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The Brremangurey pearl: a 2000 year old archaeological find from the coastal Kimberley, Western Australia

Katherine A. Szabo
University of Wollongong, kat@uow.edu.au

Brent Koppel
University of Wollongong, bk830@uowmail.edu.au

M Moore
University of New England, mmoore2@une.edu.au

Iain Young
University of New England

Matthew Tighe
University of New England

See next page for additional authors

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The Brremangurey pearl: A 2000 year old archaeological find from the coastal Kimberley, Western Australia

Katherine Szabo[1], Brent Koppel[1], Mark W. Moore[2], Iain Young[3], Matthew Tighe[3] and Michael J. Morwood[1]

1. Centre for Archaeological Science, School of Earth and Environmental Sciences, University of Wollongong, Wollongong NSW 2522, Australia <kat@uow.edu.au> <bk830@uowmail.edu.au>
2. Archaeology, School of Humanities, University of New England, Armidale NSW 2351, Australia <mmoore2@une.edu.au>
3. School of Environmental and Rural Science, University of New England, Armidale NSW 2351, Australia <iain.young@une.edu.au> <mtighe2@une.edu.au>

Abstract

A small marine pearl was recovered at the Brremangurey rockshelter, on the Kimberley coast, from layers dating to approximately 2000 years ago. In an area famous for its pearls and history of cultured pearl production, public interest centred on whether the pearl was as old as the layer in which it was contained, or whether it was a recent cultured pearl that had infiltrated down from above. The near-spherical shape of the pearl hinted at a possible cultured origin. Owing to the uniqueness and historic cultural significance of this find, non-invasive analytical techniques were used to investigate whether the Brremangurey pearl was cultured or natural. Midden analysis was further used to assess the likely origin of the pearl within the stratified deposits. Analysis confirmed that the pearl is of natural origin and a dense midden lens of Pinctada albina *shells is its likely origin.*

Introduction

During excavations in 2011 at Brremangurey, a north Kimberley coastal rockshelter, a small nacreous marine pearl was recovered from within the site's shell midden. Although there is no record of pearls being of cultural importance to Australia's Indigenous peoples, the pearl generated much excitement and many questions from Kimberley locals, both around the site and further afield. Given the pearling heritage of the Kimberley, many of these questions related to the age and origin of the pearl. Although recovered from a layer which was radiocarbon dated to 1800–1906 cal. BP, local pearl experts raised the possibility that it could be an intrusive cultured pearl, based on its size, colour and spherical shape. We acknowledge that the pearl is most likely an incidental find in archaeological terms, but the public interest in its history, age and origin compelled us to develop tools to address these questions. As a unique object of historical value to many, a programme of non-invasive analyses was developed; we hope some of the techniques presented here will provide a constructive pathway to others working in these fields.

Background

Brremangurey is a quartzite rockshelter located 70 m inland from the current shoreline on the north Kimberley coast (Figure 1). The site deposits span periods of the late Pleistocene and Holocene, with a dense mid- to late Holocene shell midden dominating the upper portion of the sequence; the pearl was recovered whilst screening these midden deposits. Despite having the appearance of a cultured pearl, it was recovered from a depth of 70–77 cm below datum (Square K26, Spit 14). Marine shell from this level was AMS radiocarbon dated to 1800–1906 cal. BP (Table 1). A detailed excavation report is currently being prepared for publication, as are papers on the shell midden analysis.

Measuring 5.9 mm in maximum diameter and weighing 0.25 g (Figure 2), the Brremangurey pearl is the only pearl to have been recovered from a prehistoric archaeological site in Australia and one of only a small number found in archaeological contexts globally (e.g. Charpentier et al. 2012; Koerper and Desautels-Wiley 2007 from the Arabian Gulf and southern California, respectively). The Kimberley coast is a well-known centre for the production of South Sea pearls, farmed from the large pearl oyster species *Pinctada* *maxima*. The collection of natural pearls from local beds of the smaller species *P. albina* further to the south in Shark Bay was a significant industry in the 1860s before the beds collapsed, after which the industry never entirely recovered (Kunz and Stephenson 1908:200–201; Moore 1994:123; Streeter 2006:144). Subsequently, a new industry utilising then novel Japanese technologies of pearl culturing was introduced to the areas surrounding Broome in the 1950s (Edwards 1994:70; Ward 2002:32). Today, pearl farms are scattered along the northern Australian coast from the Kimberley to Darwin (Dennis 2011; Hills 2013).

Despite the fact that the pearl was recovered from sub-surface deposits in what appeared to be a robustly stratified midden, two Broome pearl experts (James Brown and Penny Arrow) likened the Brremangurey pearl to a cultured Akoya pearl. Akoya pearls are smaller than those generally produced by *P. maxima* and are cultured from the Japanese species *P. imbricata fucata* (=*fucata*) (Bouchet 2014; Landman et al. 2001:30; Ward 2002:25). The slightly golden-rose hue of the

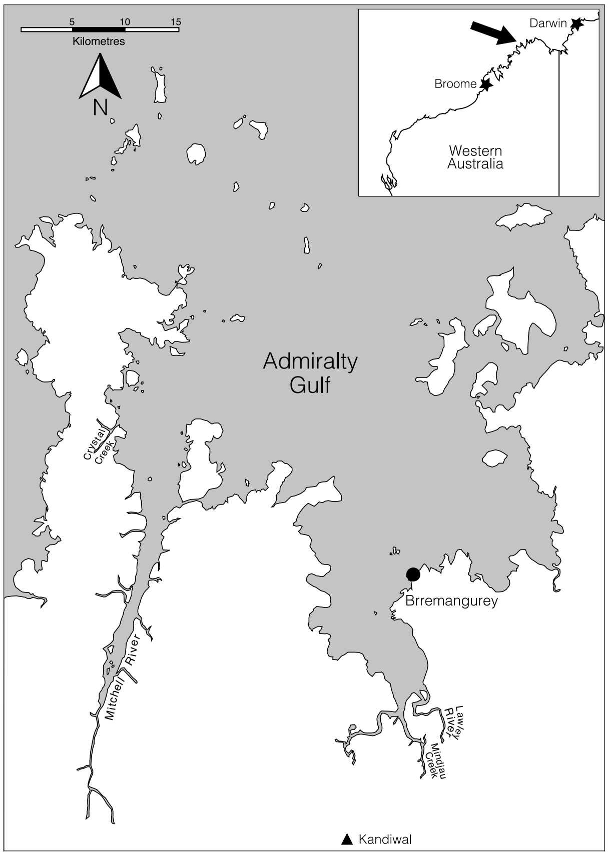

Figure 1 The location of the Brremangurey site on the shore of the Admiralty Gulf, northern Western Australia.

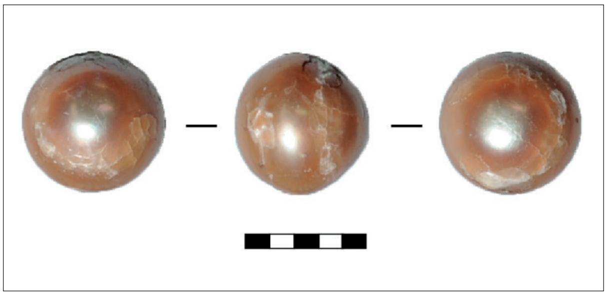

Figure 2 The Brremangurey pearl. Scale bar is in millimetres.

Laboratory Code	Material	Uncalibrated Age	ΔR	Calibrated Age (1 σ)	Calibrated Age (2 σ)
OZQ-192	*Pinctada albina*	2305±25	60±31	1800–1906	1730–1954

Table 1 AMS radiocarbon date stratigraphically associated with the Brremangurey pearl. Calibrated using Calib 7.0.2 with the Marine 13 dataset (Reimer et al. 2013; Stuiver and Reimer 1993). ΔR as recommended by Alan Hogg (23 December 2014).

Brremangurey pearl also aligned with the common colour palette of Akoya pearls. Shell midden deposits are notoriously porous (e.g. Stein 1992; Villagran et al. 2009) and detailed analytical work on the chronostratigraphic integrity of the Brremangurey shell midden using amino acid racemization clearly demonstrated that there has been significant time-averaging of portions of the midden deposits, as well as instances of substantial downward movement of shell within the matrix. The possibility that the pearl could be intrusive was therefore investigated.

Analytical Approaches

Standard analytical techniques, such as radiocarbon dating, stable isotope analysis and elemental analyses (e.g. ICP-MS), all require parts of the sample to be destroyed (Malainey 2011:106–107, 264), and thus were inappropriate for this study[1]. In coordination with Cygnet Bay Pearl Farm, a comparative analysis of known-age beaded and unbeaded ('keshi') pearls, and the Brremangurey pearl was conceived, in which x-ray computed microtomography (µ-CT) analysis would be used to visualise the pearls' interior structures, including banding and bead/nucleus morphology.

µ-CT is a non-destructive imaging methodology with high spatial resolution. Samples are typically rotated through 360°, creating a three-dimensional model comprised of a large series of two-dimensional slices which can be individually assessed. The use of x-ray technology allows differences in density to be clearly defined and mapped through the differential blocking and absorption of x-rays (Karampelas et al. 2010). The abilities and non-destructive nature of µ-CT make it ideal for studying pearls and the structures and layers of which they are composed (Karampelas et al. 2010; Krzemnicki et al. 2010).

A GE Phoenix v|tome|x ultra high resolution CT system with an additional nanofocus x-ray tube was used for the analysis, with a 3D maximum resolution of 2 µm. Three pearls (two seeded in 2010 and harvested in 2012) made available by Cygnet Bay were scanned. The beads used were aragonitic spheres manufactured from the shell of a species of North American freshwater mussel ('Mississippi mussel'). The third example from Cygnet Bay was a keshi pearl that grew without an inserted bead. The Brremangurey pearl was also scanned and, in addition to a scan of the complete pearl, a scan focused on the interior nucleus was also undertaken. Final images were scanned at the most appropriate resolution to capture the whole pearl structure; however,

1 It should be noted that 'non-destructive' in archaeological terms (i.e. no physical modification of the object) is more equivalent to the term 'non-invasive' in the physical sciences, rather than their usage of the term non-destructive (Cassar and Degrigny 2005).

initial scans at high resolution were checked to ensure that small changes in final resolution did not alter the type and number of banding observed in each pearl.

Results

The scans of the beaded Cygnet Bay pearls, which had a growing duration of two years before harvest, showed clear bands of aragonite laid down over the bead. For each year of growth, a single band of nacre was deposited (Figure 3). In contrast, the scan of the Brremangurey pearl revealed no less than 14 layers of nacre (Figure 4). The layers of nacre are also relatively thinner than those seen in the cultured Cygnet Bay pearls.

The µ-CT scans demonstrated that the Brremangurey pearl had a near-spherical nucleus (Figure 5). It was also apparent that it was composed of calcium carbonate. As with the aragonite beads of the modern cultured pearls, materials of the same mineralogical composition appear with the same colour/density in the µ-CT scans. Despite both the Brremangurey and Cygnet Bay beaded pearls having spherical calcium carbonate centres, there were clear visual differences in their internal structures. The Cygnet Bay examples had a solid, homogeneous aragontic mass at their centre in line with the sculpted bead used in pearl aquaculture (Figure 3). The Brremangurey pearl had a nucleus seemingly comprised of a hollow centre surrounded by radial calcium carbonate struts projecting outwards to a pustulose exterior (Figure 5). This morphology clearly accords with what is expected in a natural pearl generated by damage during growth at the mantle of the mollusc (Hänni 2012). The younger mantle cells, which sit outermost on the mantle, generate the dull outer calcitic prismatic layer of shell, whereas the older cells produce the nacreous lustrous shell interior (Hänni 2012). Thus, when damage occurs at the edge of the mantle, a small cyst is often formed in which prismatic cells are laid down first, followed by sequential layers of nacre (Hänni 2012). This is a recognised growth mode and structure for natural pearls, and matches precisely the internal structure of the Brremangurey pearl.

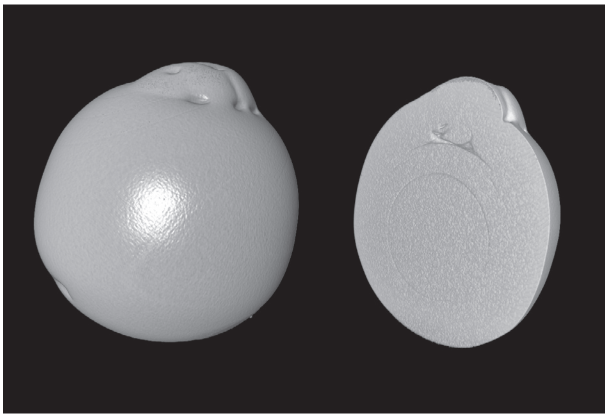

Figure 3 µ-CT surface rendering of a Cygnet Bay Pearl seeded in 2010 and recovered in 2012 (left) and showing two bands of nacre in cut-away view (right). An irregularity in banding has formed around an intrusive object during pearl growth. Scanning was undertaken at 31 µm resolution at 130 kV and 70 µA. Pearl is 10.6 mm in lateral diameter.

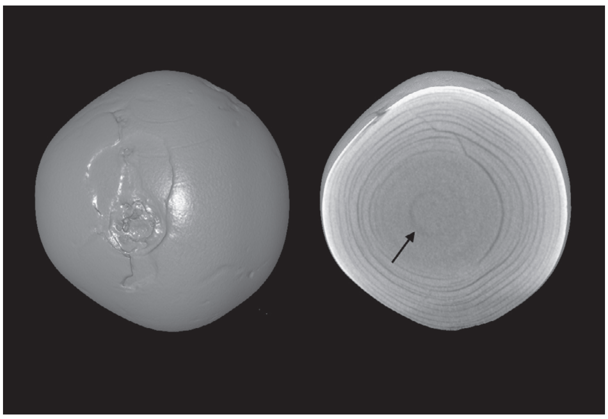

Figure 4 µ-CT surface rendering of the complete Brremangurey pearl (left) showing layers in cut-away view (right). Scanning was undertaken at 15 µm resolution at 130 kV and 70 µA. Pearl is 5.9 mm in diameter.

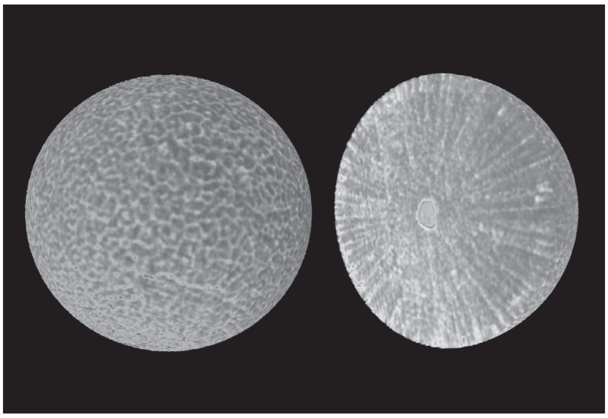

Figure 5 µ-CT rendering of the nucleus of the Brremangurey pearl, taken at 650 µm radius from the centre void (left), with cut-away view showing the centre void and radial strut-like structures (right). Scanning was undertaken at 6.7 µm resolution at 100 kV and 70 µA.

Discussion and Conclusion

The µ-CT analysis shows that the Brremangurey pearl has neither the type of banding nor internal artificial bead that we would expect to see in a cultured pearl. The extended period of growth evidenced by the high number of nacreous internal layers is also well in excess of conventional and historical culturing practices. Although the programme of non-invasive analysis did not allow us to date the pearl directly, no data generated during the course of these analyses implies intrusion from higher levels. The pearl has also been emphatically demonstrated to be of natural formation.

In terms of its archaeological context, the pearl was embedded within a dense lens of shells from the small pearl oyster species *P. albina*, with the midden both above and below this lens being dominated by the much more common soft-shore bivalve *Marcia hiantina*. Amino acid racemization analyses demonstrate that the *P. albina* lens is in situ and stratigraphically distinct from other midden formation episodes (Brent Koppel unpub. data). With the pearl likely being an incidental introduction through ancient Indigenous shell collection, the most important aspect of the pearl recovered from Brremangurey may not be the pearl itself, but the dense lens of pearl oyster shells in which it was embedded. It has been previously argued that *Pinctada* spp. pearl oysters were of cultural significance in the Kimberley (Akerman and Stanton 1994; Balme and Morse 2006; O'Connor 1999:121). The potential cultural significance of the *P. albina* layer at Brremangurey will be further explored within the larger context of the shell midden analysis in an upcoming publication.

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