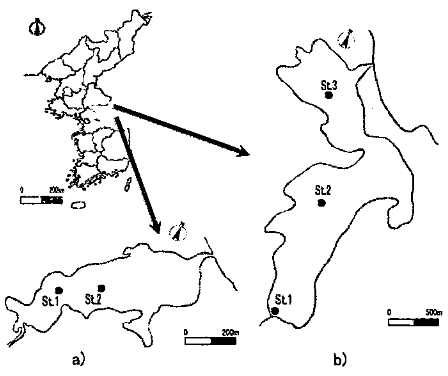

Fig. 1 Map showing the location of study site
a) Lake Youngrang b) Lake Hwajinpo

Analysis of water samples

The water samples obtained using hand pump were immediately filtered through a teflon filter (PTFE, 0.45μm pore size, 25 mm) for an analysis of manganese, iron and DOC (dissolved organic carbon). The dissolved methane concentrations were immediately displaced by He gas according to the head-space method. The collected gas was determined using a methane gas chromatograph analyzer (Semi Conductor Detector, Sensortec GS-15). Manganese and iron were determined with atomic absorption spectrometer.

Results and Discussion

Lake Youngrang

In 2005, the maximum dissolved methane was 1530 nM at St. 2 (depth 4 m). The air equilibrium concentrations of methane ranged 2-4 nM. And minimum dissolved methane was 79 nM St. 2 (depth 1.75 m). The PMn maximum value of 0.216 mg $^{-1}$ obtained at 1.75 m layer and the minimum DOC content were measured 4.14 mgCl^{-1} at 2.0 m depth. The dissolved manganese (DMn) lapidary increased in that layer, and a high value of 0.622 mg l^{-1} was obtained in the lake.

Lake Hwajinpo

In 2005, the maximum bubbled methane (0.197μM m^{-2} h^{-1}) was shown in surface water at St. 3. A higher concentration of dissolved methane in the surface water seemed to occur more often in the center of the lake rather than near the shore. The maximum values of PMn were 0.423 mgl^{-1} at 1.75 m and 0.594 mgl^{-1} at 2.0 m, respectively. Minimum DOC was observed from 3.13 $mgCl^{-1}$ at 1 m to 2.54 $mgCl^{-1}$ at 2 m, and these values were higher than those at another depth in Lake Hwajinpo. In 2006, the PMn peak layer of 0.140 mg l^{-1} was observed at 2.5 m. No DOC decrease was obtained in that layer because the DOC declines were shown with the lowering of depth.

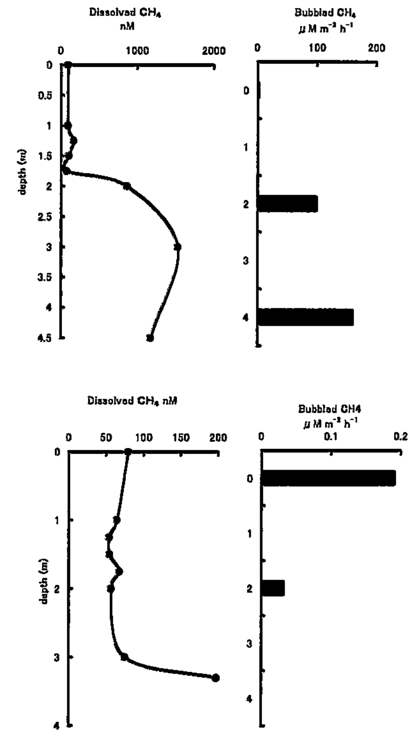

Fig. 2 Vertical distributions of dissolved and bubbled methane (Above: Lake Youngrang, Below: Lake Hwajinpo)

The DOC decreased at the maximum of PMn layer and DMn rapidly increased beneath that layer. It was also suggested that biological manganese oxic and anoxic actively occurred in the oxic-anoxic boundary layers in Lake Youngrang and Lake Hwajinpo.

The reason for the high dissolved methane level in the hypolimnion was the extremely low oxygen concentration. Given the Mn and Fe distributions, the minimum dissolved methane was considered due to the formation of oxic-anoxic boundary layers. Dissolved methane shows different vertical distributions in two lakes. Dissolved methane concentrations were higher in Lake Youngrang than in Lake Hwajinpo.

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