Paleoenvironmental and Paleoclimate change from lagoon sediments in Korea and Japan during the Holocene

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https://doi.org/10.15017/2534378

出版情報：九州大学, 2019, 博士（理学）, 課程博士
バージョン：

（様式３）

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論 文 名　:
Paleoenvironmental and Paleoclimate change from lagoon sediments in Korea and Japan during the Holocene
(日本および韓国のラグーン堆積物を用いた完新世における古環境および古気候変動の復元に関する研究)

区　　分　:　甲

論　文　内　容　の　要　旨

Korea and Japan are an essential place to understand environmental change induced by sea level change and climate change in East Asia. Even though both Korea and Japan close to each other, climate change and sea level change have worked differently. Therefore, the environmental change also reacts differently depending on relative sea level (RSL) and monsoon. Lagoon sediment offers critical information for paleoenvironment and climate change. Therefore, reconstruction of the environment during the Holocene is necessary to understand paleoclimate change and sea level fluctuation. The paleoenvironmental change was reconstructed by using diatom assemblage, sedimentary characteristics, grain analysis, chemical analysis and chronology by optical luminescence age, radiocarbon age, ^{137}Cesisum dates in Hwajinpo lagoon in Korea and Lakes Hamana, Ryuuoo and Kawahara in Japan.

Chapter 1 is a concise introduction about the lagoon, relative sea level change in East Asian, East Asian monsoon and El Niño/Southern Oscillation (ENSO). The objective and importance of my researches are also introduced.

Paleoenvironment, climate change, and the history of Hwajinpo lagoon were studied in Chapter 2. Centennial to millennial-scale sea-level fluctuation and paleoclimate changes strongly influenced the coastal ecosystem and human civilization. Hwajinpo lagoon is the largest lagoon in Korea and is located along the east coast of the country. Even though many lagoons including Hwajinpo were developed along the east coast of Korea during the Holocene, there were a few publications about the Holocene sea-level and precipitation change. Here, we studied the evolution of Hwajinpo lagoon to reconstruct the Holocene climate and sea-level changes using grain-size and diatom assemblage. Lagoonal Holocene sediments provide an important record of past climate change. We investigated an 11.0-m core named HJ02, which was obtained at the mouth of a small river that drains into the lagoon. Core chronology was established with accelerator mass spectrometry (AMS) ^{14}C and optically stimulated luminescence (OSL) dates. Diatom assemblages and grain size analysis revealed that estuarine conditions in the inner lagoon area transitioned to an open embayment ca. 8 ka as a result of sea-level rise. Around 7.8 ka, the open bay became a semi-closed bay as a consequence of the development of a sand barrier. After the bay was semi-closed, marine water inflow was generally restricted as the sand barrier development, and the semi-closed bay became a completely enclosed, low-salinity, brackish lagoon around 6 ka. There was an erosional hiatus between 5.5 and 1.7 ka (7.0 m depth), likely caused by river flooding and a switch in the location of drainage along the delta. The lagoon became oligohaline around 1.6 ka, likely because of increasing precipitation associated with an intensified Asian summer monsoon. This increase in precipitation resulted in expansion of the sand bar by sediment inflow, driven by agricultural development in the area. About 1 ka, the diatom assemblage was similar to the modern assemblage, suggesting the lagoon's current geomorphic conditions had been established.

In Chapter 3, the environmental change depended on coastal deformation associated with great earthquake along the Nankai Trough from Lakes Hamana, Ryuuoo, and Kawahara in subduction zone. The environmental change was reconstructed from three lakes using sedimentary record and diatom assemblage. The environmental change of these three lakes occurred almost the same time as a consequence of great earthquakes which are recorded from the historical document. Approximately AD 600 to 700, the environments changed to freshwater lake from Oligohaline lake in Lake Hamana, from a brackish lagoon to a freshwater lake in Lake Ryuuoo, and from the lagoon, which was affected by sea water to the brackish lagoon in Lake Kawahara. These environment changes in three lakes suggest less marine water as a result of falling RSL. Therefore, these environment change of three lakes might be related to falling RSL as the groud recovered after subsidence by Tenmu earthquake in AD 684. Around AD 1100, three lakes indicate lake level decreased at the same time. It might be assumed that the environmental change was resulted by Kowa and Eicö earthquakes in AD 1099 and 1096, respectively. The last environment change happened in approximately AD 1700. The environment changed from oligohaline pond to the oligohaline lake in Lake Kawahara. Also, The environment of Lake Ryuuoo changed to freshwater lake from a freshwater pond in AD 1750. This environmental change of both lakes indicates that the lakes level increased. The environmental change was might because of Hoei earthquake in AD 1707 as the ground of lakes have not recovered yet after subsidence by the earthquake. Therefore, the evrionmental change from Lake Hamana, Ryuuoo and Kawahara were strongly influcenced by great earthquakes during common era.

In Chapter 4, paleoenvironment and paleoclimate changes during the Little Ice Age (LIA) were investigated using sediments from Lake Hamana. This lagoon in central Japan is under a complicated climate system influenced by the East Asian summer monsoon (EASM), East Asian winter monsoon (EAWM), and strong typhoon events. Diatom assemblages and chemical components of a 1.3 m sediment core suggest historical events of rapid salination and cyclical ecosystem shifts accompanied by monsoon condition changes. Most research has indicated that Lake Hamana changed from a freshwater lake to a brackish lagoon because of the Meio earthquake in AD 1498. However, based on results from the diatom assemblage and chemical components, this salination occurred because of changes in the Hamana paleoriver flow, and this change happened before the earthquake, around the mid-15th century. Furthermore, it is clear that Lake Hamana was an oligohaline lagoon before salination. The lithology of the lake sediments and the diatom assemblage changed during the LIA; sand, water, and total diatom contents decreased. However, the relative abundance of marine diatom taxa increased during the LIA. These changes were introduced by a weakening EASM coupled with low precipitation under low solar activity during the LIA. Several flood events represented by freshwater diatom taxa and magnetic susceptibility peaks co-occurred with strong El Niño events during the LIA. It is inferred that this strong El Niño during the LIA induced frequent typhoons causing floods in central Japan.

In Chapter 5, the main results and conclusions of my works are summarized. Future directions are also suggested in this chapter.