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A record of Holocene lake-level change reconstructed from mineralogical analysis and acoustic profiling of the Balkhash

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Introduction

Global warming is the matter in recent years. Although IPCC pointed out that the main factor is human activities, some mention importance of natural environmental changes. To understand actual cause, it is essential to investigate global environmental change and evaluate the influences of human activity. Restoration of local environmental changes is also significant, that enable to consider correlation of those among areas. Local and global climate of Holocene has been restored to know interaction between environmental changes and human activities. Recent study demonstrated that destruction of civilization occurred corresponding with abrupt climatic changes in some cases. This strongly suggests that climate changes have seriously damaged human society. While paleoenvironment of Central Asia which is semiarid has been restored by such as Mischke et al. (2010), the amount of records is short. Lake Balkhash which has the largest area in Central Asia and has recorded detailed paleoenvironment of the region was focused.

This research reconstructed lake level change of Lake Balkhash from the lake sediments with acoustic profiling, and discussed the cause of change comparing climatic changes in near regions.

Study area and methods

The research area is the eastern part of the Lake Balkhash, where is the deepest with the depth of over 20 m. To restore lake level changes, lake sediment cores and acoustic profiling images of the sediments were analyzed. In acoustic profiling the change is captured by analyzing sequence stratigraphy. Two sedimentary cores of 0901 and 0902 were obtained and minerals in sediments were particularly analyzed because they record water quality and origin of the sediments.

Results and discussion

Onlap and toplap structure were confirmed at each upper and lower stratum of reflecting boundary 2 identified in the acoustic profiling images of Line 11, respectively. Onlap structure is formed when water level rises, while toplap structure is formed when water level drop. Therefore, lake level drop phase changed into rise phase bordering the reflecting boundary 2 at Line 11.

Peak of X-ray intensity of quartz and feldspar in 0901 core and that of magnesite and gypsum in 0902 core were confirmed by identifying minerals based on XRD peak chart. Magnesite and gypsum in 0902 core formed under arid environment indicate water level drop. Quartz and feldspar rich horizon in 0901 core indicates increase of fluvial input into the lake suggesting lakeshore migration because of the lake level drop. As a result of core contrast, coarse grain deposition facies of 0901 cores are coincident with gypsum and magnesite of 0902 cores. Therefore, Lake Balkhash fell down its lake level rapidly at this time. Subsequently, terrigenous matter has deposited surrounding the Lepsy river mouth where 0901 core is situated whereas gypsum and magnesite has produced at around 0902 core far from the river mouth. Accumulation of gypsum and magnesite happened ca. 5500 cal years BP. After that, this horizon that shows water level decline is called as event horizon.

As a result of contrasting 0901 core with acoustic profiling of Line 8, the event horizon of 0901 core is coincident with the reflecting boundary of Line 8. Furthermore, the reflecting boundary of Line 8 is coincident with the reflecting boundary 2 of Line 11. Since the reflecting boundary 2 of the event horizon is concordant with the result of acoustic profiling, lake level drop phase changed into rise phase about 5500 cal years BP in Lake Balkhash. Other researches indicated that climate changed from wet to dry at various places ca. 5500 cal years BP. To summarize, the timing of lake level drop phase into rise phase ca. 5500 cal years BP in Lake Balkhash is coincident with climate change period from wet to dry. And Lake level change of Lake Balkhash is caused by aridification. This research clarified lake level change and contributed to discussion of climate change in Central Asia.

Keywords: Lake-level change, Holocene, Lake Balkhash, lake sediments, acoustic profiling, mineralogical analysis