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Depositional facies and sequence of the latest Pleistocene to Holocene incised valley fill in Kushiro Plain, Hokkaido, northern Japan

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ABSTRACT

The development of the latest Pleistocene to Holocene incised valley fill in the Kushiro area, Hokkaido, Japan is investigated in this study. Nine boring core samples drilled in the Kushiro marsh were examined using depositional facies analysis, total sulfur content (TSC) measurement, and radiocarbon dating methods. Based on these methods, 12 depositional facies were recognized including marsh, subaqueous talus, bay-head delta, sand dune, beach, shoreface, barrier sand body, drowned valley-central basin, salt marsh, fluvial, pond, and pyroclastic deposits. The incised valley fill forms a depositional sequence primarily controlled by glacio-eustatic sea-level changes. The lowstand systems tract is composed of river deposits. The transgressive systems tract includes salt marsh, drowned-valley fill central basin, bay-head delta, barrier sand body, central basin, and subaqueous talus deposits. The highstand systems tract is composed of barrier sand body, shoreface, beach, sand dune, central basin bay-head delta, marsh, salt marsh, subaqueous talus, fluvial, and pond facies. Radiocarbon dating analysis indicates that the period of maximum marine flooding was around 7 ka cal. BP.

1. Introduction

The Kushiro marsh (Fig. 1) was the first location in Japan to be registered as a Ramsar site (as per the provisions of the Convention on Wetlands of International Importance especially as Waterfowl Habitat) in 1980. This marsh, located in eastern Hokkaido prefecture, northern Japan, contains river water and cultivated surface water from precipitation. In addition, spring water supplied continually from groundwater throughout the year is considered to be crucial for preservation of the Kushiro marsh ecosystem. Although the average air temperature in the Kushiro region during the winter season is less than 0 °C, the spring water supplied from groundwater with a temperature of approximately 6–8 °C never freeze in the area near spring. However, the sedimentological and geological characteristics of the spring water aquifer in the Kushiro marsh have not been completely understood thus far. Therefore, analysis of such characteristics is needed to enable management of the spring water for conservation of the wetland ecosystem.

Previous research related to the development of incised valley fill in the Kushiro area has indicated that the fill is composed of four parts, including lower gravel, middle mud, upper sand and gravel, and uppermost peat members, with the maximum thickness of the fill being 81 m (Okazaki, 1960a, 1960b, 1960c; Okazaki et al., 1966). Okazaki et al. (1966) also pointed out that the lower gravel member is composed of fluvial deposits from the last glacial maximum period. In addition, they reported that the middle mud member is composed of post-transgression bay floor deposits from the paleo-Kushiro Bay. The upper sand and gravel member is only well developed in the southern coastal area. Okazaki et al. (1966) conclude that the southern and central areas respectively became

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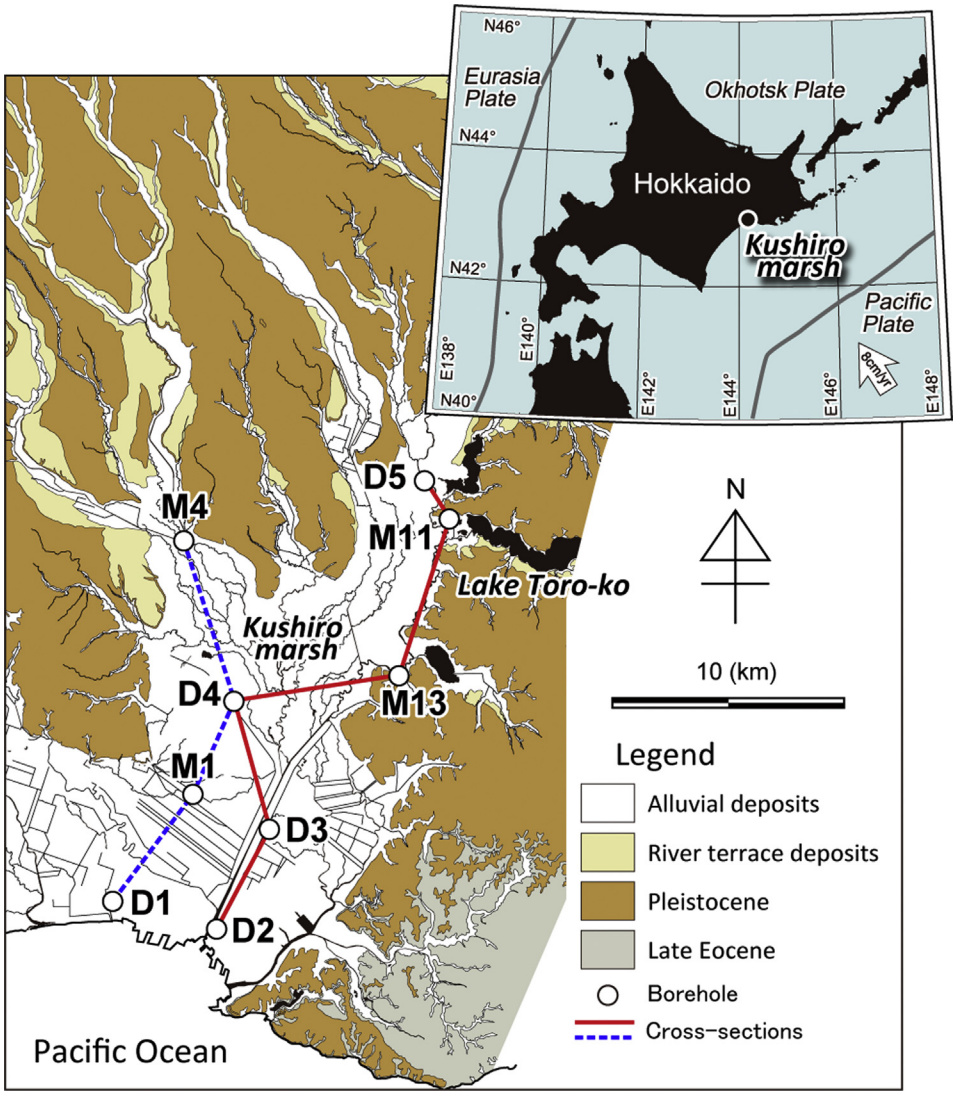

Fig. 1. Index and geological map of study area in northern Japan; white circles indicate the locations, and solid and dashed lines represent cross-sections.

submerged coastal bars and a lagoon due to the end of transgression or regression around 10,000 years ago. The southern area subsequently emerged and changed to a sand dune environment, and the central to northern areas became the Kushiro marsh environment.

In the present study, nine boring core samples drilled in the Kushiro marsh were examined using depositional facies analysis, total sulfur content (TSC) measurement, and radiocarbon dating. The purpose of this study is to clarify the development of the latest Pleistocene to Holocene incised valley fill in the Kushiro area.

2. Regional setting

The Kushiro area, consisting of the Kushiro marsh to the north and 12 beach ridges to the south, is surrounded by hills comprising the Pleistocene Kushiro Group, Paleogene Onbetsu and Urahoro Groups, and Cretaceous Nemuro Group. The Kushiro marsh, Japan's largest natural marsh, has a length of 30 km from north to south, a width of 10 km from east to west, and a total area of 20,000 ha. The surface of the marsh consists of peats several meters thick and dips gently to the south. The Kushiro River meanders through the eastern part of the Kushiro marsh, integrating some minor rivers from the surrounding hills.

3. Material and methods

3.1. Total sulfur measurement

TSC (%) was measured using the EMIA-120 sulfur analyzer of Horiba Co., Ltd., to determine whether paleoenvironments are marine or non-marine. Generally, sediments from non-marine environments have values of less than 0.3%, whereas values of marine materials are generally greater than 0.3% (Keith and Degens, 1959; Berner, 1970; Koma, 1992). A total of 558 muddy sediment samples were measured in this study, at depth intervals of approximately 33 cm.

3.2. Depositional facies

After core scraping in the laboratory, the sediments were visually logged for color, sedimentary texture properties, and