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# Unexpected uses for obsidian: experimental replication and use-wear/residue analyses of chopping tools

Nina Kononenko [a, b, 1], Robin Torrence [a, b, 2], Peter White [b, *]

[a] Geosciences and Archaeology, Australian Museum, 6 College Street, Sydney, NSW 2010, Australia
[b] Department of Archaeology, SOPHI, University of Sydney A14, NSW 2006, Australia

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ABSTRACT

Large flaked stemmed artefacts with a morphological resemblance to axes or adzes have been recovered from stone quarries in West New Britain, Papua New Guinea, but they are made from obsidian, a volcanic glass generally considered too brittle for tasks demanding tough, long-lasting edges, such as chopping wood. To evaluate the potential of obsidian for percussive woodworking, 11 replica obsidian tools were used as axes and adzes. Although breakage was common and the tools suffered extensive edge damage, they were surprisingly effective as chopping tools. The patterns of use-wear and residue traces on the experimental tools informed the analysis of 27 archaeological artefacts which were found to have been used as axes or adzes with the addition of sawing in a few cases. As these tools have not been found outside the quarries, their occurrence suggests that during this period some forms of woodworking took place only where there was an abundant supply of raw material. The limited spatial distribution of obsidian chopping tools raises questions about the nature of forest clearance and woodworking in this tropical environment.



## 1. Introduction

Percussive cutting tools are used with a swinging force that strikes a blow with the cutting edge (e.g., Crosby, 1977:83). In most cases a handle extends the tool's length and weight and acts as a lever allowing the user to apply additional force and increase the impact of the cutting edge (Kamminga, 1982:21). As in most parts of the world, in Papua New Guinea wood chopping tools were normally made from a tough raw material, e.g., volcanic or metamorphic stone, and were ground to provide a thick, sturdy cutting edge. Ground edge tools are well provenanced in the Highlands of mainland New Guinea at the start of the Holocene and may date to the terminal Pleistocene on Manus (Golson, 2005: 467–9, 475–7, 484). In New Britain (Fig. 1), however, they have not been found in archaeological contexts dated before c. 3200 BP (Torrence and Doelman, 2007; Specht, 2009:16; Torrence, unpublished field notes; Specht, pers. comm.).

A majority of the ground stone implements date within the past 500 years and resemble those observed in use by early European travelers to the region (e.g., Parkinson, 1999; Specht, 2005a). The scarcity of clearly recognizable chopping tools potentially useful for clearing the tropical forest during the earlier period of settlement (beginning 40,000 BP) presents a problem for understanding land use patterns in this region, where shifting agriculture is the most likely form of subsistence. In addition, it seems logical that chopping tools would have been required for building the water craft that transported obsidian to neighbouring islands beginning c. 20,000 BP (e.g., Summerhayes, 2009).

Until recently, we had assumed that obsidian was not used for percussive cutting because of the likelihood that it would shatter if applied with force to a hard substance (cf. Mewhinney, 1957:25; Greiser and Sheets, 1979:296). However, given recent findings from use-wear studies that obsidian tools from Easter Island were used for woodworking (e.g., Church and Rigney, 1994; Church and Ellis, 1996), we revisited our assemblages and took a more sceptical approach to a class of large obsidian tools with retouched tangs, known locally as 'stemmed tools,' that date to c. 10,000–3200 BP (e.g., Araho et al., 2002; Torrence, 2004; Specht, 2005b). The New Britain artefacts are larger than the Easter Island tools, but both have distinctive tangs or stems and are made on kombewa flakes

* Corresponding author. Tel.: +61 2 9319 1030.
*E-mail addresses:* nina.kononenko@austmus.gov.au (N. Kononenko), robin.torrence@austmus.gov.au (R. Torrence), peter.white@sydney.edu.au (P. White).
[1] Tel.: +61 2 9320 6264.
[2] Tel.: +61 2 9320 6401.

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(i.e., double-bulbed; cf. Owen, 1938) that have relatively thick edges and two smooth faces bearing some resemblance to ground stone axes/adzes (e.g., Bollt et al., 2006; Araho et al., 2002:Figs. 12 and 13). Although it seems clear from their inherent fragility that the majority of the large stemmed tools were not used in utilitarian tasks (cf. Specht, 2005a; Torrence et al., 2013), there is a small group of more robust artifacts found in the vicinity of the obsidian sources of Kutau-Bao, Baki and Mopir in West New Britain (Fig. 1). This study tests the hypothesis that these large, heavy obsidian stemmed tools, previously thought to be practice pieces or rejects from the manufacture of the ceremonial items, represent the chopping implements that would be expected to be necessary on a forested tropical island.

In the first stage of the analysis 11 experiments evaluated the capabilities of hafted obsidian tools for chopping wood and recorded the use-wear/residue properties using both low, reflected and high powered, incident light microscopy (cf. Van Gijn, 2014). The primary aim was to assess the effectiveness of obsidian stemmed tools in the performance of percussive tasks. We recorded use-wear/residue patterns that could help determine if the ancient obsidian stemmed artefacts had been used in percussive wood-working. In the second part of the study we compared the experimental results with a use-wear/residue analysis of large obsidian retouched tools from various sites in West New Britain (Fig. 1). Surprisingly, the analyses show the tools had been used for chopping and sawing, probably on soft woods. This finding means that the potential role of obsidian tools in tasks involving heavy percussion in other regions should be carefully considered.

## 2. Materials and methods: experimental study

The design of the experiments was informed by preliminary use-wear analyses of the archaeological obsidian stemmed tools together with ethnographic and historic information concerning the use of percussive wood-working tools in Papua New Guinea (e.g., Bulmer, 2005; Coutts, 1977; Crosby, 1977; Golson, 1977, 2005; Parkinson, 1999; Pétrequin and Pétrequin, 1993). Since the mechanical principles of wear formation are consistent if the relevant conditions are comparable (e.g., Rots, 2010:7), the experimental tools were made with obsidian from the same geological sources as the prehistoric tools (Kutau-Bao and Baki in Fig. 1; cf. Torrence et al., 1992) and were applied to species of wood similar to those used by indigenous populations in West New Britain in the relatively recent past (e.g., Floyd, 1954; Parkinson, 1999; Inline Supplementary Table S1).

Inline Supplementary Table S1 can be found online at http://dx.doi.org/10.1016/j.jas.2014.11.010.

The replica stemmed axes and adzes were knapped by Kononenko using hard hammer percussion. Following the production of a large kombewa flake, stems were created using bifacial or unifacial retouch. The manufacture of each stemmed tool took from 1.5 to 3 h but experienced and skilled prehistoric knappers probably required much less time. With one exception (2013/8), the working edges of the experimental tools were not retouched, similarly to the archaeological artefacts. Care was taken to reduce the thickness and curvature of the original flake because the degree of flatness determines the amount of contact between the stem's surface and the haft. Tools with a pronounced longitudinal curvature are more difficult to haft and the stems are at greater risk of fracture during use (Rots, 2010:179).

The variables proposed by Rots (2010:9; Rots et al., 2006:936) are used in Inline Supplementary Table 2 where the hafting arrangements of the experimental tools are recorded. (1) The haft types included a bent handle for hafting axes and adzes (Fig. 2a–e) and a straight handle for hafting axes (Fig. 2f–h). (2) Both direct and indirect methods for placing the stone tool next to the bent handle were used. In direct contact the presence of ridges formed by retouching the stem always creates some space between the

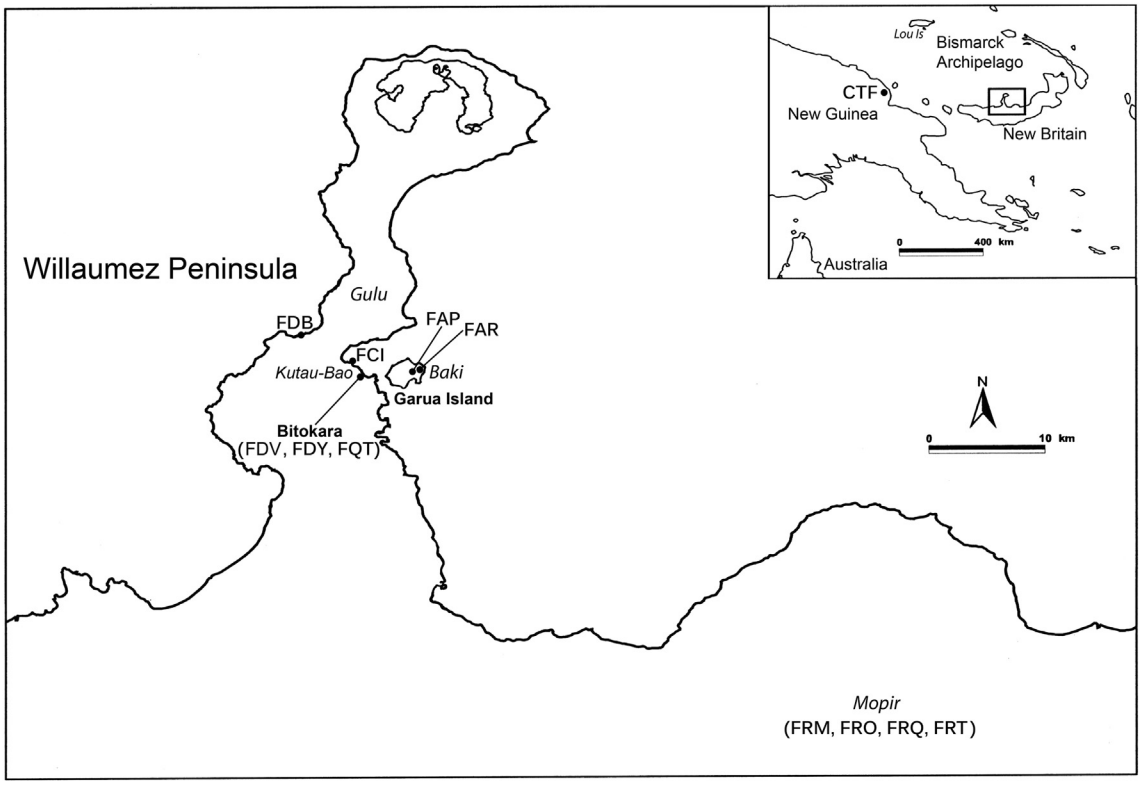


**Fig. 1.** Willaumez Peninsula, New Britain, PNG, with sites and obsidian sources (italic).