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Cryptotephra from the 74 ka BP Toba super-eruption in the Billa Surgam caves, southern India

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ABSTRACT

The ~74 ka BP Youngest Toba Tuff (YTT), from the largest known Quaternary volcanic eruption, has been found for the first time as a non-visible (*crypto-*) tephra layer within the Billa Surgam caves, southern India. The occurrence of the YTT layer in Charnel House Cave provides the first calendrical age estimate for this much debated Pleistocene faunal sequence and demonstrates the first successful application of cryptotephrochronology within a cave sequence. The YTT layer lies ~50 cm below a major sedimentological change, which is related to global cooling around the MIS 5 to MIS 4 transition. Using this isochronous event layer the Billa Surgam Cave record can be directly correlated with other archaeological sites in peninsular India and palaeoenvironmental archives across southern Asia.

1. Introduction

The Youngest Toba Tuff (YTT) was erupted from Sumatra, Indonesia, around 74 ka BP (Ninkovich et al., 1978). This volcanic eruption is the largest known in the Quaternary, erupting more than 2800 km^3 of magma (Rose and Chesner, 1987) and dispersing visible deposits of ash from sites as far west as the Arabian Sea and reaching east to the South China Sea (Buhring et al., 2000; Oppenheimer, 2002; Schulz et al., 2002). Although the YTT eruption is not believed to have contributed to glaciation (Robock et al., 2009; Timmreck et al., 2010), the eruption took place close to the onset of global cooling associated with the end of marine isotope stage (MIS) 5 and the start of glacial MIS 4, a time when human populations were expanding out of Africa and adapting to new environments. Despite much debate over the direct impact of this super-eruption on human populations and the changing global environments (e.g. Rampino and Self, 1992; Ambrose, 1998; Petraglia et al., 2007; Williams et al., 2009, 2010; Haslam and Petraglia, 2010), the YTT undoubtedly acts as a useful isochronous horizon for the climatic transition from MIS 5 to MIS 4, and facilitates correlation of widespread sites.

Cryptotephra investigations have been used widely across Europe as a means of locating widespread tephra isochrones in sites where they are not preserved as visible horizons (Dugmore et al., 1995; Lowe and Turney, 1997). These methods, which extract volcanic glass shards from their host sediment, have allowed known tephra fallout areas of volcanic eruptions to be greatly extended, facilitating chronostratigraphic correlations of widespread palaeoenvironmental records (e.g. Wastegård et al., 2000; Turney et al., 2004; Margari et al., 2007; Lane et al., in press). As well as tracing tephra deposits into ever more distal sites, cryptotephra investigations are also capable of locating tephra layers within sedimentary contexts where they are less concentrated and therefore do not form visible horizons. The method is therefore well suited to the study of Palaeolithic cave sediments within known tephra fallout areas, however, to date no such successful study has been published.

Here, we present the results of a cryptotephra investigation in one of the Billa Surgam caves, southern India (Fig. 1). This is the first example of a successful cryptotephra investigation within an archaeological cave record, and also within South Asia, and it demonstrates the potential extension of this dating method both across wider geographical areas and into non-open-air sedimentary deposits.

2. The Billa Surgam caves

The Billa Surgam caves (N 15° 26.126′; E 78° 11.131′) of Andhra Pradesh have been investigated by archaeologists and

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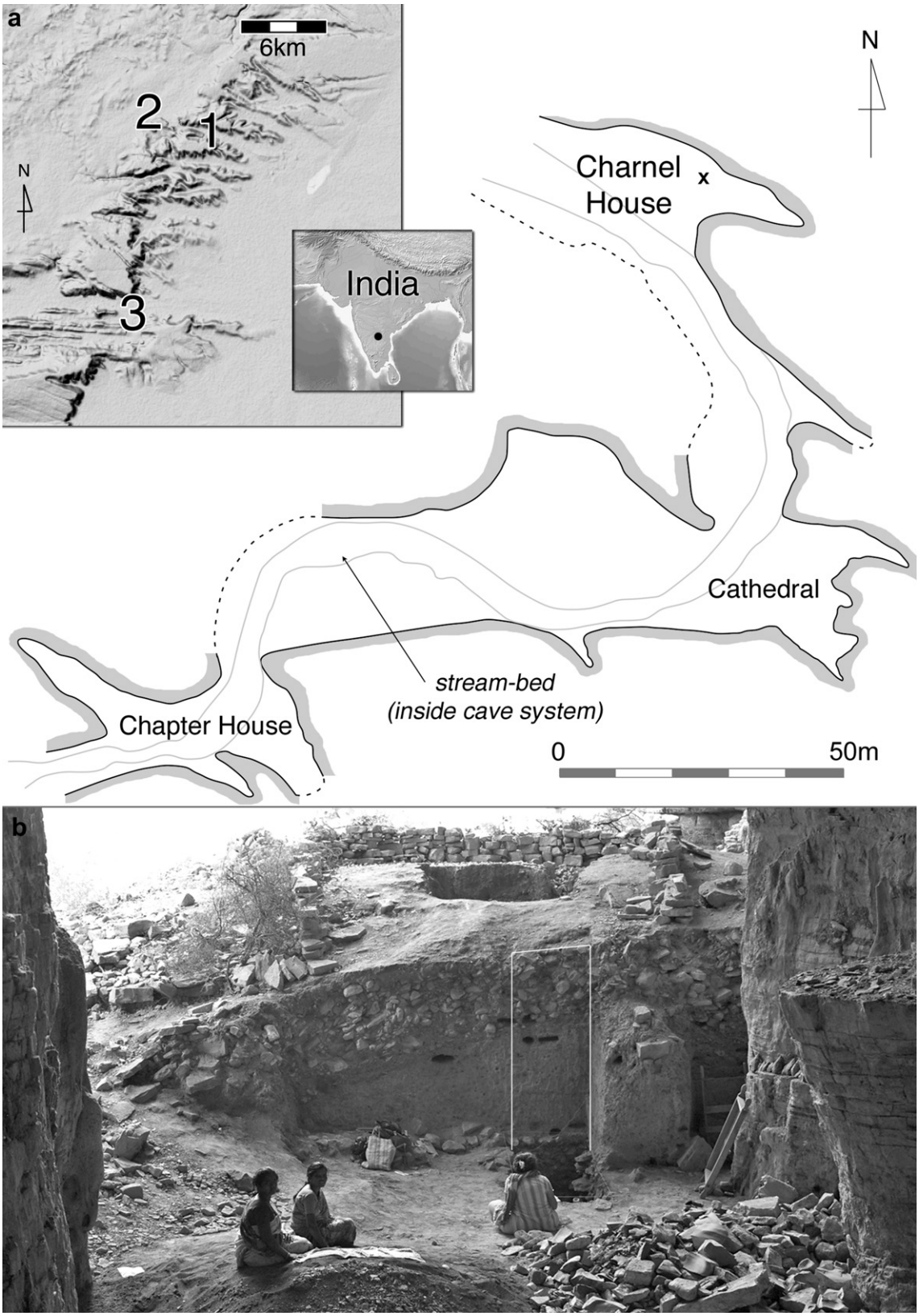

Fig. 1. (a) Map of the Billa Surgam Cave system showing the position of Charnel House Cave at its northern end; 'x' marks the spot from which the samples analysed in this study were collected. The inset shaded relief maps show the cave's location in southern India, with nearby towns marked: 1) Billa Surgam, 2) Betamcherla, 3) Jwalapuram. (b) View of the cave during excavation in 2009, facing west towards the entrance. The sampled section is outlined in white, and continues below the current cave floor level.