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Difference in timing of maximum flooding in two adjacent lowlands in the Tokyo area caused by the difference in sediment supply rate

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A B S T R A C T

The Arakawa incised-valley fill beneath the Tokyo area, Japan, has formed by delta progradation during Holocene transgression and highstand. This paper presents the integrated stratigraphy of this valley fill as deduced from three continuous sediment cores with rich radiocarbon age control and abundant data from the surrounding, and compares the filling history with the adjacent Nakagawa valley.

Six depositional units make up the valley fill, distinguished based on sedimentary facies. In a sequence-stratigraphic framework, these units span from lowstand fluvial deposits (latest Pleistocene) through retrogradational to transgressive marine deposits (early and middle Holocene), to highstand fluvio-deltaic deposits (middle and late Holocene). The isochron and stacking pattern of sedimentary facies indicate that around 8 cal ka BP the shoreline trajectory flipped from landwards to seawards and maximum flooding occurred in the Arakawa valley. This is considerably earlier than in the neighboring Nakagawa valley, where this happened between 7 and 6 cal ka BP. Differences in the sediment supply at the time of transgression explain the diachronicity. The findings identify the Tone River, which was at that time feeding the Arakawa valley, as a system of very large sediment supply, compared to average rivers worldwide.

1. Introduction

Latest Pleistocene to Holocene transgression and high-stand incised-valley fills have been studied in many parts of the world for decades. The valleys last deepened erosively during Last Glacial Maximum (LGM, ca. 21 cal ka BP: hereinafter ka), and their basal geometry thus was defined at this time. Subsequently, they were filled with non-marine and marine clastic sediments that accumulated during late glacial and Holocene stages of sea-level rise. Models of valley-fill processes in relation to post-LGM relative sea-level changes have been proposed for many geologic settings, based on coring surveys and radiocarbon dating (e.g., Hori et al., 2002; Tanabe et al., 2006; Boyd et al., 2006; Hijma and Cohen, 2011; Blum et al., 2013; Amorosi et al., 2016). However, relatively few studies have investigated in systems that experienced high rates of sediment supply after the LGM (c.f. Hori et al., 2002; Tanabe et al., 2006; Amorosi et al., 2016).

Here, we focus on sedimentary processes of the post-LGM incised-valley fill beneath the lowlands in the Tokyo area of central Japan (Fig. 1), which in latest Pleistocene to Holocene times received abundant sediment supply from the Tone River, Japan's second largest river. The area of lowlands is 960 km^2 and hinterland catchment area is 12900 km^2. The ratio between these areas (delta plain area/catchment area) serves as a relative measure of sediment supply from hinterland to deltaic lowland since the time of maximum flooding. It approximates 7.4×10^{-2} in the Tone River/Tokyo area case. This is larger than reference large delta systems such as Rhine-Meuse system (1.2×10^{-2}, Hijma and Cohen, 2011), the Nile delta (0.5×10^{-2}, Stanley and Warne, 1993; Orton and Reading, 1993), the Po delta (0.51×10^{-2}, Nelson, 1970; Stefani and Vincenzi, 2005), and comparable to Asian deltas well-known for high-sedimentation rate (and monsoon and typhoon runoff regimes), including Mekong delta (11.7×10^{-2}, Tamura et al., 2009; Orton and Reading, 1993), the Ganges-Brahmaputra system

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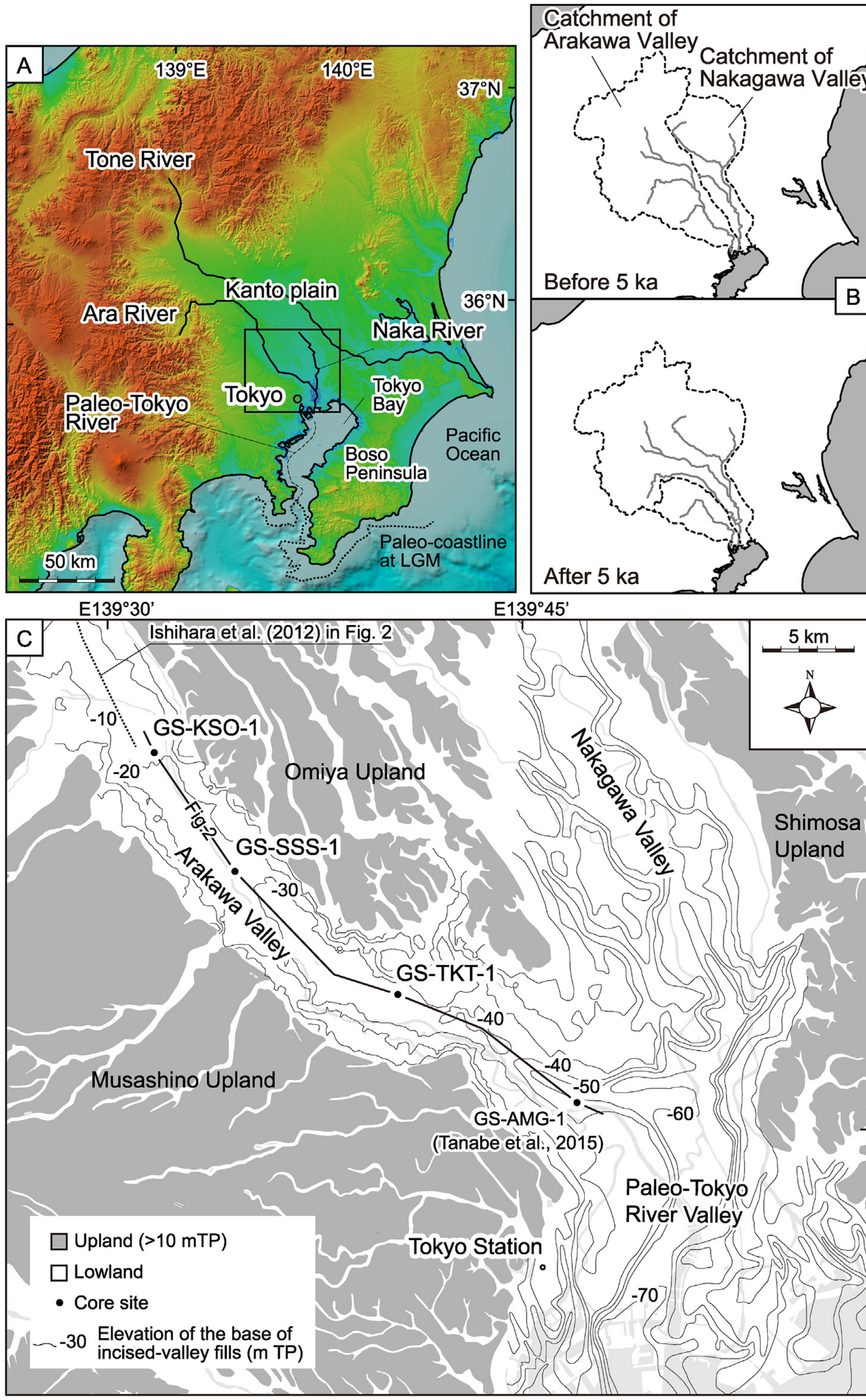

Fig. 1. Location map of study area. (A) Location of Kanto Plain and major rivers. Geographical map from GSI Maps of the Geospatial Information Authority of Japan. Paleo-coastline at LGM is based on −120 m contour line of bathymetrical map (Japan Coast Guard, 1971a, 1971b, 1983, 2000) and the axis of paleovalley is from Kaizuka et al. (1977). (B) Catchment areas of two incised valleys. (C) Map showing the core locations and the topography of the incised paleovalleys during MIS 2 (after Ishihara et al., 2012; Komatsubara, 2014; Tanabe et al., 2015). The valley names are adapted from Tanabe et al. (2015).

(6.6×10^{-2}, Orton and Reading, 1993) and Song Hong delta (6.1×10^{-2}, Tanabe et al., 2003).

Tanabe et al. (2015) reconstructed the sedimentary processes associated with the post-LGM marine and nonmarine deposits in the Nakagawa and paleo-Tokyo River valleys and the lowermost part of the Arakawa valley (Fig. 1C). They provided a sequence stratigraphic scheme for the fill and developed a sedimentary model of basin infilling related to changes in the sediment supply, rate of sea-level rise and development of bay current system. Ishihara et al. (2012), investigated Holocene paleoenvironmental

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