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Archaeological implications of a widespread 13th Century tephra marker across the central Indonesian Archipelago

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ABSTRACT

Despite the occurrence of exceptionally large eruptions in the Indonesian Archipelago in recent historic times (i.e. Krakatoa 1883, Tambora 1815), no historic tephra beds have been widely identified in the terrestrial realm that could facilitate the correlation of equivalent aged sequences and/or archaeological remains. This study has identified one such tephra bed of 13th Century age that can be correlated throughout central-east Java and now can be unequivocally correlated with the Samalas 1257 A.D. tephra recently described from Lombok. The occurrence of this historic tephra marker extending ≥650 km west from its eruptive source provides the first opportunity to effect inter-regional correlation over large swathes of central Indonesia. It remains entirely conceivable that in the aftermath of this exceptionally large eruptive event there was considerable westward disruption to subsistence agriculture and trade, food shortages and famine, dislocation of affected populations and socio-political unrest on a scale that equalled or exceeded the catastrophic effects documented from the more recent Tambora 1815 A.D. eruption. Indeed the effects of this mid-13th Century eruption can be registered globally in a variety of records from Antarctica, Europe, Middle East and the Americas. Unfortunately, archaeological evidence indicating such disruption in mid-13th Century Indonesia is yet to be deciphered from the so-far sparse accounts and inscriptions of that time. However, this paucity of evidence does not diminish the utility of this widespread tephra bed as a unique chronostratigraphic marker for archaeological studies across large areas of central Indonesia.

1. Introduction

Globally, there are few examples where exceptionally large-magnitude eruptions have catastrophically impacted upon early historical human populations. The obvious examples are the eruption of Santorini (Thera) that extinguished the Cycladian Maritime culture in the eastern Mediterranean during the late Bronze Age (between *c.* 1662 and *c.* 1599 B.C., Bronk Ramsay et al., 2004), the 79 A.D. eruption of Vesuvius that destroyed the Roman towns of Herculaneum and Pompeii, the Terra Blanca Joven (TBJ) eruption of Volcán Ilopango in El Salvador between 440 and 550 A.D. that may explain an episode in Mayan history known as the Classic Period Hiatus (Dull et al., 2001, 2010) and the closely spaced eruptions of Tambora and Krakatoa in Indonesia whose direct and indirect effects resulted in widespread loss of life in 1815 and 1883 A.D., respectively. In this study we report upon a mid-13th Century eruption whose products are widely distributed across the central Indonesian archipelago, and like the Tambora 1815 A.D. eruption is likely to have had significant and far-reaching effects not only upon those populations residing around the eruptive centre itself but also those living hundreds of kilometers away on adjacent and down-wind islands. At the time of this 13th Century eruption, competing kingdoms flourished over large swathes of the western and central Indonesian archipelago with sophisticated networks of trade and commerce, and constructing elaborate temple complexes often with stone inscriptions and iconography that detailed religious doctrine, deities, rulers and their successors, military

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campaigns, and providing some limited insight into the socio-political conditions of the time. The purpose of this study is first to document the widespread occurrence of this 13th century eruptive event across east-central Java, compare its distribution with that of the Tambora 1815 A.D. eruption and its effects, and then explore the possible connection between this Samalas eruptive event and any archaeological evidence that might elude, either directly or indirectly, to the effects of this earlier widespread eruption.

2. Background

In the mid-1990's a centimeter-thick, yellow-brown coloured, vitric-rich tephra bed of fine ash grade was identified on the flanks of Merapi Volcano (Fig. 1) inter-bedded with locally sourced fall- and flow-units of late Holocene age. It was quickly recognized that this tephra (then informally named Muntilan tephra (Andreastuti, 2000; Andreastuti et al., 1996, 2000)) was not sourced from Merapi Volcano on account of its unique mineralogy, glass geochemistry and consistent fine-textured grain-size characteristics that clearly distinguished it from Merapi-sourced tephra. This same tephra was also identified within equivalent-aged sequences at Bromo, Kelut and Ijen volcanoes in central and eastern Java. Glass shard geochemistry, grain size characteristics and associated radiocarbon dates were obtained and established clear correlation (Andreastuti, 2000; Andreastuti et al., 2000). It became quickly evident that Muntilan tephra represented the product of an eruption from an unknown distal source and most likely, eastward of Java. In 2013, an exceptional large eruption was described (Lavigne et al., 2013) in Lombok that occurred in 1257 A.D. from Rinjani Volcanic Complex (Fig. 1), the dynamics of which were later described (Vidal et al., 2015). The age and glass geochemistry of the proximal Samalas Tephra was strikingly similar to that determined for Muntilan tephra (Andreastuti, 2000; Andreastuti et al., 2000) and it became clear that the inter-regional tephra we described across east-central Java in the 1990's was the same as the proximal event recently described extending westward from Lombok (Lavigne et al., 2013; Vidal et al., 2015) – although the latter publication did tentatively correlate Samalas Tephra with Muntilan tephra on the basis of its similar radiocarbon chronology and trace element composition from a single distal bulk tephra sample (RIN-1401-CW1). Muntilan tephra was recently re-sampled and then geochemically reanalysed at Merapi, Bromo and Ijen Volcanoes. Samples were also collected on, and analysed from, the paroxysmal eruptive phase (P4) exposed on the lower north-western and northern flanks of Rinjani Volcano on the island of Lombok to ensure direct geochemical comparisons being made using the same analytical instruments. These results are presented here. A number of organic samples associated with the inter-regional tephra in Java as well as from proximal Lombok localities were also obtained for comparative radiocarbon dating.

3. Stratigraphy

3.1. Merapi Volcano (~660 km from eruptive source)

At all localities on the flanks of Merapi Volcano (Fig. 1) and irrespective of their elevation with respect to the present-day

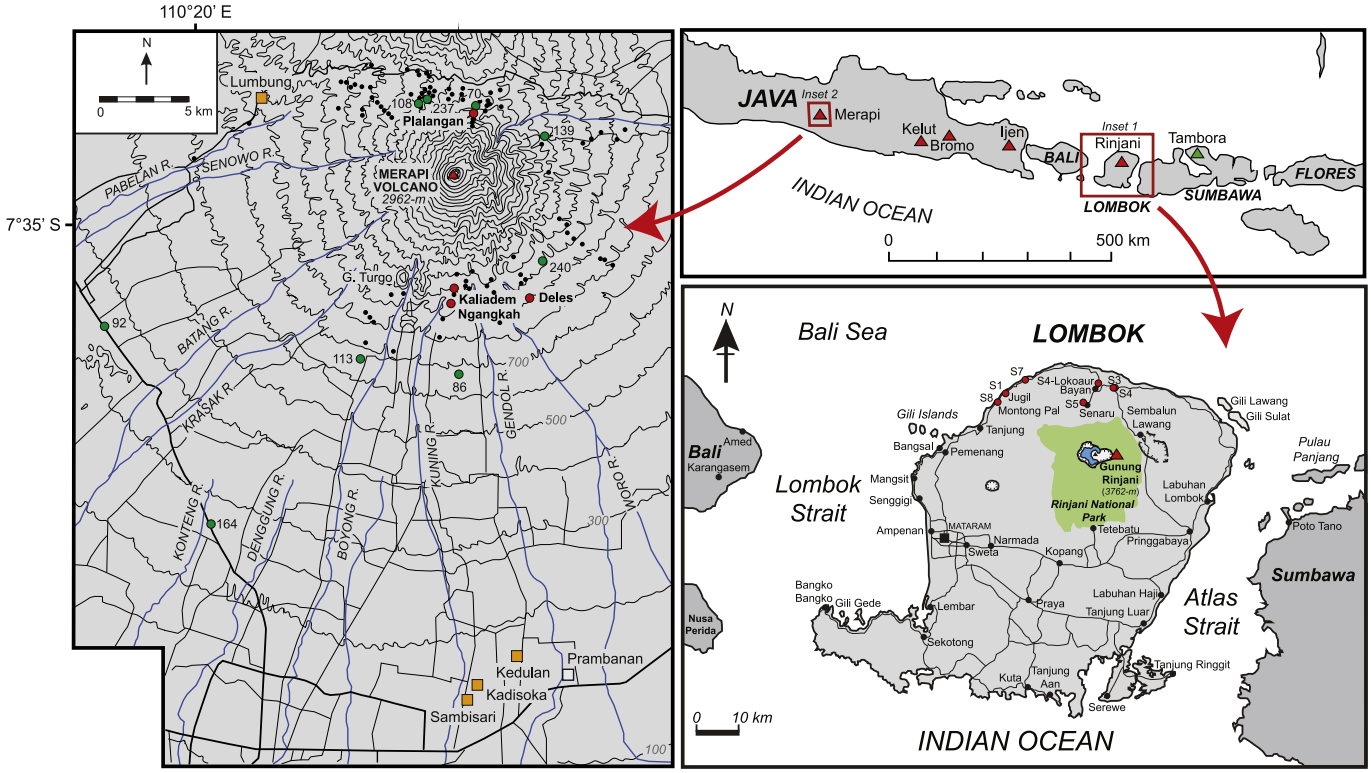

Fig. 1. Map of the central Indonesian Archipelago extending (west to east) from central Java to Flores. The locations of key volcanoes (Tambora, Rinjani, Ijen, Bromo, Kelut and Merapi) referred to in this study are indicated. Two insets are presented. The first is centered on Lombok Island and shows the location of proximal Samalas sample sites that are referred to in this paper. The second is centered at Merapi Volcano in central Java and shows the location of tephra cover-bed descriptive sites (black dots) and those profiles containing Muntilan tephra (green dots) (Andreastuti, 2000; Andreastuti et al., 1996, 2000). Descriptive and sample sites from the more recent continuation of this earlier PhD-related research are indicated as red dots. Archaeological sites and structures that have been inundated and buried by Merapi-sourced volcaniclastic deposits containing Samalas Tephra are also indicated as orange squares. The stratigraphy associated with some of these archaeological sites is presented in Fig. 9. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)