Late Holocene Geomorphic Development of Coastal Barriers Around Lake Hamana and in Hamamatsu Strand Plain

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Abstract

This study discussed the geomorphological development of coastal sand barriers around the lake Hamana and western Hamamatsu strand plain during the middle to late Holocene. The Holocene geology of lake bed at the central part of the lake and the alluvial lowland were presumed by coring survey and previous studies. Chronologies of the core samples were determined by accelerator mass spectrometry (AMS) radiocarbon measurements and tephra layers. The lacustrine and sedimentary environments were reconstructed mainly by diatom fossil assemblages with molluscan fossils and depositional facies.

In order to reconstruct lacustrine environmental change of the Lake Hamana during the middle to late Holocene, diatom assemblages in a lake bed core (HMN08-7) were investigated. Six diatom zones were identified based on major species composition changes in the diatom assemblages. Diatom zones V and VI in the upper part of the core were subdivided into 3 sub-zones respectively. Stepwise development of the lacustrine environment in the Lake Hamana was suggested: Vigorous seawater inflow inferred by marine diatoms (Stage I, 4600-4700 cal BP); A closed inner bay environment with laminated sediments due to rapid formation of sand barriers (Stage II, 4500-4600 cal BP); A circulative brackish lacustrine environment by active mixture of riverine fresh water with enhanced inflow of seawater since 3500 cal BP (Stage III, 2650-4500 cal

BP); Gradual salinity decrease of the lake water by reduced seawater inflow (Stage IV, 2250-2650 cal BP); Lake water from brackish to fresh since 2250 cal BP with intermittent salinity increase in the middle of this period, water depth of the lake getting deeper (Stage V, 1498 AD-2250 cal BP); Re-development of an inner bay environment after the Meio earthquake in 1498 AD with temporal salinity increase during 1600 AD to 1750 AD (Stage VI, after 1498 AD).

Analyses on diatom assemblages of sediment cores taken from alluvial lowlands around the Lake Hamana, Rokkengawa Lowland, Higashi-Kandagawa Lowland, Miyakodagawa Lowland and Shinjo Lowland indicated stepwise environmental changes from a shallow marine (intertidal zone of a bay) to a fresh water ponds or marsh, which occurred during the middle to late Holocene. In particular, fresh water ponds and/or marshes were formed around 5000 cal BP and during 3200-3500 cal BP. During 3200-4500 cal BP, seawater flowed into the lowlands overlying the peaty deposits of fresh water marshes. In the Miyakodagawa Lowland, seawater inflow was expanded in ca. 6800 cal BP. With riverine inputs of sediments, fresh water marsh was formed in the central part of the lowland in ca. 3500 cal BP. Before formation of the fresh water marsh, episodic salinity increase was suggested by brackish to marine diatom species.

Well-developed six beach ridges (BR) are in the western Hamamatsu Strand Plain, called BR I to VI from landward to seaward. Diatom assemblages in sediment cores in the inter-ridge marshes were investigated. Timings of development of fresh water pond/marsh at the two inter-ridge marshes were estimated from radiocarbon ages and tephra layers and indicate that they occurred almost simultaneously. Tidal area changed to fresh water marsh/pond at ca. 3200 cal BP in two drowned lowlands and synchronous with those in the inter-ridge marshes. Formation of the fresh water pond at the inter-ridge marsh between BR III and IV and wide distribution of the BRs suggests that emergence of the BR IV caused this environmental change. In addition, salinity presumably increased before ca. 3200 cal BP in both lowlands. Timings of fresh water pond/marsh formation of the inter-ridge marshes were at ca. 3200 cal BP based on radiocarbon ages and tephra chronologies. This suggests that emergence of the BR IV was occurred at ca. 3200 cal BP.

Paleo-geographical changes during the middle to late Holocene in the study area were reconstructed. After the Last Glacial Maximum, sea area expanded associated with relative sea-level rise (the Jomon Transgression). Because the BR I had not developed enough to prevent seawater inflow, inner bay in the incised valleys were formed around the lake. During 6500-5000 cal BP, fresh water pond and/or marshes started to form in the alluvial lowlands associated with the BR I development. However, repeated seawater inflow into the lowlands due to vulnerability of the BRs was suggested in this period. During 4500-5000 cal BP, BRs I, II and III were developed and emerged to form fresh water ponds/marshes in the alluvial lowlands and strongly closed inner bay in the lake. However, obstruction by the BRs became weaker after 4500 cal BP resulting in re-formation of brackish to marine water environment in the alluvial lowlands. In particular, active seawater inflow into the lake became vigorous since 3500 cal BP. After 3200 cal BP, fresh water pond and/or marshes formed in the alluvial lowlands around the lake and the western Hamamatsu Strand Plain, presumably associated with the BR IV emergence. Limited seawater inflow since 2650 cal BP leaded gradual salinity decline and stable fresh water environment formed after 2250 cal BP.

Geomorphic development of coastal sand barriers around the Lake Hamana and in western Hamamatsu Strand Plain during the middle to late Holocene was generally categorized into two periods, one was transient period between ca. 6500 to ca. 3200 cal BP and the other was stable

period since ca. 3200 cal BP. Before 3200 cal BP, development process of sand barriers in the study area was characterized by temporal fresh water environment, related to co-seismic subsidence (i.e., abrupt relative sea-level rise). On the other hand, after 3200 cal BP, the developing process was characterized by stable fresh water environment. Assuming that the seismic activities have been constant throughout the late Holocene, trend shift of geomorphological developing processes at ca. 3200 cal BP was due to faster sedimentation to form BRs than that before. Fast enough sedimentation made the BRs less affected by co-seismic subsidence. Because most of sandy deposits composing BRs were supplied by the Tenryugawa River, enhanced sediment discharge by the Tenryugawa River may have been increased since 3200 cal BP. Such enhanced sediment discharge around 3200 cal BP was reported in the lower Yahagigawa Lowland, relating to the Yayoi Regression.