Present earth-surface processes and historical hydro-environmental fluctuations inferred from lake-catchment systems

博　士　論　文　要　約

Present earth-surface processes and historical hydro-environmental fluctuations inferred from lake-catchment systems

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博 士 論 文 要 約

Lacustrine sediments contain both high-resolution regional environmental records and global information in lake-catchment systems. Therefore, they have been widely used for reconstructing not only regional environmental changes from the paleo-limnological point of view, but also long-term global environmental changes from the paleo-climatical point of view. In addition, they are also of great use for reconstructing short-term environmental changes (precipitation, water discharge, etc.) and understanding earth-surface processes (erosion, transportation, sedimentation) in the lake-catchment system.

Considering above views, this thesis consists of three parts:

1. Disastrous flood events found in Lake Biwa sediments (Chapter 2); this chapter aims to clarify rapid hydrological changes in the instrumental period using a large lake-catchment system (Lake Biwa) with long environmental records because short-term changes should be finally discussed in the context of long-term and global ones. Long-term hydro-climatological changes found in Lake Biwa sediments are closely linked to long-term and global environmental changes (e.g., Kashiwaya et al., 1991; Meyers et al., 1993).

2. Reconstructing hydro-environmental fluctuation in snowfall area (Chapter 3); hydrological fluctuations in winter are often distorted with snow cover area in Japan, where different processes from summer season should be also considered for establishing general expressions on erosion and sedimentation. To make clear the difference in processes and influences on physical properties, Onuma lake-catchment system in southern Hokkaido is discussed.

3. Present earth surface processes and pond sediment information (Chapter 4); process understanding is essential for clarifying causal relations in earth surface phenomena and proper interpretation of sediment information. Instrumental observation (monitoring) is of great use for the process understanding. Chapter 4 deals with the instrumental observation for a small pond-catchment system (Takidani-ike) near Kanazawa University.

The analytical results for lacustrine sediments obtained from Lake Biwa and for hydrological data suggest that: i) disastrous flood events, namely the Isewan Typhoon (IT; 1959) and the Meiji heavy rainfall (MH; 1896), are recorded in the physical properties of the lacustrine sediments (mineral content, density, grain size); ii) the density and mineral content respond positively to rainfall intensity (70-mm excess rainfall); and iii) the mineral grain size distribution may respond positively to the rainfall intensity in the catchment and negatively to the distance transported from the river mouth. These lead to that physical parameters of sediments are closely related to hydrological conditions, which is indicated also in long-term hydro-climatological studies. This suggests that interpretation of physical properties supported with modern observation is of great help for considering the properties in the long-term fluctuation if the relationship between signal and noise is properly recognized in short-term and long-term fluctuations.

Analytical results for the physical properties of Lake Onuma sediments and hydrological data around the Lake Onuma system (snowfall area) indicate that: i) earth-surface processes are different between summer and winter periods; ii) the mineral grain size correlates highly with summer precipitation, and fairly with annual precipitation, suggesting that it may be a proxy for precipitation; and iii) the mineral

grain size is also available for estimating discharge in the lake.

Observational and analytical results for a small pond-catchment system called Takidani-ike show (the system is used for clarifying erosion and sedimentation processes in a lake-catchment system in order to establish suitable proxy data from sedimentary records) that; the sedimentation rate (both monthly and seasonal sedimentation) is expressed as a function of two factors; precipitation intensity (external factor) and water level change (system factor, closely related to size of erosible area). The correlation for the seasonal relationship is better than one for the monthly relationship, suggesting that reservoir effect in the catchment should be considered. The results also show that some physical properties (mineral grain size, etc.) may be used as proxies for sedimentation rate.

These provide precious information for proper interpretation of data without observation and a significant clue for establishing mathematical expressions of past proxy data.