Toba supereruption: Age and impact on East African ecosystems

Richard G. Roberts[a,1], *Michael Storey*[b], *and Michael Haslam*[c]

[a]*Centre for Archaeological Science, School of Earth and Environmental Sciences, University of Wollongong, Wollongong, NSW 2522, Australia;* [b]*Quaternary Dating Laboratory, Department of Environmental, Social and Spatial Change, Roskilde University, DK-4000 Roskilde, Denmark; and* [c]*Research Laboratory for Archaeology and the History of Art, School of Archaeology, University of Oxford, Oxford OX1 3QY, United Kingdom*

Lane et al. (1) recovered microscopic glass shards (cryptotephra) from a thin layer of sediment deposited in Lake Malawi and chemically characterized them as volcanic ash (Youngest Toba Tuff, YTT) from the Toba "supereruption" in Sumatra. The authors found no evidence of significant climate change at multidecadal to millennial timescales in the sedimentary record, and in their report conclude that the eruption distributed ash much more widely than previously documented but did not trigger a volcanic winter or human bottleneck in East Africa. Although the YTT event had limited impact on ecosystems around Lake Malawi, we think Lane et al. (1) are premature in extrapolating their environmental findings to all of East Africa, and we dispute their contention that "the most robust age for the YTT" is 75.0 ± 0.9 ka.

Lake Malawi is the southernmost great lake in the East African Rift Valley. The Rift Valley traverses a diverse range of environments and paleoclimatic reconstructions are complicated by the interaction of several ocean–atmosphere systems, including the Intertropical Convergence Zone and the Congo Air Boundary. Each lake, therefore, contains a sedimentary record of the response of the contributing catchments to changes in local hydrology and vegetation, but the magnitude and direction of past climate changes have differed markedly along the Rift Valley. Two recent synopses (and the primary references cited therein) highlight the longitudinal differences in hydrological response of these lakes to climate change (2, 3), which commonly exhibit converse trends, such as between Lakes Malawi/Tanganyika in the south and Lakes Naivasha/Challa further north (2). Given these climatic gradients, shifting boundaries, and heterogeneous local responses, we consider it hazardous to extend the Lake Malawi climate record—and the limited environmental and demographic effects inferred for the Toba eruption (1)—to all of East Africa. YTT ash associated with paleoclimate records from more northerly lakes in the Rift Valley is required to establish Toba's broader impact on East African ecosystems and human populations.

As a chronological tie-point, Lane et al. (1) use an age of 75.0 ± 0.9 ka for the YTT event based on an "optimization model," rather than the astronomically calibrated age of 73.88 ± 0.32 ka (4). These two $^{40}Ar/^{39}Ar$ ages differ only because alternative ages for the Alder Creek sanidine (ACs) dating standard were used. Lane et al. state that the best constrained age is ∼75 ka, but no single age for ACs is universally endorsed by the $^{40}Ar/^{39}Ar$ dating community. Additional data supporting the ACs age used by ref. 4 have recently been published (5) that indicate an age of ∼75 ka is too old for the Toba eruption. We note that an age of ∼74 ka also agrees closely with other chronologies for the eruption, including those developed from ice cores and from speleothems with high-resolution $^{230}Th/^{234}U$ ages (4, 6), whereas an age of ∼75 ka conflicts with these independent chronologies (6). We suggest, therefore, that the YTT event is currently best constrained by the high-precision age of 73.88 ± 0.32 ka (4).

1 Lane CS, Chorn BT, Johnson TC (2013) Ash from the Toba supereruption in Lake Malawi shows no volcanic winter in East Africa at 75 ka. *Proc Natl Acad Sci USA* 110(20):8025–8029.
2 Gliganic LA, Jacobs Z, Roberts RG, Domínguez-Rodrigo M, Mabulla AZP (2012) New ages for Middle and Later Stone Age deposits at Mumba rockshelter, Tanzania: Optically stimulated luminescence dating of quartz and feldspar grains. *J Hum Evol* 62(4):533–547.
3 Blome MW, Cohen AS, Tryon CA, Brooks AS, Russell J (2012) The environmental context for the origins of modern human diversity: A synthesis of regional variability in African climate 150,000–30,000 years ago. *J Hum Evol* 62(5):563–592.
4 Storey M, Roberts RG, Saidin M (2012) Astronomically calibrated $^{40}Ar/^{39}Ar$ age for the Toba supereruption and global synchronization of late Quaternary records. *Proc Natl Acad Sci USA* 109(46):18684–18688.
5 Rivera TA, Storey M, Schmitz MD, Crowley JL (2013) Age intercalibration of $^{40}Ar/^{39}Ar$ sanidine and chemically distinct U/Pb zircon populations from the Alder Creek Rhyolite Quaternary geochronology standard. *Chem Geol* 345:87–98.
6 Haslam M (2013) Climate effects of the 74 ka Toba supereruption: Multiple interpretive errors in 'A high-precision $^{40}Ar/^{39}Ar$ age for the Young Toba Tuff and dating of ultra-distal tephra' by D. Mark, et al. *Quat Geochronol*, 10.1016/j.quageo.2013.03.002.

Author contributions: R.G.R., M.S., and M.H. designed research, performed research, and wrote the paper.

The authors declare no conflict of interest.

[1]To whom correspondence should be addressed. E-mail: rgrob@uow.edu.au.