

Reply to Simon and Reed: Independent and converging results rule out historic disturbance and confirm age constraints for Barrier Canyon rock art

We welcome this further discussion of our results on the age of the Great Gallery rock art in the Canyonlands of Utah. The comment by Simon and Reed (1) focuses on just one of the three components of our study (2), which is presented in greater technical detail in ref. 3 and is surely our best-constrained and least-surprising result: the dating of a rock-fall that removed some of the art and thus provides a minimum age. Simon and Reed (1) point out that the Great Gallery panel is not pristine and relate the sordid human history of visitation and possible disturbance to the site. Indeed, being aware of this during our research, one of our initial hypotheses was that the rock fall may be historic. Despite the possibility of recent disturbance to some of the talus boulders, our results document that the rock fall occurred ~900 y ago, and for the boulder we sampled a scenario of historic disturbance and exposure such as postulated by Simon and Reed (1) can be ruled out.

We sampled the deepest part of the buried surface of the rock, well away from any exposure at the boulder's outer edges. We also sampled the compacted grains of buried sediment in contact with the rock surface and an intervening cottonwood leaf flattened between the two surfaces. Independent optically stimulated luminescence ages for the buried rock surface and the buried sediment grains, as well as an accelerated mass spectrometry radiocarbon age for the leaf, all converge on an age of ~900 y. These results are from three

different types of sample and produced from three different laboratories. In an effort to dispute the radiocarbon age, Simon and Reed (1) cite an article about issues encountered when dating water-saturated organic material from marine and lacustrine settings that commonly have hard-water effects. Our radiocarbon sample could not be in a more different context: an annual leaf, intact despite its fragility, buried in a bone-dry alcove. It is, in fact, an ideal target for radiocarbon dating. The standard sampling, handling, and analytical procedures we used were developed for exactly this kind of straightforward sample.

Historic disturbance of the sampled boulder can be ruled out because of these independent, converging results. Had the sampled boulder been overturned and exposed to light, our results would provide a historic age for the rock surface, as well as the sediment grains beneath it, because of solar bleaching. Furthermore, the optically stimulated luminescence depth profile we report in our paper from the buried rock surface records a simple history of exposure and then burial. There is no evidence for any historic solar resetting; had this occurred, it would have resulted in an obvious distortion of the near-surface profile.

An intriguing possibility might be that, if the surfaces we analyzed were vandalized and exposed to light, then it was by people of the Fremont archaeological culture ~900 y ago! Further testing may support this or

other interesting histories for Barrier Canyon rock art.

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1 Simon N, Reed R (2014) Incorrect representation of Barrier Canyon rock art site's history and other factors invalidate reported dates. *Proc Natl Acad Sci USA* 111:E5602–E5603.

2 Pederson JL, et al. (2014) Age of Barrier Canyon-style rock art constrained by cross-cutting relations and luminescence dating techniques. *Proc Natl Acad Sci USA* 111(36):12986–12991.

3 Chapot MS, Sohbati R, Murray AS, Pederson J, Rittenour T (2012) Constraining the age of rock art by dating a rockfall event using single-grain and surface dating luminescence techniques. *Quat Geochronol* 13:18–25.

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The authors declare no conflict of interest.

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