Special Issue: Personal Ornaments in Early Prehistory

40,000 Years of Ochre Utilization in Timor-Leste: Powders, Prehensile Traces, and Body Painting

MICHELLE C. LANGLEY
Australian Research Centre for Human Evolution, Environmental Futures Research Institute, Griffith University, 170 Kessels Road, Nathan 4111, Queensland, AUSTRALIA; m.langley@griffith.edu.au

SUE O'CONNOR
Archaeology & Natural History, School of Culture History & Language, College of Asia & the Pacific, Australian National University, Acton 0200, Canberra, AUSTRALIA; sue.oconnor@anu.edu.au

submitted: 22 June 2017; accepted 18 December 2018

ABSTRACT

With both rock art and ochre-stained marine shell ornamentation identified at the four Timor-Leste sites of Jerimalai, Lene Hara, Matju Kuru 1, and Matja Kuru 2, it should not be surprising that almost one kilogram of colorants were also recovered from these same sites. Pieces displaying clearly identifiable use wear (grinding, scraping, rubbing) were collected from the earliest levels of Jerimalai dating to around 40,000 cal. BP, and continued up through the deposit to the near present levels. Similar quantities and distributions were also found in Matju Kuru 1 and 2, along with Lene Hara. Alongside these colorant fragments were six stone implements displaying evidence for ochre processing, providing insights into the exact pigment producing tools used in this location. Also found was an artifact dated to >10,200–9909 cal. BP from MK2 which may be a fragment of a mastic including ochre as an ingredient in its formation. Overall, this Timorese assemblage offers the ideal opportunity to explore ochre processing and use over a 40,000 year period in Island Southeast Asia — information which has been previously lacking.

This special issue is guest-edited by Daniella E. Bar-Yosef Mayer (Steinhardt Museum of Natural History and Institute of Archaeology, Tel Aviv University) and Marjolein D. Bosch (McDonald Institute for Archaeological Research, University of Cambridge). This is article #5 of 12.

INTRODUCTION

Archaeology has demonstrated that the use of red to yellow earth minerals—generically termed 'ochre' in the literature—is a persistent feature of hunter-gatherer decorative traditions since the Late Pleistocene. Indeed, color is one of the symbolic frameworks used extensively by near-contemporary and contemporary societies to convey information, with colors being carefully chosen and applied to both bodies and material culture (e.g., Sagona 1994; Turner 1966). Having said this, several researchers have pointed out that colorants also have utilitarian aspects, such as being a key ingredient in some adhesives, leading to debate regarding the symbolic value of the earliest identified instances of utilized ochres (e.g., Lombard 2005, 2006a, 2006b, 2007; Wadley 2005, 2010; Wadley et al. 2004). Despite this debate, it has been shown that there is no traditional modern society in which the production and use of colorants is merely functional (d'Errico 2003), and thus, it is generally agreed that color selective behavior has a deep history in human behavioral development (e.g., Hovers et al. 2003). Indeed, researchers have found that with the emergence of *H. sapiens* some 200,000 years ago (McDougall et al. 2005; White et al. 2003), a preference for strong red hues emerged (Watts 2010).

In recent years, ochre has been a particularly important artifact class for investigating early cognitive and cultural development, with the exploration of how colorants were selected, processed, and utilized contributing to a more comprehensive understanding of how early human communities in both Africa and Eurasia constructed and negotiated social boundaries and interactions (e.g., d'Errico 2008; d'Errico et al. 2012; Henshilwood et al. 2009, 2011; Hodgskiss and Wadley 2017; Rosso et al. 2017; Soressi and d'Errico 2007). However, similar work in Southeast Asia (SEA), and particularly Island Southeast Asia (ISEA), is lacking owing to a dearth of archaeological finds, or their reportage, coincident with the earliest human presence in the region. Excavations at Jerimalai, Lene Hara, Matja Kuru

  ISSN 1545-0031
doi:10.4207/PA.2019.ART125

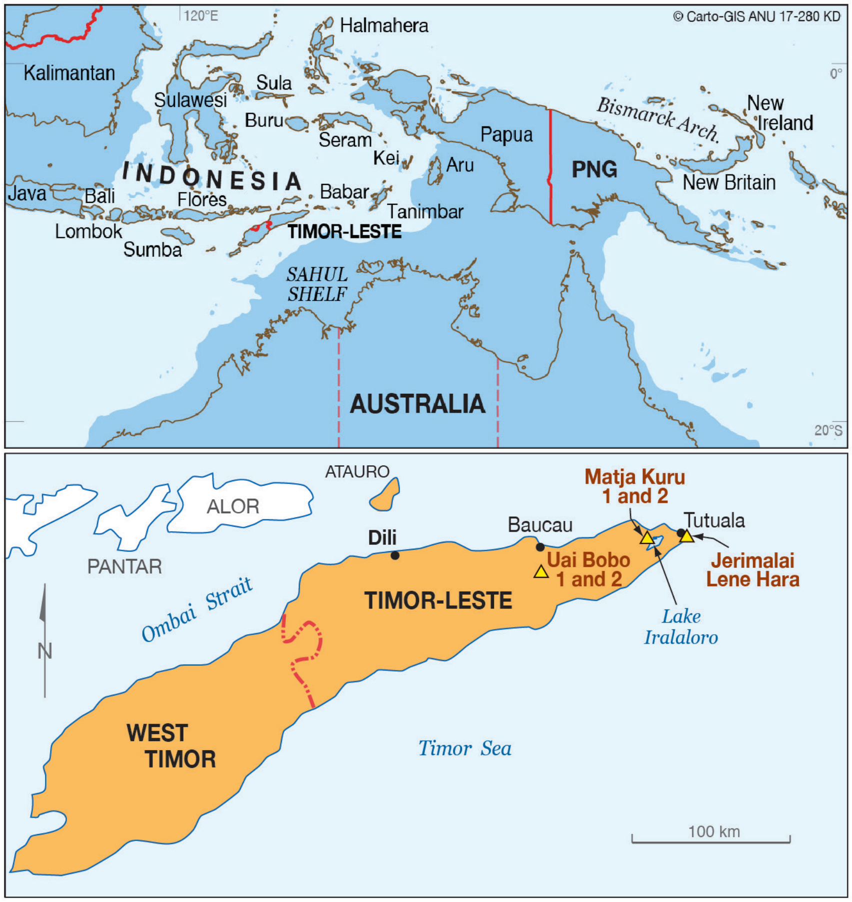

Figure 1. Location of sites within Timor-Lese, ISEA.

1, and Matja Kuru 2 in Timor-Leste, have uncovered a large assemblage of utilized ochre pieces stretching back some 40,000 years. Here we describe 100 ochre pieces which display unequivocal traces of processing and use, with many consistent with having been used to paint the bodies of those who visited these sites. Additionally, several examples exhibiting particularly clear prehensile wear were identified, along with ochre stained grindstones, grinding and scraping tools, and a possible mastic fragment.

CONTEXT

The sites of Jerimalai (8′24.84′ S, 127′17.50′ E) and Lene Hara (8′24.35′ S, 127′17.58′ E) are located less than a kilometer apart and within a kilometer of the current coastline at the easternmost tip of Timor-Leste, southeast of the village of Tutuala (Figure 1). They are formed in uplifted Pleistocene marine terraces which run parallel to the coastline. As such, Jerimalai is a coralline limestone shelter approximately 75m above present sea level, with Lene Hara sitting at 100m above present sea level (based on GPS using WGS 84).

Excavation of Jerimalai was undertaken during July 2005, when two 1m x 1m square test pits were dug in the eastern and central area of the shelter (Squares A and B) (Figure 2). The Jerimalai deposit has an upper ceramic-rich and a lower aceramic horizon, and was excavated in spits varying from 1cm to 5cm thickness (average 2.2cm) within stratigraphic units, where such could be identified. Wet screening of all cultural deposits through 1.5mm mesh ensured recovery of even very small finds, including lithic micro-debitage and shell beads. Pottery occurred in the upper horizon, with stone artifacts, shell, and bone remains being found throughout the deposit. Owing to the fact that more than 50kg of anthropogenic marine shell was excavated from these two squares and that the deposit was cemented in the lower units, 3-D piece plotting of individual artifacts was not feasible, though items such as finished beads, obviously worked pieces of shell, and utilized ochre were separated and individually bagged when identified during wet sieving and sorting in the field. Other ochre pieces were only identified once back in the laboratory.

While the analysis of the Jerimalai cultural materials is ongoing, radiometric dating of the lower levels has already demonstrated that it is one of the oldest modern human occupation sites in ISEA (O'Connor 2007; O'Connor et al. 2011). The lowest sample from Test Pit A is dated to 43,381–41,616 cal. BP (38,255±596 BP, Wk-17831), while Test Pit B returned a date of 42,475–41,125 cal. BP (37,267±453 BP, Wk-17833) (see Figure 2). These samples place first occupation at Jerimalai at before 42,000 cal. BP. The radiocarbon dates indicate that the site saw little habitation during the Last Glacial Maximum (LGM), though it was occupied

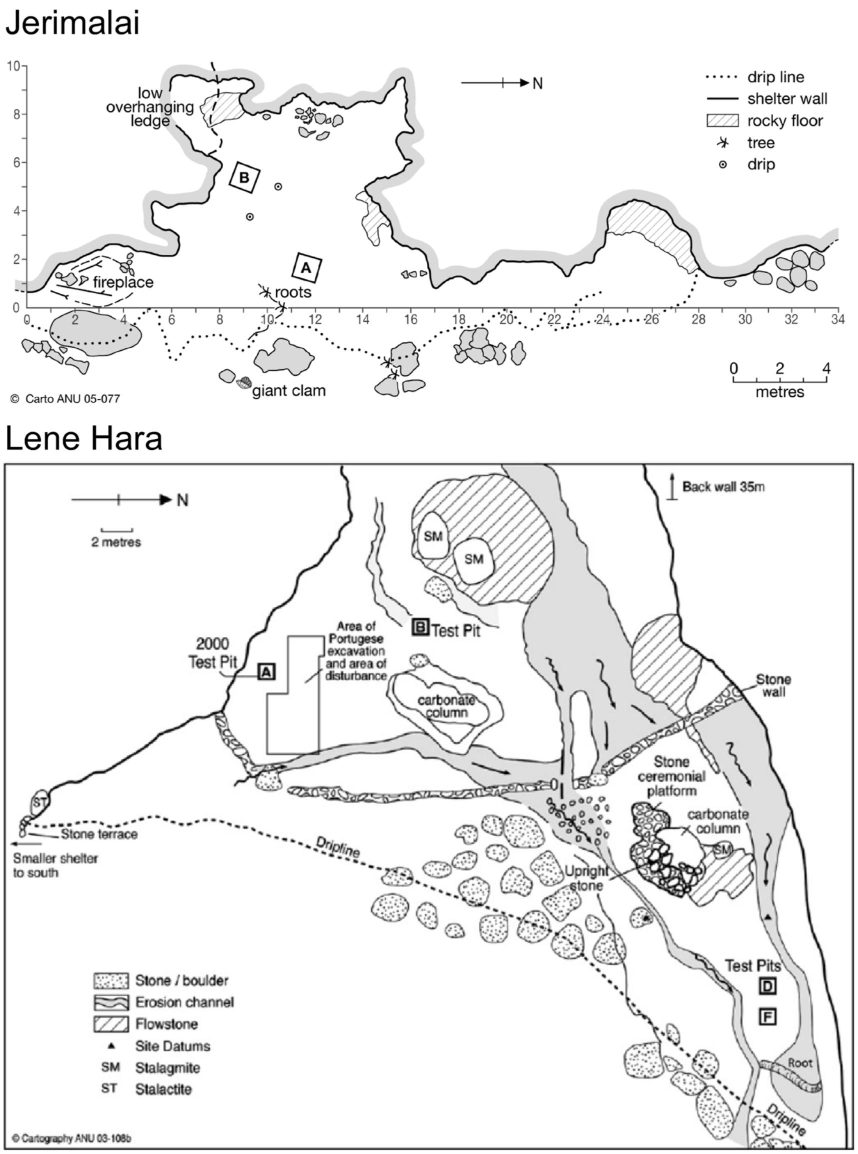

Figure 2. Floor plans of Jerimalai and Lene Hara.

during the early Holocene, before seeing more intense occupation after about 6000 cal. BP. While the currently available dates suggest that some depositional mixing has occurred in the middle section of the Jerimalai sequence (in levels dated to between c. 9,000 and 16,000 cal. BP; Table 1), we believe that post-depositional disturbance of these, and the lower levels, is minimal for two reasons: (1) some of the dates from these layers were obtained on shell artifacts, particularly *Oliva* shell beads which may represent heirloomed or reused artifacts deposited long after their creation (see Langley and O'Connor 2016); and, (2) the deposit becomes increasingly compact and carbonate cemented at depth, reducing the amount of bioturbation and other post-depositional disturbances that may affect the oldest layers.

At Lene Hara, excavation undertaken in 2000 and 2002 by one of the authors (SO) along with colleagues resulted in an initial 1m x 1m test pit (Test Pit A), which was positioned adjacent to Almeida's trench. It was excavated in approximate 5cm spits, with all material wet sieved through fine mesh (<2mm) (see Figure 2). The sequence is comprised of an upper dark sediment which was found to be a mixture of silt, coarse to very coarse sand, roof fall, and organics (including bone, shell, and some charcoal), and a lower unit starting from 30cm down. This lower unit had a higher silt content and significantly more roof fall, little charcoal but well preserved bone and shell.

In 2002, a second 1m x 1m test pit (Test Pit B) was sunk in the same area of the cave as Test Pit A, with two other test pits (Test Pit D and Test Pit F) also excavated, this time in the lower northern chamber (see O'Connor et al. [2010] and O'Connor and Veth [2005] for more details on this excavation). While Test Pit D was discontinued at a depth of only 0.8m below surface level, Pit F was taken down to a depth of 2.05m without reaching bedrock. The stratigraphy in this latter pit contained pottery down to a depth of

TABLE 1. DISTRIBUTION OF OCHRE IN JERIMALAI, SQUARE A.

SPIT	DATE	Material Dated	C14 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 4
1								
2				0.23				
3	2570±34 (Wk-19224)	Charcoal	2759–2695 (69.1%) 2635–2615 (6.6%) 2592–2501 (19.7%)					
4				0.9	0.11	1	G+R	1
5	3245±39 (Wk-19225)	Charcoal	3563–3387	1.32				
6	5341±41 (Wk-18154)	*Turbo* sp.	5835–5598					
7				2.9	0.06	2	G; G	7, 8
9				0.84				
11				4.26	0.69	1	G+R	21
12	5567±44 (Wk-18155)	*Turbo* sp.	6100–-5866					
13	5549±62 (Wk-17829)	*Turbo* sp.	6114–5760	2.43	0.73	1	G+R	18
14				0.36				
17				0.33	0.32	1	G+S+R	5
18				0.88				
21	5909±40 (Wk-19226)	*Turbo* sp.	6420–6244					
22				0.59	0.17	1	G+S+R	2
23				0.64				
25				1.28				
26	10,110±79 (Wk-18156)	*Haliotis* cf. *varia*	11,265–10,865	1.47				
27	19,952±235 (Wk-17830)	*Turbo* sp.	24,100–22,959	0.75				
29				0.91				
38				0.64	0.64	1	G	4
TOTAL				***20.73***	***2.72***	***8***		

*G=Grinding, S=Scraping, R=Rubbing.

0.7–0.75m, with the transition to ceramic cultural horizons below this level clearly defined. Radiocarbon dates for this square support a model of net accumulation and continuous deposition throughout the Holocene in this northern section of the cave. Preservation of both shell and bone are broadly similar at all excavated levels, and as with other parts of the site, charcoal was not found below the upper 0.2m of the deposit. Thus, marine shell was used for dating.

The cave sites of Matja Kuru 1 (MK1) (8’24.87’ S, 127’07.36’ E) and Matja Kuru 2 (MK2) (8’24.88’ S, 127’07.42’ E) are located adjacent to each other in an uplifted limestone ridge north east of the modern village of Poros, and only a few hundred meters north from Lake Ira Lalaro. They are approximately 370m above sea level and around 8km in straight-line distance from the north coast of Timor-Leste (see Figure 1), with MK2 a few hundred meters to the east of MK1 along the same cliff line. Archaeological investigation of these sites consisted of a 1m x 2m test pit (conjoined Squares A and AA) excavated at MK1, while a 1m x 1m test-pit was sunk into MK2 (Square D) (Figure 3).

At MK1, the oldest date returned was 16,355–15,566 cal. BP (13,690±130, ANU-11616 from Square AA, Spit 21), though most of the deposit built up between 5600–4600 BP (Veth et al. 2005). Archaeological material consists of stone artifacts along with lake fauna such as freshwater turtles and fish, terrestrial fauna such as large rodents, as well as marine shellfish and fish, with these last being a continuous presence throughout the sequence. Some disturbance of the MK1 lower deposit is indicated by an inversion in dates—a date of 11,098–10716 cal. BP (9940±60, OZF- 784) was obtained from a unit 15–20cm lower in the profile (Spit 25) than a date of 16,355–15,566 (13,690±130, ANU-11616) from Spit 21.

Human use of MK2 begins sometime prior to 35,000 years ago with an age estimate of 36,866–35,285 cal. BP (32,220±300, OZF-785) for a near basal unit (Spit 47) re-

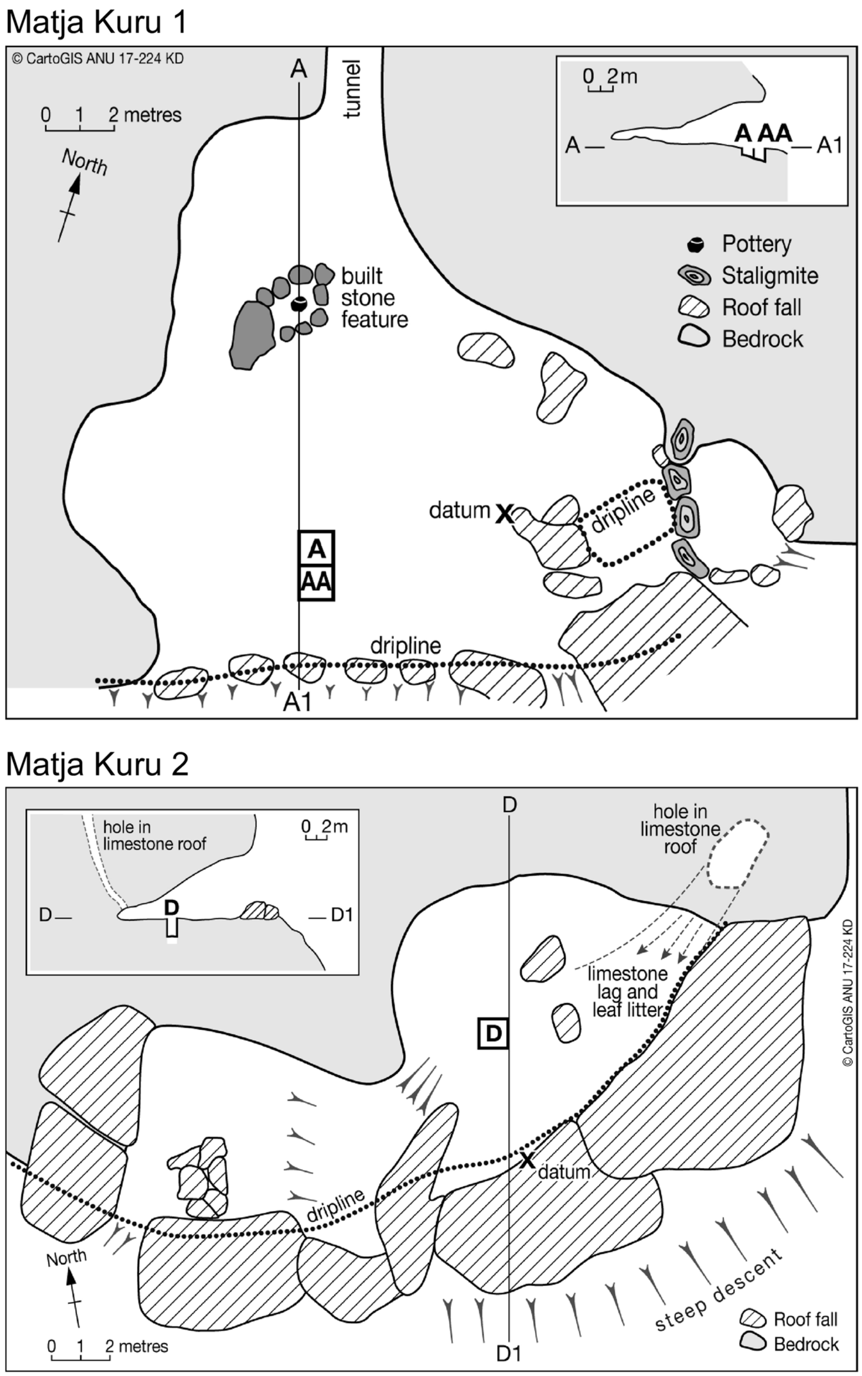

Figure 3. Floor plans of Matju Kuru 1 and Matju Kuru 2.

turned, though it should be noted that excavation was discontinued prior to reaching bedrock (O'Connor and Aplin 2007). Dating of Spits 41 and 44 at MK2 confirmed this antiquity, with ages of 36,268–34,649 cal. BP (31,060±310, NZA-16177) and 35,882–34,575 cal. BP (31,660±320, NZA-16178) respectively. At this site, cultural material includes stone artifacts, faunal remains, and marine shellfish which were most abundant in the lowest levels dated to between c. 32,000 BP and 31,000 (Spits 49–41) (Veth et al. 2005). A stone-lined oven dated to around 10,000 years BP was uncovered in Spits 19–25, while a dog burial dug from higher in the sequence was interred in Spit 25 and directly dated to 2921–3075 cal. BP (2967±50, WK-10051) (Gonzalez et al. 2013).

Both MK1 and MK2 appear to have slightly different records of occupation. MK2 constituted an attractive temporary campsite from around c. 35,000 years ago, before abandonment during the LGM and then occasional occupation across the Pleistocene-Holocene transition and through the early Holocene. The site then appears to have become much less attractive to people, perhaps owing to an opening of a hole in the roof at the back of the shelter

(O'Connor and Aplin 2007) (see Figure 3). MK1 was not used until ~15,000 years ago, when unlike MK2, it provided good shelter, and continued use of the space resulted in sedimentary buildup increasingly creating a conveniently flat floor within the shelter. Most intense use of MK1 occurred during the mid-Holocene period following sea level stabilization between 6,000 to 4,000 years ago, although MK2 was not as heavily occupied at this time (O'Connor and Aplin 2007).

METHODS

The material to be described below was examined using a Zeiss 2000-C stereomicroscope fitted with an AxioCam MRc5 camera, along with a Zeiss 508 stereomicroscope fitted with an AxioCam 105 camera. Taphonomic and anthropogenic traces were identified according to previously published examples of similar colorant assemblages and experimental regimes (e.g., Dayet et al. 2014; Henshilwood et al. 2009; Hodgskiss 2010; Hodgskiss and Wadley 2017; Lombard 2007; Marean et al. 2007; Rifkin 2012; Wadley 2005), as well as previous examinations of utilized bone, antler, ivory, wood, and shell pieces (Langley 2015; Langley et al. 2016a; 2016b; 2016c; 2016d). The localization and extent of anthropogenically modified areas, the techniques used, and their chronology were systematically recorded for each piece, with features of interest photographed using AxioVision and Zen software on the microscopes. A Canon EOS 400D digital camera produced macro-photographs of each artifact, these images imported into the *Canvas XII* illustrating program to produce tracings and the illustrations provided herein.

It should be noted that in this paper, we will use the term 'ochre', a general denomination used in the archaeological literature to describe a range of iron-rich minerals, such as hematite or goethite, and which refer to any earth mineral which leaves a purple, red, or yellowish streak when applied to another surface. Characterization of the pigment color was determined visually with like pieces grouped according to a spectrum of six shades ranging from black, through red to dark yellow developed for this study.

Dates provided in Tables 1–8, along with all others presented in this paper are given as calibrated (cal. BP), unless citing those published by other authors. Dates were calibrated in OxCal v.4.2 (Bronk Ramsey 2009). Charcoal radiocarbon samples were calibrated using the SHCal13 Southern Hemisphere curve (Hogg et al. 2013), and marine shell samples calibrated using the Marine13 modelled ocean average curve (Reimer et al. 2013). No ΔR values were used in the calibration of marine samples owing to the unknown values for the region, but it is likely to be small with values throughout Indonesia and along the northern coast of Australia averaging 32±41 ^{14}C years (Fallon and Guilderson 2008; Guilderson et al. 2009; O'Connor et al. 2010; Southon et al. 2002). All dates are given to 95.4% probability.

RESULTS

Evidence for the processing and utilization of ochre at the Timorese sites come from two sources: ochre fragments bearing signs of manipulation and ochre-stained artifacts. Here we will describe both the ochre fragments and implements used in processing them. A large collection of marine shell ornaments bearing traces of red ochre consistent with having been worn against painted bodies or other items have been described previously (Langley and O'Connor 2015, 2016; Langley et al. 2016c), and will be discussed below in the wider context of ochre use in past Timor-Leste.

To begin with the ochre fragments, in total 100 pieces which display clear traces of utilization, weighing 180.2gm in sum, were identified from the four sites. Each of these artifacts are illustrated in Figures 4–7, and their stratigraphic location and age association is indicated in Tables 1–8. A further 724.6gm of ochre also was recovered from these same excavations (also listed in Tables 1–8), though examination of these pieces found no unequivocal signs of processing or use. Nevertheless, they may still be considered as artifacts, having had to have been brought into the caves by their human occupants.

Mulberry to bright red colors are dominant in the Timor-Leste pigment collection, though a large black piece, and two truly yellow examples also are present (see Figures 4–7). Use wear observed consisted of grinding and/or scraping with a sharp-edged tool. Grinding, the action of drawing the ochre piece across a coarse surface, results in flat or slightly convex facets covered with multiple fusiform striations (d'Errico and Nowell 2000; Henshilwood et al. 2009), while scraping typically produces parallel striations of different width and depth resulting from projections on the working surface of the employed tool (Henshilwood et al. 2009). When the same tool is repeatedly drawn across the same area, the grooves created by these projections are widened and the whole area becomes increasingly concave (Henshilwood et al. 2009). These modifications, grinding and scraping, are primarily undertaken in order to produce powder—which appears to be the case with the Timor-Leste material (see examples in Figure 8). Sixty-nine pieces display evidence for having been ground (69%), while 17 exhibited surface alteration by scraping (17%). Five pieces were both ground and scraped.

Fifty-nine pieces also display evidence for having been rubbed on a surface consistent with skin or hide (71%). Rubbing on such surfaces produces few or no grooves, but often yields polishes and residues. Pieces usually have rounded edges, with smoothing generally occurring on raised areas (Hodgskiss 2010). When rubbed on human skin, specimens may acquire residual glossy sheens, most prominent on elevated areas (Rifkin 2012). Similarly, Rifkin (2012) found that carrying ochre 'crayons' in a leather pouch for several days resulted in most of the residual powder left from grinding/scraping being removed from the surface of the piece, and its angular edges acquiring a 'clean' polished appearance. The pieces labelled in Tables 1–8 as exhibiting signs of rubbing not only show rounded edges (like those carried in a bag), but extensive smoothing of the areas covered by grinding/scraping striations. While there is no doubt that at least some of the smoothing observed

TABLE 2. DISTRIBUTION OF OCHRE IN JERIMALAI, SQUARE B.

SPIT	DATE	Material Dated	C^{14} 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 4
2				2.25				
3	124±32 (Wk-19228)	charcoal	274–184 (34.3%) 178–174 (0.9%) 151–54 (45.0%) 48–10 (15.2%)					
4	4962±50 (Wk-19229)	*Turbo* sp.	5454–5171 (93.4%) 5162–5131 (2.0%)	4.82	1.09	1	G+S+R	26
5				2.83	1.06	1	G	31
6				5.60				
7				0.15	0.15	1	G+R	16
9	4580±42 (Wk-19230)	*Tectus* sp.	4901–4641	12.7				
10				2.04				
11				6.26	3.83	3	S+R; S; G	10, 20, 24
12				3.04	1.19	1	G	32
13				8.71				
14				17.27	1.23	1	G+R	23
16	4867±42 (Wk-18157)	*Tectus* sp.	5293–5032	2.25	1.59	1	G+R	33
18				0.58				
19				2.37				
20				0.37	0.26	2	S+R; S+R	3, 6
21	5595±43 (Wk-18158)	*Tectus* sp.	6122–5888	0.64				
22				1.78	0.82	1	R	11
23	5694±45 (Wk-18159)	*Tectus* sp.	6228–5972	6.13	5.05	2	G+R; S	29, 34
24				1.42	1.42	1	G	25
26				5.09	1.18	2	G+R; G	9, 19
27				1.64	0.74	1	S	22
29				0.52	0.38	1	G+R	15
30				0.81				
31				0.61				
32				4.67				
33	5939±45 (Wk-17832)	*Tectus* sp.	6454–6265	0.66				
34	6118±41 (Wk-19316)	*Nautilus* shell bead	6654–6434	0.26	0.26	1	G	13
35				0.79				
37				1.65	1.00	1	G+R	27
38								
39				0.42	0.31	1	G	28
40	8879±78 (Wk-19231)	*Tectus* sp.	9767–9390					
41	6223±26 (Wk-30500)	*Oliva* shell bead	6755–6586					
42	5575±27 (Wk-30501)	*Oliva* shell bead	6057–5887	0.53				

TABLE 2. DISTRIBUTION OF OCHRE IN JERIMALAI, SQUARE B.

SPIT	DATE	Material Dated	C14 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 4
43	13,901±45 (Wk-30502)	*Oliva* shell bead	16,461–16,057	0.99	0.30	1	R	17
46	9457±32 (Wk-30503)	*Oliva* shell bead	10,406–10,207					
49	14,007±146 (Wk-18160)	*Haliotis* cf. *varia*	16,907–16,001	0.33				
50	13,778±43 (Wk-30504)	*Haliotis* cf. *varia*	16,261–15,907	0.86				
52				0.28				
53				2.23				
55				0.22				
56	33294±380 (ANU-48106) 35,387±534 (Wk-19232)	*Oliva* shell bead *Tectus* sp.	38,246–36,136 40,796–38,495					
58				2.34				
60				2.45	1.92	2	G; G+R	14, 30
62				0.33	0.33	1	G	12
66	37267±453 (Wk-17833)	*Tectus* sp.	42,161–40,570					
TOTAL				***108.89***	***24.11***	***26***		

*G=Grinding, S=Scraping, R=Rubbing.

TABLE 3. DISTRIBUTION OF OCHRE IN LENE HARA, SQUARE A.

SPIT	DATE	Material Dated	C14 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 5
2	1030±60 (ANU-11400)	*Tectus niloticus*	691–508					
3				4.43	4.43	1	R	15
4	33150±550 (ANU-11419) 30,970±460 (ANU-11420)	*Lambis lambis* *Conomaurex luhuanus*	38,415–35,669 35,474–33,809	54.04	50.76	1	flaked core	Fig. 12:4
5	30110±320 (ANU-11398)	*Conomurex luhuanus*	34,485–33,258	0.70				
6				6.18	6.18	2	S; G	1, 14
7	4400±40 (OZF-212)	*Tectus* sp. *bead*	4705–4415	6.08				
10	3620±40 (OZF-213) 32440±400 (ANU-11399)	*Conomaurex* sp. *bead* *Conomaurex luhuanus*	3628–3404 36,920–35,004	3.84				
12				0.40				
14	30990±340 (ANU-11397) 34650±630 (ANU-11418)	*Conomaurex luhuanus* *Tectus* sp.	35,188–33,945 40,266–36,971	0.28				
18	30,950±360 (ANU-11401)	*Conomaurex luhuanus*	35,192–33,896	0.77				
19				0.06				
TOTAL				***76.78***	***61.37***	***4***		

*G=Grinding, S=Scraping, R=Rubbing.

TABLE 4. DISTRIBUTION OF OCHRE IN LENE HARA, SQUARE B.

SPIT	DATE	Material Dated	C^{14} 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 5
1				0.09				
2	18,740±400 (ANU-12138)	*Turbo argyrostoma*	23,133–21,156	1.80	0.29	1	G+R	4
3				29.59				
4				18.81				
5	18,380±220 (ANU-12141)	*Tectus niloticus*	22,353–21,192	71.5				
6				4.63				
7				13.66				
8				7.89				
9				4.49				
10	23,790±210 (ANU-12139)	*Tectus niloticus*	27,892–27,271	3.49				
11				3.71				
12				0.23				
13				4.13				
14				21.95				
15	25,770±630	*Tectus niloticus*	30,885–28,330	2.34				
16				1.81				
17				0.02				
TOTAL				***190.14***	***0.29***	***1***		

*G=Grinding, S=Scraping, R=Rubbing.

TABLE 5. DISTRIBUTION OF OCHRE IN LENE HARA, SQUARE F.

SPIT	DATE	Material Dated	C^{14} 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 5
5	1170±190 (ANU-12140)	*Tectus niloticus*	1146–444					
7				0.98				
10	3305±190 (ANU-12136)	*Tectus niloticus*	3603–2721					
11				1.23				
13				3.12				
14				9.61				
16	3850±70 (ANU-12041) 3200±240 (ANU-12029)	*Tectus niloticus* Charcoal	4003–3607 4075–4039 (0.7%) 3993–2844 (94.4%) 2817–2804 (0.2%)	54.64				
17				7.16	5.85	1	R	16
18				3.11				
20	4370±70 (ANU-12042)	*Tectus niloticus*	4775–4345					
22				0.31	0.06	1	G+R	5
23	4900±40 (OZG-893) 5270±80 (ANU-12045)	*Nautilus* shell bead *Tectus niloticus*	5313–5051 5841–5466					
24				0.82				
26				0.90	0.34	1	G+R	2
27	5782±45 (NZA-16998)	*Nautilus* shell bead	6300–6085	0.31	0.22	1	G+R	8
28				4.74	2.58	1	S+R	13

TABLE 5. DISTRIBUTION OF OCHRE IN LENE HARA, SQUARE F (continued).

SPIT	DATE	Material Dated	C14 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 5
29				4.67	0.50	1	S	10
30	6200±90 (ANU-12044)	*Tectus niloticus*	6866–6426					
32				2.60				
33				2.16	0.14	1	G	6
34				3.49				
35	6890±50 (OZG-894) 6140±100 (ANU-12043)	*Tectus niloticus* fishhook *Tectus niolticus*	7500–7295 6816–6340	5.00	1.69	2	G+R; G+R	9,11
36				0.35	0.18	1	G+R	7
37				0.36				
38				0.22				
39				0.60				
40	7945±65 (NZA-16999)	*Oliva* shell bead	8556–8283	0.75				
41	7830±50 (OZG-895)	*Oliva* shell bead	8386–8178	3.27				
42	9741±60 (NZA-17000)	*Tectus niloticus* fishhook	10,841–10,491	4.41	0.49	1	G+R	12
43	10050±80 (ANU-12040	*Tridacna maxima*	11,209–10,791	0.95	0.24	1	G+R	3
TOTAL				***115.76***	***12.29***	***12***		

*G=Grinding, S=Scraping, R=Rubbing.

TABLE 6. DISTRIBUTION OF OCHRE IN MATJA KURU 1, SQUARE A.

SPIT	DATE	Material Dated	C14 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 5
2				0.15				
3				6.68				
5	4650±70 (ANU-11835)	*Lambis lambis*	5115–4680	1.36				
6				1.34				
7				0.47	0.03	1	G+R	15
8	5005±40 (NZA-16135)	*Lambis lambis*	5456–5274	1.22				
9				3.18				
10				2.84	1.05	2	G+R: G+R	11, 18
11				5.85				
12	3776±40 (NZA-17007)	*Chiton* sp.	3832–3595	5.94	0.05	1	G+R	16
13				1.57				Tool 1 in Fig. 11
14	3840±70 (ANU-11632)	*Cymbiola vespertilio*	3985–3597	0.18				
15				38.23	0.04	1	G+R	17
16				4.66				
17				4.46				
18				8.93	1.06	1	G+R	12
19				4.14				
20				3.11				
21				3.29				
22				3.85				
23				6.29				

TABLE 6. DISTRIBUTION OF OCHRE IN MATJA KURU 1, SQUARE A (continued).

SPIT	DATE	Material Dated	C^{14} 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 5
24				8.07	2.56	3	G+R; G+R; G+R	9, 14, 20 AND Flake in Fig. 12
25	5720±50 (OZF-782)	*Tectus* sp.	6256–5992	4.76				
26				4.00				
27	5280±80 (ANU-11624)	*Turbo chrysostomus*	5848–5475	9.1				
28				9.27	3.88	2	G+R; G+R	10, 19
29				6.77				
30				28.49	21.71	3	G; G+S+R; R	5, 6, 7 AND Tool 3 in Fig. 11
31	5680±110 (ANU-11623)	*Tectus niloticus*	6317–5851	4.96	2.19	3	S; S+R; G	3, 4, 13
32				2.79				
33				6.29				
34				2.90	0.54	1	G	2
35				2.24	0.76	1	S	1
Total				***197.38***	***33.87***	***19***		

*G=Grinding, S=Scraping, R=Rubbing.

is owing to taphonomic processes (removal of excess powders at least), the pairing of significant smoothing and often glosses over grinding/scraping striations, along with the fact that the recovered shell ornamentation featured ochre staining consistent with incidental transfer (from rubbing against a painted surface) suggests that the ochre was being rubbed onto either human skin or animal hide. As leather clothing (or other items) are not a feature of the material culture of Timor owing to a lack of suitable hide sources, it is most parsimonious that these archaeological signatures were produced by the painting of the human body. In total, 47% displayed evidence for both grinding and rubbing, with these 71 pieces showing the distinctive signs of grinding later smoothed and covered with a greasy polish (see Figure 10A–C below).

Another type of wear commonly observed in this assemblage was a metallic luster found in the valleys of striations (see Figure 8F), on the plateaus between the striations (see Figure 8H), and covering entire facets altered by grinding (striations visible) (see Figure 8I). This discoloration has been demonstrated by Rifkin (2012: 180) to be created during the grinding process owing to the heating of the mineral.

While most scraped pieces were worked using a lithic edge (see examples of characteristic striations of different width and depth in Figure 8A-C, G), several appear to have

TABLE 7. DISTRIBUTION OF OCHRE IN MATJA KURU 1, SQUARE AA.

SPIT	DATE	Material Dated	C^{14} 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 5
9	5010±60 (ANU-11620)	*Conus* sp.	5537–5238					
10								
11	4640±70 (ANU-11619)	*Lambi lambis*	5069–4641	3.34	1.58			
14								Tool 2 in Fig. 11
15				1.58		1	G?	8
TOTAL				***4.92***	***1.58***	***1***		

*G=Grinding, S=Scraping, R=Rubbing.

TABLE 8. DISTRIBUTION OF OCHRE IN MATJA KURU 2, SQUARE D.

SPIT	DATE	Material Dated	C^{14} 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 6
?				1.52				
4				0.41				
9				0.16				
10	2450±40 (NZA-16136)	*Modulus* sp.	2255–1978					
13	2510±50 (OZG-537) 3190±40 (OZG-538)	*Celtis* sp. *Marine shell*	2747–2427 (94.3%) 2393–2381 (1.1%) 3126-2862	0.36	0.36	1	G+R	22
14				0.32				
15	8966±55 (NZA-18656)	*Nautilus* shell bead	9817–9499	0.58				
16				2.39	1.97	1	G+R	2
17	10292±60 (NZA-17008)	*Chiton* sp.	11,609–11,146	0.40				
18				0.60				
19				0.78				
20				2.85				
21				1.18	0.17	1	G	10
21A				0.20				
22				0.24				
22A				1.74				
23				1.87				
24	4490±40 (OZG-896)	Drilled *Tectus* shell bead	4808–4554	2.37				
25	10078±60 (NZA-17009)	*Chiton* sp.	11,215–10,884	3.55				
26	9650±55 (NZA-16137)	*Chiton* sp.	10,691–10,381	2.72				
27				3.57	2.42	2	G+R; G+R	3, 24
28				6.80				
29				5.03				
30				10.71	2.42	2	G+R; G+R	7, 19
31	9190±50 (OZG-899)	*Nautilus* shell bead	10,155–9,801	41.35	14.15	10	G+R; R; G+R; R; S+R; G+R; R; R; R; R	5, 8, 13, 15, 17, 20, 21, 23, 25, 29
32	9205±55 (NZA-17001) 9260±60 (OZG-897) 11173±55 (NZA-16138)	*Nautilus* shell bead *Oliva* shell bead marine shell	10,172–9813 10,215–9890 12,785–12,570	18.00	11.03	3	G+R; R; R	4, 12, 27
33				2.13				
34				10.1	0.65	1	G+R	9
35	9260±50 (OZG-898)	*Nautilus* shell bead	10,200–9909	4.52	4.03	2	S+R; G	1, 28
36	26690±170 (OZG-737)	*Celtis* sp.	31,135–30,640	0.53				
41	31060±130 (NZA-16177)	marine shell	34,890–34,271	1.06				
42				6.91				
43				2.75	0.29	1	S	11
44				10.1	1.26	1	R	14
45				12.58	1.69	2	R; G	16, 26

TABLE 8. DISTRIBUTION OF OCHRE IN MATJA KURU 2, SQUARE D (continued).

SPIT	DATE	Material Dated	C^{14} 2σ cal yr B.P.	Total Ochre Weight (gm)	Modified Ochre Weight (gm)	No. with Clear Use Wear	Use Wear Type Present*	No. in Figure 6
46				6.67				
47	32200±300 (OZF-785)	marine shell	36,307–35,031	6.38	0.99	1	G+R	18
48				4.09				
49				10.66	2.55	1	G+S+R	6
TOTAL				***188.18***	***43.98***	***29***		

*G=Grinding, S=Scraping, R=Rubbing.

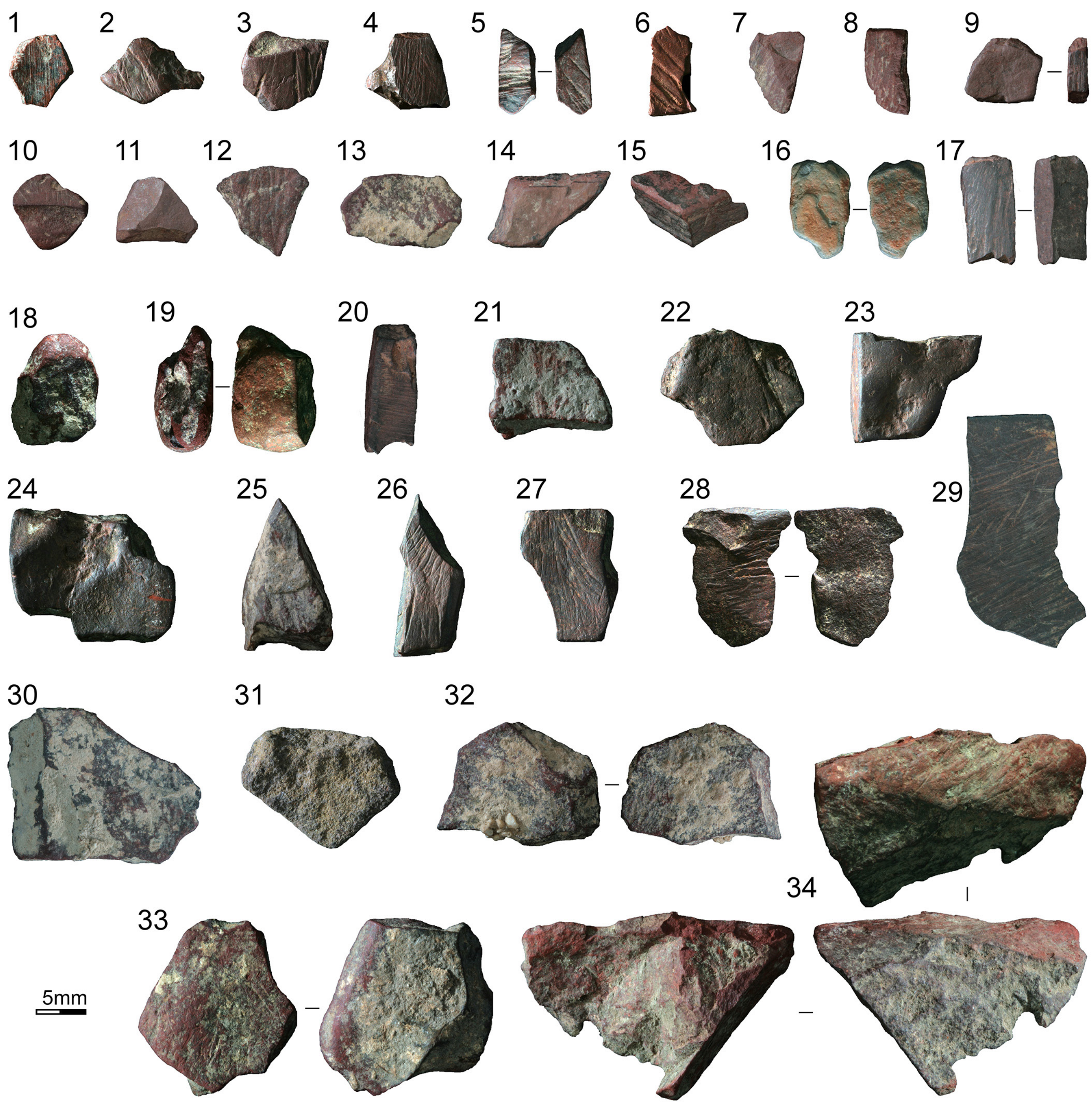

Figure 4. Jerimalai ochre with identifiable use wear.

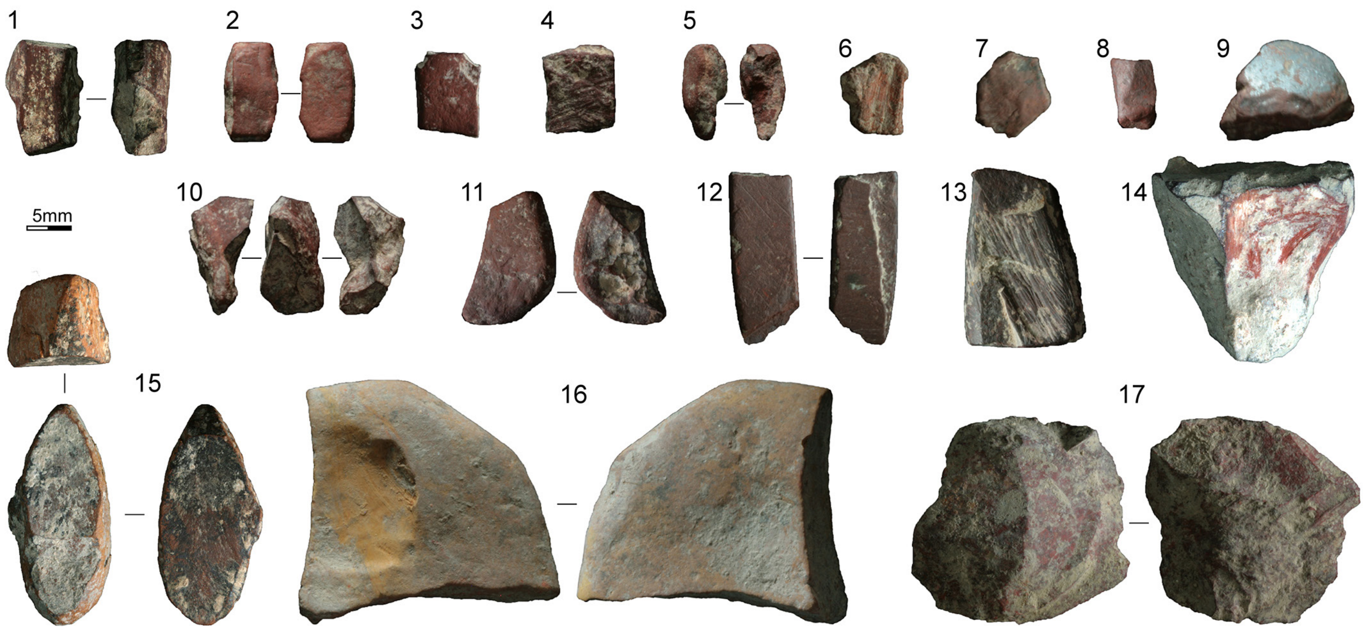

Figure 5. Lene Hara ochre with identifiable use wear.

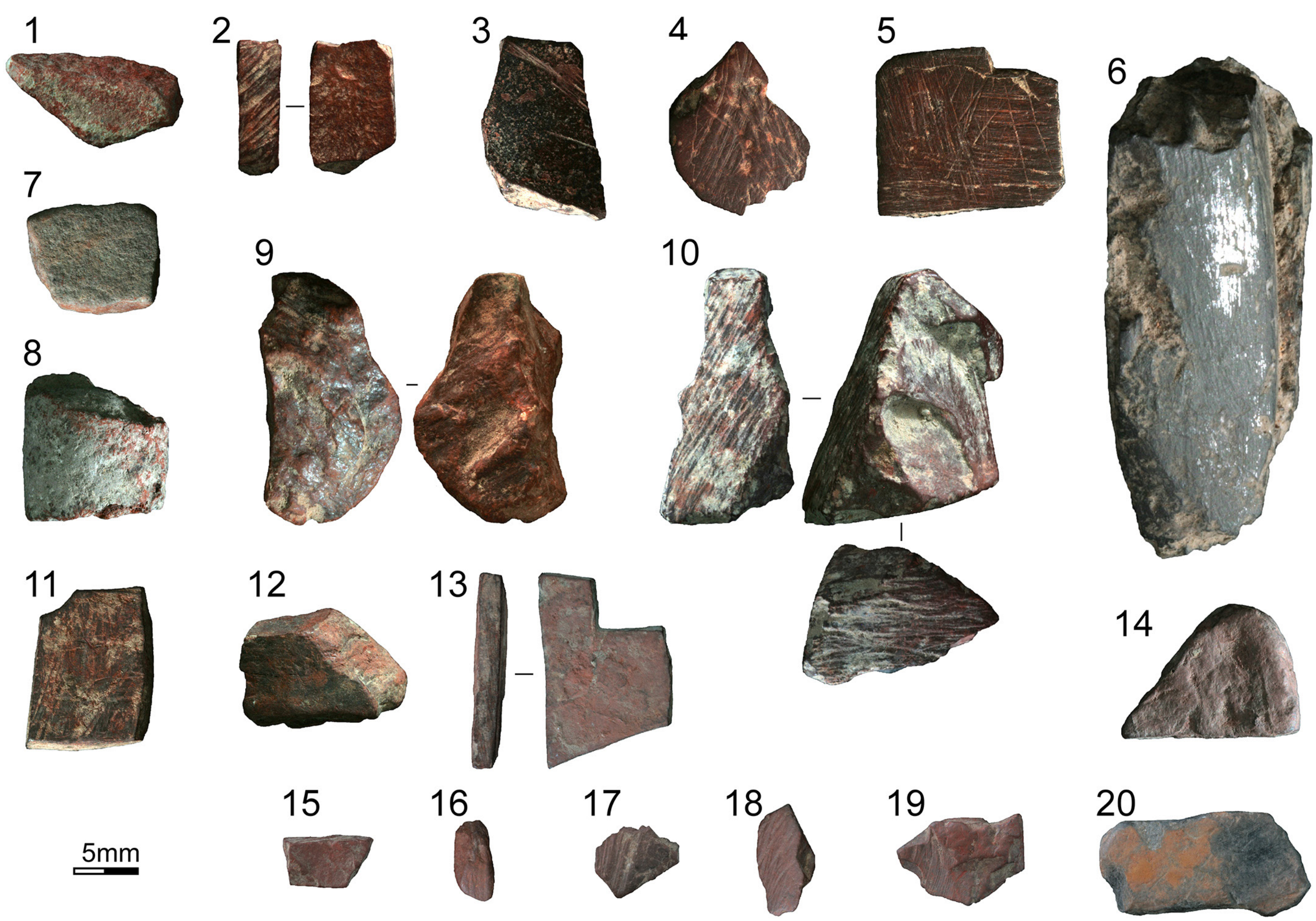

Figure 6. Matja Kuru 1 ochre with identifiable use wear.

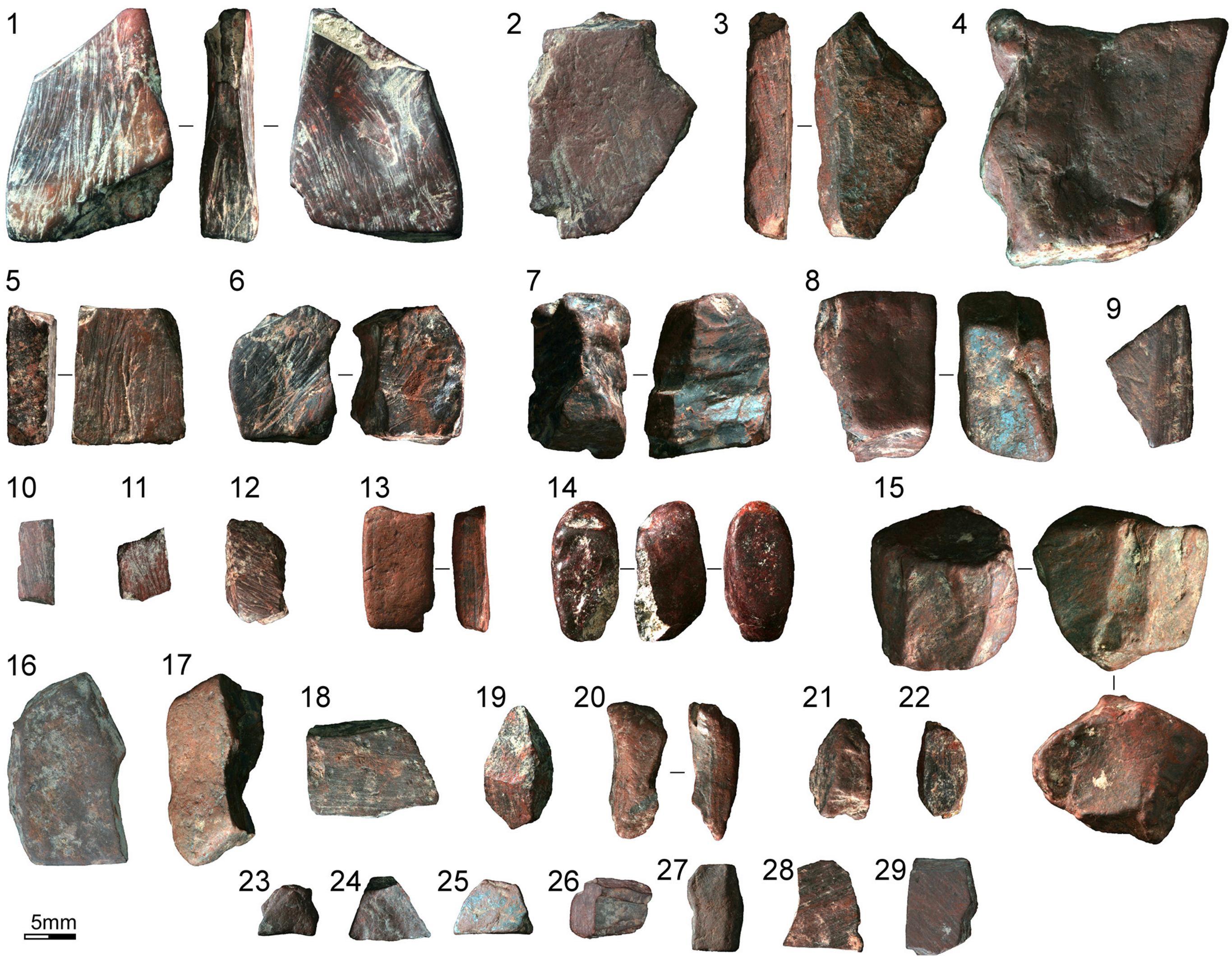

Figure 7. Matja Kuru 2 ochre with identifiable use wear. Number 14 may actually be a mastic fragment in which ochre is a component.

been scraped using a piece of shell. As shown in Figure 9A–C, these latter artifacts display striations that have a highly standardized and repeating pattern, more regular than one might expect from a carefully denticulated stone tool edge (for example). This regularity is exemplified by the example shown in Figure 9A. Interestingly, Henshilwood et al. (2009: 30) suggest that marine shell may have been used to scrape ochre at Blombos owing to the presence of a number of shells partially coated with ochre, so such a hypothesis is not without precedence, though in Timor similar ochre stained shells are yet to be identified among the excavated anthropogenic shell.

Also observed on one piece from Jerimalai (see Figure 4:24) and two from MK2 (see Figure 7:1 and 7:15) was prehensile wear, in the form of rounded areas smoothed, polished, and worn down by the skin of the finger. This wear is best shown in Figure 7:1, where one can clearly see the divots created by the piece being held between forefinger and thumb (Figure 10E), while it was ground along its proximal edge.

Another particularly interesting artifact, this one recovered from Spit 44 of MK2 (see Figure 7:14), presents a slightly different appearance to the other ochre artifacts. Dated to beyond 10,200–9909 cal. BP (Spit 35), this piece is only 13.3mm (l), 6.4mm (w) by 6.4mm (h), and presents a regular oval shape. Its edges are smooth (see Figure 9D), a crack is visible stemming from its distal surface (see Figure 9E), and small oval-shaped impressions are observed on its ventral surface (see Figure 9F). Overall, this piece does not appear to be simply another utilized ochre fragment, but rather a composite material including red ochre. Based on preliminary observations—impressions, molded form, color, and apparent composition—we would suggest that this artifact may represent a fragment of mastic.

Stone implements which appear to have been used in the processing of the ochre fragments just described also were identified. Four were excavated from MK1, and include a stone hammer or grinding implement (Figure 11:1), a stone anvil with pit (Figure 11:2), a pumice stone hammer/abrader (Figure 11:3), and a lithic flake exhibiting traces of red colorant along its active edge (Figure 12). On each of these artifacts, the colorant traces are consistent

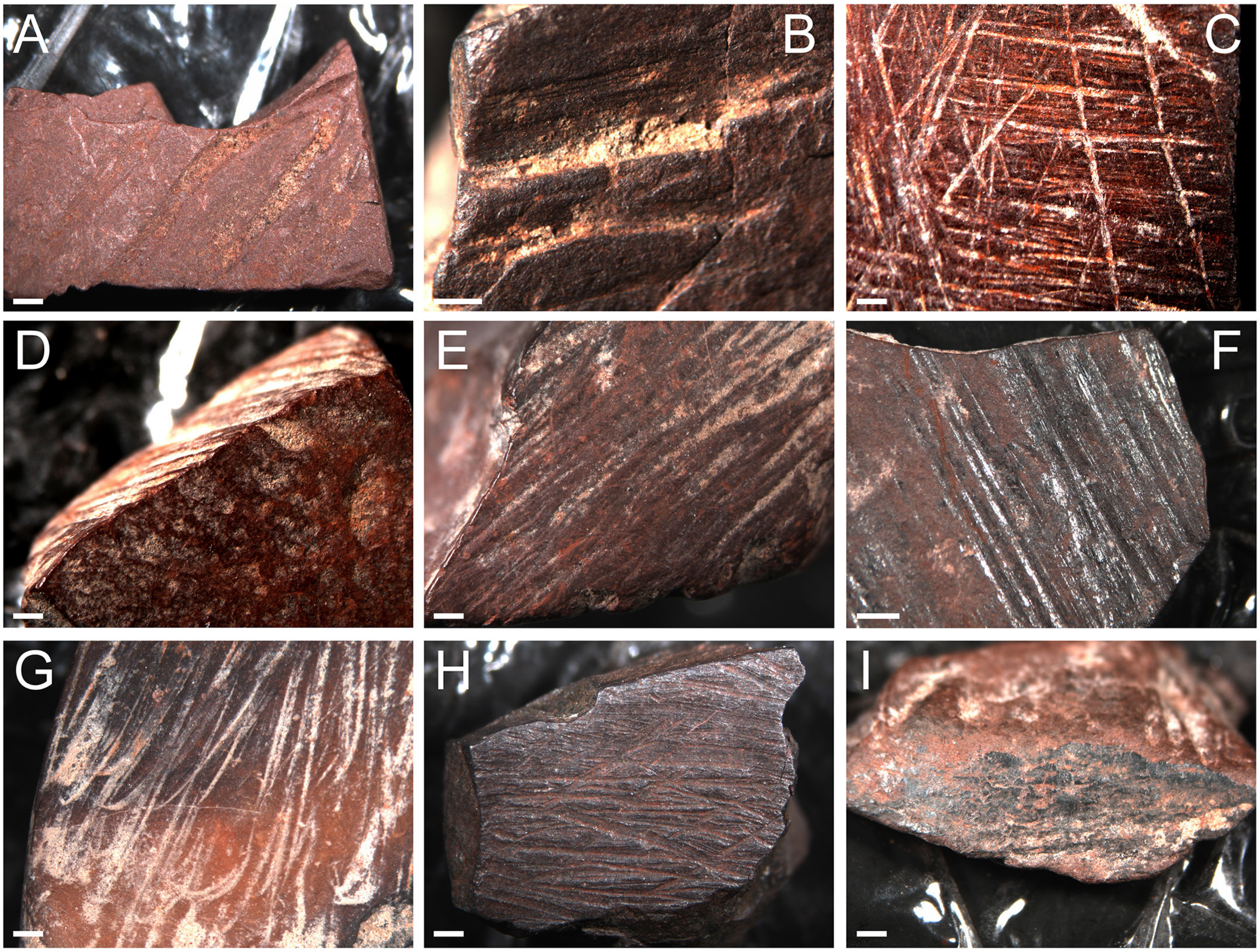

Figure 8. Typical grinding and scraping marks observed on the Timor-Leste ochre. A and B) deep incisions; C - F, H) grinding and/or scraping; G) scrape marks with feathered terminations; I) ground surface secondarily rubbed on skin (scale bar=1mm).

in color and consistency to the ochre fragments recovered from MK1 (and Jerimalai, Lene Hara, MK2), with the flake also displaying silica gloss (see Figure 12C). Two broken pieces of grinding stones exhibiting thick traces of red (see Figure 11:5), and, in one case, red and black colorants (see Figure 11:6) were also found at Lene Hara. Other indications of onsite ochre processing at MK1 and Lene Hara include numerous pieces of clearly flaked, but otherwise unprocessed, pieces of ochre. One such example from Lene Hara is shown in Figure 11:4.

No significant changes in the use wear patterns displayed by the ochre pieces through time were identified. Signs of grinding were always mirrored by roughly equal cases of rubbing—suggesting that these two are linked—while instances of scraping were much lower (by around four times) (see Tables 1–8). The connection between the traces of grinding and rubbing, along with the fact that the latter usually overlaid the former on the artifacts themselves, is a strong sign that grinding was undertaken in order to produce a powder for the application to another, non-abrasive, surface. Two peaks in ochre use are evident: the first centered around 31,000–35,000 cal. BP, and the second around 5000–6000 cal. BP. These two changes are mirrored in the marine shell ornamentation collections, with *Oliva* spp. beads first appearing at Jerimalai around 37,000 cal. BP. This type of shell bead saw a significant increase in use around 6000 cal. BP, coinciding with the first appearance of *Nassarius* shell beads around 6,500 cal. BP, before decreasing in deposition rate after 5000 cal. BP (Langley and O'Connor 2015, 2016; Langley et al. 2016c). Importantly, red ochre were found to be a feature of the use traces observed on the *Oliva* and *Nassarius* shell beads, with the quantity and distribution indicating that it has been gathered incidentally rather than deliberately. In other words, the beads had been worn against a painted body or painted piece of material culture. Given that the stratigraphic distribution of both forms of symbolic artifacts (beads and utilized ochre pieces) mirror the same trends, alongside the use wear evidence for rubbing of the ochre against skin of some form and the wearing of beads against a painted sur-

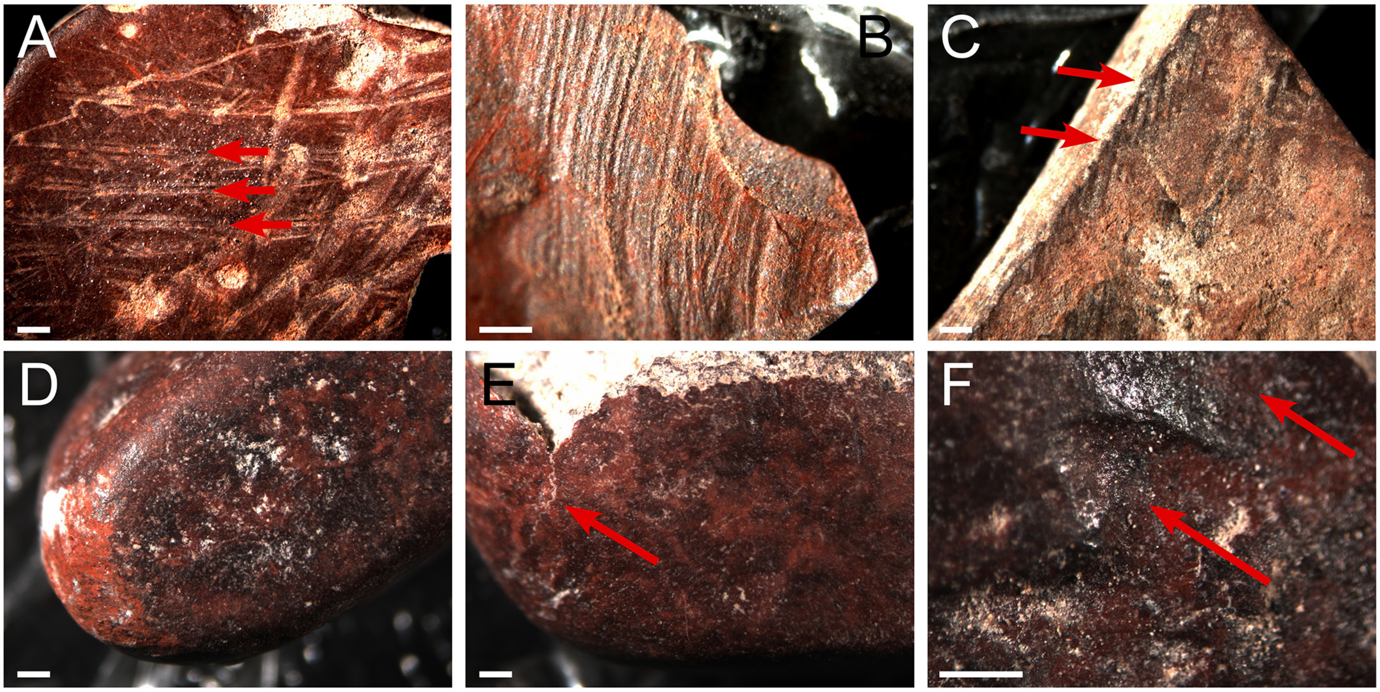

Figure 9. A - C) possible evidence for use of shell scrapers; D - F) possible 'mastic' piece from Matja Kuru 2 (scale bar=1mm).

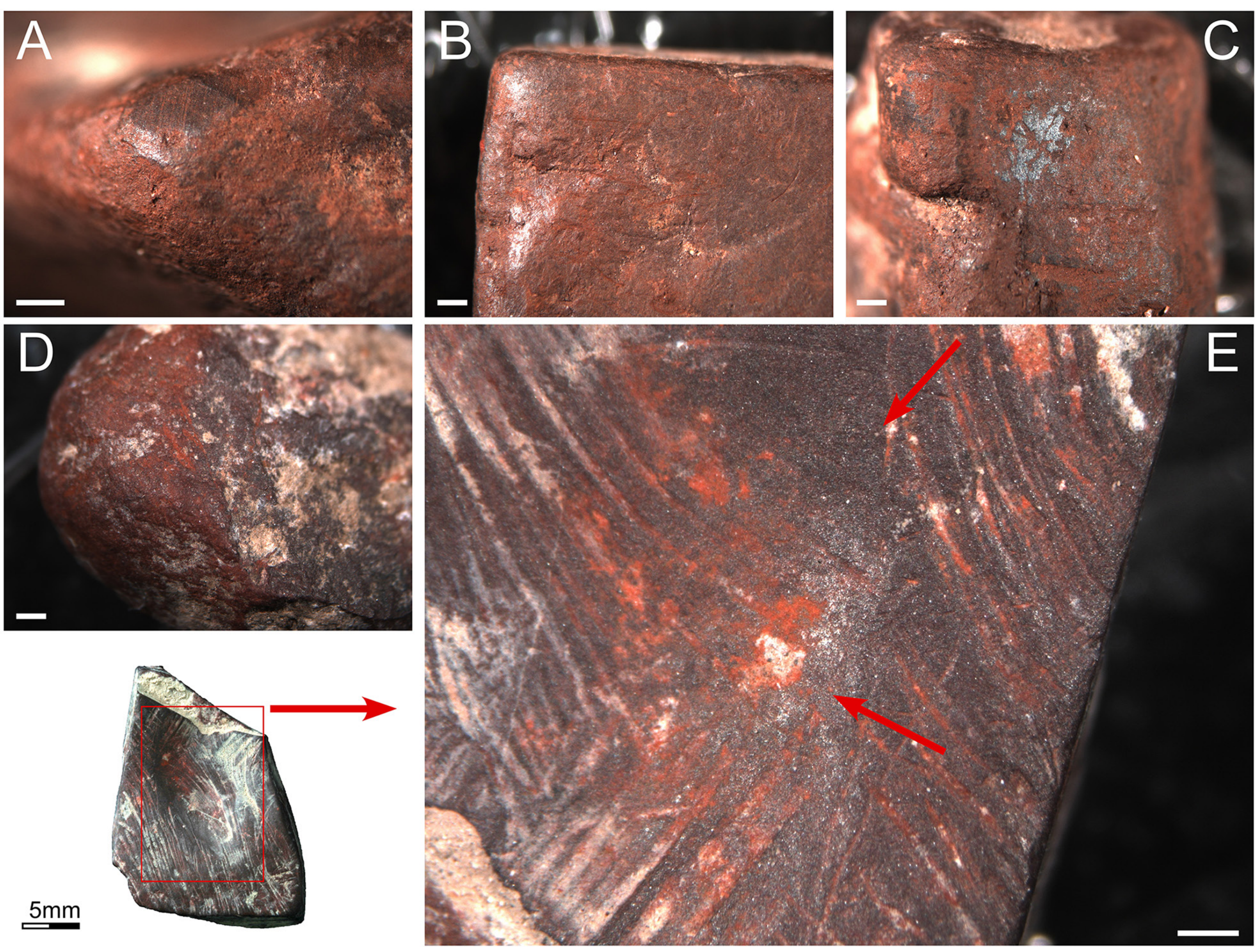

Figure 10. A - C) ochre pieces with use wear from grinding, followed by rubbing on skin; D) ochre piece formed into a 'crayon'; (E) ochre piece with prehensile wear from Matja Kuru 2 (scale bar=1mm).

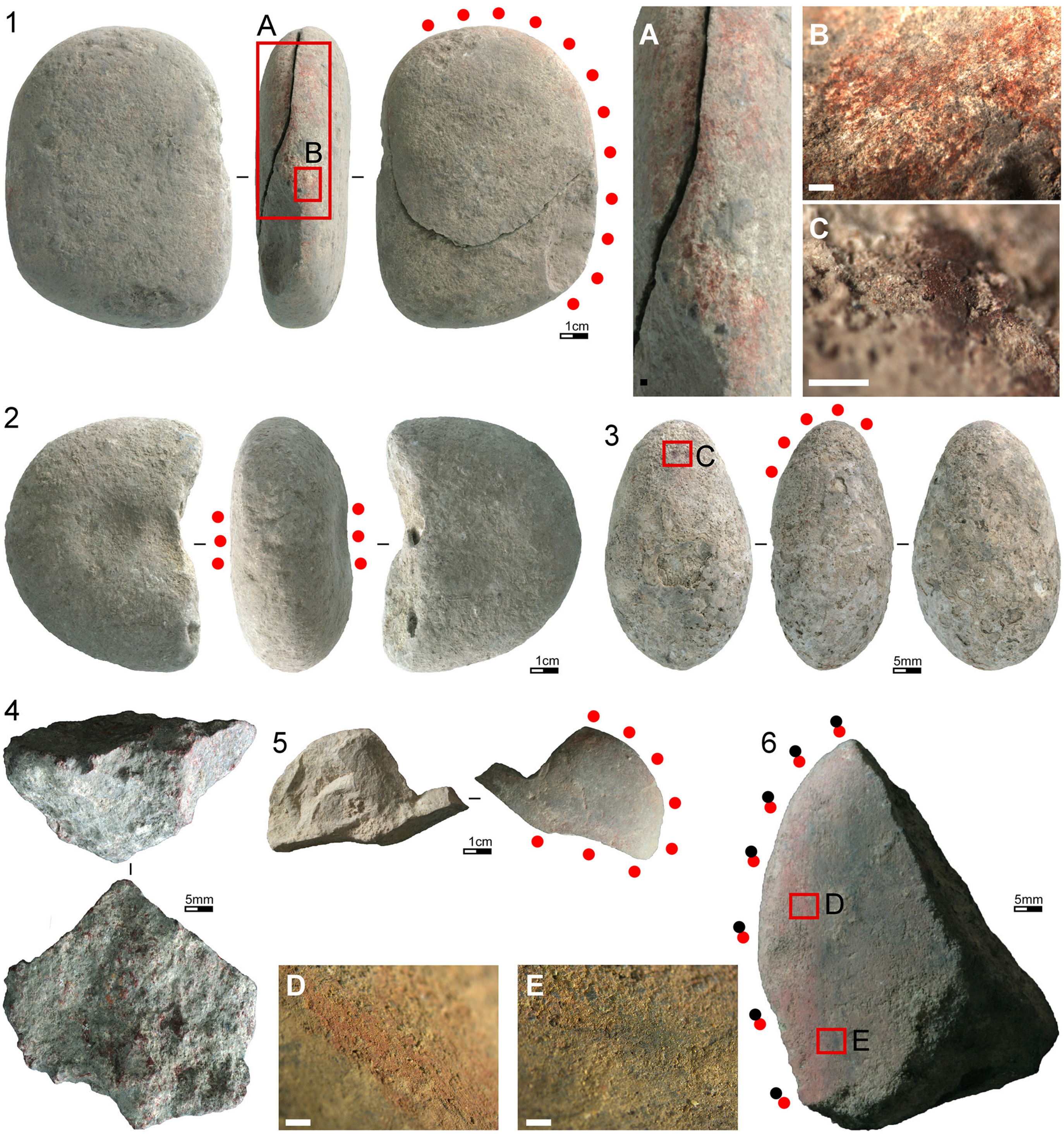

Figure 11. Grinding implements from Matja Kuru 1 (1 to 3) and Lene Hara (5 and 6). Number 4 is a core of red ochre from Lene Hara. Red/blacks dots indicate distribution of ochre of that color. Detail of ochre residue on stone and pumice surfaces (A - E) (scale bar=1mm).

face, it would appear supported that the occupants of both early and later Timor-Leste were practicing body painting as part of their decorative repertoire.

DISCUSSION

While evidence for Pleistocene ochre use and its association with the painting of the human body is frequently discussed in the literature for Africa and Eurasia (e.g., Barham 2002; d'Errico et al. 2010; d'Errico et al. 2012; Henshilwood et al. 2009; Henshilwood et al. 2011; Hovers et al. 2003; Mackay and Welz 2008; Watts 2010), similarly aged collections from securely dated contexts in SEA have been

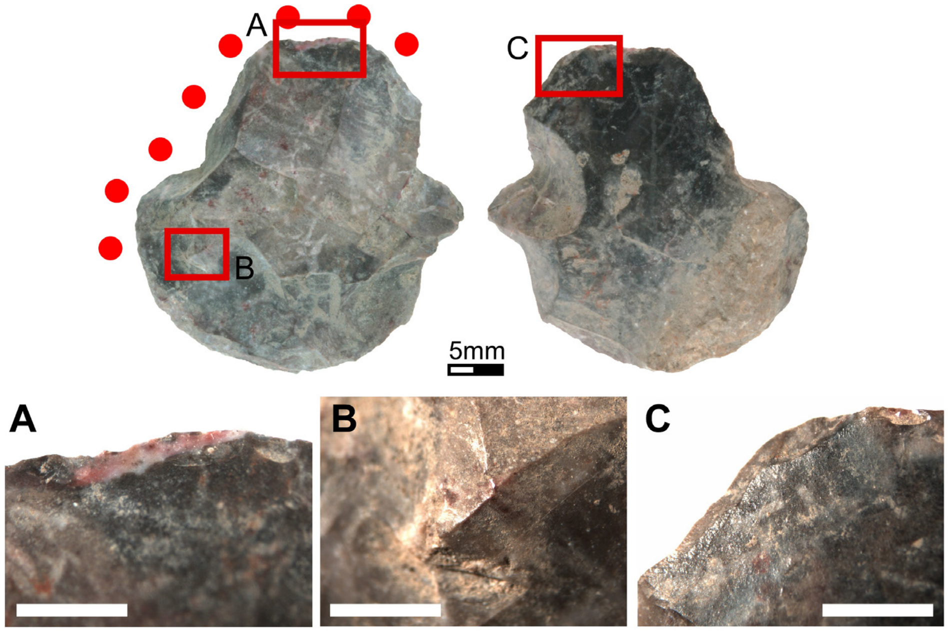

Figure 12. Lithic with gloss and ochre residues. Red dots indicate distribution of ochre around lithic edge. Detail of gloss and ochre residues (A - C) (scale bar=1mm).

lacking until now. Indeed, in this region, previous reports have been restricted to several small finds from Terminal Pleistocene deposits, including Sodong Rockshelter, Indonesia for which Van Heekeren (1972: 104) notes that "pieces of haematite (iron oxide) were found everywhere," while ochre nodules with traces of processing and/or utilization have been reported from Xom Trai and Du Sang Rockshelter both in Vietnam (Nguyen 2015), Leang Bulu Bettue, Sulawesi (Brumm et al. 2017), Leang Sarru, Salebabu, Indonesia (Tanudirjo 2005), Gua Tebok and Liang Jon, East Kalimantan, Indonesia (Chazine and Ferrié 2008), Leang Spean cave, Cambodia (Zeitoun et al. 2012), Toé Cave, Bird's Head of Papua (Pasveer 2004), and Khok Phanon Di, central Thailand (Higham and Bannanurag 1990).

For more recent contexts, the use of red ochre in mortuary practices is commonly described. As well as being included in burials as nodules ('crayons')—a funerary practice which is stated as being "quite common in the region" (Zeitoun et al. 2012: 535)—red pigment was frequently applied to both the bones of the deceased as well as large bivalves, (*Polymesoda* [Geloina] *erosa)* included as part of the grave goods in contexts dating to over the last 3500 or so years in Thailand, Sarawak, the Philippines, and surrounds (e.g., Datan 1993; Fox 1970; Harrisson 1957; Higham 2011; Thong 1980). Harrisson (1957: 136) commented that these shells are "clearly an object with specific burial significance used over five millennia or more — apparently the one thing to have carried over from the 'mesolithic' and flexed burials to the neolithic cremations…and other burial forms of later date."

Joining these examples but outside of a mortuary context is a *Cardium* sp. valve stained with ochre and with a hole at the umbo reported from Uai Bobo 2 shelter near Venilale, Timor-Leste. This site is a significant distance from the coast and the ~6000 cal. BP artifact is presumed to have been worn as a decorative piece (Glover 1986: 167, 180, 184–185). Of note in discussing the use of red colorants in ISEA are a number of bone and terrestrial shell items—two *Polymesoda* (Geloina) shells, a human cranial fragment with staining on the inner surface, and *Anadara* (Tegillarca) shell disc beads—from Niah Cave and Gua Sireh were found to have been colored using a tree resin (*Pterocarpus indicus)* based colorant (Pyatt et al. 2011). Other red painted items of material culture from Niah include a fragment of hard-shelled turtle plastron with a pigmented section with a straight and clearly defined perimeter suggesting that the colorant could have been intentionally applied. This artifact comes from layers dated to 35,890±250 BP (40,489–41,613 cal. BP, OxA-15163) and 36,470±250 BP (41,089–41,978 cal. BP, OxA-15164), though it is unclear whether the colorant is haematite or resin based in this case (Reynolds et al. 2013).

Also of archaeological value is the recovery of ochre processing implements from Lene Hara and MK1. Isolated finds of ochred grindstones and mixing palettes have been found in several locations across SEA, with examples recovered from Late Pleistocene to Middle Holocene contexts in southern Thailand and Malaysia (Anderson 2005), in Hoabinhian deposits at Spirit Cave, north Thailand (Gorman 1969, 1972), as well as on East Kalimantan, Indonesia (Chazine and Ferrié 2008), Uai Bobo 2, Timor-Leste (Glover 1986), and Palawan in the Philippines (Fox 1970). A stone palette containing ground ochre was found in a ~6000 cal. BP level of Uai Bobo 2, Timor-Leste, of which Glover (1986: 180) notes that since there is no evidence for rock art in the Venilale region, the ochre must presumably have been prepared and stored for adornment of the body or portable items such as the perforated shell. Other indications of ochre processing previously reported in the literature include flaked tools exhibiting traces of red colorants consistent with scraping for the production of pigment powder. Such finds have been reported for Ille Cave, Palawan, Philippines (Pawlik 2013), Golo Cave, Indonesia (Szabó and Koppel 2015), and from Pleistocene deposits at Leang Bulu Bettue, Sulawesi (Brumm et al. 2017). Also found—and which may have been used in the processing of ochre—are three basalt blocks and a river cobble which all bear incised decorations and red ochre staining (Nguyen 2015). These artifacts were recovered from Hoabinhian contexts dated to between 22,000 and 19,000 cal. BP at Xom Trai, Vietnam (Nguyen 2015). Similarly, recent excavations in Australia's far northwest—not too far south of Timor-Leste—has recovered ochre stained grindstones dating back to Phase 3 (53,980–26,000 cal. BP) at Madjedbebe (Clarkson et al. 2015, 2017).

Perhaps most interesting, however, is the discovery of what appears to be a fragment of impressed ochred-mastic from a context dated to beyond 10,200–9909 cal. BP at MK2. Given that ochre has been found to be a component in adhesives elsewhere (Lombard 2006a, 2006b, 2007; Wadley et al. 2004), this hypothesis is not unfounded, though still to be thoroughly tested. Further analysis of this piece is currently underway and will hopefully give insight into its chemical makeup.

CONCLUSION

Red pigment colorants began to be used immediately following first occupation of the Timor-Leste sites about 42,000 years ago. Its use continued until recent times with peaks in use coinciding with peaks in other material evidence for occupation. Use wear on the ochre itself indicates that it was probably prepared for a variety of purposes including rubbing on the skin. While red painted rock art of similar antiquity to the ochre described here is known both in Timor-Leste and in other locations around ISEA (Aubert et al. 2007, 2014), the regular appearance of this substance on pieces of personal ornamentation throughout the region indicates that it also featured in the decoration of the body. Obviously, the earliest Modern Human communities of ISEA shared the love of rich red colorants for the purpose of decorating themselves that is demonstrated in the earliest African sites, and developed its use within their own material culture suites within their own flourishing societies.

ACKNOWLEDGEMENTS

We would like to thank Daniella Bar-Yosef Mayer and Maya Bosch for their invitation to join the HEPO Symposium in Tel Aviv, and all of the participants for their interesting presentations and discussions. The fieldwork during which the Timor-Leste ochre was recovered was supported by an Australian Research Council Discovery Grant (DP0556210), while the analysis and dating was funded by the Laureate Grant (FL120100156). In Timor-Leste we extend our thanks and appreciation to staff of the Ministry of Education and the Ministry of Agriculture and Fisheries. Permissions for the archaeological excavation were obtained from the Ministry of Education and Culture, Timor-Leste. We would particularly like to thank Mrs. Cecília Assis for facilitating this process. We would also like to acknowledge the support of the people of Tutuala and Poros who assisted with the excavations and without whom this research would not have been possible. Finally, Tim Maloney assisted with the calibration of the Timor-Leste dates reported in Tables 1–8 and Mirani Litster advised regarding the latin names of the shellfish species mentioned.

REFERENCES

Anderson, D. 2005. The use of caves in Peninsular Thailand in the Late Pleistocene and Early to Middle Holocene. *Asian Perspectives* 44, 137–153.

Aubert, M., Brumm, A., Ramli, M., Sutikna, T., Saptomo, E.W., Hakim, B., Morwood, M.J., van den Bergh, G.D., Kinsley, L., and Dosseto, A. 2014. Pleistocene cave art from Sulawesi, Indonesia. *Nature* 514, 223–227.

Aubert, M., O'Connor, S., McCulloch, M., Mortimer, G., Watchman, A., and Richer-Lalèche, M. 2007. Uranium-series dating rock art in East Timor. *Journal of Archaeological Science* 34, 991–996.

Barham, L. 2002. Systematic pigment use in Middle Pleistocene of south-central Africa. *Current Anthropology* 43, 181–190.

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51, 33–360.

Brumm, A., Langley, M.C., Moore, M.W., Hakim, B., Ramli, M., Sumantri, I., Burhan, B., Saiful, A.M., Siagian, L., Suryatman, Sardi, R., Jusdi, A., Abdullah, Mubarak, A.P., Haliana, Hasrianti, Oktaviana, A.A., van den Bergh, G.D., Aubert, M., Zhao, J.-X., Huntley, J., Li, B., Roberts, R.G., Saptomo, E.W., Perston, Y., and Sutikna, T. 2017. Early human symbolic behavior in the Late Pleistocene of Island southeast Asia. *Proceedings of the National Academy of Sciences USA* 114, 4105–4110.

Chazine, J.-M. and Ferrié, J.-G. 2008. Recent archaeological discoveries in East Kalimantan, Indonesia. *Bulletin of the Indo-Pacific Prehistory Association* 28, 16–22.

Clarkson, C., Smith, M., Marwick, B., Fullagar, R., Wallis, L.A., Faulkner, P., Manne, T., Hayes, E., Roberts, R.G., Jacobs, Z., Carah, X., Lowe, K.M., Matthews, J., and Florin S.A. 2015. The archaeology, chronology and stratigraphy of Madjedbebe (Malakunanja II): a site in northern Australia with early occupation. *Journal of Human Evolution* 83, 46.64.

Clarkson, C., Jacobs, Z., Marwick, B., Fullagar, R., Wallis, L., Smith, M., Roberts, R.G., Hayes, E., Lowe, K., Carah, X., Florin, S.A., McNeil, J., Cox, D., Arnold, L.J., Hua, Q., Huntley, J., Brand, H.E.A., Manne, T., Fairbairn, A., Shulmeister, J., Lyle, L., Salinas, M., Page, M., Connell, K., Park, G., Norman, K., Murphy, T., and Pardoe, C. 2017. Human occupation of northern Australia by 65,000 years ago. *Nature* 547, 306–310.

Datan, I. 1993. Archaeological excavations at Gua Sireh and Lubang Angin, Sarawak, Malaysia. *Sarawak Museum Journal* XLV (66).

Dayet, L., d'Errico, F., and Garcia-Moreno, R. 2014. Searching for consistencies in Châtelperronian pigment use. *Journal of Archaeological Science* 44, 180–193.

d'Errico, F. 2003. The invisible frontier. A multiple species model for the origin of behavioral modernity. *Evolutionary Anthropology* 12, 188–202.

d'Errico, F. 2008. Le rouge et le noir: implications of early pigment use in Africa, the Near East and Europe for the origin of cultural modernity. *Goodwin Series* 10, 168–174.

d'Errico, F., García Moreno, R., and Rifkin, R.F. 2012. Technological, elemental and colorimetric analysis of an engraved ochre fragment from the Middle Stone Age levels of Classes River Cave 1, South Africa. *Journal of Archaeological Science* 39, 942–952.

d'Errico, F. and Nowell, A. 2000. A new look at the Berekhat Ram figurine: implications for the origins of symbolism. *Cambridge Archaeological Journal* 10,123–167.

d'Errico, F., Salomon, H., Vignaud, C., and Stringer, C. 2010. Pigments from the Middle Palaeolithic levels of Es-Skhul (Mount Carmel, Israel). *Journal of Archaeological Science* 37, 3099–3110.

Fallon, S.J. and Guilderson, T.P. 2008. Surface water processes in the Indonesia throughflow flow as documented by a high-resolution coral $\Delta^{14}C$ record. *Journal of Geophysical Research-Oceans* 113. doi: 10.1029/2008JC004722.

Fox, R.B. 1970. *The Tabon Caves: Archaeological Explorations and Excavations on Palawan Island, Philippine*s. National Museum Publications, Manila.

Glover, I. 1986. *Archaeology in Eastern Timor, 1966-67*. Terra Australis, 11. Department of Prehistory, Australian National University, Canberra.

Gonzalez, A., Clark, G., O'Connor, S., and Matisoo-Smith, L. 2013. A 3,000 year old dog burial in Timor-Leste. *Australian Archaeology* 76, 13–20.

Gorman, C.F. 1969. Hoabinhian: a pebble-tool complex with early plant associations in Southeast Asia. *Science* 163, 671–673.

Gorman, C.F. 1972. Excavations at Spirit Cave, North Thailand: some interim interpretations. *Asian Perspectives* 13, 79–107.

Guilderson, T.P., Fallon, S., Moore, M.D., Schrag, D.P., and Charles, C.D. 2009. Seasonally resolved surface water Δ14C variability in the Lombok Strait: a coralline perspective. *Journal of Geophysical Research-Oceans* 114. doi: 10.1029/2008JC004876.

Harrisson, T. 1957. The great cave of Niah: a preliminary report on Bornean prehistory. *Man* 57, 161–166.

Henshilwood, C.S., d'Errico, F., and Watts, I. 2009. Engraved ochres from the Middle Stone Age levels at Blombos Cave, South Africa. *Journal of Human Evolution* 57, 27–47.

Henshilwood, C.S., d'Errico, F., van Niekerk, K.L., Coquinot, Y., Jacobs, Z., Lauritzen, S.-E., Menu, M., and García-Moreno, R. 2011. A 100,000-year-old ochre-processing workshop at Blombos Cave, South Africa. *Science* 334, 219–222.

Higham, C. 2011. The Bronze Age of Southeast Asia: new insights on social change from Ban Non Wat. *Cambridge Archaeological Journal* 21, 365–389.

Higham, C. and Bannanurag, R. 1990. *The Excavation of Khok Phanom Di*. Thames and Hudson, London.

Hodgskiss, T. 2010. Identifying grinding, scoring and rubbing use-wear on experimental ochre pieces. *Journal of Archaeological Science* 37, 3344–3358.

Hodgskiss, T. and Wadley, L. 2017. How people used ochre at Rose Cottage Cave, South Africa: sixty thousand years of evidence from the Middle Stone Age. *PLoS One* 12(4), e0176317.

Hogg, A.G., Hua, Q., Blackwell, P.G., Niu, M., Buck, C.E., Guilderson, T.P., Heaton, T.J., Palmer, J.G., Reimer, P.J., Reimer, R.W., Turney, C.S.M., and Zimmerman, S.R.H. 2013. SHCal13 Southern Hemisphere Calibration, 0–50,000 Years cal BP. *Radiocarbon* 55(4), 1889–1903.

Hovers, E., Ilani, S., Bar-Yosef, O., and Vandermeersch, B. 2003. An early case of color symbolism. Ochre use by modern humans in Qafzeh Cave. *Current Anthropology* 44, 491–522.

Langley, M.C. 2015. Investigating maintenance and discard behaviours for osseous projectile points: a Middle to Late Magdalenian (c.19,000 to 14,000 cal. BP) example. *Journal of Anthropological Archaeology* 40, 340–360.

Langley, M.C. and O'Connor, S. 2015. 6,500-year-old *Nassarius* shell appliqués in Timor-Leste: technological and use wear analyses. *Journal of Archaeological Science* 62, 175–192.

Langley, M.C. and O'Connor, S. 2016. An enduring shell artefact tradition from Timor-Leste: *Oliva* bead production from the Pleistocene to Late Holocene at Jerimalai, Lene Hara, and Matja Kuru 1 and 2. *PLoS One* 11(8), e0161071.

Langley, M.C., O'Connor, S., and Aplin, K. 2016a. A >46,000-year-old macropod bone implement from Carpenter's Gap 1: challenging past perspectives of Pleistocene Australia. *Quaternary Science Reviews* 154, 199–213.

Langley, M.C., Dilkes-Hall, I.E., Balme, J., and O'Connor, S. 2016b. A 600-year-old boomerang fragment from Riwi Cave (South Central Kimberley, Western Australia). *Australian Archaeology* 82, 106–122.

Langley, M.C., O'Connor, S., and Piotto, E. 2016c. 42,000-year-old worked and pigment-stained *Nautilus* shell from Jerimalai (Timor-Leste): evidence for an early coastal adaptation in ISEA. *Journal of Human Evolution* 79, 1–16.

Langley, M.C., Boivin, N., Prendergast, M., and Shipton, C. 2016d. Poison arrows and bone utensils in Late Pleistocene eastern Africa: evidence from Kuumbi Cave, Zanzibar. *Azania* 51, 155–177.

Lombard, M. 2005 Evidence of hunting and hafting during the Middle Stone Age at Sibudu Cave, KwaZulu-Natal, South Africa: a multi-analytical approach. *Journal of Human Evolution* 48, 279–300.

Lombard, M. 2006a First impressions on the functions and hafting technology of Still Bay pointed artifacts from Sibudu Cave. *South African Humanities* 18(1), 27–41.

Lombard, M. 2006b. Direct evidence for the use of ochre in the hafting technology of Middle Stone Age tools from

Sibudu Cave, KwaZulu-Natal. *South African Humanities* 18(1), 57–67.

Lombard, M. 2007. The gripping nature of ochre: the association of ochre with Howiesons Poort adhesives and Later Stone Age mastics from South Africa. *Journal of Human Evolution* 53, 406–419.

Mackay, A. and Welz, A. 2008. Engraved ochre from a Middle Stone Age context at Klein Kliphuis in the Western Cape of South Africa. *Journal of Archaeological Science* 35, 1521–1532.

Marean, C.W., Bar-Matthews, M., Bernatchez, J., Fisher, E., Goldberg, P., Herries, A.I.R., Jacobs, Z., Jerardino, A., Karkanas, P., Minichillo, T., Nilssen, P.J., Thompson, E., Watts, I., and Williams, H.M. 2007. Early human use of marine resources and pigment in South Africa during the Middle Pleistocene. *Nature* 449, 905–908.

McDougall, I., Brown, F.H., and Fleagle, J.G. 2005. Stratigraphic placement and age of modern humans from Kibish, Ethiopia. *Nature* 433, 733–736.

Nguyen, V. 2015. First archaeological evidence of symbolic activities from the Pleistocene of Vietnam. In *Emergence and Diversity of Modern Human Behavior in Paleolithic Asia*, Kaifu, Y., Izuho, M., Goebel, T., Sato, H., and Ono, A. (eds.). Texas A&M University Press, College Station, pp. 133–139.

O'Connor, S. 2003. Report of nine new painted rock art sites in East Timor in the context of the western Pacific region. *Asian Perspectives* 42, 96–128.

O'Connor, S. 2007. New evidence from East Timor contributes to our understanding of earliest modern human colonisation east of the Sunda Shelf. *Antiquity* 81, 523–535.

O'Connor, S. and Aplin, K. 2007. A matter of balance: An overview of Pleistocene occupation history and the impact of the Last Glacial Phase in East Timor and the Aru Islands, eastern Indonesia. *Archaeology in Oceania* 42, 82–90.

O'Connor, S., Barham, A., Spriggs, M., Veth, P., Aplin, K., and St. Pierre, E. 2010. Cave archaeology and sampling issues in the tropics: a case study from Lene Hara Cave, a 42,000 year old occupation site in East Timor, Island Southeast Asia. *Australian Archaeology* 71, 29–40.

O'Connor, S., Ono, R., and Clarkson, C. 2011. Pelagic fishing at 42,000 years before the present and the maritime skills of modern humans. *Science* 334, 1117–1121.

O'Connor, S., Ulm, S., Fallon, S., Barham, A., and Loch, I. 2010. Pre-bomb marine reservoir variability in the Kimberley Region, Western Australia. *Radiocarbon* 52, 1158–1165.

O'Connor, S. and Veth, P. 2005. Early Holocene shell fish hooks from Lene Hara Cave, East Timor establish complex fishing technology was in use in Island South East Asia five thousand years before Austronesian settlement. *Antiquity* 79, 249–256.

O'Connor, S., Spriggs, M., and Veth, P. 2002. Excavation at Lene Hara Cave establishes occupation in East Timor at least 30,000–35,000 years ago. *Antiquity* 76, 45–50.

Pasveer, J.M. 2004. *The Djief Hunters. 26,000 years of Rainforest Exploitation on the Bird's Head of Papua, Indonesia*. Modern Quaternary Research in Southeast Asia 17. A.A. Balkema Publishers, London.

Pawlik, A.F. 2013. Behavioural complexity and modern traits in the Philippine Upper Palaeolithic. *Asian Perspectives* 51, 22–46.

Pyatt, F.B., Barker, G.W., Rabett, R.J., Szabó, K., and Wilson, B. 2011. Analytical examination of animal remains from Borneo: the painting of bone and shell. *Journal of Archaeological Science* 37, 2102–2105.

Reimer, P. J., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Bronk Ramsey, C., Grootes, P. M., Guilderson, T. P., Haflidason, H., Hajdas, I., Hatt, C., Heaton, T. J., Hoffmann, D. L., Hogg, A. G., Hughen, K. A., Kaiser, K. F., Kromer, B., Manning, S. W., Niu, M., Reimer, R. W., Richards, D. A., Scott, E. M., Southon, J. R., Staff, R. A., Turney, C. S. M. and van der Plicht, J. 2013. IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years cal BP. *Radiocarbon* 55(4), 1869–1887.

Reynolds, T., Barker, G., Barton, H., Cranbrook, G., Farr, L., Hunt, C., Kealhofer, L., Paz, V., Pike, A., Piper, P.J., Rabatt, R.J., Rushworth, G., Stimpson, C., and Szabó, K. 2013. The first modern humans at Niah, c. 50,000-35,000 years ago. In *Rainforest Foraging and Farming in Island Southeast Asia*, Barker, G. (ed.). McDonald Institute for Archaeological Research, Cambridge, pp. 135–172.

Rifkin, R.F. 2012. Processing ochre in the Middle Stone Age: testing the inference of prehistoric behaviours from actualistically derived experimental data. *Journal of Anthropological Archaeology* 31, 174–195.

Rosso, D.D., d'Errico, F., and Queffelec, A. 2017. Patterns of change and continuity in ochre use during the late Middle Stone Age of the Horn of Africa: the Porc-Epic Cave record. *PLoS One* 12(5), e0177298.

Sagona, A. 1994. The quest for the red gold. In *Bruising the Red Earth: Ochre Mining and Ritual in Aboriginal Tasmania*, Sagona, A. (ed.). Melbourne University Press, Melbourne, pp. 8–38.

Soressi, M. and d'Errico, F. 2007. Pigments, gravures, parures : les comportements symboliqués controversés des Néandertaliens. In *Les Néandertaliens. Biologie et Cultures*, Vandermeersch, B. and Maureille, B. (eds.). Éditions du CTHS, Paris, pp. 297–309.

Southon, J., Kashgarian, M., Fontugne, M., Metivier, B., and Yim, W.W.S. 2002. Marine reservoir corrections for the Indian Ocean and Southeast Asia. *Radiocarbon* 44, 167–180.

Szabó, K.A. and Koppel, B. 2015. Limpet shells as unmodified tools in Pleistocene southeast Asia: an experimental approach to assessing fracture and modification. *Journal of Archaeological Science* 54, 64–76.

Tanudirjo, D. 2005. Long-continuos or short-occasional occupation?: the human use of Leang Sarru rockshelter in the Talmud Islands, North eastern Indonesia. *Bulletin of the Indo-Pacific Prehistory Association* 25, 15–19.

Thong, P.H. 1980. Con Moong Cave. A noteworthy archaeological discovery in Vietnam. *Asian Perspectives* 23, 17–21.

Turner, V. 1966. Color classification in Ndembu ritual: a problem in primitive classification. In *Anthropological Approaches to the Study of Religion*, Barton, M. (ed.). Tavistock, London, pp. 47–84.

Van Heekeren, H.R. 1972. *The Stone Age of Indonesia*. Martinus Nijhoff, The Hague.

Veth, P., Spriggs, M., and O'Connor, S. 2005. The continuity of cave use in the tropics: examples from East Timor and the Aru Islands, Maluku. *Asian Perspectives* 44, 180–192.

Wadley, L. 2005. Ochre crayons or waste products? Replications compared with MSA 'crayons' from Sibudu Cave, South Africa. *Before Farming* 2005/3, 1–12.

Wadley, L. 2010. Cemented ash as a receptacle or work surface for ochre powder production at Sibudu, South Africa, 58,000 years ago. *Journal of Archaeological Science* 37, 2397–2406.

Wadley, L., Williamson, B., and Lombard, M. 2004. Ochre in hafting in Middle Stone Age southern Africa: a practical role. *Antiquity* 78, 661–675.

Watts, I. 2010. The pigments from Pinnacle Point Cave 13B, Western Cape, South Africa. *Journal of Human Evolution* 59, 392–411.

White, T.D., Asfaw, B., DeGusta, D., Gilbert, H., Richards, G.D, Suwa, G., and Howell, F.C. 2003. Pleistocene *Homo sapiens* from Middle Awash, Ethiopia. *Nature* 423, 742–747.

Zeitoun, V., Forestier, H., Sophady, H., Puaud, S., and Billault, L. 2012. Direct dating of a Neolithic burial in the Laang Spean Cave (Battambang Province, Cambodia): first regional chromo-cultural implications. *Comptes Rendus Palevol* 11, 529–537.