LETTER

Reply to Nott: Assessing biases in speleothem records of flood events

In our reconstruction of extreme rainfall events from the Australian tropics (1), we relied on a method still in its infancy: linking accumulations of sediment trapped within stalagmites to discrete cave flooding events. This sedimentological approach (2, 3) represents an important complement to speleothem-based isotopic methods (4, 5) that expand our understanding of prehistoric tropical cyclone activity.

In his Letter to the Editor (6), Nott notes that identifying mud layers represents a somewhat subjective component of this analysis. In particular, differentiation between thin mud layers and stains on stalagmite carbonate not associated with sediment accumulations is a possible source of error. As we discuss in our report (1) and the associated *Supporting Information*, recognizing flood-derived sediment layers in our stalagmites was complicated by this issue, as well as other factors, including biases associated with preservation of sediment on stalagmite caps and the location of the cuts used to bisect the stalagmites.

To provide the most robust and independent determination possible for identifying flood events, we relied on (*i*) replication of coeval sections of different stalagmites and (*ii*) calibration with historical records of extreme rainfall with a stalagmite formed over the same time period (A.D. 1908–1986). As Nott notes (6), we observed little difference in the temporal trends of extreme rainfall activity over the last two millennia, whether or not we interpreted these stains as cave flooding events.

In addition, we restricted our mud layer analysis to aragonite stalagmites (which comprise the late Holocene portion of the KNI-51 record) because they are faster growing (~1 mm/y) than calcite stalagmites and much more suitable for ^{230}Th dating techniques. Relative to most other studies, the accurate dates well constrained by small errors and the exceptionally high growth rates of KNI-51 stalagmites make this suite of samples unique.

With that said, high-resolution analysis via techniques such as fluorescence, as suggested by Nott (6), may provide new insight into the nature of flood activity in the aragonite speleothems of KNI-51. As Nott notes, abundances of fluorescent compounds such as organic acids would likely be exceptionally diluted in flood waters associated with extreme rainfall events. This would particularly be the case in areas such as the uplands of the eastern Kimberley, which are characterized by thin soils with little organic carbon content, and thus flood waters may contain a different fluorescent signature than traditionally infiltrated fluids.

Rhawn F. Denniston[a,1], Gabriele Villarini[b], Angelique N. Gonzales[a], Victor J. Polyak[c], Caroline C. Ummenhofer[d], Matthew S. Lachniet[e], Alan D. Wanamaker Jr.[f], William F. Humphreys[g], David Woods[h], and John Cugley[i]

[a]Department of Geology, Cornell College, Mount Vernon, IA 52314; [b]IIHR-Hydroscience and Engineering, University of Iowa, Iowa City, IA 52240; [c]Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131; [d]Department of Physical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, MA 02543; [e]Department of Geoscience, University of Nevada Las Vegas, NV 89154; [f]Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011; [g]Western Australia Museum, Welshpool DC, WA 6986, Australia; [h]Department of Parks and Wildlife, Broome, WA 6725, Australia; and [i]Australian Speleological Federation, Willetton, WA 6155, Australia

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2 Dasgupta S, et al. (2010) Three thousand years of extreme rainfall events recorded in stalagmites from Spring Valley Caverns, Minnesota. *Earth Planet Sci Lett* 300(1-2):46–54.
3 Frappier A, et al. (2014) Two millennia of tropical cyclone-induced mud layers in a northern Yucatan stalagmite reveal multiple overlapping climatic hazards during the Maya Terminal Classic "megadroughts". *Geophys Res Lett* 41(14):5148–5157.
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5 Haig J, Nott J, Reichart G-J (2014) Australian tropical cyclone activity lower than at any time over the past 550–1,500 years. *Nature* 505(7485):667–671.
6 Nott J (2015) Identification of mud flood layers within stalagmites. *Proc Natl Acad Sci USA* 112:E4636.

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The authors declare no conflict of interest.

[1]To whom correspondence should be addressed. Email: rdenniston@cornellcollege.edu.