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Chemical discrimination of obsidian sources in the Kirigamine area and provenance analysis of obsidian artifacts from the Hiroppara prehistoric sites I and II, central Japan

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ABSTRACT

Chemical discrimination of obsidian sources and chemical classification of obsidian artifacts is an essential tool for studying the provenance of obsidian artifacts. The Hiroppara prehistoric sites (I and II) are associated with a cluster of obsidian sources within the Kirigamine area (Nagano Prefecture), central Japan. More than 1000 obsidian artifacts were recovered during excavations in 2011–2013. Here, we conduct a provenance analysis for these obsidian artifacts using Wavelength and Energy Dispersive X-ray Fluorescence (WDXRF and EDXRF, respectively). Quantitative, destructive WDXRF analysis on geological obsidian samples reveals that the Kirigamine obsidian sources can be classified into 12 geochemical groups. Qualitative EDXRF analysis of these geological obsidians samples can also discriminate these 12 chemical groups. To test the reliability of the EDXRF approach, which is non-destructive and rapid, for provenancing obsidian artifacts, we selected 40 obsidian artifacts and compared EDXRF and WDXRF measurements. The results obtained by WDXRF method achieved a success rate of 93% (37 samples) compared to 65% (26 samples) by the EDXRF method. The EDXRF results from four samples are inconsistent with the results from the WDXRF data. While the non-destructive EDXRF method is straightforward and convenient it is evidently less reliable than the destructive WDXRF method. With these results in mind, we performed provenance analysis for all obsidian artifacts (689 samples) from Hiroppara site I using the EDXRF method, and successfully classified 60% of the analyzed artifacts (411 samples). The majority of these samples (352 samples) identify with the Higashimochiya and Takayama sources. Additional information about morphological features, including texture, shape, color, and transparency of samples, can improve the discrimination that is possible by chemical analysis alone.

1. Introduction

Geoarchaeological and archaeological studies have suggested that the obsidian in the Kirigamine area (Nagano Prefecture, central Japan) was widely exported as high-quality lithic raw material to the Kanto and Hokuriku regions (e.g., Tsutsumi, 2010; Ikeya, 2014, 2015). In addition, prehistoric hunter-gatherers who occupied the Kanto Region used obsidian from other sources, such as Kozu Island (Kozushima), Mount (Mt.) Takahara, and Amagi (Fig. 1a). Several investigations of obsidian procurement and consumption have focused on the correlations between changes in human activity in the Kirigamine area at the elevation of around 1400 m above sea level (a.s.l.) and paleoclimatic fluctuations during the last glaciation and the early Holocene (e.g., Shimada, 2014, 2015; Shimada et al., 2017; Yoshida et al., 2016). Accordingly, reliable obsidian provenance data for prehistoric sites in the Kirigamine area are essential for understanding human activity and adaptations to paleoenvironmental changes in this area.

Archaeological studies were conducted at Hiroppara sites I and II in the vicinity of the Hiroppara bog in 2011, 2012, and 2013 (Ono et al., 2016, Fig. 1b). Shimada et al. (2016) reported more than 1000 obsidian artifacts recovered from these sites, dated to the Upper Paleolithic and Jomon periods, and consisting mainly of

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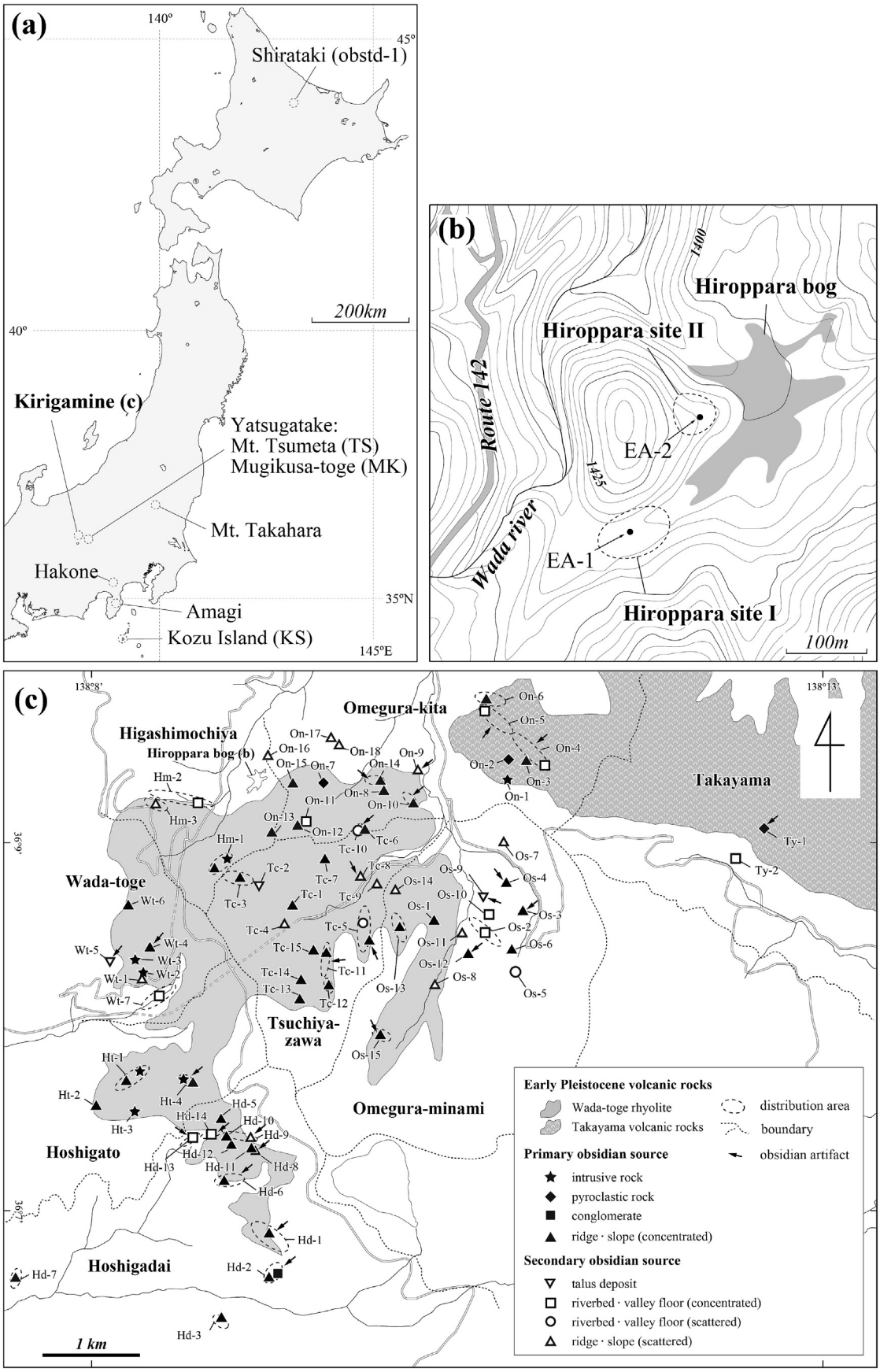

Fig. 1. (a) Localities of major obsidian sources in eastern and central Japan. (b) Distribution of Hiroppara prehistoric sites I and II, and trench locations (EA-1 and EA-2) near the Hiroppara bog. (c) Map showing the distribution of obsidian sources in the Kirigamine area. Modified after Oyokawa et al. (2016: 29).

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