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Human responses to climate change on obsidian source exploitation during the Upper Paleolithic in the Central Highlands, central Japan

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ABSTRACT

Upper Paleolithic hunter-gatherers intensively exploited obsidian sources 1200–2000 m a.s.l. in the Central Highlands, central Japan. Previous studies have suggested that the last glacial maximum (LGM) decreased human obsidian procurement in the source area because of its high altitude. However, the relationship between the impacts of the LGM and human responses in the source area based on convincing evidence from the paleoclimate, obsidian provenance data, and archaeology remains poorly understood. This study examines the correlations among pollen record datasets during the past 30,000 years from the Central Highlands 1400 m a.s.l.; more than 85,000 pieces of obsidian provenance data for the Chubu-Kanto region; and chronological sequences of Upper Paleolithic industries in the Central Highlands. Through synthetic analysis, we reconstruct historical changes in the human–environment interaction in the Central Highlands during the Upper Paleolithic. Our combined data shows the early LGM constraining the procurement activity at the sources; an increase in active human responses to the LGM cold phase; and changes in the land use of the source area in the terminal LGM triggered by the appearance of new lithic technology and the reorganization of mobility ranges. We find that human adaptations to the LGM conditions related to the natural resource exploitation around a latitude of 36°N were complex.

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1. Introduction

Reconstructing the impact of the last glacial climate on interactions of prehistoric hunter-gatherers with the natural resource environment provides important clues to understanding the diversity of human society during the Late Pleistocene (Birks et al., 2015). This study focuses on obsidian source exploitation for stone tool production to examine relationships between local climate fluctuations and human responses during the Upper Paleolithic (UP) in central Japan.

The study of obsidian artifacts in the Japanese archipelago, in which archaeology and elemental analyses for provenancing obsidian artifacts are closely connected, has played a significant role in reconstructing resource procurement strategies and exchange networks among prehistoric hunter-gatherer societies (for recent works in English, see Izuho and Hirose, 2010; Obata et al., 2010; Tsutsumi, 2010; Izuho et al., 2014; Sato and Yakushige,

2014; Shiba, 2014; Shimada, 2014; Kimura and Girya, 2016). Since the early 1970s, obsidian provenance analysis has accumulated more than 100,000 pieces of provenance data from the UP industries in the Chubu-Kanto region, central Japan (Fig. 1A). The data reveal that the UP hunter-gatherers exploited obsidian sources scattered in the Central Highlands with the highest frequency compared with the other source areas of Takahara, Hakone, Amagi, and Kozu-Onbase Island (Figs. 1A and 3f) (Shimada, 2015).

The highest frequency of obsidian use in the Central Highlands resulted in a dense concentration of sites closely related to obsidian procurement activities in the area during the UP (38,000–16,000 cal BP) (Fig. 1B). The sources in the Central Highlands are today located in a cool-temperate broad-leaved deciduous forest. Because the sources are distributed across 1200–2000 m a.s.l. (Fig. 1B), the last glacial landscapes in and around the sources seem to have affected human activities related to obsidian procurement for around 22,000 years during the UP.

Previous works argued that the cold, dry conditions during the last glacial maximum (LGM) might have heavily constrained

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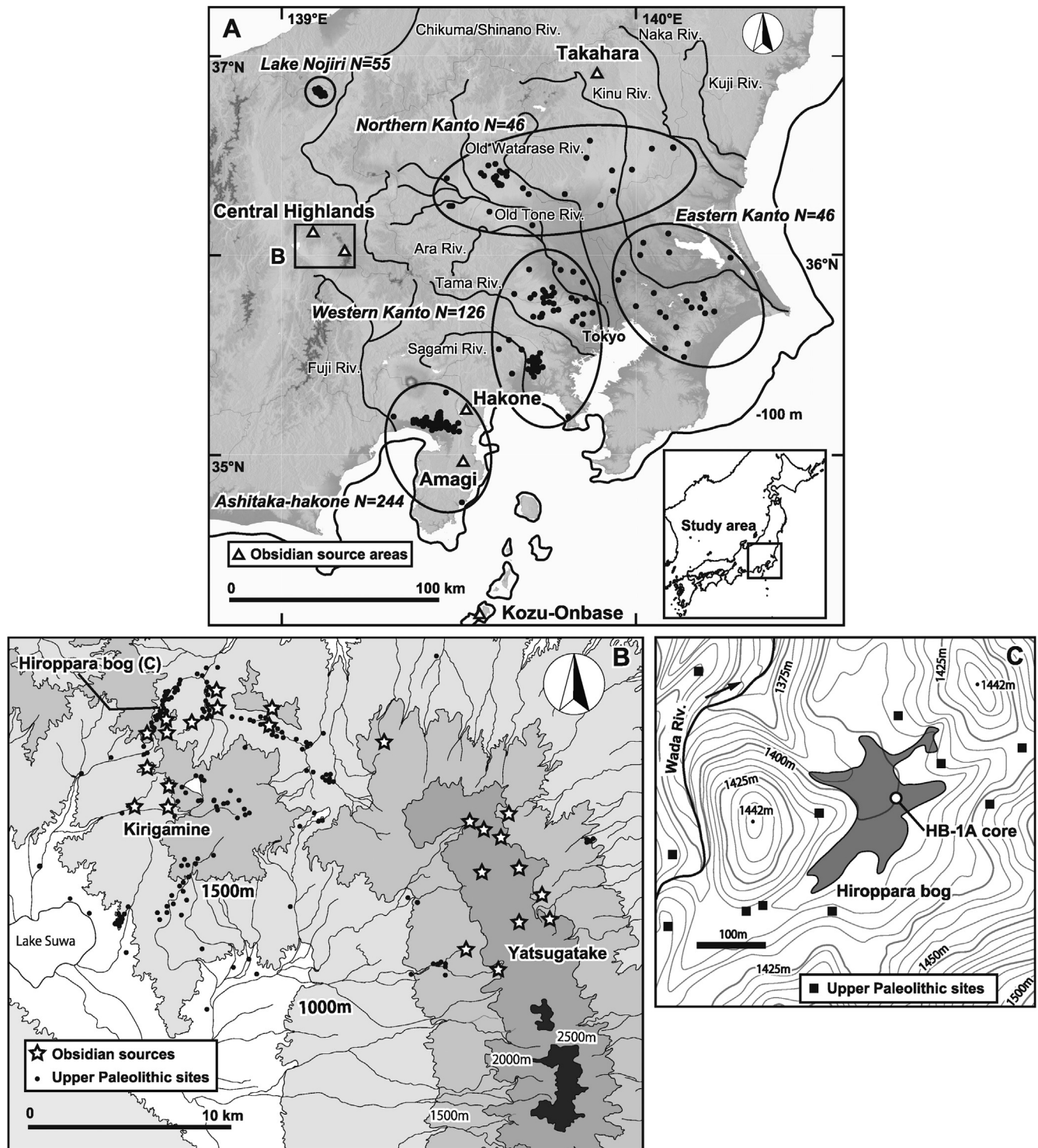


Fig. 1. Study area: (A) UP settlement areas in the Chubu-Kanto region and sites from which obsidian provenance data used in this study were obtained ($N = 517$ lithic industries), modified from Shimada (2015); (B) location of obsidian sources and the Hiroppara bog in the Central Highlands and the distribution of UP sites; and (C) the Hiroppara bog from which the pollen record for the past 30,000 years used in this study was obtained.

obsidian procurement in the Central Highlands because the use of obsidian derived from the Central Highlands in the western Kanto area (Fig. 1A) shows a large decrease in the early marine isotope stage 2 (MIS2) after ca. 30,000 cal BP (Sato, 1996; Tsutsumi, 2000, 2002, 2003; Suwama, 2002). Previous discussions, however, lacked the following: provenance data indicating the precise changes in obsidian use over the entire Chubu-Kanto region;

convincing climate records including the LGM conditions obtained from the Central Highlands; and archaeological records from the Central Highlands relevant to the human responses to the changes in the landscape. Accordingly, current understanding of the impact of the last glacial climate changes on human obsidian procurement activity still lacks this combination of supporting evidence.

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