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COMMENT

Response to comment on Ward et al.'s 'Insights into the procurement and distribution of fossiliferous chert artefacts across southern Australia from the archival record'

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We appreciate the opportunity to respond to the arguments put forward by Bird et al. against the premise of a long-distance source and trade of bryozoan fossiliferous chert across southern Australia. Given the long-standing enigma of fossiliferous chert artefacts and their apparent offshore source, it is appropriate for there to be some debate when this enigma is challenged. However, it is difficult to understand why Bird et al. ignore the geological evidence that indicates unequivocally that the source of fossiliferous chert cannot be from the Perth Basin (O'Leary et al. 2017), and offer no alternative source. Bird et al. themselves seem to acknowledge, with reference to Glover (1975a), that 'no local sources [of fossiliferous chert] are known, but it most closely resembles chert from the Eucla area'.

As noted in O'Leary et al. (2017:37), the idea of a transport pathway of Eocene-age fossiliferous chert along the south coast (from Eucla) was first proposed by Glover and Cockbain (1971). Only after petroleum exploration wells were drilled on the Rottnest Shelf, which contained bands of fossiliferous chert, did Glover (1975a, 1975b) and Quilty (1978) opt for an offshore source. This change in thinking was considered to account for the apparent westward increase in frequency of chert artefacts, absence of a suitable local onshore chert source, and absence of chert artefacts in strata younger than 4.5 ka. The latter was attributed to an elimination of source following post-glacial flooding of the continental shelf. Yet an offshore source in the Perth Basin remains unlikely given that the well data show chert bands in Eocene to Miocene age formations (a similar age to the chert deposits on the Nullarbor) at depths of 50–400 m below lowest sea levels at the Last Glacial Maximum (LGM). Critically, chert can only form under pressure from burial. There are extensive supporting datasets including geological (e.g. borehole), geochronological (Glover and Cockbain 1971), geophysical (e.g. shallow seismic) and neotectonic evidence that show the surficial and shallow subsurface sediments of the Rottnest Shelf consist of Pleistocene marine calcarenites. It is a geological impossibility for in situ Eocene chert deposits to exist at or just below the seabed on the Rottnest Shelf where it could be accessed as a resource.

The main part of Bird et al.'s argument revolves around the distance-from-material-source concept, namely that raw material distribution declines with increasing distance from source. While this decline may exist for local Plantagenet chert, this trend (effect) and the various processes that are involved in making it (cause) may not hold up when considering material sources over distances of hundreds of kilometres where research and preservation bias are significant factors. Even within the Perth region, Bird et al.'s figure highlights the distribution of sites with fossiliferous chert in a broad arc around the Perth floodplain. This mirrors the distribution of archaeological sites generally, with the vast majority, whether a result of research bias or preservation, associated with the Bassendean sand (Bowdler et al. 1991).

The archaeological record is largely based on material remains being created, preserved and found. Thus, an easterly decline in archaeological material may reflect one or more of the following aspects:

1. Population density. There is higher occupation and use of the Swan Coastal Plain, decreasing to the east;
2. Preservation bias. The depositional nature of the Swan Coastal Plain will be more likely to preserve material within a stratigraphic context (although see Bowdler et al. 1991) whereas the environments east of the Darling Scarp are more likely to behave as a palimpsest;

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3. Visibility and survey bias. Erosion blowouts of coastal dunes on the Swan Coastal Plain are more likely to expose lithics whereas these types of erosional features are less common east of the Darling Scarp; and fewer archaeological surveys have been conducted east of the Darling Scarp.

Consideration also needs to be given to visibility and preservation bias along the inundated southern coastal plain. The idea of people utilising resources on a now inundated coastal plain, albeit off the southern rather than the western Australian coast, was considered by Ward et al. (2019a; see also Munroe 2011). However, evidence for exploitation and trade of Eocene fossiliferous chert along the southern coastline may now be lost to sea level rise. Archaeological evidence along parts of the current Eucla coast will also have been subject to erosion rates of 1 m/yr or more for many millennia (Geoscience Australia 2019).

Bird et al. question why spiculitic-rich Plantagenet 'chert' would be bypassed in favour of more distant Eucla chert. One answer might be that the Plantagenet chert is an inferior lithic material with which to manufacture stone tools (Glover 1984). It should be noted that in the geological literature the Plantagenet material is defined as a spiculite and specifically 'spiculite-rich Princess Royal Spongolite' and is not a true chert (Gammon et al. 2000). Bird et al. add that 'there is no evidence that this [Plantagenet] material travelled as far as the west coast'. We question how much of this absent evidence, including the cited studies of Bird (1985) and Ferguson (1980), actually involved the qualitative differentiation of spiculitic-rich Plantagenet material.

Similarly, Bird et al. comment on the distinction of Eucla 'white or black flint', arguing if these were in the assemblages of the Swan Coastal Plain then they would be expected to show high levels of curation. The problem is that chert can rapidly lose its colour and develop a white patina if exposed to air (Flint et al. 1989:26; and cited in Ward et al. 2019a) or if buried may take on the colour of the sediment (Dortch and Glover 1983; Glover 1974). So, without sectioning the artefacts, it may be difficult to identify them as white or black flint.

Finally, we come to the question about the use of fossiliferous chert as a chronological marker. Bird et al. identify a key issue, namely that with absolute dates from only nine sites 'the dated evidence is scarce'. Taking their argument, a testable hypothesis needs to be put forward that all sites younger than 6 ka are a result of 'site formation factors' (i.e. reworking) or recycling. Bowdler et al. (1991) argue that most sites in the Swan Coastal Plain are seriously disturbed and the archaeological interpretations from these are open to argument (cf. Pearce 1992). O'Leary et al. (2017:42), and earlier Ferguson (1980) and Worrell (2008), have explored recycling and found it to be inconsistent, with Worrell (2008) concluding that there must be some other explanation for the continued availability of chert into the middle late Holocene.

Ultimately, fossiliferous cherts of all types remain an archaeological enigma and they all warrant much further investigation. Rather than engaging in dialectic arguments around the likelihood of a westerly source of Eocene fossiliferous chert, it may be better to re-examine the data on distance-from-material-source trends and likelihood of offshore sources. This may include exploring transport patterns represented in existing debitage assemblages (e.g. Ditchfield 2016), and utilising the most diagnostic feature of this material – the embedded fossils – to characterise and compare various sources of chert with available archaeological assemblages (e.g. Ward et al. 2019b). As a start, it would be worthwhile applying the non-destructive methods outlined by Ward et al. (2019b) to the characterisation and provenance of the Dunsborough (Glover et al. 1978) and Scadden (Dortch and Glover 1983) implements.

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