Distribution and characteristics of dissolved organic matter in Lake Baikal and Yenisei River, Russia

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1.Introduction

Recently, rapid permafrost melting has been observed in Siberia because of the global warming (Fukuda et al., 1995), and a great amount of green house effect gas was supposed to be released from the region. As a result, it can cause the acceleration in global warming. In addition, the other problems such as expanding lake areas and increase of flow volume or rates of the rivers in the region are concerned. These potential adverse effects on the Siberian environment results from the permafrost melting are on-going serious problems.

Dissolved organic matter (DOM) is a large carbon reservoir comparable to the atmospheric carbon dioxide. Moreover, DOM has many important functions controlling aquatic ecosystems: It is a main energy source of aquatic heterotrophic bacteria; controlling the attenuation of ultraviolet radiation in the water column and the stability of trace organic materials or inorganic elements in water by complexation. Because DOM reflects geographic and hydrologic conditions in the watershed environment, great qualitative and quantitative changes in DOM can occur by global warming.

In this study, we studied about the distribution and spectroscopic characteristics of DOM in Lake Baikal and Yenisei River watershed, which is one of the biggest water systems inflowing into the Arctic Ocean, using DOC measurement, three-dimensional fluorescence excitation-emission matrix spectroscopy and high resolution fourier transform ion cyclotron resonance mass spectrometry (FT-ICRMS). The results would be a valuable basis for estimation of environmental changes in the permafrost area in the near future.

2.Materials and methods

Water samples were collected in August 2007, at the deepest point in the south basin (0˜900 m depth) of Lake Baikal and at the 17 stations from St-1(55’59’N) to St-17(67’23’N) along the Yenisei River. Collected samples were filtered using GF/F filters on board or in the laboratory. The filtered samples were stored under freezing and dark conditions and brought back to Japan. In Japan, DOC concentration and fluorescence properties were determined. For FT-ICRMS, the samples were subjected to C18 solid phase extraction, evaporated to dryness by nitrogen gas spray and carried to Old Dominion University (Virginia, USA). Then samples were dissolved in 80% methanol and analyzed by ESI-FT-ICRMS.

3.Results and discussions

DOC concentrations in Lake Baikal ranged from 1.2 to 1.8 mg C/l and they showed similar distributions to that of protein-like fluorescence peak intensities (Ex: 220˜225nm, Em: 298˜308nm). It indicated that increase of DOC concentrations in surface water in L.Baikal was due to the biological activities in the lake.

Meanwhile, DOC concentrations in Yenisei River had higher values than in L. Baikal and ranged from 3.1 to 8.4 mg C/l. They showed similar distributions to that of humic-like fluorescence peak intensities (Ex: 230˜250nm, Em: 410˜420nm). It indicated that allochthonous organic matter from the surrounding soils mainly controlled the DOC distribution in the Yenisei River system. Particularly high DOC values (5.2˜8.4 mgC/l) were observed at the permafrost area (65’48’N˜67’23’N), and permafrost melting seemed to contribute to the high DOC values in this region. We will also discuss about the molecular level characteristics of DOM from the results by FT-ICRMS.