Geomorphic development of the Takaragi terrace since the Last Interglacial Period in the North Central Part of Kanto Plain, Japan

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1.Introduction
Takaragi terrace is located in the northern part of the Kanto Plain, where Late Quaternary tectonic movements are relatively inactive (Kaizuka 1987; Suzuki and Koike 2000). There have been few studies of landform development in this region. And the terrain boundary between Takaragi terrace and Sashima terrace that ranging to the south has not been clarified in detail.The purpose of this study is to clarify the landform evolution in the Takaragi-Sashima terraces after MIS5e by the terrain analysis using GIS and analysis of borehole core sediment.

2. Methods
Slope gradation map, hillshade map, Rainbow Contour map (Suginaka et al. 2018), and valley density map were made from 5m and 10m DEM using by ArcGIS10.6. Based on these maps and aerial photography interpretation the Takaragi-Sashima terraces and incised valleys were recognized.The following analyses were performed on four drilling core samples collected from the Takaragi Terrace: facies analysis using by Surface Peel Specimens, grain analysis and measurement of magnetic susceptibility. Based on these results, borehole cores were divided into several sedimentary units Tephra layers collected from the borehole cores were compared with key marker tephras distributed in Kinu River Lowland by analyzing the mineral components, sedimentary Units, shape and chemical composition of the volcanic glass.

3.Results and Discussion
As a result of aerial photography interpretation and DEM analysis, distribution of Takaragi-Sashima terrace and the incised valleys were confirmed from Utsunomiya to Toride. The flow direction of incised valleys on the Takaragi terrace surface has a tendency to change from north-south to northwest-southeast near Koga city. And the valley density becomes higher on the downstream side of Koga city.
Borehole core sediments were divided into five sedimentary units(U1:aeolian sediments with volcanic ash, U2: mudflow sediments, U3:braided river sediments, U4:meandering river sediments, U5:delta front sediments). And the thickness of meandering river sediments(U4) reaches 15~20m, and piles up riverbed sediments, natural levee sediments, back marsh sediments and interbeds many pumice layers.On the other hand, braided river sediments(U3) cannot be confirmed in NG1.
AT(30ka:Machida,Arai2003)and Ag-KP(44ka)were identified in aeolian sediments (unit 1), and Ag-MzP1(60ka)in fluvial deposits of unit 3.
These results suggest following geomorphic development: sea area (Paleo-Tokyo Bay) expanded to at least near the Oyama city at the Marine Oxygen Isotope Stage (MIS) 5e. After that, marine regression has started (U5), and on the delta plane, flooding of the Paleo-Kinu River was repeated, meandering river zone has formed (U4). During the last glacial period, the Paleo-kinu River transported gravels and formed an alluvial fan (U3). The alluvial fan expanded to the south, but when the fan toe reached between GC-OY1 and GC-NG1, it turned to an erosion trend, and terrace was affected by intermittent overflows.
After that, the southern part of the Takaragi terrace (from Oyama to Nogi), it is considered that the Takaragi terrace formed (U2) during the fall age of Ag-KP(44ka)(U1).
In addition, terrain analysis and distribution of tephra suggest that the boundary of the Takaragi and Sashima terraces could be set near Koga and Shimotsuma city.

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