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Title: A stable, inexpensive and widely available burial environment or keeping place for archaeological or historical human skeletal remains

Authors: F. Donald Pate, Maciej Henneberg, Timothy J. Anson, Timothy D. Owen, Jeffrey Newchurch, Neale Draper, Chantal Wight, Teghan Lucas, Ian Moffat, Laura S. Weyrich, Emily Skelly, John Naumann, Angela Gurr, Calvin Logan and Jenna Walsh

In 2003 historical (non-Aboriginal) human skeletal remains archaeologically excavated from St Mary's Anglican Church cemetery in Adelaide, South Australia were reinterred in a concrete subterranean crypt. This paper examines preservation status following 15 years of interment. Skeletal remains placed in sealed plastic bags inside plastic curation boxes provided the best method to ensure physical and chemical preservation. Prefabricated concrete containers offer a cost-effective solution for the reburial of human skeletal remains associated with a range of archaeological contexts, including eroding burial sites, urban development sites, or those derived from earlier archaeological excavations. In relation to Indigenous burial sites, in cases where considered culturally appropriate, onsite crypts allow storage or repatriation of ancestral remains 'on country'. Concrete crypts provide cultural heritage management professionals and Indigenous communities with stable, dry, long-term burial sites that allow quick and easy access should ongoing management options, Indigenous cultural practices, or future research require re entry into the crypt.

Introduction

This paper provides an assessment of the preservation of historical human skeletal remains that were interred in a concrete crypt at the St Mary's Anglican Church cemetery in Adelaide, South Australia in 2003 following archaeological excavation and the completion of initial research (Anson and Henneberg 2004).

The location, excavation and study of burials in the unmarked "pauper" section of the cemetery at the rear of the church by Flinders University Archaeology staff members was solicited by parish priest Father John Stephenson in 1999 in relation to the church's plans to employ this area for additional burials of parish members. Following completion of research, the church requested the reburial of excavated human remains and associated coffin materials and other mortuary artefacts. This was achieved in a memorial crypt placed adjacent to the original area of interment rather than in the soil (Anson 2004: Appendix 1; Matic 2003; Pate and Anson 2012).

We endorse the use of concrete crypts as a cost-effective and reliable means to manage reburial of human remains encountered in relation to urban development and to repatriation of ancestral

remains to their appropriate cultural region or “country”. This method of reburying repatriated human remains is preferable to simple interment in the soil because it prevents taphonomic deterioration of bones, access by predators, accidental destruction by unauthorized or unapproved earthworks and exposure to geomorphological factors resulting in soil erosion. In addition, associated mortuary remains and artefacts can be retained in association with the skeletal remains. Finally, the crypt allows simple and controlled access by community members and researchers in relation to cultural ceremonies, further study or transfer.

Materials and methods

Following the completion of the initial archaeological research projects at St Mary’s Anglican Church (Anson 2004; Coussens 2002; Coussens *et al.* 2002; Matic 2003; Pate and Anson 2012; Taylor 2001; Townsend 2002), in order to allow future research access to the remains, a subterranean crypt located at the gardens of the cemetery was employed to rebury all human skeletal material and associated funerary items. In addition to facilitating further access in later years, this enabled reburial of the remains within consecrated ground, ensuring the local church community continuity of respect and the ability to commemorate former members of their congregation.

Figure 1: Concrete tank employed as a crypt at St Mary’s Anglican Church cemetery, Adelaide, South Australia, 2003 (photograph courtesy of RI Industries, Adelaide, South Australia).

Figure 2: Vent built into the tank access hatch, 2018 (photograph by Chantal Wight).

Figure 3: Memorial plaque to commemorate early European colonists interred in the unmarked section of the St Mary's Anglican Church cemetery, Adelaide, South Australia (photograph by Angela Gurr).

The crypt was constructed using an RI Industries 13,640 litre (13.64 cubic metre) concrete tank with a 2.87 m diameter and 2.44 m height (Figure 1). Wooden shelving was installed along the walls of the tank and individual skeletons were placed on the shelves in separate cardboard or plastic archive boxes padded with acid-free paper. The remains of 70 individuals, as distinct skeletons, were interred within the tank. The tank capacity would allow the addition of another 130 individuals (Anson and Henneberg 2004: 17). A small ventilation shaft was mounted on the lid of the crypt to evacuate moisture and any gases that might accumulate in the tank (Figure 2). A padlock was placed on the entry hatch on top of the tank to secure the crypt. The top of the tank was covered with wooden garden chips in order to blend into the garden setting associated with this part of the cemetery. The wooden chips also functioned to conceal the

entry hatch and associated padlock from the general public. In total, the cost of the crypt was A\$3,000 in 2003. A memorial plaque was placed at ground surface adjacent to the crypt (Figure 3) to commemorate the early European colonists interred below.

Adelaide has a Mediterranean climate (Köppen Csa), with cool to mild winters and warm to hot, dry summers. At the urban West Terrace Bureau of Meteorology recording site, located 8.1 km north of the St Mary's Anglican Church cemetery, mean annual rainfall is 528.3 mm, mean maximum temperature 21.8 degrees, and mean minimum temperature 12.0 degrees (Australian Government Bureau of Meteorology 2019). Thus, Adelaide provides a relatively hot and dry climate compared to most other Australian population centres that have been subject to extensive urban development affecting both historical and pre-contact Indigenous burial grounds.

In 2018, 15 years following the establishment of the underground concrete burial crypt at the St Mary's Anglican Church cemetery (Anson and Henneberg 2004), we revisited the site in relation to newly proposed bioarchaeological research involving DNA, stable isotopes, paleopathology and CT imaging. The research was approved by the Anglican Diocese and the Flinders University Social and Behavioural Research Ethics Committee. During several visits to the crypt site, we assessed the state of preservation of the human skeletal remains and associated interment materials in relation to determination of the long-term potential of concrete tanks for cultural heritage management and Indigenous reinterment associated with human remains.

Figure 3A: Detail of memorial plaque.

Figure 4: Tripod and harness equipment deployed for access to the crypt, 2018 (photograph by Donald Pate).

The bark covering was raked away to expose the top of the crypt, and the entry hatch was unlocked and opened. Prior to entry and for the duration of the inspection a multi-gas detector was employed to assess the presence of any gases in the crypt. The multi-gas detector displayed a consistent 21 per cent oxygen reading, indicating the ventilation system was functioning effectively as there were no gases besides the air present and the interior of the crypt was mostly dry. A ladder was inserted through the entry hatch and a technical staff member with confined space clearance (CW) descended into the crypt using a safety winch system attached to a tripod above the crypt (Figure 4). A spotter remained at the entrance to the crypt to maintain a constant visual contact with the person accessing the crypt for safety purposes.

Some moisture was present as indicated by minor deterioration and mould on the cardboard boxes in which individual skeletal remains had been stored. Individual archival boxes containing remains were then loaded into a cradle and secured via cords and netting and retrieved using the winch. At the surface, each archival box and its contents were examined on a small rectangular table. The remains were physically inspected for signs of deterioration, particularly for evidence of degradation due to moisture or other organic interference. Some remains were transferred into new plastic boxes due to moisture-related degradation of the former cardboard boxes. New sealable plastic bags were provided for these remains and relabelled in accordance with the original data. A catalogue of all material removed from the crypt was made, and cross correlated with a similar catalogue made during the original interment to ensure that no material had been removed during the intervening period.

Results

Due to an initial storage system of sealed archival plastic bags inside either cardboard or plastic archival boxes, skeletal remains (bones and teeth) were in fundamentally the same state as when they were deposited into the crypt 15 years ago. The state of the individual remains is described in Anson (2004). DP and MH studied all the remains 15 years ago and had good memory of their condition before interment into the crypt in 2003, and again when inspecting them in 2018. No physical deterioration of any bone, dentine or tooth enamel was observed. There was no mould growing on the bones, nor was there any damage by invertebrates or vertebrates. The condition of the bones was precisely comparable to those held in museum storerooms with stable atmospheric characteristics for many decades following excavation (Antoine 2014; Giesen 2013).

However, many of the cardboard archival boxes had perished significantly, especially those closest to the walls of the crypt. Mould was present on these boxes and the integrity of the boxes had been compromised. However, the remains held in the cardboard boxes had been sealed and protected in resealable plastic bags and their excellent physical preservation was equal to those that had been stored within the crypt in plastic boxes. The deterioration of the cardboard archival boxes was attributed to the inadequacy of the ventilation system initially installed and operation over the first few years of the crypt's existence. In 2004 Anson and Henneberg detected an accumulation of moisture on the walls of the crypt and damage to the cardboard boxes, to rectify the issue a ventilation shaft was installed in the access hatch. This allowed escape of the accumulated moisture and ensured dryness inside the crypt. No further deterioration of cardboard boxes occurred.

Preservation of ancient DNA (aDNA) in the crypt environment was also assessed in relation to chemical integrity of the skeletal remains. Ancient DNA preservation is dependent upon the

post-mortem environmental factors, such as temperature or moisture (Allentoft 2012). Because Australia has notoriously poor DNA preservation due to its hot climate (Smith *et al.* 2003), crypt storage provides a solution for long-term preservation of human remains and prevention of DNA degradation.

Dental calculus (calcified dental plaque)—ubiquitously found across historical human populations—is known to contain more total DNA by weight than other human tissues (Warinner *et al.* 2014; Weyrich *et al.* 2015), although preservation kinetics of dental calculus are currently limited. We successfully extracted aDNA from the dental calculus of 12 St Mary's individuals, reconstructing authentic oral microbial communities from 23 of the 28 collected samples. Five samples of dental calculus were discounted because they contained more than 10 per cent environmental or laboratory contaminant microorganisms (Skelly 2019), potentially indicative of water damage prior to crypt storage. Overall, a success rate of more than 80 per cent demonstrates the favourable preservation of the aDNA sample material postexcavation and maintenance of integrity during crypt storage, as long as DNA was present prior to entry. Long-term DNA preservation over greater lengths of time (i.e. more than 15 years) in this storage environment needs to be further evaluated.

DNA preservation in the crypt environment suggests that bone and tooth collagen should also survive and enable future isotopic and other chemical analyses of human skeletal remains (cf. Pate 1998).

Conclusions

The mechanism for long term storage and preservation of excavated human skeletal remains, interred in a subterranean concrete crypt in Adelaide, South Australia for a 15-year period, was deemed successful. The dual aims of conserving the physical and chemical integrity of skeletal remains in a safe and suitable location, in a burial context, but allowing a mechanism for simple access was achieved. The skeletal remains had suffered no macroscopically visible physical damage or degradation since the time of their excavation in 2000. In addition, extraction of DNA suggests the preservation of the chemical integrity of the skeletal remains. The crypt itself was in original condition after being buried, and had remained waterproof and well-ventilated over a long period of varying weather conditions. Thus, the initial criteria for the solution, as stated by Anson and Henneberg (2004) have been met, and it can be concluded that this type of concrete crypt provides a long-term, cost effective means for reburial of skeletal remains in association with archaeological cultural heritage management requirements, on-site curation of Indigenous and non-Indigenous remains, and potential repatriation of Indigenous ancestral remains. The preservation of associated wooden coffin materials and mortuary artefacts that were placed in the crypt suggests that concrete crypts could also provide suitable keeping places for other cultural objects, including secret and/or sacred materials.

The placement of human remains inside sealed plastic bags proved essential to the long-term viability of the system, and the research team has recommended future reinterment inside archival plastic storage containers, possibly with small holes drilled into the base of each box for ventilation. Cardboard boxes are not recommended for long-term storage.

Although the subterranean concrete crypt provided a relatively dry and stable burial environment in the Adelaide climate, additional research will be required to determine long-term skeletal preservation conditions associated with varying climatic regions. Locations in

more humid climates may require further mechanised techniques to retain a consistent humidity within the burial chamber.

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References

ALLENTOFT, M.E., M. COLLINS, D. HARKER, J. HAILE, C.L. OSKAM, M.L. HALE, P.F. CAMPOS, J.A. SAMANIEGO, M.T. GILBERT, E. WILLERSLEY, G. ZHANG, R.P. SCOFIELD, R.N. HOLDAWAY and M. BUNCE 2012, 'The Half-Life of DNA in Bone: Measuring Decay Kinetics in 158 Dated Fossils', *Proceedings of the Royal Society B: Biological Sciences* 279(1748): 4724–4733.

ANSON, T.J. 2004, *The Bioarchaeology of the St. Mary's Free Ground Burials: Reconstruction of Colonial South Australian Lifeways*, PhD thesis, University of Adelaide.

ANSON, T.J. and M. HENNEBERG 2004, 'A Solution for the Permanent Storage of Historical Skeletal Remains for Research Purposes: A South Australian Precedent that Keeps Scientists and the Church Community Happy', *Australian Archaeology* 58: 15–18.

ANTOINE, D. 2014, 'Curating Human Remains in Museum Collections: Broader Considerations and a British Perspective' in A. Fletcher, D. Antoine and J.D. Hill (eds), *Regarding the Dead: Human Remains in the British Museum*, British Museum, London, pp. 3–9.

BUREAU OF METEOROLOGY 2019, Climate statistics for Australian locations: Monthly climate statistics, All years on record, http://www.bom.gov.au/climate/averages/tables/cw_023000.shtml, retrieved 18 Sep. 2019.

COUSSENS, A. 2002, *The Reliability of DNA Extraction Methods from Ancient Skeletal Remains*, Honours thesis, University of Adelaide.

COUSSENS, A., T.J. ANSON, R.M. NORRIS and M. HENNEBERG 2002, 'Sexual Dimorphism in the Robusticity of Long Bones of Infants and Young Children', *Anthropological Review* 65: 3–16.

GIESEN, M. (ed.) 2013, *Curating Human Remains: Caring for the Dead in the United Kingdom*, Boydell and Brewer, Woodbridge.

MATIC, A. 2003, *Here I Lie because I am Poor*, Master of Arts thesis, Flinders University.

PATE, F.D. 1998, 'Bone Collagen Preservation at the Roonka Flat Aboriginal burial ground: A natural laboratory', *Journal of Field Archaeology* 25: 203–217.

PATE, F.D. and T.J. ANSON 2012, 'Stable Isotopes and Dietary Composition in the Mid-Late 19th Century Anglican Population, Adelaide, South Australia', *Journal of the Anthropological Society of South Australia* 35: 1–16. SKELLY, E. 2019, Processes of Industrialisation Influencing the Human Oral Microbiome, PhD thesis, University of Adelaide.

SMITH C.I., A.T. CHAMBERLAIN, M.S. RILEY, C. STRINGER, and M.J. COLLINS 2003, 'The Thermal History of Human Fossils and the Likelihood of Successful DNA Amplification', *Journal of Human Evolution* 45(3): 203–217.

TAYLOR, D. 2001, Stable Isotope Ratio Analysis of the Human Bone Retrieved from St Mary's Churchyard and Chemical Analysis of the Surrounding Soil, Bachelor of Science Honours thesis, Flinders University.

WARINNER C., J.F.M. RODRIGUES, R. VYAS, C. TRACHSEL, N. SHVED, J. GROSSMAN, A. RADINI and E. CAPPELLINI 2014, 'Pathogens and Host Immunity in the Ancient Human Oral Cavity', *Nature Genetics* 46(4): 336.

WEYRICH, L.S., K. DOBNEY and A. COOPER 2015, 'Ancient DNA Analysis of Dental Calculus', *Journal of Human Evolution* 79: 119–124.