Holocene Sedimentary Environmental Changes of Coastal Lowlands in Japan

UMITSU Masatomo
Department of Geography, Nagoya University
Chikusa, Nagoya 464-8601, JAPAN

I. Introduction

There are a number of small coastal lowlandss both on the Pacific and Sea of Japan coasts of the Japanese islands. Many studies have been carried out on both sea-level changes and landform evolution of the coastal lowlands including deltas in Japan. The stratigraphy and chronology of Holocene sediments of coastal lowlands relate to the sedimentary environment in which landforms have responded to sea-level changes in the past.

Typical Japanese riverine plains consist of alluvial fans, floodplains, and deltas from the inner to coastal regions in that order (Oya et al. 1988). However, considerable variation in landform is observed between the individual riverine coastal plains. There are plains without deltas, plains with broad flood plains, and plains in which alluvial fans occupy the entire plain. Large dunes or sandy barriers also develop along the shoreline of the Tsugaru, Akita, Shonai, and Niigata plains which located along the coast of the Sea of Japan. Rows of beach ridges are typically recognized in the Kuju-kuri plain, eastern Japan. Similar rows of beach ridges are also recognized in the Ishikari, Yufutsu, and Sendai plains in north and northeastern Japan. In general, relatively large plains

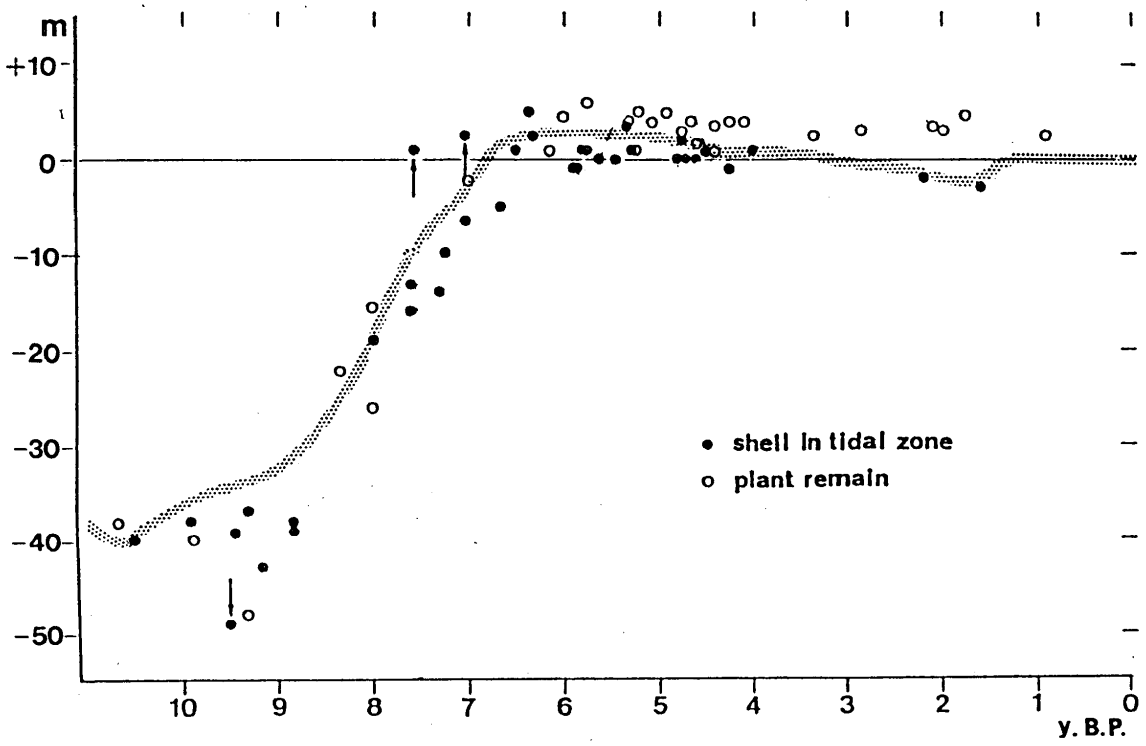

Fig. 1 Relative sea-level curve during the last 10,000 years from the Paleo-Okutokyo Bay and its surroundings. (Endo *et al.*1989)

develop in regions where the land tended to subside during the late Quaternary.

II. Holocene sea-level changes in Japan.

There are many opinions about the lowest sea-level during the last glacial maximum: -80 m (Oshima 1982, 1990); -95+-3m (Saito et al. 1989) ; -100 m (Fujii 1990); -127+-30 m (Oba 1988) ; -140 m (Iseki 1977) and so on. Many studies, however, regard the level around -100 m as the sea-level at that time (Ota and Omura 1991, etc.) . The extensions of paleoriver valleys formed during the last glacial maximum have been recognized in various places such as Tokyo and Osaka Bays and the continental shelves around the Japanese islands. The buried paleochannel under the bottoms of Tokyo and Osaka Bays are called the paleo-Tokyo River and paleo-Osaka River, respectively.

Sea-level changes during the late glacial period are still poorly understood. Sediments of the period in buried channels of riverine coastal lowlands are sandy and have a relatively high N-value (indicator of the hardness of sediments). Sea levels of the early Holocene reported in various sites are around -30 to -50 m (Ota et al. 1982, 1990). In the Kanto plain, an unconformity and the deposition of a conspicuous sandy bed are recognized between the contact of the Pleistocene and Holocene sediments in the riverine coastal plains. These sandy sediments were called as the Holocene basal gravel bed (HBG) by Endo et al. (1982), and they are considered to be sediments that were deposited in the period of Younger Dryas.

A slow rise of sea level in the early Holocene was reported by Matsushima (1987) and Endo et al. (1989) in the Kanto plain, eastern Japan. The period of slow transgression continued until approximately 8,500-8,300 yr BP. After that period, the sea level rose rapidly and reached a high stand in the middle Holocene around 7,000-6,000 yr BP. In many places, the sea level during that period is reported to have been 2-3 m higher than present level (Ota et al. 1982, 1990).

Minor fluctuations and temporal sea-level falls after the middle Holocene are reported on the Okhotsk coast (Maeda 1984, Sakaguchi et al. 1985, Hirai 1987), the Inland Sea coast (Naruse et al. 1984), the Chita Peninsula (Maeda et al. 1983), etc. In many places, minor sea-level falls are recognized around 4.500 and 3,000-2,000 yrs BP, and they are called middle Jomon small regression (Ota et al. 1982) and Yayoi regression (Ariake Bay Research Group 1965), respectively.

III. Evolution of deltas and river-dominated riverine coastal plains in Japan.

Many studies on the sedimentary environments and landform evolution of riverine coastal plains have been done based on the examination of drilling logs and detailed fossil analysis of sediments. Detailed study on the basal topography of the Holocene and latest Pleistocene sediments in the Kanto plain was conducted by Endo et al. (1988). They also discussed the mode of deposition of the sediments including the courses of paleochannels in the plain.

Studies on the landform evolution and sediments of the riverine coastal plains of the Kanto plain

during the Holocene were done by Endo et al. (1982, 1987, 1989), Ando (1986, 1988), Ando et al. (1987, 1990), Matsushima (1987), Kosugi (1989), etc. Most of the studies involved reconstruction of the Holocene depositional environments of the riverine coastal plains, and determining the extent of marine transgression through diatom analysis. These studies clarified more detailed landform evolution and environmental change in comparison to previous studies. Based on diatom analysis (Kosugi 1985, 1986, 1988), Kosugi (1989) clarified the evolution of the Oku-Tokyo Bay which expanded to the north of the Tokyo lowland during the postglacial transgression. Evolution of the region was classified into three stages: (1) transgressive stage (10,000-6,500 yr BP); (2) maximum transgression (6,500-5,300 yr BP); and (3) regressional stage (5,300 yr BP-present). He also presented the Holocene relative sea-level curve and paleogeographical maps of the region at 9,500, 5,500 and 4,500 yr BP. Based on diatom and pollen analyses , Endo et al. (1987, 1989) discussed the landform evolution and vegetational change in a riverine coastal plain, and they pointed out that these physical environmental changes did not all occur independently of each other, but in part due to mutual interaction.

Further studies on the evolution of landforms and the deposition process of the Holocene sediments in riverine coastal plains with references to the postglacial transgression have been carried out in several riverine coastal plains. A study on the depositional sequence of the Nobi plain was done by Umitsu (1990). He classified the Holocene sedimentary sequence into the following stages: slow transgressive stage (10,000-8,500 yr BP); rapid transgressive stage (8,500-6,500 yr BP); aggradational stage (6,500-5,500 yr BP); and progradational stage (5,500 yr BP-present) which includes minor regressional stages during the periods of 5,000-4,500 yr BP and 3,000-2,000 yr BP (Fig. 2). Umitsu (1997) also discussed the regional differences of the sedimentary environment of delta front in the period around the Holocene / Pleistocene boundary (Fig. 3).

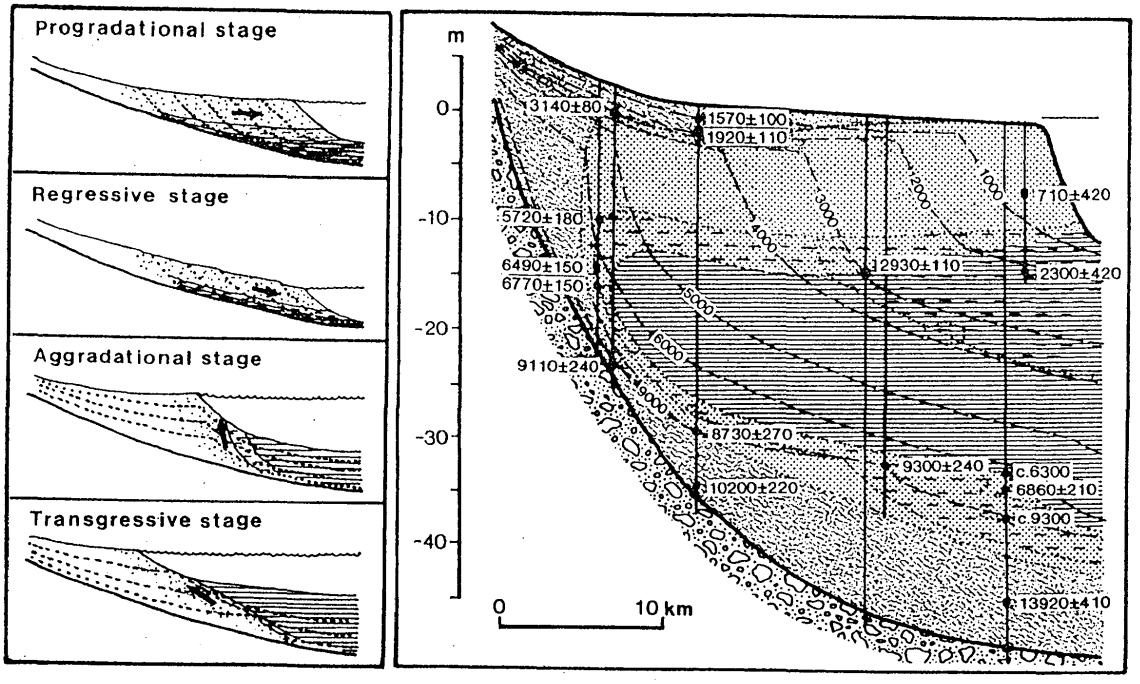

Fig. 2 Schematic diagram of an idearizes stratigraphy of the Kiso river delta. (Umitsu,1992)

Studies on small estuarine coastal lowlands were also done by Ota et al. (1985, 1986), Matsubara et al. (1986), Fujimoto (1990, 1993) , and Sawa et al. (1994) based on the analysis of molluscs and/or microfossils. They clarified the sedimentary environments, paleogeography, and sea-level changes of the region in the middle and late Holocene.

Ohira et al. (1994, 1996) discussed the evolution of peatland in small estuarine plains located along the shores of Lake Furen, northern Japan. They concluded that the formation and evolution of peatland is closely related to middle and late Holocene sea-level fluctuations.

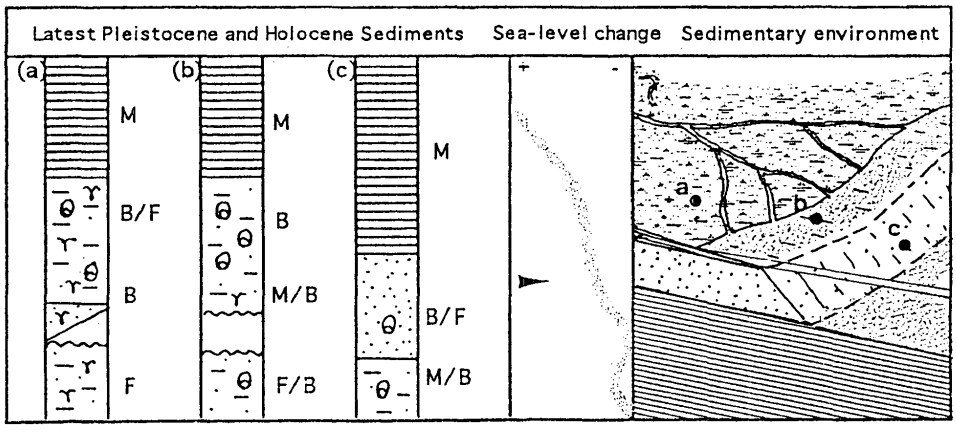

Fig. 3 Sediments and sedimentary environment of the Kiso river delta in the Pleistocene and Holocene boundary . (Umitsu, 1997)

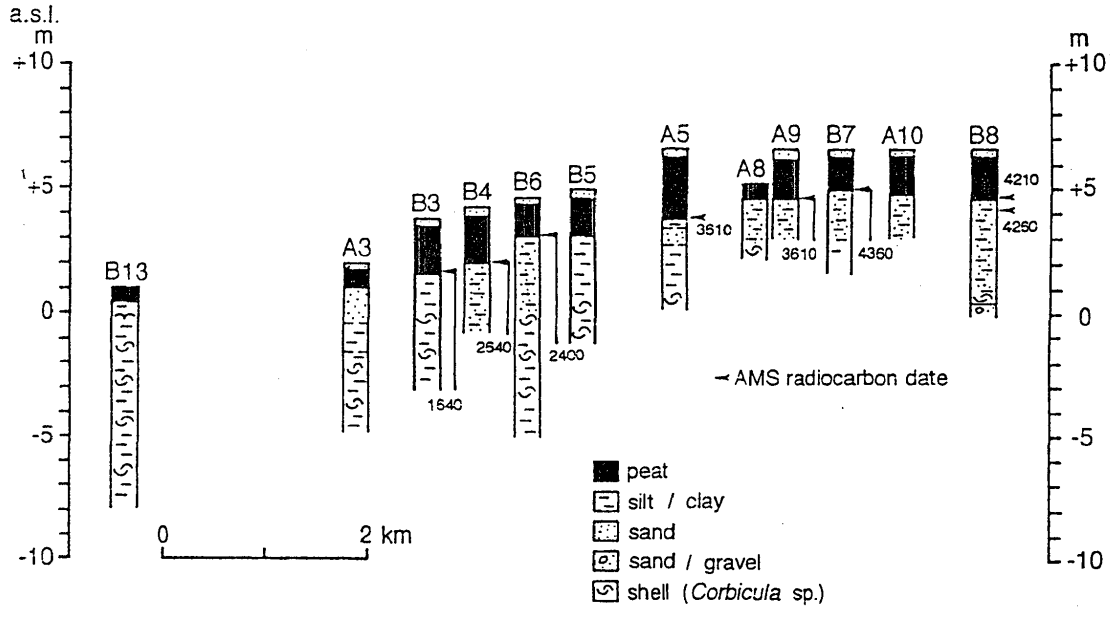

Fig. 4 Geological section of the surface sediments in the Koetoi river lowland, Northern Hokkaido. (Ohira and Umitsu, 1996)