Direct dating reveals earliest evidence for parietal rock art in southern Africa

Authors: Adelphine Bonneau[a,b,c], David Pearce[b], Peter Mitchell[d], Richard Staff[e], Charles Arthur[f], Lara Mallen[b], Fiona Brock[e], Tom Higham[e]

Affiliations: [a]Laboratoire Lux/Centre de recherche Géotop, Département des Sciences de la Terre et de l'atmosphère, Université du Québec à Montréal, CP 8888 Succ. Centre-Ville, Montréal, Québec, H3C 3P8, Canada.

[b]Rock Art Research Institute, GAES, University of the Witwatersrand, Private Bag 3, 2050, South Africa.

[c]Centre interuniversitaire d'études sur les lettres, les arts et les traditions, Université du Québec à Montréal, Montreal, Canada

[d]School of Archaeology, University of Oxford, St Hugh's College, Oxford, OX2 6LE, United Kingdom and GAES, University of the Witwatersrand, South Africa.

[e]Research Laboratory for Archaeology and the History of Art, University of Oxford, South Parks Road, Oxford OX1 3QY, United Kingdom.

[f]Institute of Archaeology, University of Oxford, 36 Beaumont Street, Oxford, OX1 2PG, United Kingdom.

Corresponding author: Adelphine Bonneau, Laboratoire Lux/Centre de recherche Géotop, Département des Sciences de la Terre et de l'Atmosphère, Université du Québec à Montréal, CP 8888 Succ. Centre-Ville, Montréal, Québec, H3C 3P8, Canada, E-mail: adelphine.bonneau@gmail.com, Phone: +1-418-914-8920

Current address : Laboratoire d'archéologie historique, Laval University, 3 rue de la Vieille-Université (Pavillon Camille-Roy), Québec, Québec, G1R 5X8, Canada and

Introduction

Southern Africa is home to one of the world's largest and best-understood bodies of hunter-gatherer rock art. Comprising both engravings and paintings, it was produced by Later Stone Age (LSA) communities related to the contemporary Bushman (San) peoples of the Kalahari and it is their ethnography, along with accounts obtained from Bushman informants in the late nineteenth century, that provides the basis for its understanding (Lewis-Williams & Pearce 2004). Research over the past 40 years has shown that the art is most productively and comprehensively explained as the material expression of the powers of ritual specialists (shamans) and of the wider cosmology within which those powers were exercised, often in altered states of consciousness (trance) (Lewis-Williams 1981; Lewis-Williams & Pearce 2004). This southern African research has influenced rock art studies around the world (e.g., Whitley 1998; Lewis-Williams 2002).

Fig. 1. Example of fine-line LSA paintings (panel from RSA LAB1)

It has long been clear that LSA rock art was implicated in the social and economic reproduction of its makers (Lewis-Williams 1982), but researchers have encountered persistent difficulties in linking the parietal and excavated components of the archaeological record and in exploring temporal variability within the art itself (e.g.

Mazel & Watchman 2003, Mazel 2009). The reason is straightforward: worldwide, rock art is extremely difficult to directly date. Instances of paintings or engravings found within datable archaeological deposits in southern Africa are exceptionally rare (Wendt 1976; Walker 1995; Mazel 1993, 1996; Jerardino & Swanepoel 1999). Most attempts at developing a chronological framework have therefore focused elsewhere and almost wholly on paintings. However, stylistic sequences—with or without inferences drawn from situations where one image overlies another—remain contested, while the art's content (which sometimes includes imagery with chronological associations, such as cattle, sheep, horses, or Europeans) sets only very broad constraints (Mazel 2009a).

Thus far, efforts at directly dating images surviving on rock-shelter walls have been limited. Early in the development of accelerator mass spectrometry (AMS) radiocarbon dating a single result was obtained for a painting in the Cederberg Mountains of the Western Cape Province, South Africa (Van der Merwe *et al.* 1987). Subsequently, attention shifted to the Drakensberg Escarpment of KwaZulu-Natal, South Africa, where eight dates were obtained on white paintings and on weathering layers composed of calcium oxalates present above, or below, painted images at a total of four sites (Mazel & Watchman 1997, 2003). Two dates on overlying layers calibrated to between approximately 1000 and 2000 BP; six dates on underlying layers came to between approximately 2000 and 4000 BP. These results, though suggestive, nevertheless offer only *termini ante* or *post quos* for the art, although a ninth—from a plant fiber embedded within paint at a further site in the same region—may perhaps directly date the painting in question (Mazel & Watchman 1997).

Attempts at directly dating LSA rock paintings have thus been few in number and restricted in spatial extent. This leaves their chronology poorly constrained compared to Upper Palaeolithic paintings in Western Europe (Pettitt & Pike 2007) or those of Australia's Kimberley region (Aubert 2012). In this paper, we report on the direct AMS radiocarbon dating of rock paintings at 14 sites in three different regions of southern Africa: the Thune Dam area of southeastern Botswana (n = 3), the Metolong Dam catchment of western Lesotho (n = 5), and the Maclear District of South Africa's Eastern Cape Province (n = 6) (Fig. 2).

Fig. 2. Southern Africa: locations of rock art research areas dated in the current project.

Rock art sites

The Thune Dam, Botswana

The Thune Dam is located in the Kalahari Desert, near the town of Mathathane, approximately 20 km west of the South African border, and 500 km north-east of Gaborone, the capital city of Botswana. Forty archaeological sites are present in the narrow band of about 35 km long and 5 km wide, along the Thune River. Among them, six rock art sites have been flooded by the construction of a dam and 18 others may be impacted in case of exceptional floods. All 24 sites were recorded and some excavated revealing some LSA artefacts (Walker 2009).

Rock art in the sites include finger paintings and LSA fine-line tradition paintings, but interestingly, few superimpositions appear. Distinctive regional representations such as giraffe and fish are present. The most important representation in these sites is sheep paintings as these constitute the only example at this time in Botswana (Walker 2009). The finger paintings are peripheral to, or superimposed upon, LSA paintings and thus appear to have been made at a later period. Three of the 24 sites were sampled for dating: TD2, TD12 and TD21.

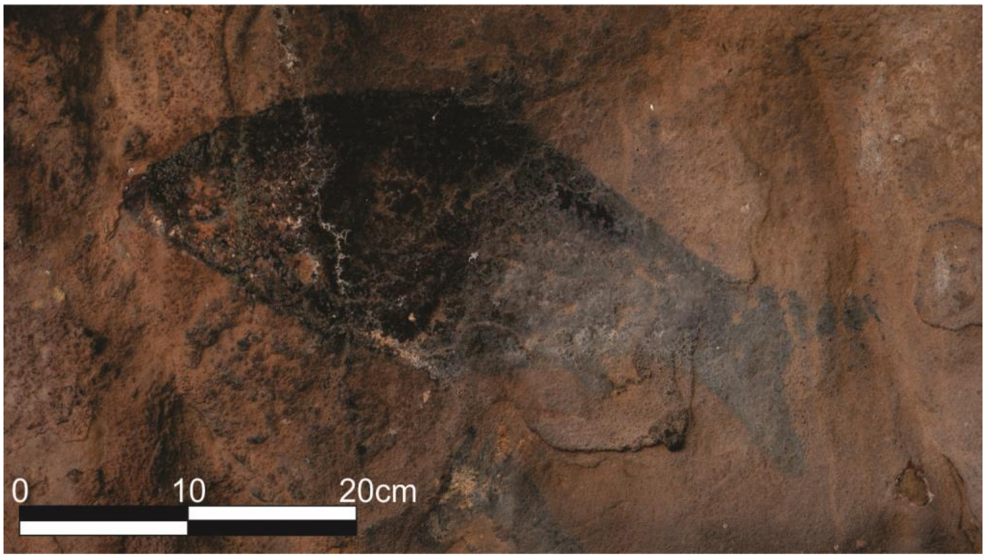

Fig. 3: Painting in the Thune Valley, Botswana

The Phuthiatsana Valley, Lesotho

The Phuthiatsana River Valley is located approximately 30 km east of Maseru, the capital city of Lesotho. From 1979 to 1982, this valley (and three other areas) was examined by Lucas Smits and his team in order to record rock art sites as part of the Analysis of Rock Art of Lesotho project. The sites recorded were called “ARALXXX” (Smits 1983). In total, 493 sites were recorded, of which 259 sites were in the Phuthiatsana Valley.

Between 1989 and 1990, excavations and survey were conducted in the Phuthiatsana Valley by one of us (PM). These were resumed in 2008 as a dam was planned to be built in the valley and thus flood sites. Several of the most important sites were excavated. Excavations gave evidence of Middle Stone Age (MSA) occupations in several rock shelters, extensive LSA occupations and, in some cases, evidence of recent Sotho-speaking communities (Mitchell 1994; Mitchell & Whitelaw 2005; Mitchell & Arthur 2014).

The Metolong catchment, where the dam has been built, is only a very small section of the Phuthiatsana Valley, comprising 29 rock arts sites. They were recorded (Mallen 2011) and some panels were removed from the sites to be stored in a museum. Five separate painted traditions have been identified in the Metolong Dam area. The two most common traditions are LSA fine-line tradition and Basotho tradition. Ochre smears, finger-painted figures and figures of unknown traditions complete the list (Mallen 2011).

Five sites (ARAL171, ARAL172, ARAL175, ARAL 249 and ARAL252) were sampled for dating.

Fig. 4: Painting in the Phuthiatsana Valley, Lesotho

The Maclear District, South Africa

The Maclear District is located around the town of Maclear, in the Eastern Cape Province, South Africa. About 300 rock art sites have been recorded in this area. This area is part of a larger region known as "Nomansland" by the former colonial administration (Blundell 2004). Although very few dates from archaeological deposits are available for Nomansland, they give evidence of an occupation by hunter-gatherers from at least 22 000 years ago to the colonial period (Opperman & Heydenrych 1990).

Six rock art sites were sampled for dating: RSA CHA1, RSA FRE4, RSA LAB1 (also called Storm Shelter), RSA LAB7, RSA PRH1 and RSA TYN2. Paintings are all of the LSA tradition with fine-lined paintings and colors gradients (Fig. 5).

None of these sites has been excavated, thus no other archaeological material is available for comparison with the paintings or to give an idea of possible periods of occupations.

Fig. 5: Paintings in the Maclear District, South Africa

Methods

Rock art is extremely challenging to reliably AMS date. We have therefore developed rigorous protocols for field collection of paint samples, characterization of pigment samples, and preparation for radiocarbon dating. These include a two-stage sampling strategy to increase the success rate for dating samples.

In the first stage we collected small samples for characterization. Approximately 0.5 mm^2 samples of paint were collected from potentially datable paintings. These samples were analyzed unprepared and in cross section using light microscopy, SEM-EDS, Raman and FTIR spectroscopies to determine morphology and elemental and molecular composition (Fig. 6, see details in Supplementary Information). Results of these analyses informed decisions as to which paintings should be sampled for AMS radiocarbon dating and we selected those samples that were most likely to be successfully radiocarbon-dated.

In all but two cases, this characterization confirmed that the samples dated were carbon blacks, i.e. incomplete combustion products of organic compounds such as fat, resin, and so forth. This means that the carbon that was dated derived from short-lived organic materials unlikely to have been significantly older than the date of paint manufacture. This is important because it overcomes the oft-leveled criticism that charcoal used in paint may be significantly older than the painting event in which it was used. We have, at the scale of radiocarbon uncertainty, therefore dated the time of paint manufacture.

We prepared samples for AMS dating using a modified Acid-Base-Acid procedure that is designed to remove calcium carbonates and calcium oxalates from the pigments. We tested several methods to find the most suitable approach. We used 1M HCl for 20 minutes to 1 hour at 80 °C, routine NaOH (0.1M) and a further HCl step (1M) for 30 minutes to 1 hour at 80 °C was then applied, with ultrapure Milli-Q™ water rinsing in between the steps. This approach was modified for different samples depending on sample size and characterization results. The pigments were freeze-dried and FTIR analysis was conducted to confirm that previously identified contaminants were eliminated prior to further preparation. Samples were then combusted to CO_2 in an EA-IRMS, and graphitized before AMS dating. Graphite samples were uniformly small (<0.5–1 mg C) and were analyzed with standards and backgrounds of a similar size to the unknown-age archaeological samples. Methods are described in detail in the Supplementary Information.

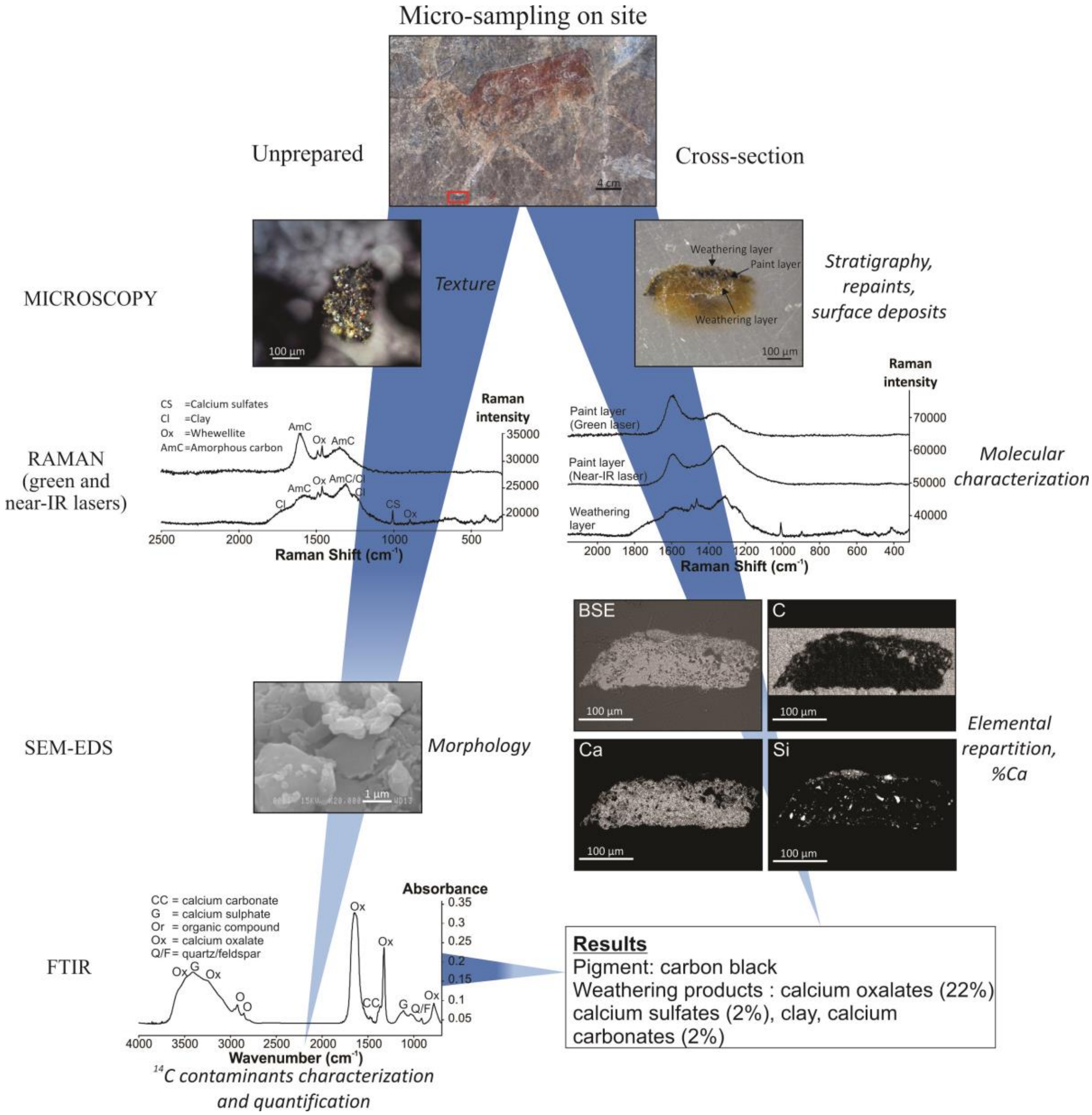

Fig. 6: Example of characterization of a black paint (FTIR: instruments; *Morphology*: results)

Results and Discussion

Little previous research has been conducted on the rock art of Botswana's Central District. Our samples came from sites in its southeastern corner that were flooded in 2013 by construction of the Thune Dam. We succeeded in producing nine dates from three sites, though four were obtained on <100µg of carbon and thus need to be interpreted with care. These are the first direct radiocarbon dates on rock paintings in Botswana. All of the paintings are unequivocally attributable to the fine-line LSA tradition.

Our Lesotho samples came from rock art sites in its western lowlands, in that section of the Phuthiatsana Valley flooded since early 2014 following impoundment of the Metolong Dam. We successfully dated eight images from a total of three sites; four more samples from two further sites should be treated with caution as they were obtained on <100µg of carbon and, as a result, two of them also have unacceptably large uncertainties. These are nevertheless the first direct radiocarbon dates for rock paintings in Lesotho. While some of the images present at Metolong can be attributed to the area's present-day Basotho population or to groups of multi-ethnic origin living in the broader region during the nineteenth century, all those that we have dated belong to the fine-line LSA tradition (Mallen 2011).

In contrast to the other regions, South Africa's Maclear District has long been a major center for interpretative rock art research. It is situated towards the southern end of the Drakensberg Range. Unlike the other two areas where we have worked, rock art sites here are not endangered by dams. Our research to characterize and date rock art paints began on a series of painted naturally spalled flakes (Bonneau *et al.* 2011; Bonneau *et al.* 2012). We have gone on to produce 22 dates from six sites. One further sample failed due to the continued presence of calcium oxalates after pre-treatment. Besides one painting at RSA LAB7, all of the dated paintings clearly belong to the fine-line LSA tradition. Further details of all our sites and samples are given in the Supplementary Information.

Table 1 summarizes our results as calibrated using the Southern Hemisphere SHCal13 calibration curve and OxCal 4.2 software (Bronk Ramsey 2009; Hogg *et al.* 2013). Although some measurement uncertainties are large (because of very small sample sizes), even in these cases our results are informative given the total lack of any previous chronometrically based rock art dating for our regions. In western Lesotho, for example, the bulk of the paintings dated were created in the last thousand years before present (BP).

Our study has produced several significant results. Firstly, it demonstrates that the protocol previously used at Maclear on painted flakes is robust and can be successfully extended to *in situ* parietal paintings, as well as to other regions of southern Africa where paint preparation, geology, weathering conditions, and contaminants may vary. It is therefore likely that the same protocol could be used anywhere that carbon-based paints are found. The strength of this protocol is that it provides a detailed characterization of the paint which makes it possible to adjust sample collection and chemical pre-treatment to ensure removal of any contaminants. Knowing the paint's composition also allows for better interpretation of dates (Methods section).

Secondly, we have established that southern African hunter-gatherers were creating images on rock-shelter walls as long ago as 5723–4420 cal. BP in southeastern Botswana, 2326–965 cal. BP in western Lesotho, and 2998–2381 cal. BP in the Maclear region of South Africa (all the calibrated ages are given with a 95.4% confidence range). We are confident that these dates reflect the date of paint manufacture according to a characterization process which identifies black paintings as being composed of carbon-blacks. The older of our dates from site TD12, Botswana, currently provides the oldest evidence for extant painting on rock-shelter walls anywhere in southern Africa, although we note the presence of spalls with paint at two sites in the Matopos Hills, Zimbabwe, found in stratified contexts dating to between the mid- and early Holocene (Walker 1995). Moreover, our study also reveals the remarkable time depth of painting on individual rock-shelter walls, with two sites in Botswana (TD2 and TD12) providing a chronological range of between two and three millennia.

Thirdly, in each of our research areas the direct radiocarbon dating of painted images opens up space for developing a chronometrically grounded approach to diversity and change within LSA rock art. Because the meaning of LSA rock art is so well understood, these chronological changes should be understood in social terms (see Mazel 2009b for an example of this approach in the northern Drakensberg).

Fourthly, our results allow us to start developing a dialogue between the record of hunter-gatherer activity preserved in paint and that preserved in excavatable deposits. In the case of Lesotho's Metolong Dam catchment, for example, previous work there and in the wider Phuthiatsana Basin struggled to identify hunter-gatherer sites dating to the second half of the Holocene, and completely failed to locate any at all for the period 5600–700 cal. BP (Mitchell 1994), notwithstanding their presence in an environmentally very similar area directly across the Caledon River in South Africa (Wadley 1995). Our results (from ARAL171 and, though more cautiously, ARAL172) now show that hunter-gatherers *were* present for at least part of this period, implying that faulty survey methodologies and/or post-depositional changes to the region's landscape or to specific site stratigraphies have hindered detection of *in situ* archaeological deposits.

Previous research in the northern Drakensberg region of South Africa dating oxalate crusts above surviving images indicated that the practice of painting rock-shelter walls began there >2000–3000 years ago. Our direct dating of carbon-based black pigments now establishes that paintings were made in the southern Drakensberg at least as long ago as 2998–2381 cal. BP and that the practice of painting on rock-shelter walls is up to 2000 years older than this in Botswana. Meanwhile, we have shown that LSA rock paintings can be directly dated using AMS radiocarbon technology and that the results obtained can contribute meaningfully to wider archaeological debates. These techniques should also prove useful in chronological studies of rock art elsewhere, including the only three sites—all in Lesotho—for which specific interpretations of individual paintings were provided by a Bushman informant from a community in which rock art was still being produced (McGranaghan *et al.* 2013).

Table 1. AMS radiocarbon ages of rock paintings from Maclear, Metolong and Thune. Samples are listed in chronological order within each research area. Calibrated dates were obtained using the SHCal13 calibration curve and are expressed at 95.4% confidence limits. Further details of each sample and its calibration are provided in the Supplementary Information.

Sample identification	AMS laboratory code	Conventional ^{14}C age BP ($\pm 1\sigma$)	Calibrated age BP (95.4% range)
Botswana			
TD2-2012-1	OxA-X-2555-49	1250±80	1276-962
TD2-2012-19	OxA-X-2555-48	2130±90	2320-1878
TD12-2012-7	OxA-X-2555-45	2500±100	2754-2332
TD12-2012-9	OxA-X-2543-6	2580±390	3593-1712
TD21-2012-2	OxA-X-2555-44	2580±130	2923-2327
TD21-2012-3	OxA-X-2555-43	2630±230	3325-2109
TD2-2012-21	OxA-X-2555-47	2960±160	3448-2751
TD12-2012-8	OxA-29182	3060±30	3343-3077
TD12-2012-6	OxA-X-2555-46	4500±260	5723-4420
Lesotho			
ARAL175-C1	OxA-X-2470-49	300±65	495-12
ARAL175-C2	OxA-X-2470-48	390±70	516-291
ARAL175-2012-2	OxA-X-2555-39	410±130	635-present
ARAL175-C2	OxA-X-2495-27	470±90	630-300
ARAL175-2012-3	OxA-X-2555-26	575±75	664-460
ARAL175-2012-1	OxA-X-2555-40	760±120	905-518
ARAL249-2012-1	OxA-X-2555-24	770±90	897-540
ARAL171-C1	OxA-X-2470-50	1210±90	1274-927
ARAL172-C1	OxA-X-2479-37	1700±310	2326-965
ARAL252-C4	OxA-X-2479-36	2640±390	3691-1748
ARAL-252-C2	OxA-X-2479-35	5300±1000	9003-4177
ARAL-252-C1	OxA-X-2479-34	5700±2000	13579-1591
South Africa			
LAB7-2013-C2	OxA-28978	124±23	254-present
LAB7-2013-C1	OxA-28977	147±23	263-present
FRE4-2013-C7	OxA-X-2555-19	290±90	494-present
PRH1-2013-C2	OxA-29186	308±35	452-155
PRH1-2013-C1	OxA-28980	447±23	509-338
FRE4-2013-C6	OxA-X-2555-20	510±90	641-318
FRE4-2013-C4	OxA-X-2555-21	770±100	903-531
FRE4-2013-C3	OxA-X-2555-22	1160±140	1297-768
FRE4-2013-C8	OxA-X-2555-18	1420±140	1561-977
LAB1-2013-C3	OxA-X-2555-17	1530±90	1585-1189

LAB1-C2	OxA-25961	1620±90	1700-1305
TYN2-C6	OxA-25966	1900±90	2002-1586
TYN2-C5	OxA-25965	1940±90	2050-1607
LAB1-C1	OxA-25960	2040±120	2308-1705
TYN2 RP/2009/003/13	OxA-X-2370-29	2072±28	2081-1919
TYN2-C3	OxA-25964	2080±90	2306-1754
TYN2 RP/2009/003/29	OxA-X-2370-31	2083±32	2093-1920
TYN2 RP/2009/003/14	OxA-X-2370-30	2100±40	2148-1926
TYN2-C7	OxA-25967	2290±110	2699-1941
TYN2-C1	OxA-25962	2390±140	2748-2060
CHA1-C1	OxA-X-2590-20	2590±110	2848-2352
LAB1-2013-C5	OxA-X-2555-16	2690±100	2998-2381

Acknowledgments: This project was funded by the South African National Research Foundation (D.P.), the United Kingdom's Natural Environment Research Council (P.M.; NERC 2011/2/4 and NERC 2013/2/11), the French Institute in South Africa (A.B. and D.P.), and the Social Sciences and Humanities Research Council of Canada (A.B.), the Fonds de Recherche Québécois Société et Culture (A.B.), and the Université du Québec à Montréal (A.B.). We are grateful to landowners and local communities for allowing us to work on their properties or in their territories. A.B. particularly thanks Prof. Daniel Arsenault and Prof. Michel Lamothe for their help and advice, Michelle Laithier for her help with the figures, and the Laboratoire de Microanalyse (Université Laval) and the Laboratoire de Caractérisation des Matériaux (Université de Montréal) for permission to use their equipment. Jess Meyer photographed the Lesotho sites, including Figs S6, S8, S10, S12, and S14. We thank David Whitley and Aaron Mazel for comments on the manuscript.

References

AUBERT, M. 2012. A review of rock art dating in the Kimberley, Western Australia. *Journal of Archaeological Science* 39: 573–577.

BLUNDELL, G. 2004. *Nqabayo's Nomansland: San Rock Art and the Somatic Past*. Uppsala: Uppsala University Press.

BONNEAU, A., F. BROCK, T.F.G. HIGHAM, D.G. PEARCE & A.M. POLLARD. 2011. An improved pretreatment protocol for radiocarbon dating black pigments in San rock art. *Radiocarbon* 53: 419–428.

BONNEAU, A., D.G. PEARCE & A.M. POLLARD. 2012. A multi-technique characterization and provenance study of the pigments used in San rock art, South Africa. *Journal of Archaeological Science* 39: 287–294.

BROCK, F., T. HIGHAM, P. DITCHFIELD & C. BRONK RAMSEY. 2010. Current pretreatment methods for AMS radiocarbon dating at the Oxford radiocarbon Accelerator Unit (ORAU). *Radiocarbon* 52: 103-112.

BRONK RAMSEY, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51: 337–360.

HOGG, A.G., H. QUAN, P. G. BLACKWELL, N. MU, C.E. BUCK, T.P. GUILDERSON, T. J. HEATON, J.G. PALMER, P.J. REIMER, R.W. REIMER, C.S.M. TURNEY & S.R.H. ZIMMERMAN. 2013. SHCal13 Southern Hemisphere Calibration, 0–50,000 Years cal BP. *Radiocarbon* 55: 1889–1903.

JERARDINO, A. & N. SWANEPOEL. 1999. Painted slabs from excavations at Steenbokfontein Cave: implications for past and future research. *Current Anthropology* 40: 542–548.

LEWIS-WILLIAMS, J.D. 1981. *Believing and Seeing: Symbolic Meanings in Southern San Rock Paintings*. London: Academic Press.

- 1982. The economic and social context of southern San rock art. *Current Anthropology* 23: 429–449.

- 2002. *The Mind in the Cave: Consciousness and the Origins of Art*. London: Thames & Hudson.

LEWIS-WILLIAMS, J.D. & D.G. PEARCE. 2004. *San Spirituality: Roots, Expression, and Social Consequences.* Walnut Creek: AltaMira Press.

MALLEN, L. 2011. Phase 2: Rock Art Recording and Interpretation. Oxford: St Hugh's College, Oxford. Unpublished report prepared for the Commissioner for Water, Government of Lesotho.

MAZEL, A.D. 1993. Rock art and Natal Drakensberg hunter–gatherer history: a reply to Dowson. *Antiquity* 67: 889-892

— 1996. Maqonqo Shelter: the excavation of Holocene deposits in the eastern Biggarsberg, Thukela Basin, South Africa. *Natal Museum Journal of Humanities* 8: 1–39.

— 2009a. Images in time: Advances in the dating of Maloti-Drakensberg rock art since the 1970s. In P.J. Mitchell & B.W. Smith (ed.) *The Eland's People: New Perspectives in the Rock Art of the Maloti-Drakensberg Bushmen. Essays in Memory of Patricia Vinnicombe*. 81–97. Johannesburg: Witwatersrand University Press.

— 2009b. Unsettled times: shaded polychrome paintings and hunter-gatherer history in the southeastern mountains of southern Africa. *Southern African Humanities* 21:85–115.

MAZEL, A.D. & A.L. WATCHMAN. 1997. Accelerator radiocarbon dating of Natal Drakensberg paintings: results and implications. *Antiquity* 71: 445–449.
- & - 2003. Dating rock paintings in the uKhahlamba-Drakensberg and the Biggarsberg, KwaZulu-Natal, South Africa. *Southern African Humanities* 15: 59–73.

MCGRANAGHAN, M., S. CHALLIS & J.D. LEWIS-WILLIAMS. 2013. Joseph Millerd Orpen's 'A glimpse into the mythology of the Maluti Bushmen': a contextual introduction and republished text. *Southern African Humanities* 25: 137–166.

MITCHELL, P.J. 1994. The archaeology of the Phuthiatsana-ea-Thaba Bosiu Basin, Lesotho, southern Africa: changes in Later Stone Age regional demography. *Antiquity* 68: 83–96.

MITCHELL, P.J. & C. ARTHUR. 2010. Archaeological fieldwork in the Metolong Dam Catchment, Lesotho, 2008–10. *Nyame Akuma* 74:51–62.
- & -. 2014. Ha Makotoko: Later Stone Age occupation across the Pleistocene/Holocene transition in western Lesotho. *Journal of African Archaeology* 12: 205-232.

MITCHELL, P. & G. WHITELAW. 2005. The archaeology of southernmost Africa from c. 2000 BP to the early 1800s: a review of recent research. *The Journal of African History* 46: 209-241.

OPPERMAN, H. & B. HEYDENRYCH. 1990. A 22 000 Year-Old Middle Stone Age Camp Site with Plant Food Remains from the North-Eastern Cape. *The South African Archaeological Bulletin* 45: 93-99.

PETTITT, P.B. & A.W.G. PIKE. 2007. Dating European Palaeolithic cave art: progress, prospects, problems. *Journal of Archaeological Method and Theory* 14: 27–47.

SMITS, L.G.A. 1983. Rock Paintings in Lesotho: Site Characteristics. *The South African Archaeological Bulletin* 38: 62-76.

SMITH, B.W. 2010. Envisioning San history: problems in the reading of history in the rock art of the Maloti-Drakensberg Mountains of South Africa. *African Studies* 69: 345–359.

VAN DER MERWE, N.J. & J.C. SEALY, R. YATES. 1987. First accelerator carbon-14 date for pigment from a rock painting. *South African Journal of Science* 33: 56–57.

WADLEY, L. 1995. Review of dated Stone Age sites recently excavated in the eastern Free State, South Africa. *South African Journal of Science* 91: 574–579.

WALKER, N.J. 1995. *Late Pleistocene and Holocene Hunter-gatherers of the Matopos: An Archaeological Study of Change and Continuity in Zimbabwe*. Uppsala: Societas Archaeologica Upsaliensis.

— 2009. Archaeological Mitigation Measures for the Thune Dam Construction and Associated Works. Water Resources Consultants, Report prepared for the Republic of Botswana, Ministry of Minerals, Energy and Water Resources.

WENDT, W.E. 1976. 'Art mobilier' from the Apollo 11 Cave, South West Africa: Africa's oldest dated works of art. *South African Archaeological Bulletin* 31: 5–11.

WHITLEY, D.S. 1998. Cognitive neuroscience, shamanism and the rock art of Native California. *Anthropology of Consciousness* 9: 22–37.