

## REPLY TO KLEIN:

## Ysterfontein 1 shell midden (South Africa) and the antiquity of coastal adaptation

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Klein (1) challenges two interpretations in Niespolo et al. (2). Regarding his first point, we maintain that Ysterfontein 1 (YFT1) does provide the oldest known example of full coastal adaptation as indicated by the presence of shell middens (cf. ref. 3). Klein inaccurately characterizes the age of the deepest shell midden layers at Klasies River Main (KRM) given in ref. 4. While other workers identify even the oldest light brown sand (LBS) layer at KRM as similar in age or younger than the deepest deposits at YFT1 (cf. refs. 5 and 6), the reference cited by Klein (4) and subsequent dating efforts show that the shell midden lenses in beach-sand deposits within the LBS layer likely postdate the marine isotope stage 5e sea level highstand (~120 ka) as does the midden at YFT1. However, existing dates suggest that KRM shell middens may, in fact, be younger than YFT1. Layer LBS has been directly dated using multiple techniques that converge on an age of ~104 ka (5), notably younger than the 95% confidence interval for YFT1 deposition (2). However, complicating matters, a capping speleothem with a U-series age of ~110 ka is interpreted as a minimum age of the LBS layer at KRM (5). Thus, layer LBS yields conflicting dates and its true age remains uncertain. The next oldest layer at KRM hosting midden deposits (layer shell and sand [SAS]) is definitively younger than YFT1 (5, 7). Thus, there is no basis for the assertion that KRM middens are older than those at YFT1, and we stand by our claim that

YFT1 provides the oldest currently known example of systematic coastal resource exploitation.

Second, Klein disputes our characterization of the YFT1 shell midden as evidence of intensive use of marine resources by its human occupants. Our interpretation follows from three considerations: 1) true shell middens (i.e., shell-supported deposits) like those at YFT1 form when shell deposition was fast enough to exceed deposition of sediments, 2) middens are generally an accepted archaeological proxy indicator of coastal adaptation (e.g., ref. 3), and 3) midden accumulation rates are an accepted proxy for marine resource exploitation (e.g., refs. 8 and 9). We showed that YFT1 is substantially older and was more rapidly accumulated than previously thought (2). The high accumulation rates indicated by our ages are comparable to those observed in Later Stone Age middens (e.g., ref. 10), which are unquestioned examples of intensive marine exploitation. We suggest that YFT1 represents an early stage on the trajectory of human exploitation of marine resources, where evidence of full coastal adaptation and intensive coastal site use are present, but indicators of resource depletion characteristic of Later Stone Age middens, perhaps driven by larger populations (e.g., ref. 11) are absent, as was stated in ref. 2. We stand by our conclusions that YFT1 is currently the oldest well-dated true shell midden and that at times it was intensively occupied by humans, documenting an early example of coastal adaptation (sensu ref. 3).

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The authors declare no competing interest.

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