2013

Mid-Holocene age obtained for nested diamond pattern petroglyph in the Billasurgam Cave complex, Kurnool District, southern India

Paul S.C Tacon
Griffith University

Nicole Boivin
University of Oxford

Michael Petraglia
University of Oxford

James Blinkhorn
University of Oxford

Allan Chivas
University of Wollongong, toschi@uow.edu.au

See next page for additional authors

Mid-Holocene age obtained for nested diamond pattern petroglyph in the Billasurgam Cave complex, Kurnool District, southern India

Abstract

India has one of the world's largest and most significant bodies of rock paintings and engravings, yet not a single rock art site or image has been directly and accurately dated using radiometric techniques. Here we report on results from the Billasurgam Cave complex near Kurnool in southern India. Although this cave complex has been investigated archaeologically since the late 1800s, it was not until 2008 that a large petroglyph, consisting of the remains of three nested diamond designs on a stalactite, was noted. In order to determine if this petroglyph had been made recently, flowstone was sampled from on top of and below the engraving. Radiocarbon dating revealed a mid-Holocene age of about 5000 cal BP for the petroglyph, but we cannot rule out the possibility that the engraving is several centuries younger. Similar nested diamond designs at some rock painting sites and on a chert core elsewhere in India have been assumed to be Mesolithic. Our result is consistent with this hypothesis, although we note that it also consistent with the creation of the petroglyph in the early Neolithic. We conclude that the Billasurgam engraved diamond design was probably made by Mesolithic foragers of the Kurnool region and is the oldest surviving form of rock art yet directly dated in southern India.

Keywords

southern, district, kurnool, complex, cave, billasurgam, india, petroglyph, mid, pattern, diamond, nested, obtained, age, holocene, GeoQuest

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

Publication Details

Tacon, P., Boivin, N., Petraglia, M., Blinkhorn, J., Chivas, A., Roberts, R. G., Fink, D., Higham, T., Ditchfield, P., Korisettar, R. & Zhao, J. (2013). Mid-Holocene age obtained for nested diamond pattern petroglyph in the Billasurgam Cave complex, Kurnool District, southern India. Journal of Archaeological Science, 40 (4), 1787-1796.

Authors

Paul S.C Tacon, Nicole Boivin, Michael Petraglia, James Blinkhorn, Allan Chivas, Richard G. Roberts, David Fink, Thomas Higham, Peter Ditchfield, Ravi Korisettar, and Jian-xin Zhao

*Manuscript

Mid-Holocene age obtained for nested diamond pattern petroglyph in the Billasurgam Cave complex, Kurnool District, southern India

Paul S.C. Taçon[a], Nicole Boivin[b], Michael Petraglia[b], James Blinkhorn[b], Allan Chivas[c,d], Richard G. Roberts[d], David Fink[e], Thomas Higham[b], Peter Ditchfield[b], Ravi Korisettar[f] and Jian-xin Zhao[g]

a PERAHU, School of Humanities, Gold Coast campus, Griffith University, Queensland 4222, Australia; p.tacon@griffith.edu.au

b School of Archaeology, Research Laboratory for Archaeology and the History of Art, University of Oxford, Oxford OX2 1HU, UK

c GeoQuest Research Centre, School of Earth & Environmental Sciences, University of Wollongong, New South Wales 2522, Australia

d Centre for Archaeological Science, School of Earth & Environmental Sciences, University of Wollongong, New South Wales 2522, Australia

e Institute for Environmental Research, Australian Nuclear Science and Technology Organization, Kirrawee DC New South Wales 2232, Australia

f Department of History and Archaeology, Karnatak University, Dharwad 580 003, India

g School of Earth Sciences, The University of Queensland, Brisbane, Queensland 4072, Australia

Abstract

India has one of the world's largest and most significant bodies of rock paintings and engravings, yet not a single rock art site or image has been directly and accurately dated using radiometric techniques. Here we report on results from the Billasurgam Cave complex near Kurnool in southern India. Although this cave complex has been investigated archaeologically since the late 1800s, it was not until 2008 that a large petroglyph, consisting of the remains of three nested diamond designs on a stalactite, was noted. In order to determine if this petroglyph had been made recently, flowstone was sampled from on top of and below the engraving. Radiocarbon dating revealed a mid-Holocene age of about 5000 cal BP for the petroglyph, but we cannot rule out the possibility that the engraving is several centuries younger. Similar nested diamond designs at some rock painting sites and on a chert core elsewhere in India have been assumed to be Mesolithic. Our result is consistent with this hypothesis, although we note that it also consistent with the creation of the petroglyph in the early Neolithic. We conclude that the Billasurgam engraved diamond design was probably made by Mesolithic foragers of the Kurnool region and is the oldest surviving form of rock art yet directly dated in southern India.

Keywords: India, Rock art, Dating, Radiocarbon, Mesolithic

1. Introduction

How old is it and what does it mean? These are two of the most commonly asked questions in rock art research, but in many ways they are related; knowing how old something is tells us about an aspect of its meaning. For instance, an age can inform us about the probable group of people that produced the rock art and/or changing relationships to local landscapes and environments. But assigning age and meaning to rock art are both highly challenging and controversial, with the literature littered with speculation and the possibility of miscalculation and misinterpretation (e.g. reviews by Bednarik, 1995, 2002; Pettit and Pike, 2007). In recent decades, archaeological (e.g. Taçon and Chippindale, 1998) and broader scientific (e.g. Bednarik, 2001) approaches to rock art research have been advocated, especially for rock art dating. A variety of dating techniques has been employed, primarily accelerator mass spectrometry (AMS) radiocarbon and, more recently, uranium-series with fairly good success, and a number of other methods are being trialed (Langley and Taçon, 2010; Rowe, 2012; Taçon and Langley, 2012). After early efforts in East Timor (e.g. Aubert et al., 2006), Uranium-series dating was recently used to establish that the oldest surviving rock engraving in the United Kingdom is at least 14,000 years old (Nash et al., 2012), that in northern Spain a hand stencil is at least 37,000 years old and a red disk is over 40,000 years old (Pike et al., 2012) and that paintings in northwest Yunnan Province, China date to the mid-Holocene or earlier (Taçon et al., 2012). However, very few of the hundreds of thousands of rock art sites scattered across the globe have been directly dated and hardly any have been dated at all in much of Asia (Rowe, 2012).

The rock art of India (Figure 1) is undoubtedly of global significance as many researchers have noted (e.g. Allchin and Allchin, 1994-95; Bednarik and Chakravarty, 1997; Blinkhorn, 2012; Boivin, 2004; Chakravarty, 1984; Chakraverty, 2003; Chandramouli, 2002; Ghosh, 1998; Mathpal, 1984, 1998; Neumayer, 1992, 1993; Pandey, 1992; Pradhan, 2001; Taçon, Boivin et al., 2010), especially with the rock art of the Bhimbetka area a UNESCO world heritage site, but it has not been well dated nor integrated with the excavated archaeological record (Blinkhorn et al., 2012). In 2008 and 2009, as part of an extensive and continuing archaeological investigation of the Kurnool area of southern India, we sampled two sites to obtain minimum ages of what are considered to be the oldest surviving forms of rock art in the area. These consist of small naturalistic outline paintings in a rock shelter (Taçon, Boivin et al., 2010) and engraved geometric designs in a cave. The latter engravings, the subject of this paper, were discovered on 8 January 2008 by Ramdas, an Indian villager assisting with public outreach and excavation and someone who had previously worked with N.B. on a rock art project in the Bellary District of the south Deccan plateau to the west (Boivin, 2004). Despite extensive research on the cave complex (see Haslam et al., 2010 for summary), the engraved panel was not noted previously, partly because of its obscure orientation in relation to natural corridors through the complex. Here we report on initial dating results for this petroglyph.

1.1 Kurnool rock art and the Billasurgam Caves

The Kurnool District of south India is an area of outstanding archaeological significance, rich in exceptional Palaeolithic deposits (Clarkson et al., 2009; Petraglia et al., 2007, 2009a) and an abundance of varied hunter-gatherer, Neolithic and Megalithic sites (Allchin, 1962; Blinkhorn, 2008; Murty, 1985, 1992). Field surveys undertaken since 2003 have located 88 rock art sites in the vicinity of the Jurreru Valley and in the Billasurgam Cave complex, close to Betamcherla (Figure 2), although many hundreds of rock art sites remain undocumented. Several different styles of rock art associated with various time periods have been identified (Boivin et al., 2009; Taçon, Boivin et al., 2010) and connections to the rock art of other parts of India and beyond are under investigation (Blinkhorn et al., 2012). The rock art is also being studied in relation to the excavated archaeological record, environmental change and cultural change, with a chronology linked with numerical as well as relative dating.

The extensive Billasurgam Cave complex, situated about 50 km southeast of Kurnool, has been investigated for faunal remains (Murty, 1975; Prasad, 1996) and archaeological material (Murty, 1974, 1985; Thimma Reddy, 1980) since 1884, when Bruce Foote, of the Geological Survey of India, explored the caves with his son Henry (Foote, 1884, 1885; see also Haslam et al., 2010). Although the Billasurgam rock engravings were not noted until over 120 years later, petroglyphs and pictographs elsewhere in India have also been studied since the late 1800s (Cockburn, 1899; Franke, 1902).

1.2 Site description

In the Billasurgam Cave complex, consisting of several linked caves or chambers, there is a small engraved panel on and under flowstone that faces west at 257º (Figure 3). It is located near the northern entrance of 'Cathedral Cave' (Figure 4) and consists of the remains of two concentric diamonds, one above the other, and a rougher concentric diamond, with a more rounded innermost shape, between them and to the right (Figure 5, 6 and 7). Today, the exposed portion of the panel measures 29 cm wide by 61 cm high, but it may extend slightly in width and possibly a few centimeters in height under flowstone. The upper concentric diamond is 19 cm wide by 30 cm high, while the lower one measures 24 cm wide by 32 cm high. The third concentric diamond is a bit smaller at 17 cm wide by 25 cm high. The large stalactite on which the designs are situated measures 3.7 m wide. At its northern end, the stalactite is 3.5 m high, but only 0.9 m high at its southern end. The base of the stalactite is currently 1.25 m above the ground, with the lowest part of the lower diamond 0.65 m above the base.

All three concentric diamonds have five nested shapes. The grooves that form the designs do not have a fresh appearance. Part of the lower half of the lower diamond has weathered away and there is much weathering of grooves where the upper and lower diamonds meet. The designs were cut into the stalactite and subsequent flowstone formation has covered the upper, top left, part of the upper diamond, a small part of the lower half of the lower diamond, and part of the right side of the right diamond.

2. Materials and methods

Five pieces of flowstone associated with the engraving were obtained for AMS radiocarbon dating (Figures 8 and 9). One sample was taken from a context on the left lateral mid-section of the engraving, adjacent to it and proposed as overlying the engraving. This sample was broken in half, and one half (C-1) was submitted to the Oxford Radiocarbon Accelerator Unit (ORAU), University of Oxford, for dating. The other half was sent to the Australian Nuclear Science and Technology Organisation (ANTSO) for independent analysis. The latter piece was, in turn, sub-divided into two parallel layers, an outer part (C-2) and an inner part (C-3). Samples C-1 and C-2/C-3 were therefore considered to be complementary, with the view that C-2 and C-3 might yield younger and older ages than C-1.

A fourth sample (C-4) was taken from a microstratigraphic context slightly above samples C-1 to C-3, on the upper left lateral section of the engraving. Because C-4 overlies the engraving, the resulting radiocarbon date constitutes a minimum age estimate (*terminus ante quem*) for the engraving. Sample C-5 was taken a distance of about 1 m away from the engraving, on the lower left side of the stalactite. The intention of sample C-5 was to obtain an age from a surface that underlies the engraving, thus producing a maximum age estimate (*terminus post quem*) for the petroglyph. Samples C-4 and C-5 were both dated at the ORAU.

3. Results and discussion

Table 1 lists the radiocarbon results as conventional ages (in radiocarbon years before present, BP, where the 'present' is AD 1950) and as calibrated ages (cal BP). The latter were obtained using OxCal (Bronk Ramsey, 2001) and the IntCal09 calibration curve (Reimer, et al. 2009) (Figure 10), and are listed at both the 68.2% (1σ) and 95.4% (2σ) confidence intervals in Table 1. The calibrated ages are in calendar years BP, so they are directly comparable to the uranium-series ages discussed below, provided allowance is made for the time difference between AD 1950 and the date of measurement of the uranium-series samples.

In radiocarbon dating of flowstone, the event being dated is the time of precipitation of calcite ($CaCO_3$), which has carbon in its crystal structure. An important consideration in radiocarbon dating of calcite is the evaluation of the dead-carbon fraction (DCF) associated with the incorporation of 'infinitely old' carbon derived from carbonate rocks, such as the Upper Proterozoic limestone in which the Billasurgam Cave complex has formed. The incorporation of dead carbon in precipitated calcite will give rise to 'apparent' radiocarbon ages that are older than the 'true' ages, so an estimate of the DCF effect must be made for the samples in question.

To do so, we selected what appeared to be a recently precipitated, although dry, shawl of calcite in a nearby part of the cave system (opposite the entrance to Chapter House, Figure 4), assuming it to be close to modern in age. We obtained a conventional radiocarbon age of 900 ± 30 BP and a uranium-series age of 260 ± 2900 years (the large uncertainty being due to detrital thorium). The $\delta^{13}C$ value of the carbonate is –7.7‰, which is close to the value expected for atmospheric $\delta^{13}C$ and could be interpreted as indicating little contribution of carbon from dissolving limestone. The radiocarbon age, however, implies either that the calcite was deposited ~900 years ago or that it has a DCF equivalent to ~900 years at Billasurgam. A cautious approach would suggest that the measured radiocarbon ages at Billasurgam (Table 1) may be too old by up to a millennium, due to the DCF.

The measured ages show good internal consistency. The two halves of the same sample obtained from adjacent to the engraving produced comparable ages, as did the outer and inner parts of the sub-divided portion: the calibrated age ranges (at the 95.4% confidence interval) for C-1, C-2 and C-3 are 4872–5272, 4618–5033 and 5041–5466 cal BP, respectively. Sample C-4 produced a calibrated age of 5041–5296 cal BP, which overlaps the age for C-1 and falls within the period bracketed by samples C-2 and C-3. This concordance increases confidence in the measurements, because sample C-4 was collected from on top of another part of the engraving. Sample C-5 was taken from a location thought to underlie the engraving, and produced a calibrated age of 5656–5585 cal BP. This age is older than those of the other samples, which is consistent with their stratigraphically younger contexts.

We next used a Bayesian model to integrate the relative age sequence described above (i.e. the order of superposition of the different samples) with the calibrated age ranges. In the model, we assigned OxA-23442 (sample C-5) as pre-dating the engraving and OxA-23441 (sample C-4) as post-dating it. The remaining three ages were incorporated within a single phase that we think correlates most closely to the period during which the rock engraving was created. Under these assumptions, the model determined the start boundary for the rock art as 5390–5197 cal BP (68.2% CI) or 5620–5032 cal BP (95.4% CI), and the end boundary as 5245–5136 cal BP (68.2% CI) or 5265–4986 cal BP (95.4% CI) (Figure 10).

OxA-23441 constrains the Bayesian model in an important way, since it acts as a *terminus ante quem* for the rock art, dating the flowstone overlying the engraving. As samples C-1, C-2 and C-3 also overly the engraving, the age of OZN-104 (sample C-3, the oldest of the results) exerts a similar if not slightly stronger influence. When we then take into account the influence of C-5, which underlies the engraving, this approach suggests that the engraving probably dates to 5400–5000 cal BP. When we take into account the possible age-offset associated with the DCF the prospect is raised that the actual age of the engraving may be even younger than this, by several centuries, giving a conservative *terminus ante quem* of around 4100 cal BP.

3.2 Significance and discussion

The mid-Holocene age for the engraving is significant for several reasons. It represents the oldest reliable and direct radiometric date for any rock art in India. As yet, no other rock art has been directly dated in India and, for the most part, the age of India's rock art has been arrived at by indirect means (Blinkhorn et al., 2012). The age is also comparable to the oldest yet obtained from direct dating attempts on rock art elsewhere in continental Asia (e.g. Taçon et al., 2012), and is the first mid-Holocene date associated with a continent-wide rock art design, the nested diamond pattern.

The age of the Billasurgam nested diamond engraving suggests it was most likely made by Mesolithic foragers. This is because the modelled date for the end boundary (Figure 10b) falls just before the Neolithic lifestyle expanded across the region, beginning around 4500 cal BP (Petraglia et al., 2009b: 130–131). Fuller et al. (2007) argue that the southern Neolithic started around 5000 cal BP, focusing initially on the granitic landscapes of the south Deccan plateau and only later spreading into more upland landscapes at the periphery of the Erramalai Hills, where Billasurgam is located (Petraglia et al. 2009b). In the nearby Kunderu Valley, the Neolithic sites are also younger than the age of the Billasurgam engraving (Fuller et al., 2007; Petraglia et al., 2009b). We recognize, however, that the Billasurgam engraving could have been made as recently as 4100 cal BP, based on the potential for age overestimation due to the DCF, so there remains the possibility that the engraving was created in the early Neolithic.

Importantly, the Billasurgam nested diamond pattern is similar to that found on a presumed Mesolithic chert core from Chandravati, far to the north, near Mount Abu, in the southern hilly region of Rajasthan (Sonawane, 1984, 1992). As Sonawane (1992: 274) describes it:

> One of the fluted chert cores of the lithic assemblage collected from Chandravati has engravings executed on its flat rectangular patinated cortex. The incised design appears to have been cut into the incrustation of opaline silica whose hardness is less than that of chert. The engraved design… consists of a spiraling rhomboid formed by a pair of parallel lines moving clockwise from the centre. The design appears to be the result of two intertwining spiraling arms. One of these arms bears a series of short diagonal lines, whereas the other one is left plain.

Although the core has been assigned to the Mesolithic, it has not been securely dated. The result from Billasurgam shows that the design found on the core may indeed have Mesolithic roots, at least in southern India, supporting the hypothesized time period in which the core was incised.

We may never know exactly what the nested diamond design meant to those that made it. However, there is some resemblance to diamond designs in honeycombs still found in the cave complex (Figure 11). As with the later Neolithic peoples, resident *Apis* colonies would have been a strong attraction for Mesolithic foragers. For instance, the importance of bees and honey in human evolution, and for various foraging peoples of south India, is well documented (e.g. Crittenden, 2011; Gardner, 1993), some Mesolithic rock paintings in Spain feature honey gathering (Dams and Dams, 1977) and Aboriginal Australians actually made rock art with beeswax obtained from honey gathering (e.g. see Taçon et al., 2004; Taçon, May et al., 2010). In the Billasurgam caves, Petraglia et al. (2009b: 130–131) dated a ceramic-bearing layer in Chapter House North to 4527–4414 cal BP (95.4% CI, using IntCal09), argued to be associated with the onset of the Neolithic. Neolithic pottery was also found by F.R. and B. Allchin (1962) at Billasurgam and a pot was reconstructed from fragments at the British Museum. The ware is of a type (A4) typical of the Upper Neolithic. On the basis of ethnographic information, they suggest that pots like this one were used both as collecting vessels and as hives for honey-producing bees (Allchin and Allchin, 1962: 303 and plate XLIV). As there is no evidence of permanent Neolithic settlement at Billasurgam, they also speculated that the pot was left behind during an occasional visit by Neolithic people from nearby settlements and that 'The obvious purpose of such visits would be to collect honey' (1962: 303).

Across India, including elsewhere in the Kurnool area, there are numerous rock shelters with paintings that feature diamond, nested diamond, spiraling rhomboid and honeycomb-like designs of varying ages (Chandramouli, 2002: figures 35, 37c; Neumayer, 1992: figures 2, 5, 7, 10; Neumayer, 1993: figures 34–37; Pandey, 1992: figures 1–4; Sonawane, 1984, 1992; Taçon, Boivin et al., 2010: 342, 348; Tyagi, 1992), some of which have been interpreted as being representative of honeycombs. Unfortunately, like the Chandravati core, the painted images have not been directly dated. The Billasurgam result suggests some may yet be shown to date to the Mesolithic, while elsewhere the design continued to be made at rock painting sites through the Neolithic (e.g. see Taçon, Boivin et al., 2010). Whether it represents an actual honeycomb is a reasonable hypothesis supported by analogy but, as with the meaning of most ancient rock art, this is difficult, if not impossible, to test scientifically.

4. Conclusion

The Billasurgam panel is the oldest surviving, directly dated form of rock art in India. An age of about 5000 cal BP was obtained for a nested diamond pattern engraving by radiocarbon dating of flowstone under and over the petroglyph. However, the engraving may be up to several centuries younger, depending on the fraction of 'dead carbon' in the flowstone at the time of formation. Similar results were obtained from two laboratories, which lends support to the sample preparation and measurement procedures used in this study. It appears that the Billasurgam engraving was most likely made by late Mesolithic foragers (but possibly by very early Neolithic people), due to its mid-Holocene age. This highlights the potential for much more rock art to be dated beyond a few thousand years in India.

The Billasurgam panel is not only the oldest surviving securely-dated petroglyph from India but also the oldest dated honeycomb-like design. This illustrates that the preference for this type of design has ancient roots, with probable origins among Mesolithic foragers. It also supports the long-held hypothesis that a chert core with a similar engraved design, found at Chandravati, Rajasthan, could have been made in the Mesolithic, as we now know that the design was being made near the Mesolitic/Neolithic boundary elsewhere, in southern India.

This research also highlights the potential for numerical dating of Indian rock art, a potential already being explored in other parts of the world, particularly Europe (e.g. Pettitt and Pike, 2007; Pike et al., 2012; Rowe, 2000, 2012) and Australia (Aubert, 2012; David et al., 2013; Langley and Taçon, 2010). Future rock art research in India should include a variety of dating programs and techniques, as well as better integration of rock art studies with excavation, landscape archaeology and environmental studies.

Acknowledgements

We are grateful to the Archaeological Survey of India for permission to conduct this work. We appreciate the logistical support of the American Institute for Indian Studies. This research was supported by grants from the Leverhulme Trust and the British Academy (to M.P.) and by Australian Research Council grant DP0880675 (to R.G.R., A.C. and M.P.). We wish to sincerely thank Ramdas for the discovery of the engraving and for his views on the history of the region. We thank Michael Haslam for assisting with sample collection and express our gratitude to the radiocarbon laboratory staff at ORAU and ANSTO. Jessica Blackman is thanked for the digital rock art tracing.

References

Allchin, F.R., 1962. Neolithic cattle-keepers of south India: a study of the Deccan ashmounds. Cambridge: Cambridge University Press.

Aubert, M., 2012. A review of rock art dating in the Kimberley, Western Australia. Journal of Archaeological Science 39, 573-577.

Aubert, M., O'Connor, S., McCulloch, M., Mortimer, G., Watchman, A., Richer-LaFlèche, M., 2006. Uranium-series dating rock art in East Timor. Journal of Archaeological Science 34, 991-996.

Allchin, F.R., Allchin, B., 1962. A Neolithic pot from Andhra Pradesh. Antiquity 36, 302-303.

Allchin, F.R., Allchin, B., 1994-95. Rock art of North Karnataka. Bulletin of the Deccan College Post-Graduate and Research Institute 54-55, 313-339.

Bednarik, R., 1995. Logic in direct dating of rock art. SAHARA 7, 69-78.

Bednarik, R., 2001. Rock art science: the scientific study of palaeoart. Brepols, Turnhout.

Bednarik, R., 2002. The dating of rock art: a critique. Journal of Archaeological Science 29, 1213-1233.

Bednarik, R., Chakravarty, K.K., 1997. Indian rock art and its global context. New Delhi: Shri Jainendra Press.

Blinkhorn, J., 2008. In which context does symbolic behaviours first become manifest in the archaeological record? A case study from Kurnool District, India. Unpublished M.Phil. thesis. Cambridge: University of Cambridge.

Blinkhorn, J. 2012. Rock art research in India 2000-2009: methodological and theoretical trends in the 21st Century. In Bahn, P.,Franklin, N. (Eds.), Rock art studies news of the world IV. Oxbow Books, Oxford, pp. 196-206.

Blinkhorn, J., Boivin, N., Taçon, P.S.C., Petraglia, M., 2012. Rock art research in India: historical approaches and recent theoretical directions. In McDonald, J., Veth, P. (Eds.), A companion to rock art. Chichester: Wiley-Blackwell, pp. 179-196.

Boivin, N., 2004. Rock art and rock music: petroglyphs of the south Indian Neolithic. Antiquity 78, 38-53.

Boivin, N., Hampson, J., Blinkhorn, J., Korisettar, R. and Petraglia, M., 2009. Re-examining rock art studies in India: a case study from Kurnool District, Andhra Pradesh. In Paddayya, K.,Joglekar, P.P., Basa, K.K., Sewant, R. (Eds.), Recent research trends in South Asian archaeology. Pune: Deccan College, pp. 261-278.

Bronk Ramsey, C., 2001. Development of the radiocarbon calibration program OxCal, *Radiocarbon* 43, 2A, 355-363.

Chakravarty, K.K. (ed.), 1984. Rock-art of India: paintings and engravings. New Delhi: Arnold-Heinemann.

Chakraverty, S., 2003. Rock art studies in India: a historical perspective. Kolkata: The Asiatic Society.

Chandramouli, N., 2002. Rock art of south India: with special reference to Andhra Pradesh. Delhi: Bharatiya Kala Prakashan.

Clarkson, C., Petraglia, M., Korisettar, R., Haslam, M., Boivin, N., Crowther, A., Ditchfield, P., Fuller, D., Miracle, P., Harris, C., Connell, K., James, H., Koshy, J., 2009. The oldest and longest enduring microlithic sequence in India: 35 000 years of modern human occupation and change at the Jwalapuram Locality 9 rockshelter. Antiquity 83(320), 326-348.

Cockburn, J., 1899. Cave drawings in the Kaimur range, Northwest Provinces. Journal of the Royal Asiatic Society 1899, 89-97.

Dams, M., Dams, L., 1977. Spanish rock art depicting honey gathering during the Mesolithic. Nature 268, 228-230.

David, B., Geneste, J.-M., Petchey, F., Delannoy, J.-J., Barker, B., Ecclston, M., 2013. How old are Australia's pictographs? A review of rock art dating. Journal of Archaeological Science 40, 3-10.

Foote, R.B., 1884. Mr. H. B. Foote's work at Billasurgam Caves. Records of the Geological Survey of India 17(4), 200-08.

Foote, R.B., 1885. Notes on the results of Mr. H.B. Foote's further excavations in the Billa Surgam caves. Records of the Geological Survey of India 18(4), 227-35.

Franke, A.H., 1902. Notes on rock carvings from Lower Ladakh. The Indian Antiquary 31, 398-401.

Fuller, D., Boivin, N. Korisettar, R., 2007. Dating the Neolithic of South India: new radiometric evidence for key economic, social and ritual transformations. Antiquity 81 (313), 755-778.

Ghosh, R.S.M., 2001. Rock-paintings and other antiquities of prehistoric and later times. New Delhi: Archaeological Survey of India.

Haslam, M., Korisettar, R., Petraglia, M., Smith, T., Shipton, C., Ditchfield, P., 2010. In Foote's steps: the history, significance and recent archaeological investigation of the Billa Surgam Caves in southern India. South Asian Studies 26(1), 1-19.

Langley, M., Taçon, P.S.C., 2010. The age of Australian rock art: a review. Australian Archaeology 71, 70-73.

Mathpal, Y., 1984. Prehistoric rock paintings of Bhimbetka Central India. New Delhi: Abhinav Publications.

Mathpal, Y., 1998. Rock art in Kerala. New Delhi: Indira Gandhi National Centre for the Arts.

Murty, M.L.K., 1974. A late Pleistocene cave site in south India. Proceedings of the American Society 118(2), 196-230.

Murty, M.L.K., 1975. Late Pleistocene fauna of Kurnool caves. In Clason, A.T. (Ed.), Archaeo-zoological studies. Amsterdam: North Holland Publishing Co., pp. 132-38.

Murty, M.L.K., 1985. Ethnoarchaeology of the Kurnool Cave areas, South India. World Archaeology 17(2), 192-205.

Murty, M.K.L., 1992. Hunter-gatherers, pastoralists and the state in southwestern Andhra Pradesh, South India. In Audouze, F. (Ed.*), Ethnoarchéologie: Justification, Problèmes, Limites*. XIIe Rencontres Internationales d'Archéologie et d'Histoire d'Antibes. Juan-les-Pins: Editions APDCA, pp. 326-338.

Nash, G.H., Simms, M.J., Thomas, L., van Calsteren, P., 2012. A discovery of possible Upper Palaeolithic parietal art in Cathole Cave, Gower Peninsula, south Wales. Proceedings of the University of Bristol Spelaeological Society 25(3), 327-336.

Neumayer, E., 1992. Rock art in India. In Lorblanchet, M. (Ed.), Rock art in the Old World. New Delhi: Indira Gandhi National Centre for the Arts, pp. 215-247.

Neumayer, E., 1993. Lines on stone: the prehistoric rock art of India. New Delhi: Manohar.

Pandey, S.K., 1992. Central Indian rock art. In Lorblanchet, M. (Ed.), Rock art in the Old World. New Delhi: Indira Gandhi National Centre for the Arts, pp. 249-272.

Pettitt, P., Pike, A., 2007. Dating European Palaeolithic cave art: progress, prospects, problems. Journal of Archaeological Method and Theory 14(1), 27-47.

Petraglia, M., Korisettar, R., Boivin, N., Clarkson, C., Cunningham, K. Ditchfield, P., Jones, S., Koshy, J., Lahr, M., Oppenheimer, C., Pyle, D., Roberts, R., Schwenninger, J.-L., Arnold, L. and White, K., 2007. Middle Paleolithic assemblages from the Indian Subcontinent before and after the Toba super-eruption. Science 317, 114-116.

Petraglia, M., Clarkson, C., Boivin, N., Haslam, M., Korisettar, R., Chaubey, G., Ditchfield, P., Fuller, D., James, H., Jones, S., Kivisild, T., Koshy, J., Lahr, M., Metspalu, M, Roberts, R., Arnold, L. 2009a. Population increase and environmental deterioration correspond with microlithic innovations in South Asia ca. 35,000 years ago. Proceedings of the National Academy of Sciences, *USA*.106 (30), 12261-12266 [28 July 2009; doi/10.1073/pnas.0810842106].

Petraglia, M., Korisettar, R., Bai, M.K., Boivin, N., Janardhana, B., Clarkson, C., Cunningham, K., Ditchfield, P., Fuller, D., Hampson, J., Haslam, M., Jones, S., Koshy, J., Miracle, P., Oppenheimer, C., Roberts, R. and White, K., 2009b. Human occupation, adaptation and behavioral change in the Pleistocene and Holocene of South India: recent investigations in the Kurnool District, Andhra Pradesh. Eurasian Prehistory 6(1-2), 119-166.

Pike, A.W.G., Hoffman, D.L., García-Diez, M., Pettitt, P.B., Alcolea, J., De Balbín, R., González-Sainz, C., de las Heras, C., Lasheras, J.A., Montes, R. and Zilhão, J., 2012. U-series dating of paleolithic art in 11 caves in Spain. Science 336, 1409-1413.

Pradhan, S., 2001. Rock art in Orissa. New Delhi: Aryan Books International.

Prasad, K.N., 1996. Pleistocene cave fauna from peninsular India. Journal of Caves and Karst Studies 58(1), 30-34.

Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Burr, G., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning, S.W., Reimer, R.W., Richards, D.A., Southon, J.R., Talamo, S., Turney, C.S.M., van der Plicht, J. and Weyhenmeyer, C.E., 2009. IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. Radiocarbon, 51 (4), 1111-1150.

Rowe, M.W., 2000. Dating by AMS radiocarbon analysis. In Whitley, D. (Ed.), Handbook of rock art research. Walnut Creek, AltaMira Press, pp. 139-166.

Rowe, M.W., 2012. Bibliography of rock art dating. Rock Art Research 29(1), 118-131.

Sonawane, V.H., 1984. An important evidence to date paintings of Mesolithic Period. In Chakravarty, K.K. (Ed.), Rock-art of India: paintings and engravings. New Delhi: Arnold-Heinemann, pp. 61-63.

Sonawane, V.H., 1992. Significance of the Chandravati engraved core in the light of prehistoric art of India. In Lorblanchet, M. (Ed.), Rock art in the Old World. New Delhi: Indira Gandhi National Centre for the Arts, pp. 273-283.

Taçon, P.S.C., Nelson, E., Chippindale, C. and Chaloupka, G. 2004. The beeswax rock art of the Northern Territory: direct dating results and a 'book of record'. *Rock Art Research* 21(2), 155-160.

Taçon, P.S.C., Aubert, M., Gang, L., Yang, D., Liu, H., May, S.K., Fallon, S., Ji, X., Curnoe, D. and Herries, A.I.R., 2012. Uranium-series age estimates for rock art in southwest China. Journal of Archaeological Science 39(2), 492-499.

Taçon, P.S.C., Boivin, N., Hampson, J., Blinkhorn, J., Korisettar, R. and Petraglia, M., 2010. New rock art discoveries in the Kurnool District, Andhra Pradesh, India. Antiquity 84(324), 335-350.

Taçon, P.S.C., May, S.K., Fallon, S.J., Travers, M., Wesley, D., Lamilami, R., 2010. A minimum age for early depictions of Southeast Asian praus in the rock art of Arnhem Land, Northern Territory. *Australian Archaeology* 71, 1-10.

Taçon, P.S.C., Chipindale, C. 1998. An archaeology of rock-art through informed methods and formal methods. In Chippindale, C., Taçon, P.S.C. (Eds.), The archaeology of rock-art. Cambridge, Cambridge University Press, pp. 1-10.

Taçon, P.S.C., Langley, M. 2012. Rock art dating in Australia and beyond: what does it tell us? In Clottes, J. (Ed.), L'art pléistocène dans le monde / Pleistocene art of the world / Arte pleistoceno en el mundo. Actes du Congrès Ifrao, Tarascon-sur-Ariège, septembre 2010 –

Symposium « Datation et taphonomie de l'art pléistocène ». Tarascon-sur-Ariège, INORA, 1129-1156.

Thimma Reddy, K., 1980. Billa Surgam: an Upper Palaeolithic cave site in southern India. Asian Perspectives 20(2), 206-27.

List of Tables and Figures

flowstone overlying and underlying the engraving, respectively. TPQ is the acronym for *terminus post quem*.

Figure 11: A large honeycomb found in the Billasurgam Cave complex in 2009, not far from the engraved panel.

Table 1

Sample No.	Laboratory code	Conventional age (BP)	$\delta^{13}C$ (‰)	Calibrated age range (cal BP, 68.2% CI)	Calibrated age range (cal BP, 95.4% CI)	Notes
C-1	OxA-20623	4424±30	-0.1	4892-5212	4872-5272	Adjacent to engraving, left lateral mid-section; first half of sample; proposed as overlying engraving.
C-2	OZN105	4270±60	0.8	4655-4959	4618-5033	Adjacent to engraving, left lateral mid-section; second half of sample, outer portion; proposed as overlying engraving.
C-3	OZN104	4570±60	-0.9	5062-5442	5041-5466	Adjacent to engraving, left lateral mid-section; second half of sample, inner portion; proposed as overlying engraving.
C-4	OxA-23441	4490±28	0.1	5051-5281	5041-5296	Adjacent to engraving, left lateral upper section; proposed as overlying engraving.
C-5	OxA-23442	4876±29	-1.2	5590-5643	5585-5656	One meter away from engraving, left lower section of stalactite; proposed as underlying engraving.

Table 1: AMS radiocarbon results for Billasurgam samples associated with engraved design submitted to two independent laboratories (OxA: Oxford; OZN: ANSTO). Conventional ages

are in radiocarbon years before present (BP), and the corresponding calibrated age ranges (cal BP) are given for the 68.2% (1σ) and 95.4% (2σ) confidence intervals.

Figure 1
Click here to download high resolution image

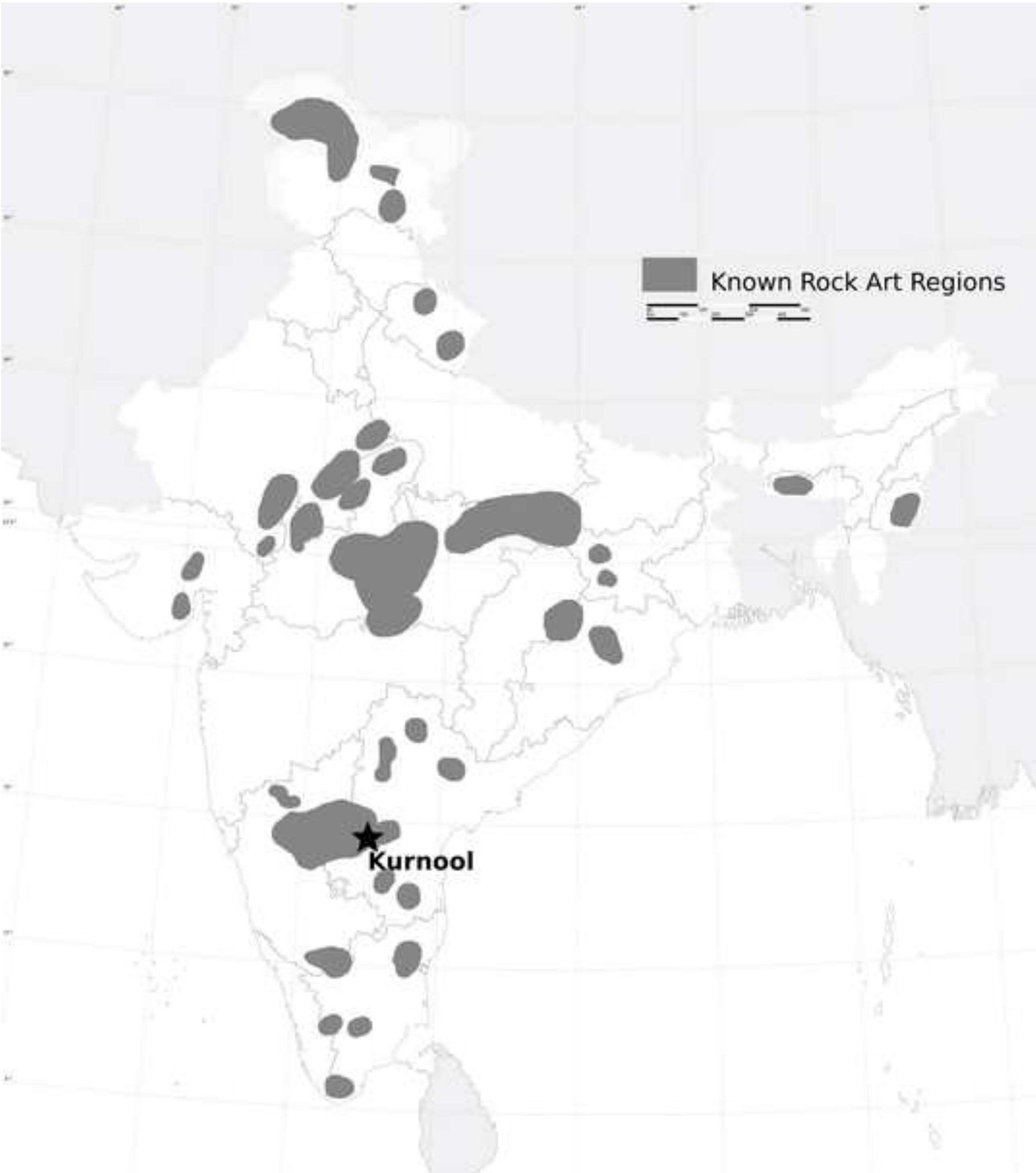

Figure 2

Click here to download high resolution image

Figure 3
Click here to download high resolution image

Figure 4

Click here to download high resolution image

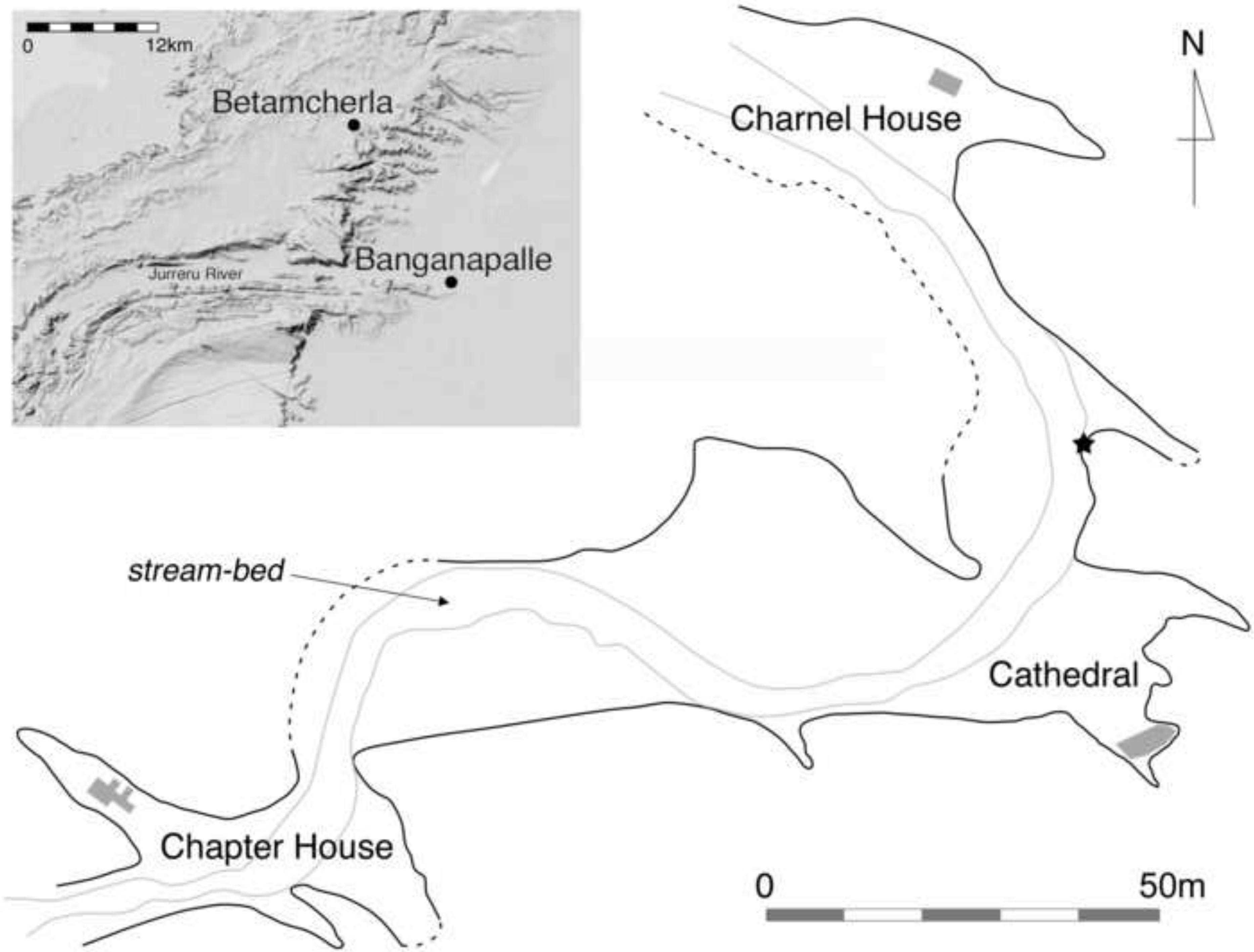

Figure 5
Click here to download high resolution image

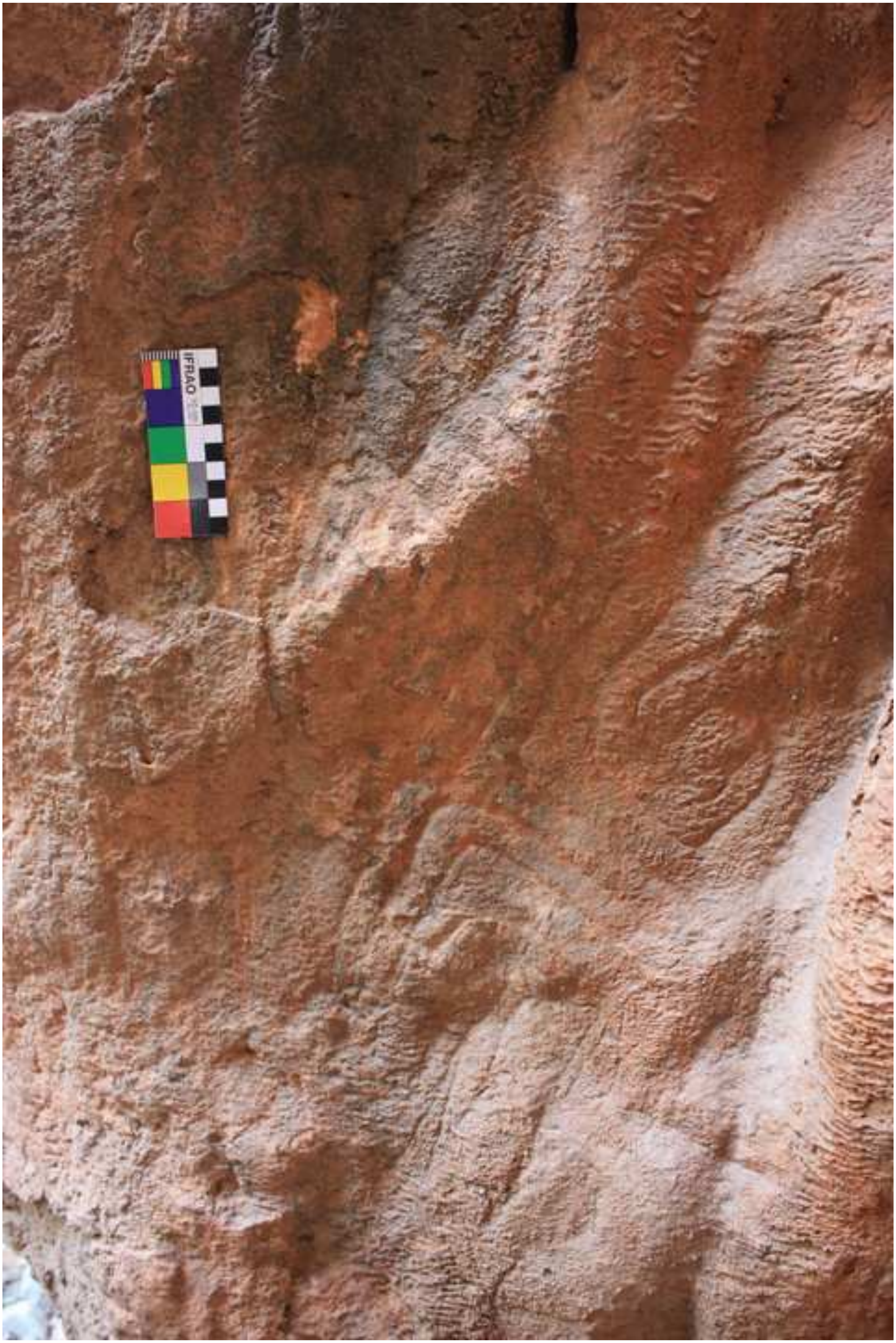

Figure 6
Click here to download high resolution image

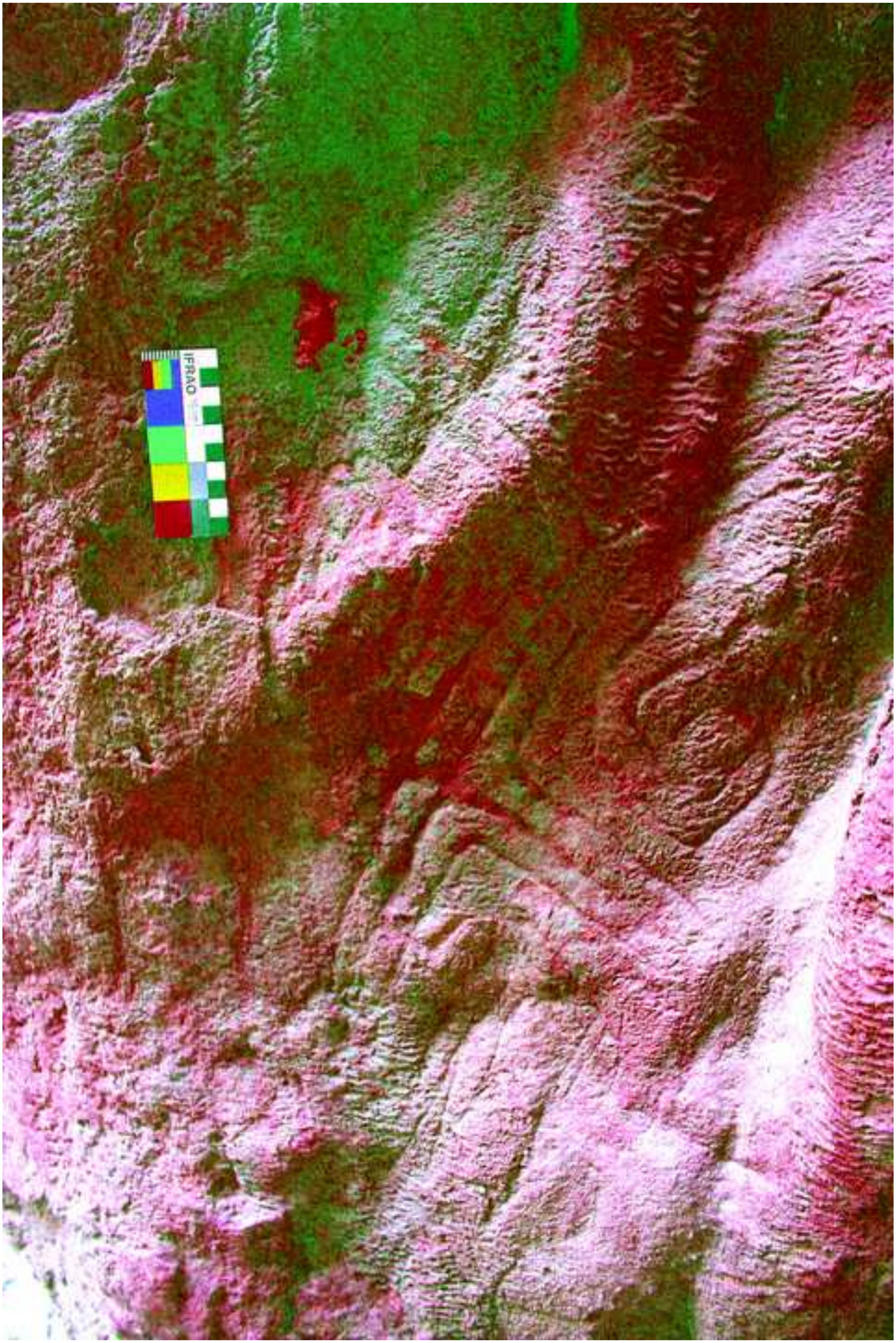

Figure 7

Click here to download high resolution image

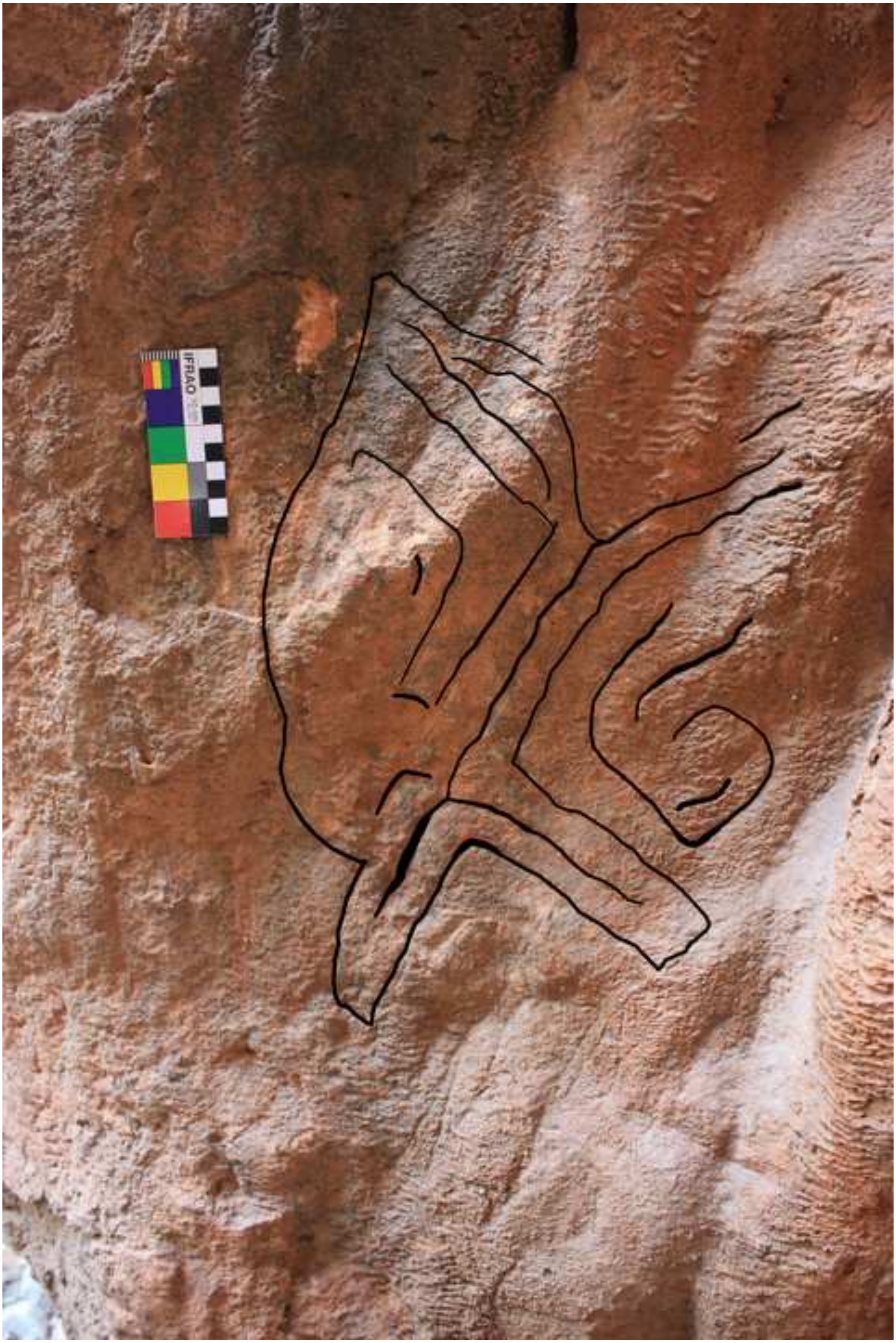

Figure 8

Click here to download high resolution image

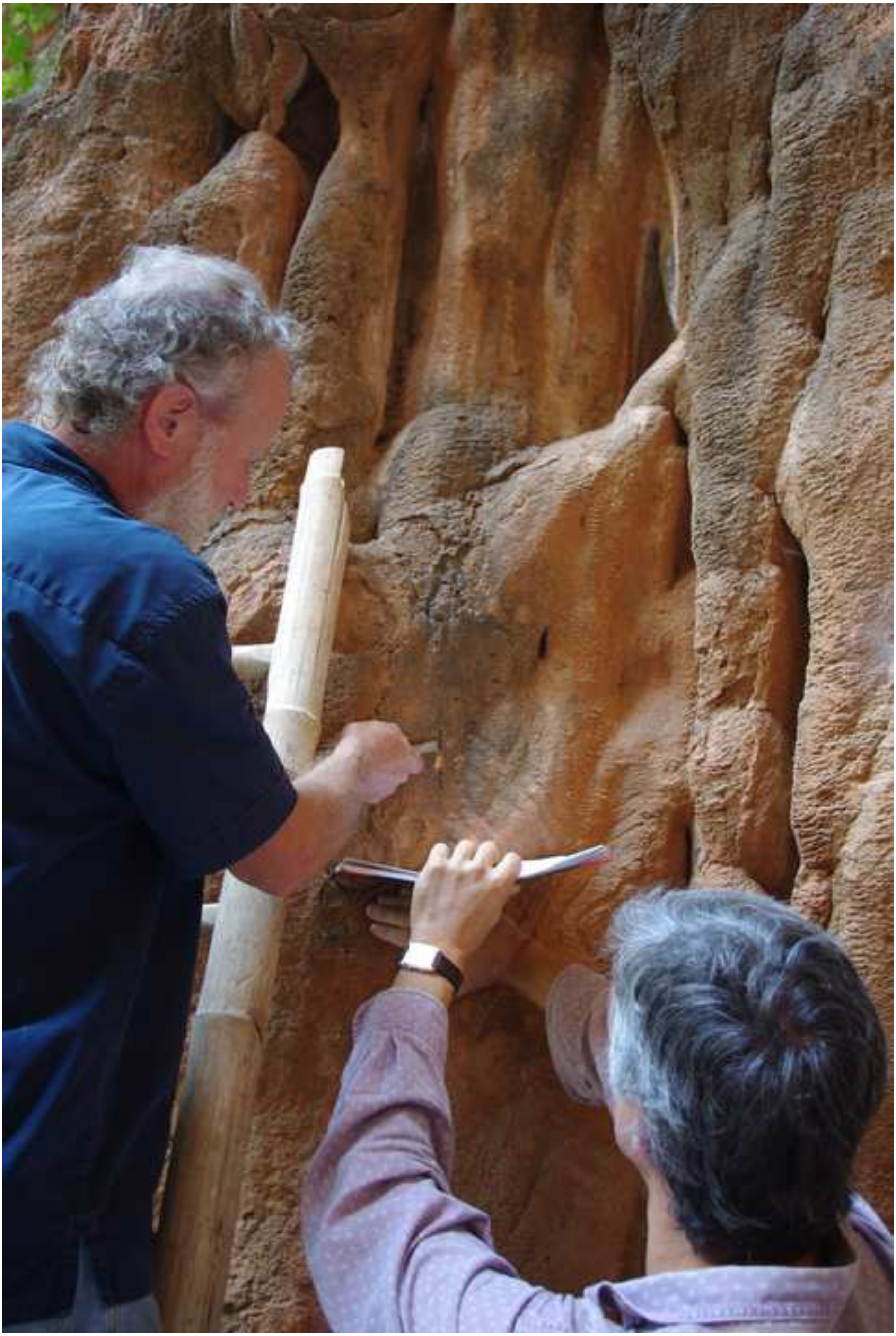

Figure 9
Click here to download high resolution image

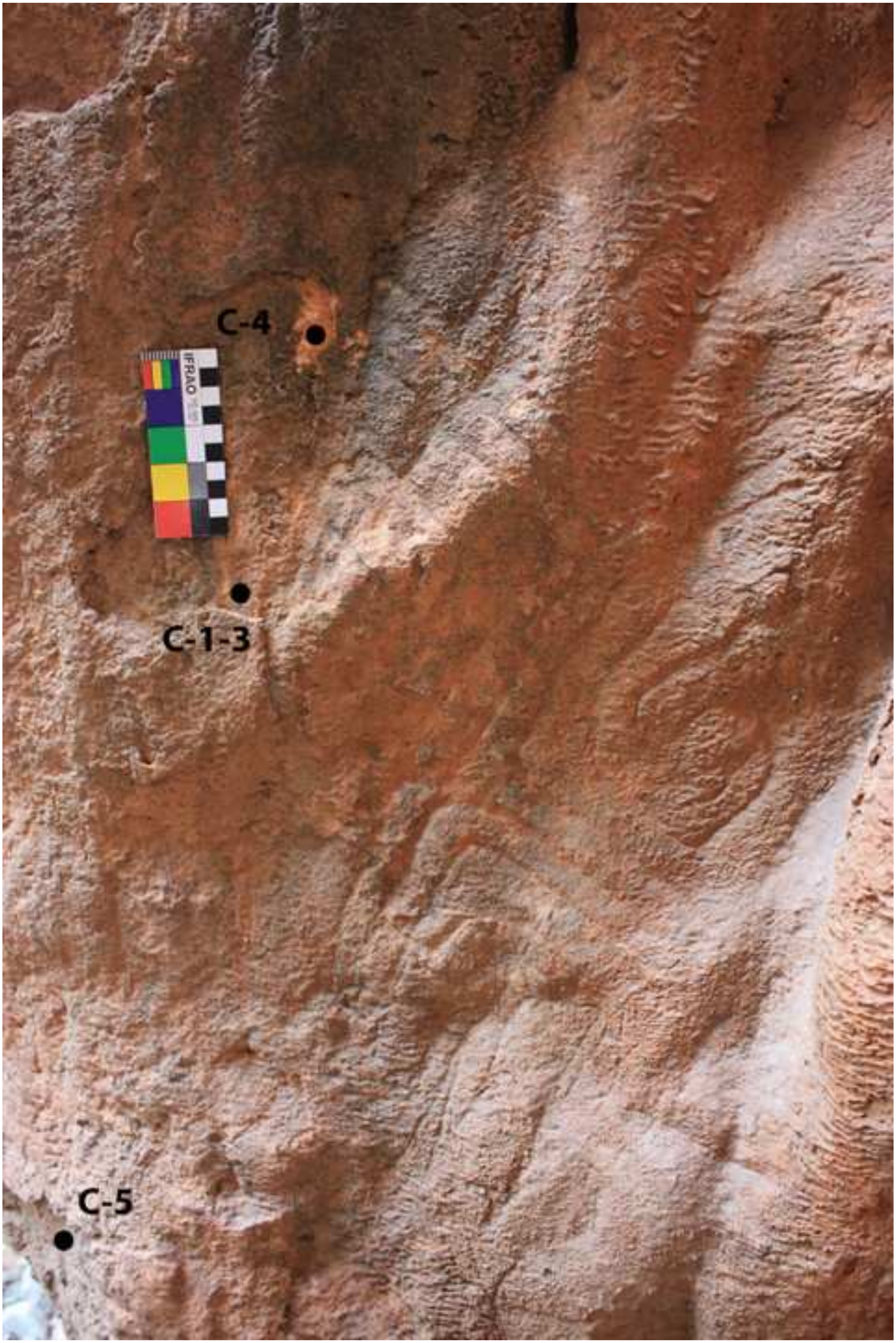

Figure 10

Click here to download high resolution image

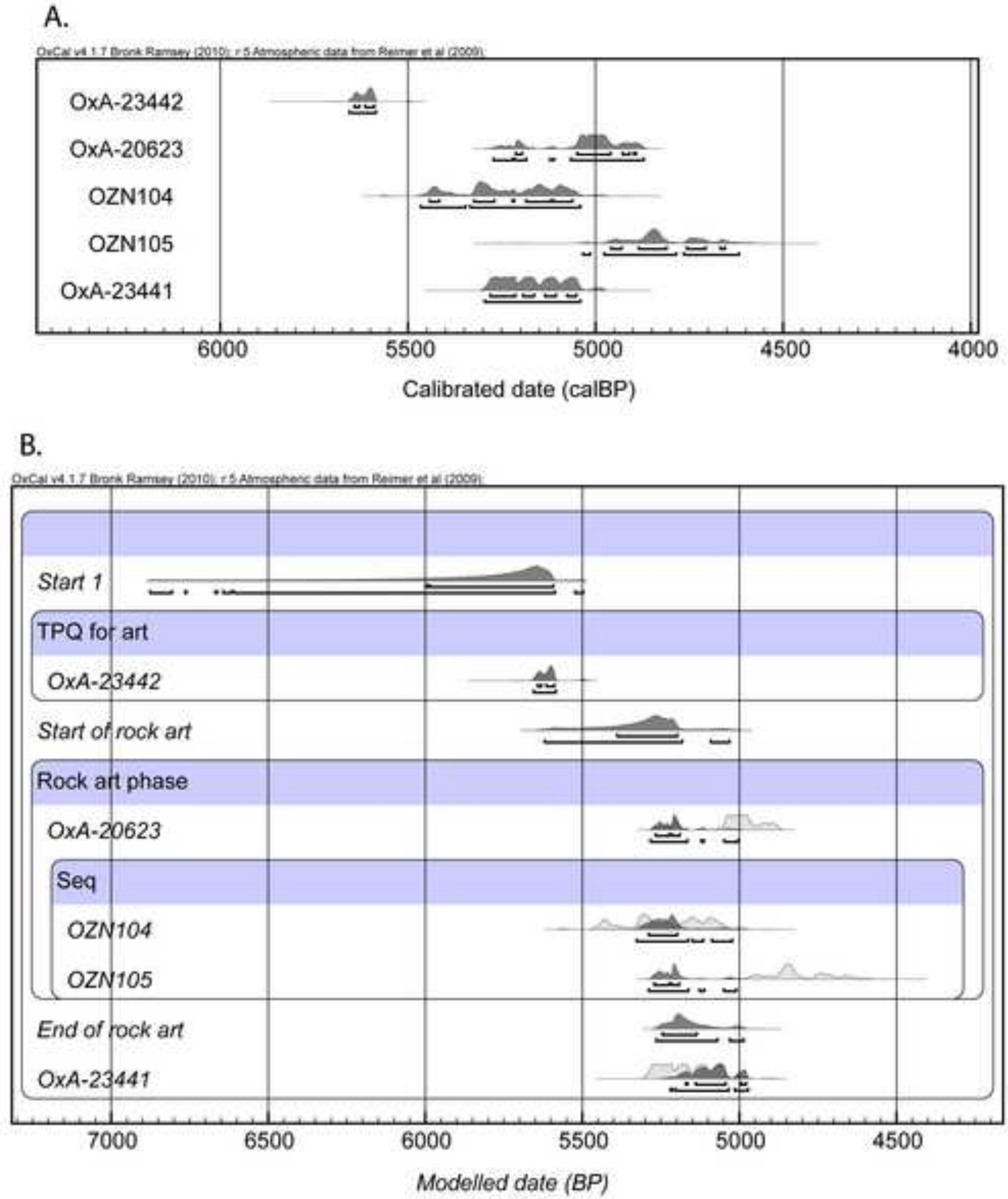

Figure 11
Click here to download high resolution image