

# DATING THE MYANMAR BRONZE AGE: PRELIMINARY <sup>14</sup>C DATES FROM THE OAKAIE 1 CEMETERY NEAR NYAUNG'GAN

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Keywords: Southeast Asia, Myanmar, Bronze Age, Nyaung'gan, apatite, <sup>14</sup>C

## ABSTRACT

*Since 2014 the Mission Archéologique Française au Myanmar has been excavating a prehistoric cemetery, Oakaie 1, adjacent to the famous Nyaung'gan Bronze Age cemetery in Sagaing Division. Oakaie 1 (OAI1) was selected as a Nyaung'gan proxy in order to better understand the Neolithic-Bronze Age-Iron Age chronological transitions in upper-central Myanmar, for eventual regional-scale synthesis. An initial attempt to AMS <sup>14</sup>C date 13 human femurs failed due to a lack of collagen but a subsequent effort using an apatite dating methodology on 5 femurs was successful. These preliminary data bracket part of the cemetery from the 9<sup>th</sup> to 6<sup>th</sup> c. BC with a 4<sup>th</sup>-3<sup>rd</sup> c. BC outlier. Typological and technological analogies between OAI1 and Nyaung'gan pottery grave goods likewise suggest an early 1<sup>st</sup> millennium BC date for the local Bronze Age.*

## 1. INTRODUCTION

Myanmar (formerly Burma, Figure 1) is the relatively large, c. 678,500 km<sup>2</sup>, terrestrial juncture between South and East Asia, stretching c. 950 km from 6000 m Himalayan peaks in the north to the Andaman Sea-lapped peninsular shores in the south. To highlight its critical location, Myanmar shares borders with Bangladesh, India, China, Laos and Thailand and is interlinked by several major rivers, the Chindwin, Irrawaddy, Mekong and Salween, as well as numerous tributaries and minor watercourses. Given that most explanatory frameworks for Mainland Southeast Asia's major chronological divisions (Mesolithic-Neolithic c. 1800 BC, Neolithic-Bronze c. 1000 BC, Bronze to Iron c. 500 BC and Iron to Historic c. 500 AD) explicitly cite long-range population interactions and movements, an archaeologically-informed understanding of Myanmar's past is essential for the interpretation of the region's cultural trajectory. Of the above transitions, resolving the début of the Mainland

Southeast Asian Neolithic and Bronze Ages has arguably involved the greatest expenditure of effort by regional prehistorians over the last five decades, as competing models for the derivation of 'Chinese' cultural behaviours were tested and refined with ever improved datasets (see Higham, 2014, Higham, in press and papers cited therein). The current paper is a preliminary contribution to the task of defining the Neolithic-Bronze Age transition in westernmost Mainland Southeast Asia. This is important as the current regional dataset is heavily biased in favour of Thailand, in terms both of quantity and quality of data. An initial Thai Bronze Age date of 1100-1000 BC is now widely accepted but this should not mask the potential for substantial and historically relevant regional variation. An improved research resolution in the northern regions of Myanmar, Laos and Vietnam, adjacent to the 2500+ km border with present-day China, can be expected to reveal a chronological gradient for the appearance of copper-base metallurgy. The direction and steepness of that gradient will be critical to identifying the proximal source culture/s and transmission mechanism/s responsible for initiating the Mainland Southeast Asian Bronze Age.

## 2. NYAUNG'GAN

Nyaung'gan, 35 km NNW of Monywa city, Sagaing Division (Figure 1), was the first late prehistoric site investigated in Myanmar by archaeologists from the Ministry of Culture (Moore & Pauk, 2001). Five test pits totalling 360 m<sup>2</sup> were excavated in 1998 and 1999 on the NW lip of a small extinct volcanic crater, exposing 43 burials between 0.1 to 1.5 m depth within a cemetery whose total area was estimated as 490 m<sup>2</sup> (Tayles et al., 2001). The presence of bronzes (spears, points, axes, and a halberd) and polished stone rings, in the absence of any iron or glass, bracketed the site as 'Bronze Age' but the Nyaung'gan cemetery has never been dated radiometrically due to the absence of recovered charcoal and the lack of collagen within the skeletal material (Moore, 2006: 87, Moore, 2010). Consequently date

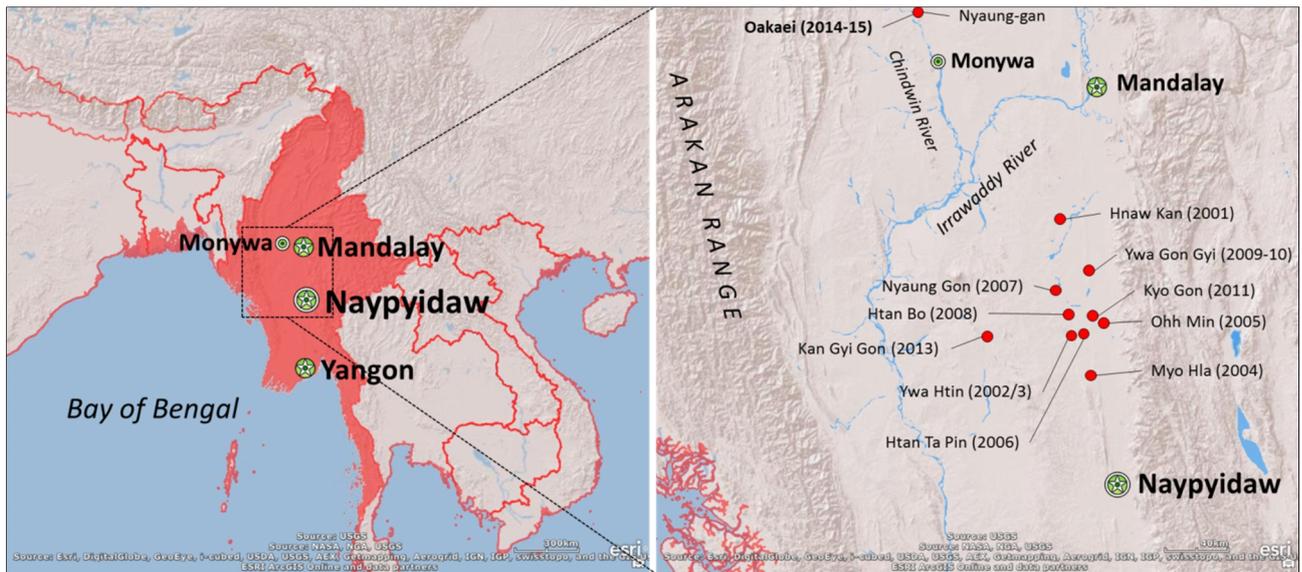


Figure 1: Left: Mainland Southeast Asia with Myanmar highlighted and the capital, major cities and the MAFM's area of operations indicated. Right: the location of sites excavated since 2001, the first eleven seasons directed by J-P Pautreau concentrated on the Samon Valley whilst the lead author's current focus is on the Nyaung'gan culture area.

estimates for the cemetery have ranged between the early-mid 2<sup>nd</sup> and early-mid 1<sup>st</sup> millennia BC (Anon., 2012, Higham, 2002: 158, Moore & Win, 2007: 87, White, n.d.). The later estimates, approaching the regional Bronze to Iron Age transition, reflect the belief, partly due to the claimed sophistication of the copper-base grave goods, that the Nyaung'gan culture may not represent the very beginning of the Myanmar Bronze Age. Nevertheless, furnishing a radiometric sequence for Nyaung'gan would be a solid step in the right direction.



Figure 2: Location of the cemeteries at Nyaung'gan and Oakaie 1, and the habitation site at Oakaie 2.

### 3. THE OAKAIE 1 CEMETERY

In 2014 the lead author sought to address this issue by reorienting the *Mission Archéologique Française au Myanmar* (MAFM) away from the Samon Valley area

south of Mandalay, where Pautreau et al. (2007, 2010) had successfully investigated nine prehistoric sites, predominantly Iron Age cemeteries, between 2001 and 2012. In conjunction with colleagues from the Mandalay Department of Archaeology, an explicit Nyaung'gan proxy site was selected only 2.6 km SSW from eponymous original (Figure 2), in the midst of an area known to be rich in prehistoric surface assemblages of comparable ceramics and lithics (Moore & Pauk, 2001). This site, Oakaie 1 (95.0492° E, 22.3901° N), named for the village 1.5 km to its north, transpired to be another cemetery. A c. 75 m<sup>2</sup> test pit (approximately 15 by 5 m) was opened in 2014 revealing 25 grave pits with 28 bodies, of which 25 were analysed. In 2015, this pit was extended west by c. 105 m<sup>2</sup> (approximately 15 by 7 m) to expose another 30 grave pits with 33 individual burials, of which 26 were analysed (Figure 3). Unfortunately, just a few days from the end of the 2015 season, a nearby irrigation pipe burst overnight and the resulting damage and delay meant we were unable to complete the excavation of 7 grave pits nor expose expected grave pits in the SE corner, which should have connected with the 2014 excavation (e.g. S25, Figure 4). The 2015 season also saw the excavation of six testpits within a settlement and funerary activity area c. 750 west of OAI1, OAI2, whose results will be published elsewhere but a Bronze Age date is expected based upon the assemblage (Figure 5).

Likewise, detailed bioarchaeological results for OAI1 will be published in a forthcoming paper but, in summary, those pits excavated over 2014 and 2015 contained 40 single and six double burials (one individual of which was not excavated). Of these, 51 human remains have been preliminarily studied using established regional

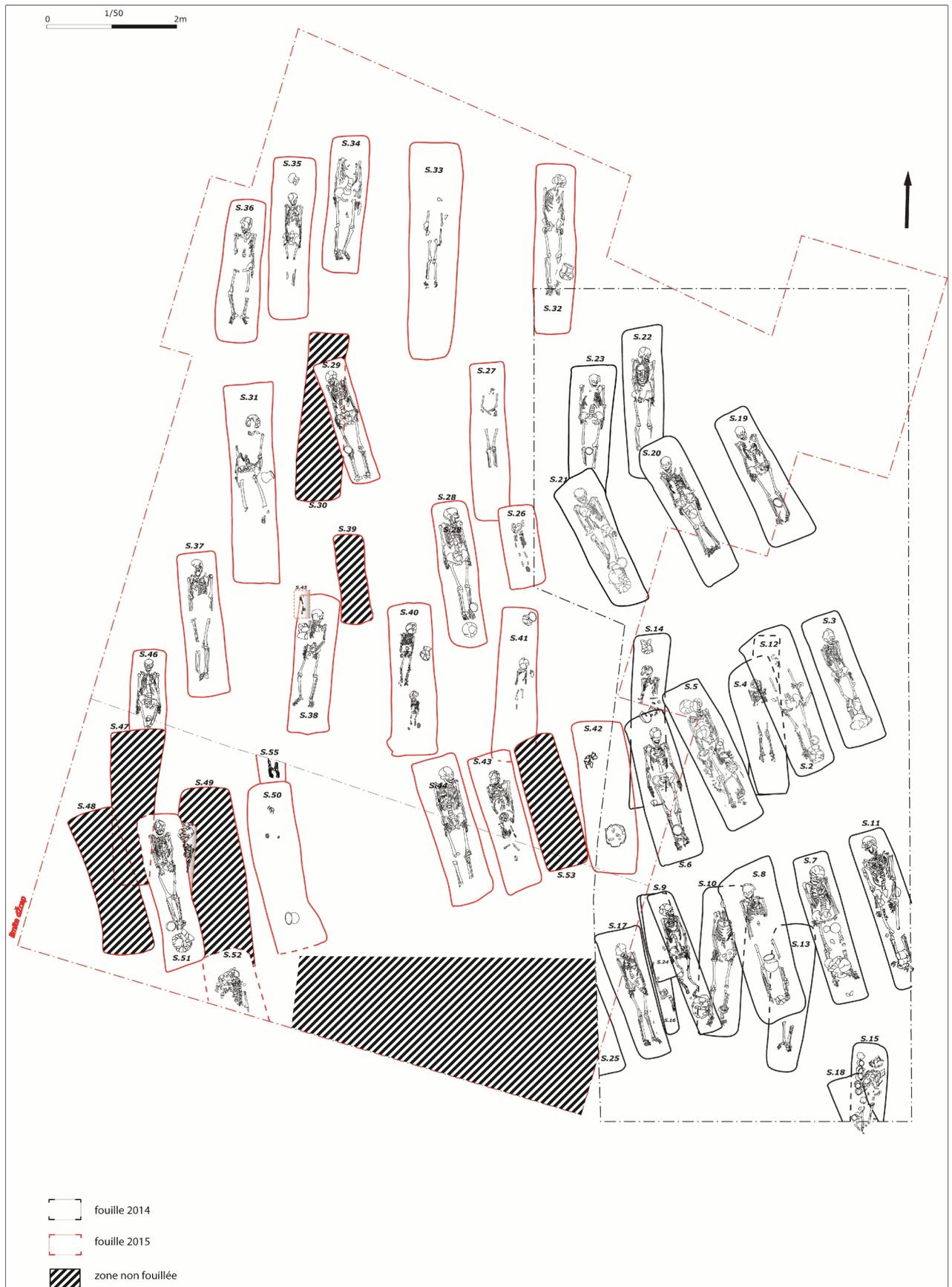


Figure 3: 2014 and 2015 excavation pits at OAI (“fouille” = excavation).

methodologies for aging, sexing, palaeopathology and burial practice (*anthologie de terrain*) (Buikstra & Ubelaker, 1994, Duday, 2006, Duday et al., 1990, Duday & Guillon, 2006, Phenice, 1969, Scheuer & Black, 2000, Ubelaker, 1989, Walrath et al., 2004). Our initial results indicate that 13 burials were sub-adults (<14 years [25.5%]) and 38 were adults (15+ years [74.5%]). Of the adults, 13 were male (25.5%), 12 were female (23.5%) and 13 were of indeterminate sex. This representative sample suggests normative burial practices with no exclusion of individuals based on age or sex. Preliminary observations of palaeohealth suggest that the older adults suffered from severe tooth wear and associated antemortem tooth loss, alveolar lesions and resorption.



Figure 4: Flood damage at dawn (facing east), 20th January 2015.

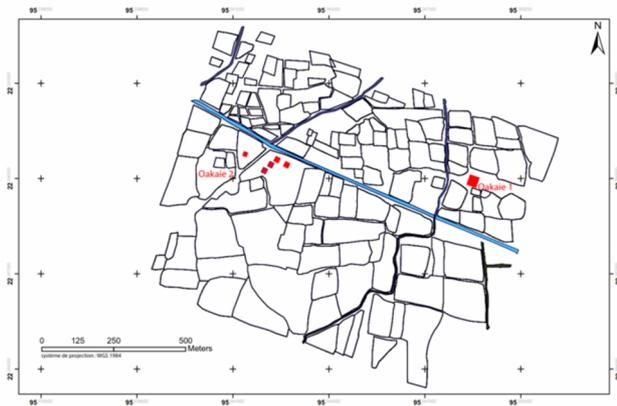


Figure 5: Position of OAI1 and OAI2 testpits in red. Thin black lines denote field systems, thick black lines cart tracks and blue lines irrigation canals and ditches.

The OAI1 burials were all primary, supine, extended interments. The observation of the articulation and movement of the labile joints of the hands and feet also indicates that they had been wrapped in a biodegradable textile prior to burial (Nilsson Stutz, 2006, Willis & Tayles, 2009); perhaps a pre-cursor to the comparable

behaviour observed at a number of Iron Age cemeteries in the Samon Valley (Pautreau et al., 2010). There was no apparent distinction between sub-adults and adults, between the sexes or among the age ranges in burial treatment. All of the burials were aligned on either a NW-SE or a N-S axis, with their heads aligned NW or N, except one adult individual (S5a) buried with their head oriented SE. The stratigraphy and intercutting of burials suggest that there was reuse of the cemetery over time (Figure 3). It is initially thought that there was an earlier N-S sub-phase due to the intercutting of N-S burials with NW-SE burials (Pryce, 2014b) but both orientations can appear at variable depths and we cannot at present offer a conclusive interpretation. Nevertheless, we view the low variation in burial orientation as a temporal continuity in the use of the cemetery, among the same population, perhaps over several generations.

The OAI1 cemetery was notably poorer in grave goods than that of Nyaung'gan. The most common artefact associated with OAI1 burials was pottery; at least 67 vessels in total, of which 19 from S15. The pottery is of a single tradition, coil built with technical variations of paddle and anvil or not. There are open and closed morphologies, which can be sub-divided based upon the presence of carinations, but the main type is a small restricted form (Figure 6). Pottery was buried with sub-adults and adults, although more frequently with adults. There appears to be no sex based distinction in the number of pots buried with males or females. Some graves (all oriented NW-SE) contain a set of two pots: one with opened profile, one with restricted profile. These open shapes may have been used as lids (Figure 6: 3-4).

Other artefacts found in association with adult burials include large oblate stone bracelets (Figure 7), clay spindle whorls, a bone anklet, a cowrie shell and lithic ornaments in stone of various colours, including fossilised wood (Figure 8). A concentrated lithic production assemblage cache, possibly representing a biodegradable container, was found next to the left ankle of adult burial S5a. If this deposit represents the deceased's former craft activity it is notable that this burial was the only one with the head oriented SE. Stone beads appear to be more commonly associated with subadults <14 years of age and the placement of two bivalve shells seems more commonly associated with individuals <1 year of age. See Table 1 for a summary of OAI1 grave goods<sup>1</sup>.

Finally, amongst the 51 excavated OAI1 burials, only S15 produced any metal; a copper-base socketed axe (Figure 9). The axe does not closely resemble those from Nyaung'gan but typological comparisons are not especially helpful with such a basic functional form. A sample from the cutting edge was mounted, polished and etched to reveal that the axe had been cold-worked and annealed after casting (Figure 10), showing a degree of

<sup>1</sup> The 2014 OAI1 excavation and preliminary bioarchaeological analysis was executed by Anne-Sophie Coupey. The complete 2014/2015 dataset is being studied by the current MAFM team.

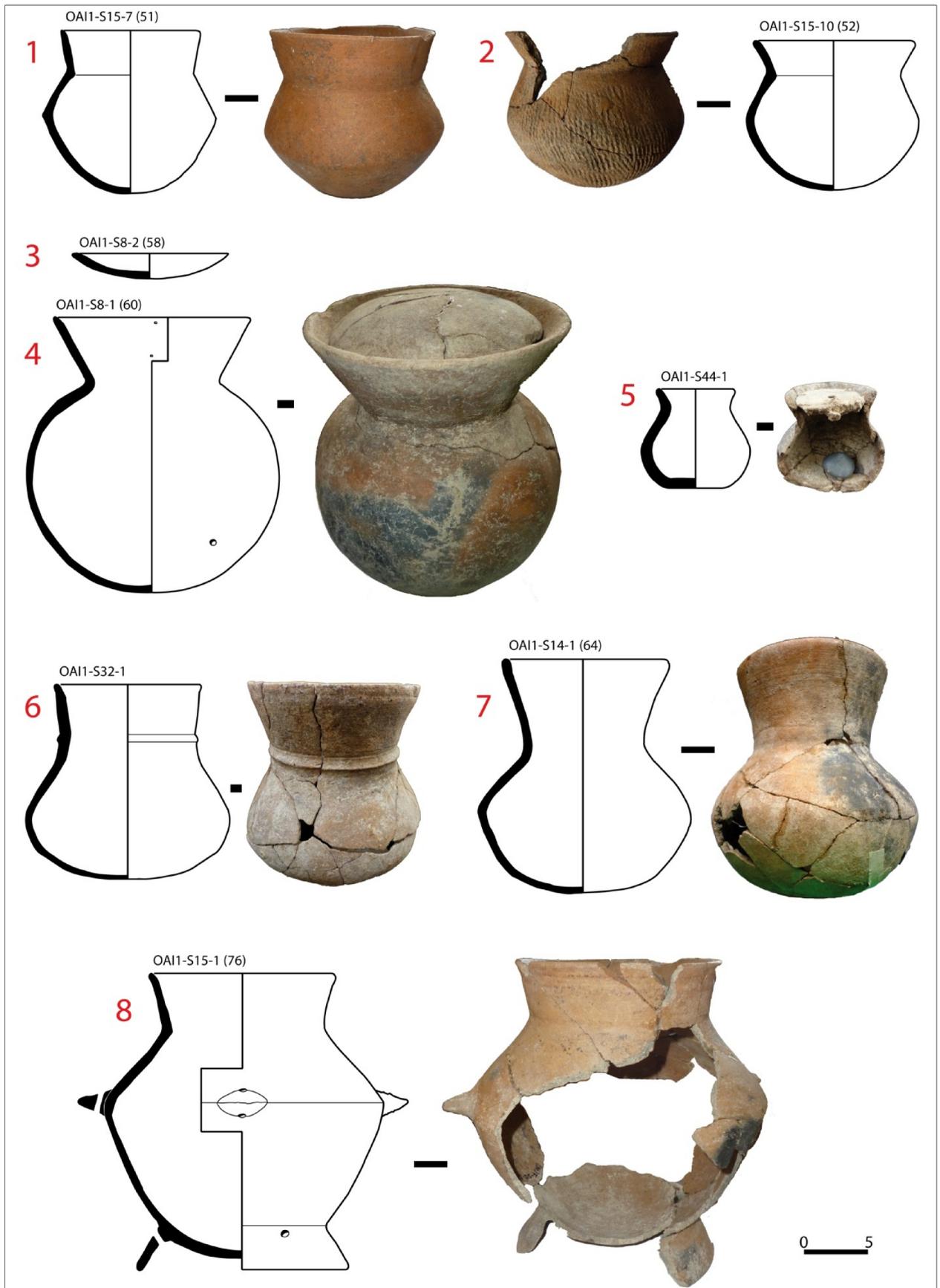


Figure 6: OAI pottery.

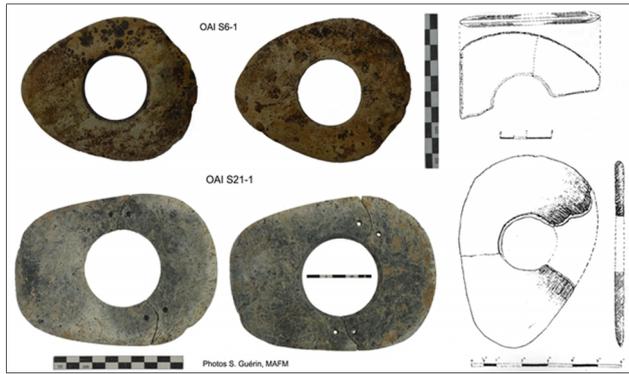


Figure 7: Oblate stone bracelet from OAI1 (left) and Nyaung'gan (right, Nyunt Han, 1999: 51).

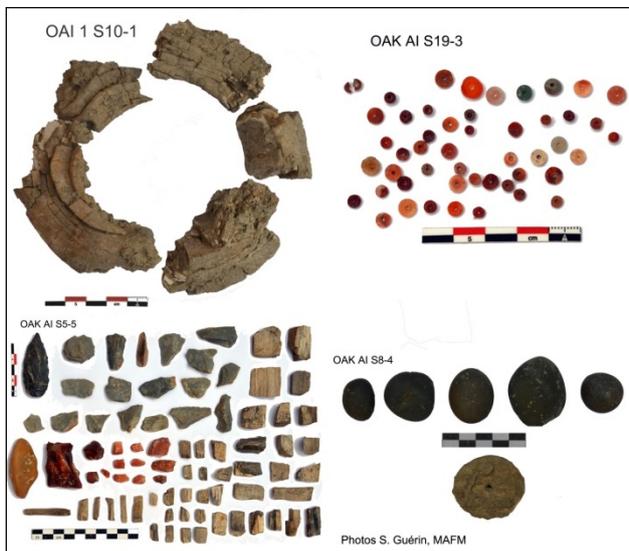


Figure 8: Bone anklet, clay spindle whorl and lithic beads and production debris from OAI1.



Figure 9: Copper-base artefacts from Nyaung'gan (left, Nyunt Han, 1999: 46) and OAI1 (right).

technical sophistication not seen in early Bronze Age axes from Ban Non Wat for example (Pryce, 2011). X-ray fluorescence analysis at the Curt-Engelhorn Centre for Archaeometry (Mannheim, Germany) showed the axe to be made from an unleaded bronze alloy with about four weight percent tin. Mass spectrometric analysis of the lead isotope ratios (also in Mannheim) must be treated

with caution as a single data point but do not match any of the known Southeast Asian copper sources (Pryce et al., 2014). There is some compatibility with an axe from Ban Non Wat in NE Thailand dated 1000-900 BC (Pryce et al., 2014) but due to completely dissimilar typologies any connection was mostly likely restricted to shared raw material supply networks rather than the exchange of complete artefacts. Previous speculation (e.g. Moore & Pauk, 2001) about possible associations between copper deposits at Monywa and ancient copper production in the Nyaung'gan area have not been substantiated by any evidence the lead author has seen, though lead isotope analysis of Monywa ores and local bronze finds would allow this hypothesis to be further tested.

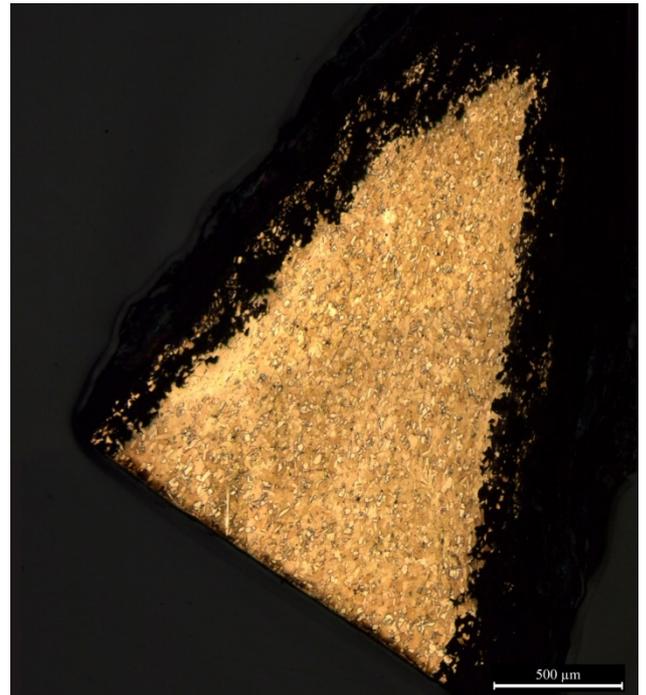


Figure 10: Optical micrograph of the OAI1 axe (courtesy Pira Venunan).

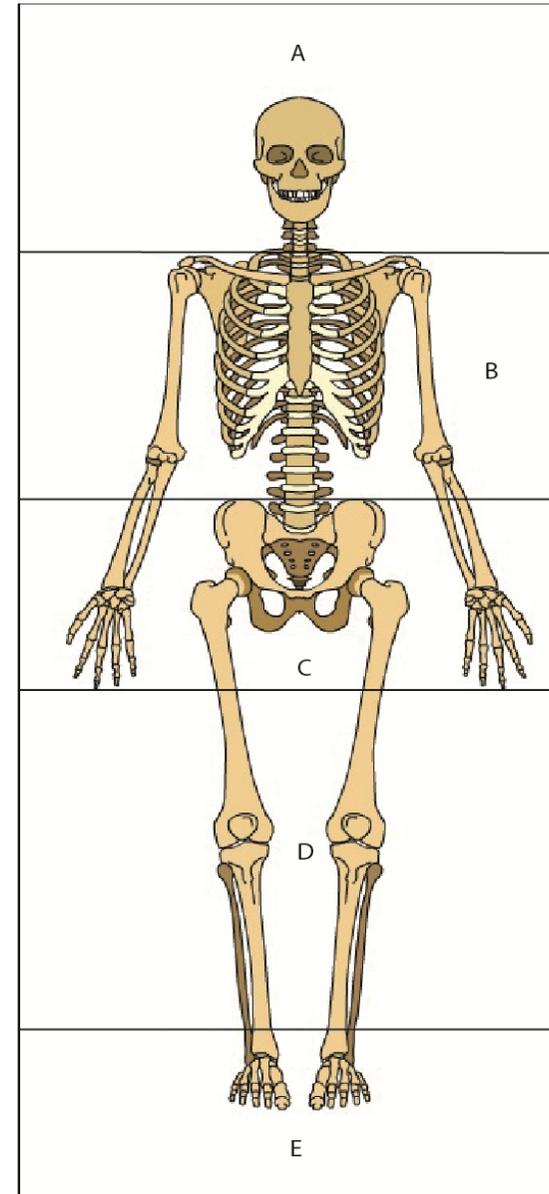
#### 4. DATING METHODOLOGY

Despite the use of archaeobotanical wet flotation for general grave fill samples, stomach cavities and pottery contents, no charcoal was recovered from the 2014 OAI1 excavation. Accordingly, 13 femur sections from burials S2, 3, 6, 8, 10, 12, 15, 19a, 19b, 20, 21a, 21b and 23 were selected for their apparent bone integrity and stratigraphic relations and submitted for AMS <sup>14</sup>C determinations. All failed due to the lack of preserved bone collagen, a common occurrence in Southeast Asian archaeological contexts (e.g. Zeitoun et al., 2013).

In the absence of other options for the OAI1 2014 assemblage, femur samples S8, 10, 15, 21A and 23 were re-submitted for bioapatite dating in association with the *Muséum national d'Histoire naturelle* (MNHN, CNRS UMR 7209 *Archéozoologie, Archéobotanique : sociétés, pratiques et environnements*). Collagen represents c. 95%

**Table 1: OAI1 grave good summary.**

Burial Number	Age	Chronological Age	Sex	Artefacts
OAI12014S1	Adult	Adult	-	-
OAI12014S2	Adult	Adult	Female	One pot (E) and one lid (D)
OAI12014S3	Adult	Adult	Female	One pot (E) and one lid (E)
OAI12014S4	Adult	Young adult	-	-
OAI12014S5a	Adult	Adult	-	One pot (A) and a cache of stone artefact debris (E)
OAI12014S5b	Subadult	1-4	-	One pot (D), red stone beads around neck region (A) and one bracelet bone? Ivory? (C)
OAI12014S6	Adult	Adult	-	Beads in pelvis (C), thorax region (B), one stone bracelet (B), one bowl (D)
OAI12014S7	Adult	Adult	Male	One pot (D), 2 bowls/lids? (D) and beads in pelvis (C), neck region (A)
OAI12014S8	Adult	Adult	-	One pot (D), one lid (E), one spindle whorl and some pebbles (E)
OAI12014S9	Adult	Adult	Male	One pot (E)
OAI12014S10	Adult	Adult	-	One bracelet bone/ivory? (E)
OAI12014S11	Adult	Adult	Male	One pot (D)
OAI12014S12	Adult	Adult	-	-
OAI12014S13	Adult	Adult	-	One pot (A)
OAI12014S14	Adult	Adult	-	One pot (A)
OAI12014S15	Adult	Adult	-	Two large pots (B), fifteen small pots (A-B-C-D) and a bronze axe (A)
OAI12014S16	Adult	Adult	-	One bowl (D)
OAI12014S17	Adult	Adult	Male	-
OAI12014S19a	Adult	Adult	Female	One bowl (D)
OAI12014S19b	Subadult	<1	-	Beads in pelvis region (C), two bivalve shells (E), one bone/ivory? bracelet (C)
OAI12014S20	Adult	Young adult	Male	One pot (D) and two bone/ivory? bracelets (C)
OAI12014S21a	Adult	Young adult	Female	One pot (E), one lid (D), one stone bracelet (C) and one bivalve shell (E)
OAI12014S21b	Subadult	1-4	-	Two pots (E) and beads in the neck region(A)
OAI12014S22	Adult	Adult	-	-
OAI12014S23	Adult	Adult	Male	One bowl (D)
OAI12015S26	Subadult	<1	-	Two bivalve shells (B-E)and two red cylindrical beads with five small in neck region (A)
OAI12015S27	Subadult	10-14	-	-
OAI12015S28	Adult	Young adult	Female	one pot (E) and one bowl/lid? (D)
OAI12015S29	Adult	Middle adult	Female	One bowl (D)
OAI12015S31	Adult	Old adult	Male	One pot (C)and one bivalve shell (D)
OAI12015S32	Adult	Old adult	Male	One pot (D)



OAI12015S33	Subadult	5-9	-	-	
OAI12015S34	Adult	Adult	Male	-	
OAI12015S35	Adult	Middle adult	Female	One pot (A)	
OAI12015S36	Adult	Middle adult	Male	-	
OAI12015S37	Adult	Middle adult	Male	One cowrie shell (A)	
OAI12015S38	Subadult	10-14	-	One pot (B) and shell beads in neck region (A)	
OAI12015S40a	Subadult	1-4	-	One pot (C)	
OAI12015S40b	Subadult	<1	-	Two bivalve shells (D-E)	
OAI12015S41	Subadult	1-4	-	Two pots (A-B)	
OAI12015S42a	Adult	Young adult	Male	One pot (D?), one stone bracelet (potentially belongs to S42b)	
OAI12015S43a	Adult	Middle adult	Female	One pot (D)	
OAI12015S43b	Subadult	1-4	-	Beads around neck region (A)	
OAI12015S44	Adult	Young adult	Male	-	
OAI12015S45	Subadult	-	-	One bivalve shell (D)	
OAI12015S46	Adult	Old adult	Female	One pot (D) and one spindle whorl/bone lid? (D)	
OAI12015S50	Subadult	<1	-	One pot (E) and two bivalve shells (D)	
OAI12015S51	Adult	Old adult	Female	one pot (E) and one bowl (E)	
OAI12015S52	Adult	Young adult	Female	-	
OAI12015S54	Adult	Old adult	Female	-	
OAI12015S55	Adult	Adult	-	-	

**Table 2: Preliminary radiocarbon data for OAI1.**

QUB ID	MNHN/MAFM ID	<sup>14</sup> C age	±	1σ range (BC)	2σ range (BC)
UBA-27929	Muse459/S8	2573	33	805-762	811-554
UBA-27926	Muse456/S10	2519	34	783-556	795-540
UBA-27927	Muse457/S15	2242	38	382-211	394-204
UBA-27930	Muse460/S21A	2566	34	804-598	809-551
UBA-27928	Muse458/S23	2584	39	811-673	826-552

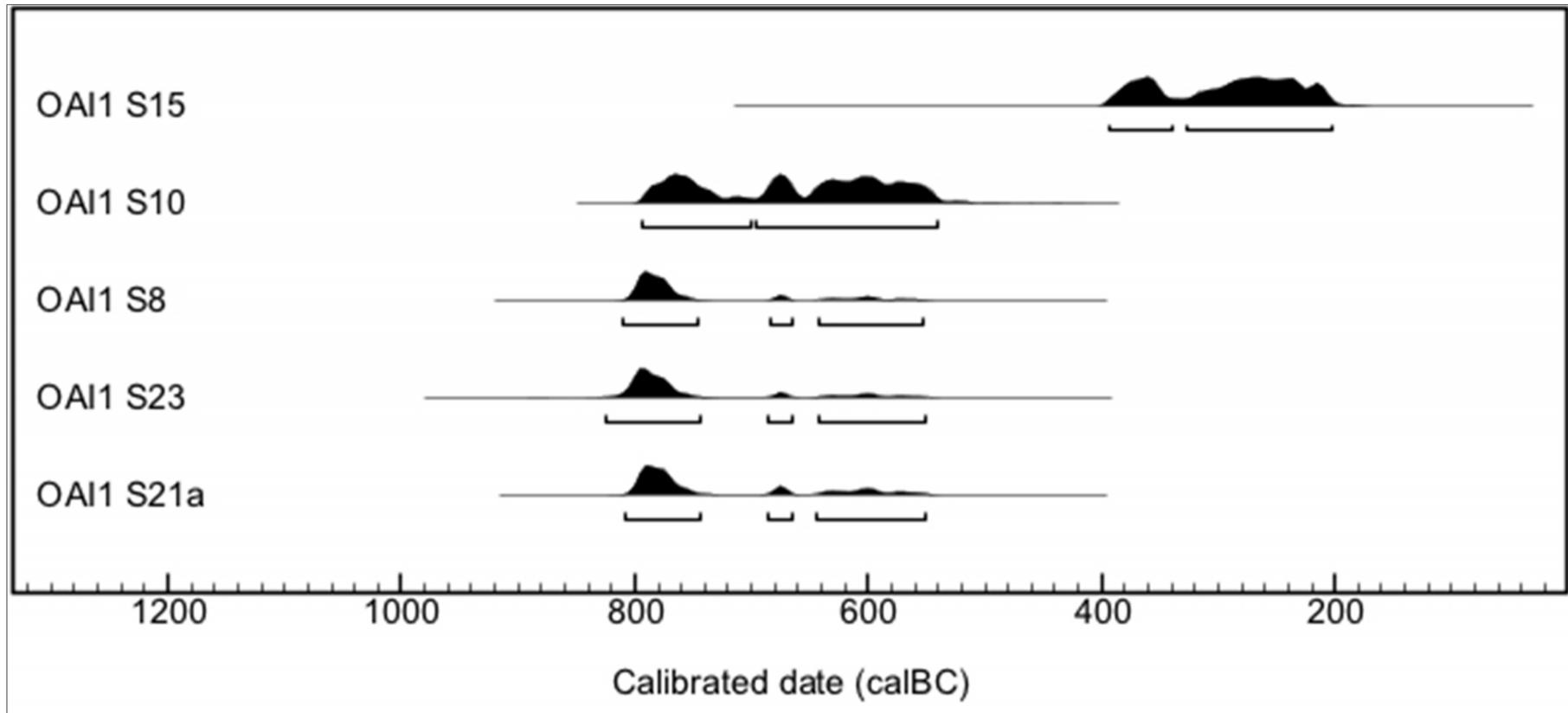


Figure 11: OxCal IntCal13 calibrated dates for the OAI1 cemetery.

of the carbon in a fresh bone sample whereas the mineralised carbon fraction, apatite, is accordingly much lower (c. 1 wt. %) but has a better survival rate as the collagen degrades over time. Great care must be taken however to distinguish between primary carbonates and secondary calcite. Prior to radiocarbon dating of the carbonate phase, bone samples are finely powdered and pre-treated under low vacuum using acetic acid (1M) for 25 h, then rinsed. This methodology aims to remove secondary calcites but cannot distinguish between primary (biogenic) and secondary (diagenetic) carbonates incorporated in the structure of apatite crystals by isotopic exchange (Zazzo & Saliège, 2011). Extensive work has demonstrated that the apparent age of secondary carbonates is always younger than carbonate from the archaeological bone (Zazzo, 2014, Zazzo & Saliège, 2011). Therefore apatite dating always provides a *terminus ante quem*. The potential age shift increases with the age of the archaeological remains but is generally less than 200 BP for samples less than 5000 BP (Zazzo, 2014). It should be pointed out that this potential error margin is substantially smaller than the oft-encountered issue of 'old wood' when using tree charcoal; and the error would trend in the generally more parsimonious direction, late rather than early.

## 5. RESULTS

All five apatite determinations, performed at Queen's University Belfast (QUB), were successful and produced archaeologically-coherent dates with low standard deviations ranging between 2242±38 and 2584±39 BP (Table 1). These data were then calibrated using the IntCal13 calibration curve and Oxcal v4 software (Figure 11, Reimer et al., 2013). Four of the five determinations indicate a late-9<sup>th</sup> to mid-6<sup>th</sup> c. BC range for the cemetery at two standard deviations. The S15 determination is an outlier at early-4<sup>th</sup> to late-3<sup>rd</sup> c. BC at two standard deviations.

## 6. DISCUSSION AND CONCLUSION

The radiometric data from the 2014 season are coherent enough to provisionally date this part of the OAI1 cemetery to the 9<sup>th</sup>-6<sup>th</sup> c. BC, which sits within the now solidly founded Bronze Age sequence of 11<sup>th</sup>-5<sup>th</sup> c. BC from neighbouring Thailand (Higham, in press). However, before we can attribute OAI1 to a now radiometrically-quantified Myanmar Bronze Age phase, we must consider that the site's sole bronze artefact comes from S15. This burial, nominally dated to the 4<sup>th</sup>-3<sup>rd</sup> c. BC, would, both regionally and nationally, typically be considered Iron Age (Higham, in press, Pryce et al., 2013). This fits awkwardly with S15's stratigraphy, which suggested it should correspond to an earlier OAI1 sub-phase of north-south aligned burials, and the burial was also distinguished by containing the highest single concentration of pottery in the cemetery. Should we thus consider the bronze-less early 1<sup>st</sup> millennium-dated OAI1 burials as Neolithic?

As discussed in the methodology section above, diagenetic carbonates can produce young determinations, typically of up to two but in extremis up to three centuries, which would provide reasonable overlap with the other four date ranges (Zazzo, 2014). We recognise that a claim of analytical 'bad luck' is hardly a satisfying outcome and further resolving the OAI1 chronological sequence was a major aim of MAFM's February 2015 season. <sup>14</sup>C determinations on eight bivalve shells (two shells from each of S26, 40b, and 50 and one shell from each of S31 and 45) from OAI1 are currently awaited, as well as comparative dates on human teeth (M3s) and bone from S29, S44 and S51.

In the meantime we remain inclined to consider this part of the OAI1 cemetery as being probably Bronze Age due to close typological and technological associations with neighbouring Nyang'gan's pottery assemblage. We also note typological similarities with the material excavated at Monhtoo and Thapan, Chindwin Valley sites with suspected Bronze Age dates, but these assemblages have not been examined by the MAFM team (Moore, 2006). The Nyaung'gan pottery is, as per OAI1, exclusively from burial contexts. Preliminary techno-stylistic examination, performed at the former's on-site museum, revealed similar details to the OAI1 pottery outlined above: the probable use of coils or slabs, the use of the paddle-and-anvil technique (sometimes associated with cordmarks), smoothed rims and the common use of a red slip. Typologically, some forms and decorative styles are very similar: small closed carinated pots and large closed pots with cord-impressed bodies and, in particular, the rare and particularly diagnostic closed carinated jars with four perforated lugs (Figure 6: 1, 2 & 8, respectively). Given the very close proximity of the two sites it seems reasonable to propose that Nyaung'gan and OAI1 share a pottery tradition and have at least overlapping chronologies. The 'Bronze Age' corresponds, of course, to far more than the mere presence of copper-base metal, which is why MAFM endeavours to conduct a broad range of research methodologies to unveil as much as is possible of late prehistoric life and death in upper-central Myanmar. Nevertheless, as Nyang'gan burials containing pottery of this shared tradition also furnish copper-base grave goods in the absence of iron and glass, it also seems reasonable to suggest that the earlier OAI1 graves are Bronze Age but simply without bronzes due to relative status, wealth, preference and/or chronology. Future research will unveil the details of this relationship.

The remaining issue we should briefly address with the preliminary dataset is the relation between our putative Myanmar Bronze Age and its regional neighbours; especially, whether our 9<sup>th</sup>-8<sup>th</sup> c. BC Nyaung'gan proxy, OAI1, is a middle Bronze Age cemetery according to the Thai chronology or an early Bronze Age cemetery within Myanmar's own sequence. By this we explicitly question whether there is a 2-3 century gap between the Thai and Myanmar Bronze Ages, which in the future must be explained in terms of cultural and technological transmission mechanisms, or whether

we simply haven't yet straddled the Myanmar Neolithic-Bronze Age transition, which means we need to test more sites. We acknowledged in section two that a majority of previous scholars, based upon their initial impressions of grave good typology, decoration and technological sophistication, anticipated that Nyaung'gan was not an 'early' Bronze Age site and attributed it to the 1<sup>st</sup> millennium BC (White, n.d.). Whilst the absolute date estimate may well have been correct, their assessment of Nyaung'gan's relative sequence was founded on a two day visit some 17 years ago, at which time, and indeed until quite recently (see Higham, in press and responses), many Southeast Asian archaeologists thought the regional (for which read 'Thai') Bronze Age was considerably older and thus longer than the currently accepted terminal 2<sup>nd</sup> millennium to mid-1<sup>st</sup> millennium BC (White, 2008). This very substantial compression of the Bronze Age, from c. 1500 to c. 600 years duration, means that distinctions between 'early', 'middle' and 'late' must consequently hold less, though not no, importance as there was so much less time for behaviours and their artefactual representations to evolve.

The Nyaung'gan bronzes may well appear relatively sophisticated (pending a technical study) and not demonstrate 'experimental' aspects but this is indeed the case for copper-base founding technologies at the radiometrically-dated early Thai Bronze Age sites of Ban Chiang, Ban Non Wat, Non Nok Tha and Non Pa Wai (Pryce, 2014a, Pryce, 2015). This is to be expected when a region's Bronze Age is thought to have been stimulated by its metal-using neighbours (probably southern China), as is also evidenced by the presence of 'exotic' imports to central Thailand apparently catalysing an experimental mode of copper smelting at Non Pa Wai. (Pryce et al., 2014, Pryce et al., 2010). In conclusion, we believe that further excavation at OAI1's relatively shallow strata would be of limited utility in establishing the absolute and relative chronology of Nyaung'gan's much deeper Bronze Age deposits. If we wish to evaluate the true age and nature of the Myanmar Bronze Age it will be necessary, at least as a next step, to re-excavate Nyaung'gan with the full spectrum of current archaeological techniques. That is exactly what the *Mission Archéologique Française au Myanmar* plans to do in 2016.

## 7. ACKNOWLEDGEMENTS

We wish to express our deep gratitude to His Excellency the Myanmar Minister of Culture, his staff and the Director General and his staff at the Department of Archaeology in Naypidaw. In Mandalay we are also indebted to the Director General of the regional Department of Archaeology and his most supportive team. In Yangon we acknowledge the tireless help and backing offered by the French Embassy and French Institute, in particular that of the Cultural Attaché, M. Charles Bonhomme, his deputy, M. Sebastien Bris, and his administrator, Mme Yi Mon. The *Mission Archéologique Française au Myanmar* is generously financed by grants from the French Ministry of Foreign

Affairs and International Development, as well as contributions from the CNRS UMR 7055 "*Préhistoire et Technologie*" based at the *Université de Paris Ouest La Défense*. Finally, we'd like to thank the headman and villagers of Oakaie for the exceedingly warm welcome they have shown us these last two years, and for inviting us back in 2016.

## 8. REFERENCES

- Anon. 2012. *Bronze Age Culture (B.C. 1800-1500)* [Online]. Yangon: Department of Archaeology, National Museum and Library (accessed at [http://www.archaeologymm.com/php/arch\\_pre.php](http://www.archaeologymm.com/php/arch_pre.php)). [Accessed 21/07/2015].
- Buikstra, J. E. & Ubelaker, D. H. 1994. *Standards for data collection from human skeletal remains: proceedings of a seminar at the Field Museum of Natural History*, Arkansas Archeological Survey Fayetteville, AR.
- Duday, H. 2006. L'archéothanatologie ou l'archéologie de la mort (archaeoethanatology or the archaeology of death). In: Gowland, R. & Knusel, C. (eds.) *Social Archaeology of Funerary Remains*. Oxford: Oxbow Books.
- Duday, H., Courtaud, P., Crubézy, E., Sellier, P. & Tillier, A. M. 1990. L'anthropologie "de terrain": reconnaissance et interprétation de gestes funéraires. *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, 2, 29-50.
- Duday, H. & Guillon, M. 2006. Understanding the Circumstances of Decomposition When the Body Is Skeletonized. In: Schmitt, A., Cunha, E. & Pinheiro, J. (eds.) *Forensic Anthropology and Medicine: Complementary Sciences from Recovery to Cause of Death*. New Jersey: Humana Press.
- Han, N. 1999. Archaeological findings at Nyaunggan Bronze Age site. In: Anon (ed.) *Proceedings of the workshop on bronze age culture in Myanmar, 7 January 1999*. Yangon: Universities Historical Research Centre.
- Higham, C. F. W. 2002. *Early Cultures of Mainland Southeast Asia*, Bangkok, River Books Ltd.
- Higham, C. F. W. 2014. *Early Mainland Southeast Asia: From First Humans to Angkor*, Bangkok, River Books.
- Higham, C. F. W. in press. Debating a Great Site: Ban Non Wat and the Wider Prehistory of Southeast Asia *Antiquity*.
- Moore, E. 2006. *Early landscapes of Myanmar*, Bangkok, River Books.
- Moore, E. & Pauk, P. 2001. Nyaung-gan: A preliminary note on a Bronze Age cemetery near Mandalay, Myanmar (Burma). *Asian Perspectives*, 40, 35-47.
- Moore, E. & Win, S. 2007. The Gold Coast: Suvannabhumi? Lower Myanmar Walled Sites of the First Millennium A.D. *Asian Perspectives*, 46, 202-232.
- Moore, E. H. 2010. Myanmar bronzes and the Dian cultures of Yunnan. *Bulletin of the Indo-Pacific Prehistory Association*, 30, 122-132.
- Nilsson Stutz, L. 2006. Unwrapping the dead: Searching for evidence of wrappings in the mortuary practices at Zvenjnieki. In: Larsson, L. & Zagorska, I. (eds.) *Back to the Origin. New research in the Mesolithic-Neolithic Zvejnieki cemetery and environment, northern Latvia*.
- Pautreau, J.-P. (ed.) 2007. *Ywa Htin, Iron Age burials in the Samon Valley, Upper Burma*, Paris: Mission Archéologique Française au Myanmar.

- Pautreau, J.-P., Coupey, A.-S. & Kyaw, A. A. (eds.) 2010. *Excavations in the Samon Valley: Iron Age burials in Myanmar*, Chiang Mai: Mission Archéologique Française au Myanmar.
- Phenice, T. W. 1969. A newly developed visual method of sexing the Os pubis. *American Journal of Physical Anthropology*, 30, 297-301.
- Pryce, T. O. 2011. XIX Technical analysis of Bronze Age Ban Non Wat copper-base artefacts. In: Higham, C. F. W. & Kijngam, A. (eds.) *The excavation of Ban Non Wat: The Bronze Age*. Bangkok: The Fine Arts Department.
- Pryce, T. O. 2014a. Metallurgy in Southeast Asia. In: Selin, H. (ed.) *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*. Dordrecht: Springer Science+Business Media.
- Pryce, T. O. (ed.) 2014b. *Rapport de la campagne de fouille 2014 de la Mission Archéologique Française au Myanmar. Chronologie et évolution des cultures des âges du Bronze et du Fer au Myanmar et leurs caractéristiques anthropologiques et technologiques*: le site d'OAKAIE, Région de Monywa., Paris: Ministère des Affaires Étrangères.
- Pryce, T. O. 2015. Ban Non Wat: Mainland Southeast Asian chronological anchor and waypoint for future prehistoric research. *Antiquity*, 89, 1227-1229.
- Pryce, T. O., Baron, S., Bellina, B., Bellwood, P., Chang, N., Chattopadhyay, P., Dizon, E., Glover, I. C., Hamilton, E., Higham, C. F. W., Kyaw, A. A., Laychour, V., Natapintu, S., Nguyen, V., Pautreau, J.-P., Pernicka, E., Pigott, V. C., Pollard, A. M., Pottier, C., Reinecke, A., Sayavongkhamdy, T., Souksavatdy, V. & White, J. 2014. More questions than answers: the Southeast Asian Lead Isotope Project 2009-2012. *Journal of Archaeological Science*, 42, 273-294.
- Pryce, T. O., Coupey, A.-S., Kyaw, A. A., Dussubieux, L., Favereau, A., Lucas, L. & Perrin, M. 2013. The Mission Archéologique Française au Myanmar: Past, present and future. *Antiquity*, 87, online only.
- Pryce, T. O., Pigott, V. C., Martínón-Torres, M. & Rehren, T. 2010. Prehistoric Copper Production and Technological Reproduction in the Khao Wong Prachan Valley of Central Thailand. *Archaeological and Anthropological Sciences*, 2, 237-264.
- Reimer, P. J., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Ramsey, C. B., Buck, C. E., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P. M., Guilderson, T. P., Haflidason, H., Hajdas, I., Hatté, 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. & Plicht, J. V. D. 2013. IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years cal BP. *Radiocarbon*, 55, 1869-1887.
- Scheuer, L. & Black, S. M. 2000. *Developmental juvenile osteology*, Academic Press.
- Tayles, N., Donnett, K. & Pauk, P. U. 2001. Bronze Age (Myanmar): a report on the people from the cemetery of Nyaunggan, Upper Myanmar. *Antiquity*, 75, 273-8.
- Ubelaker, D. H. 1989. *Human skeletal remains: excavation, analysis, interpretation*.
- Walrath, D. E., Turner, P. & Bruzek, J. 2004. Reliability test of the visual assessment of cranial traits for sex determination. *American Journal of Physical Anthropology*, 125, 132-137.
- White, J. n.d. *Workshop on the Bronze Age culture of Nyaung'gan, Myanmar* [Online]. Library of the Collective Human Record, <http://www.lchr.org/a/37/1k/seasia/10/report2.html>. [Accessed 22/07/2015].
- White, J. C. 2008. Dating early bronze at Ban Chiang, Thailand. In: Pautreau, J.-P., Coupey, A., Zeitoun, V. & Rambault, E. (eds.) *Archaeology in Southeast Asia: From Homo Erectus to the Living Traditions, Choice of Papers from the 11th EurASEAA Conference, Bougon 2006*. Chiang-Mai European Association of Southeast Asian Archaeologists.
- Willis, A. & Tayles, N. 2009. Field anthropology: application to burial contexts in prehistoric Southeast Asia. *Journal of Archaeological Science*, 36, 547-554.
- Zazzo, A. 2014. Bone and enamel carbonate diagenesis: A radiocarbon prospective. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 416 168-178.
- Zazzo, A. & Saliège, J.-F. 2011. Radiocarbon dating of biological apatites: A review. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 310, 52-61.
- Zeitoun, V., Auetrakulvit, P., Forestier, H., Zazzo, A., Davtian, G., Nakbunlung, S. & Tiamtinkrit, C. 2013. Discovery of a Mesolithic burial near the painted rock-shelter of Ban Tha Si (Lampang province, Northern Thailand): Implications for regional mortuary practices. *Comptes Rendus Palevol*, 12, 127-136.