Ochre landscapes from Albertinia (first page) and Garcia Pass. Photos by Elizabeth C. Velliky

"My attention has, by sheer chance, been drawn recently to that peculiar substance—red ochre. The responses it evoked from humanity, have caused it to be of unusual, if not pre-eminent importance for localizing temporally and spatially the dawn of symbology."[1]

THE OCHRE WORKSHOP

Past and Present-Day Perspectives on Colour and Human Behaviour

Elizabeth C. Velliky & Francesco d'Errico

Introduction

One of the most significant questions in archaeology asks when hominins started to exhibit characteristics of "modern" behaviour, such as complex syntactical language, abstract thinking, planning depth, behavioural, technological, economical innovativeness, and symbolism. The pursuit of this question has led the inquiry into the ways that hominins interacted with the environment and materials around them. One such material is a mineral pigment called ochre. Ochre is often found in the form of red rocks or clays and can create a variety of colourful streaks. It can easily be transformed into powder that can then be used to colour various things, including rocks, bones, and skin. Ochre is often proposed to be one of the oldest pieces of evidence that can be used to study how and when our ancient ancestors become "behaviourally modern"—or when they started to think, speak, and organize themselves much in the same way as we do today.[2]

However, despite the evolutionary significance of ochre and pigments, considerably less emphasis has been placed on understanding ochre in the full context of idiosyncratic prehistoric lifeways, the impact of landscape and climate on ochre use and collection, and the cultural, social, and individual drivers behind the varied and diverse uses of ochre in the past. Because the ways in which hominins used ochre were likely complex and imbued with different layers and levels of meaning and significance, the ways and methods we use today to study these behaviours must also be equally cross-disciplinary and multidimensional. It is thus of increasing importance that different research disciplines cross thematic borders and collaborate on researching, understanding, and celebrating aspects of the human experience both now and in the past.

It is with this goal in mind that *The Ochre Workshop: Past and Present-day Perspectives on Colour and Human Behaviour* was formed. As part of the artistic research project *Matter, Gesture and Soul*, the goal of this workshop is to re-create a past ochre experience that was documented from the Blombos Cave site in South Africa some 100,000 years ago.[3]

1 Dart, 1968, p. 20
2 Barham, 1998; Barham, 2002; Brooks et al., 2016; Brooks et al., 2018; McBrearty & Brooks, 2000; Watts, 1999; Watts et al., 2016
3 Henshilwood et al., 2011

This recreation is both physical and experiential, with the goal to document, observe, and learn from a variety of perspectives: contemporary art, archaeology, cognition, aesthetics, museology, and public engagement/citizen science. Through this collective experiment, we hope to shed light on new aspects of this ancient ochre practice and perhaps build a greater understanding of how ochre and pigments shaped human lives and experiences in the past.

Ochre and Humans from the Past to Today

The term ochre is used to describe a series of ferruginous (iron-rich) rocks that can be used to produce a variety of shades of coloured powder. However, the word ochre can be quite ambiguous in different academic settings. When used in archaeological, academic, or colloquial contexts, ochre generally refers to any sediment, rock, or clay that can be used to create colourful streaks. Because of the different amounts of iron content in the material, the colours expressed vary from yellow to red to purple to brown (Fig. 1). Geologically, ochre is primarily a clay or weathered by-product from primary sedimentary, metamorphic, and igneous contexts.[4] Artistically, ochre is used to describe a colour, generally a dark yellow or light red. A consensus in all fields is that the colouring properties of ochre stem from the minerals contained within it—primarily either iron oxides and oxyhydroxides.[5] There are currently sixteen known types of iron oxides and oxyhydroxides, the most widespread and well-known being hematite (α-$F_{e2}O_3$) and goethite (α-FeOOH),[6] with color variations shown in Fig. 2.

Ochre is a mineral pigment with many faces, forms, and colours, that was collected from as far back as 500,000 years ago by archaic humans in Africa[7] and 300,000 years ago in Europe.[8] Since then, its use has spread around the world and has been found on every continent that humans have inhabited. Though it was likely used primarily as a paint or pigment, it may have served a variety of both practical and symbolic uses.[9] It appears as a residue on stone tools[10], human and animal bones,[11] shells,[12] personal ornaments or beads,[13] as a component in ceramic vessels,[14] and rock walls.[15] It was likely used as a body paint by ancient societies,[16] and is still used today by indigenous communities,[17] artists,[18] industry,[19] and for medicinal purposes.[20] It was collected in specific areas and transported over great distances,[21] and its use and recognition as an important and valuable item has persisted throughout time and space.

Ochre as a pigment appears in ancient, historical, and contemporary settings around the world, and has been used with relative consistency by humans throughout this deep span of time. Though the use of ochre is often discussed solely in relation to its role in the past, this is misleading as its use never ceased and is found in a wider range of practices today than in the past. Ochre is still in use today in a number of different

4 Singh et al., 1978
5 Cornell & Schwertmann, 2003
6 Cornell & Schwertmann, 2003
7 Watts et al., 2016
8 de Lumley, 1966; de Lumley et al., 2016
9 McBrearty and Brooks, 2000; Watts, 1999; Henshilwood et al., 2009; Watts, 2009
10 Lombard, 2007; Lombard, 2006; Villa et al., 2015; Wojcieszak & Wadley, 2018
11 Darchuk et al., 2009; Román et al., 2015; Román et al., 2019
12 d'Errico et al., 2005; Peresani et al., 2013; Vanhaeren et al., 2019
13 Dayet et al., 2017; Velliky et al., 2021a; Bouzouggar et al., 2007
14 Capel et al., 2006; Eiselt et al., 2019
15 Aubert et al., 2014; Aubert et al., 2018; Chauvet et al., 1996; Cuenca-Solana et al., 2016; d'Errico et al., 2016; Huntley, 2015; Bonneau et al., 2021
16 Fiore, 2018
17 Matthews & Khahtsahlano, 1955; Rudner, 1982; Taçon, 2004; Rifkin, 2015)
18 Gustafson, 2020
19 Prim, et al., 2011; Kokins & Kostjukovs, 2017
20 Velo, 1984, Macintyre & Dobson, 2017, Abrahams, 2010
21 Brooks, et al., 2016; Velliky et al., 2021b

Figure 1. Colour varieties of ochre collected from the southern Cape, South Africa, near Blombos Cave
Photo by Elizabeth C. Velliky

Figure 2. Colour varieties of the most widespread and well known types of iron oxides and oxyhydroxides
Diagram by Velliky & Sørensen. Photos by Velliky

settings, for example: in indigenous and descendant communities,[22] in contemporary art as a paint or pigment, as a pigment for industrial paints or mixtures,[23] as a component in steel and concrete production, and as a dye in cosmetics. Because of this wide span of different uses, contexts, geography, and time, the role of ochre in both past and present-day settings is studied by researchers within a variety of disciplines, including archaeology, anthropology, history, geology, chemistry, engineering, cognition, psychology, biology, and contemporary art, to name a few. No other artefact has been so widespread in time, geography, and application: ochre is unique. Thus, studying the impact it had on the lives of ancient humans is crucial for us to understand how they perceived and interacted with the world around them, and how these behaviours formed theirs and our cultures over time.

Ochre in Africa

The earliest ochre finding associated with humans comes in a glittery, almost black form of specular hematite, or specularite (Fe_2O_3). This was found from about 500,000 to 300,000 years ago at Wonderwerk Cave in the Northern Cape region of South Africa.[24] Following this early example, there is only sparse evidence of ochre collection during this period. It was during the African Middle Stone Age (or MSA), roughly 280,000–40,000 years ago, that humans started to regularly collect and interact with colourful ochre materials.[25] The first sites in the MSA with anthropogenically modified ochre artefacts include an archaeological site labeled *GnJh-15* in the Kapthurin Formation, Kenya, from around 285,000 years ago[26] and the Twin Rivers in Zambia, from 250,000 years ago.[27] It is this early appearance of anthropogenically modified red ochre, followed by a sudden explosion of modified ochre appearing at archaeological sites, that account for why such attention is placed on the origins of behavioural modernity in Africa, and more specifically Southern Africa. Following the discoveries at these locations, ochre use becomes a common behaviour at the majority of Middle Stone Age (MSA) sites during the Late Pleistocene. Ochre pieces with evidence of grinding striations (Fig. 3), traces of ochre powder on stone tools, and possible ochre grindstones were found at the sites Blombos Cave,[28] Die Kelders Cave,[29] Diepkloof Cave,[30] Klasies River Mouth,[31] and Klipdrift Cave,[32] and at numerous other rock shelters and caves across southern Africa.[33] The caves are located geographically in Fig. 4. One common observation regarding the use of ochre in the MSA is that ochre powder extraction becomes a habitual practice from approximately 160,000 years ago and onwards.[34]

22 Taçon, 2004; Rifkin, 2015; Velo, 1984; Abrahams, 2010; Russell, 1993
23 Prim, et al., 2011; Kokins & Kostjukovs, 2017
24 Watts et al., 2016
25 Wadley, 2005; Wolf, et al., 2018; Watts, 1998
26 McBrearty & Brooks, 2000
27 Marean et al. 2007; Watts, 2010
28 Henshilwood et al., 2011; Henshilwood et al., 2001
29 Thackeray, 2000
30 Dayet et al., 2013
31 d'Errico et al., 2012
32 Henshilwood et al., 2014
33 Watts, 1998
34 d'Errico, 2008; Wadley 2001; Watts, 1999, 2002

Figure 3. Examples of different ochre modifications created by humans. Clockwise from top left: grinding striations; active grinding; scoring incisions; grinding striations; scoring incisions; grinding striations. Photos by Elizabeth C. Velliky

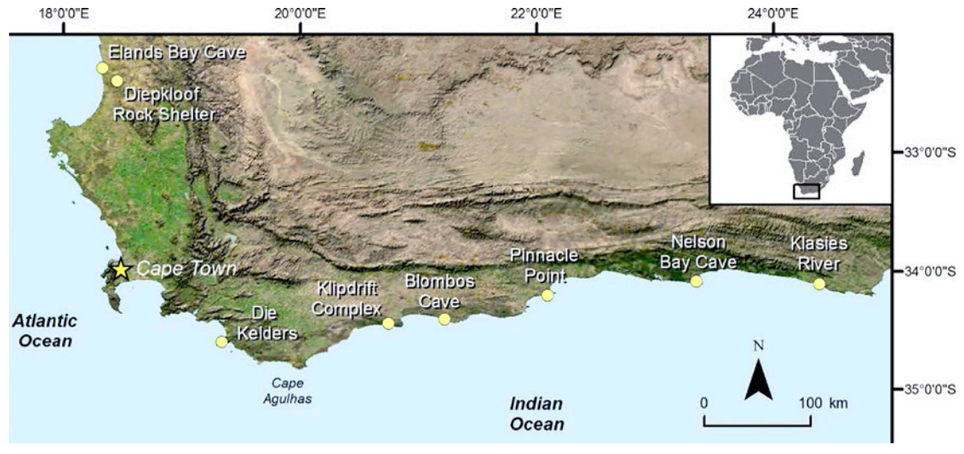


Figure 4. The location of the caves. Map by Magnus M. Haaland, 2018

Figure 5. View to the Indian Ocean from inside Blombos Cave.
Photo by Magnus M. Haaland

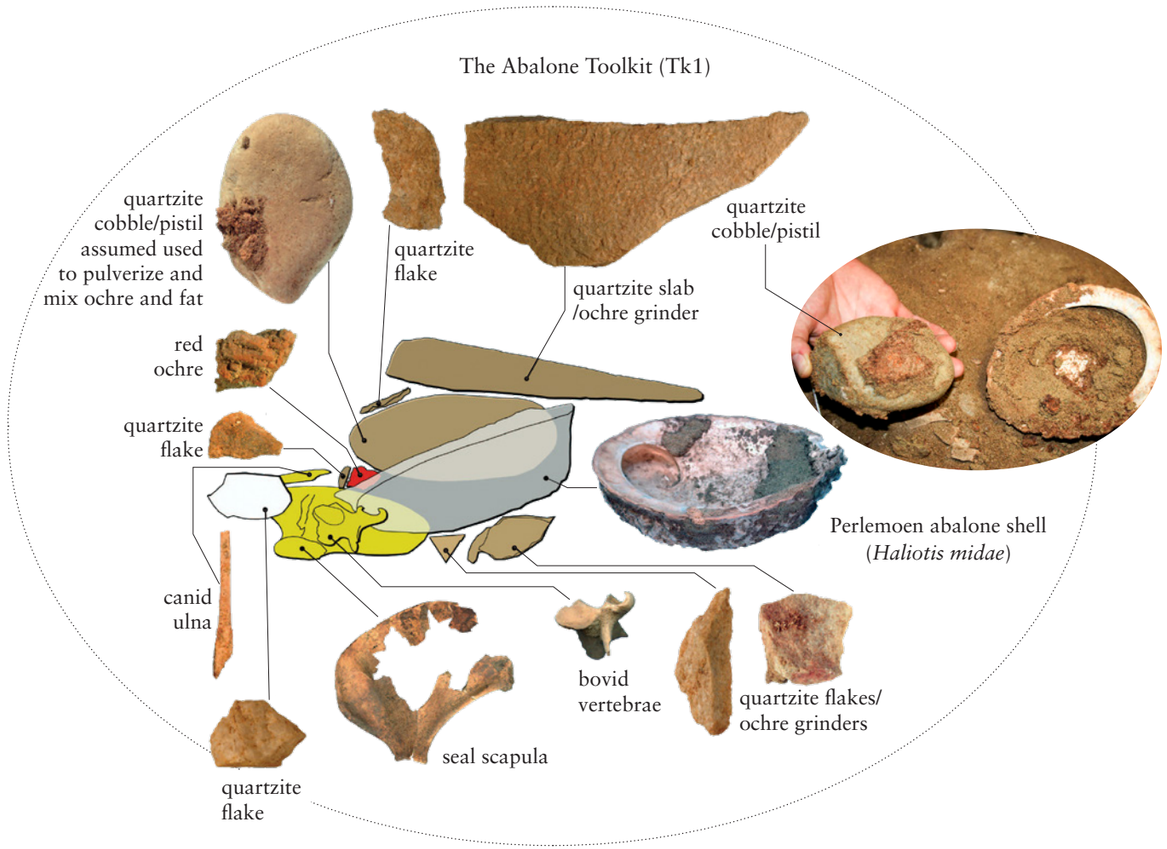


Figure 6. The artefacts associated with Toolkit-1 and their relative spatial locations. Diagram by Henshilwood & d'Errico (2011). Image of the excavated perlemoen shell courtesy of Grethe Moéll Pedersen & Christopher S. Henshilwood

Blombos Cave

The Blombos Cave is an archaeological site located on the southern Cape coastline, South Africa. The cave lies 300 km east of Cape Town and is situated in a steep wave-cut calcrete cliff, 100 m from the Indian Ocean. It contains MSA deposits from between c. 130,000 and 72,000 years ago and Later Stone Age (LSA) deposits from c. 2,000 years ago (Fig. 5). Excavations under the direction of Prof. Chris Henshilwood commenced at the site in 1992, and are still ongoing. Since the late 90s, the site has become known for discoveries that have significantly changed our vision of MSA cultures and their evolution. This includes engraving and drawing of abstract designs on ochre and stone and, to a lesser extent, bone, as well as the earliest known evidence of the manufacture of personal ornaments such as shell beads, and refined bone tools, and the heating of a lithic raw material called silcrete and its manufacture to produce bifacial stone points by pressure flaking.[35]

At the Blombos Cave, over 8,000 individual pieces of ochre have been recovered from the MSA levels, with many showing traces and markings from human interaction.[36] Many of these ochres are shales, siltstones, and mudstones, which are abundant in the nearby geological formations of the Bokkeveld Group shales (Fig. 4). The inland deposits have undergone extensive chemical weathering, resulting in red and yellow ochre deposits which are still mined today for industrial pigments.[37]

These findings from the Blombos Cave and subsequent reanalysis and excavation of other contemporary sites have resulted in a paradigm shift with regard to our understanding of the timing and location of the development of modern human behaviour. The faunal remains recovered at Blombos indicate that MSA people practiced a varied subsistence strategy. They were able to hunt large herbivores, such as eland, but also collected or trapped small animals such as tortoises, hyraxes, and dune mole rats. They were also eating seals, dolphins, and probably whale meat. Shellfish were collected and brought back to the cave, particularly during the oldest occupation of the cave, c. 100,000 years ago, when the sea was, as today, close to the cave.

The Blombos Ochre Toolkits

In 2011, Christopher S. Henshilwood and his team published a report highlighting the discovery of two large abalone shells (*Haliotis midae*) that contained residues of ochre in the form of powder and microscopic fragments (Fig. 7), along with several other artefacts, including intact ochre pieces, stone flakes, intact bones and crushed bone, charcoal, and a large quartzite cobble (Fig. 6). The two toolkits, Tk1 and Tk2 (Fig. 7), coeval and found close to each other, were interpreted as being used for the production and storage of an ochre-rich compound at the Blombos Cave. The context in which they were recovered was dated to around 100,000 years ago, using optically stimulated luminescence. The find predates other ochre toolkits by 40,000 years.[38] Chemical analysis of the ochre fragments present in the abalones, of the associated pieces of ochre, and the residues on the processing tools suggested the ochre was collected at different geological sources, and both red and yellow ochre were mixed in the compound. Traces of modification on the ochre pieces, the processing tools, and the morphology of the ochre fragments found in the shells indicated that ochre was either ground to produce a thin powder, or crushed, which produced a coarse, red matter. Lines of desiccation on the shell nacre demonstrate that the ochre was mixed with a liquid that dried out inside the shell.

Though the collective interpretation of the finds is that of an ochre processing toolkit, the exact application or use of the ochre compound is unknown. No resin or wax res-

35 d'Errico, et al., 2005; Henshilwood, 2007; Henshilwood et al., 2018; Henshilwood et al., 2001a
36 Henshilwood et al., 2009; Watts, 2009; Watts, 2002; Henshilwood et al., 2002; Henshilwood et al., 2001b
37 Rogers, 1988
38 Wadley, 2010; Van Peer et al., 2003; Rosso et al., 2016; Rosso et al., 2014; Wojcieszak & Wadley, 2019

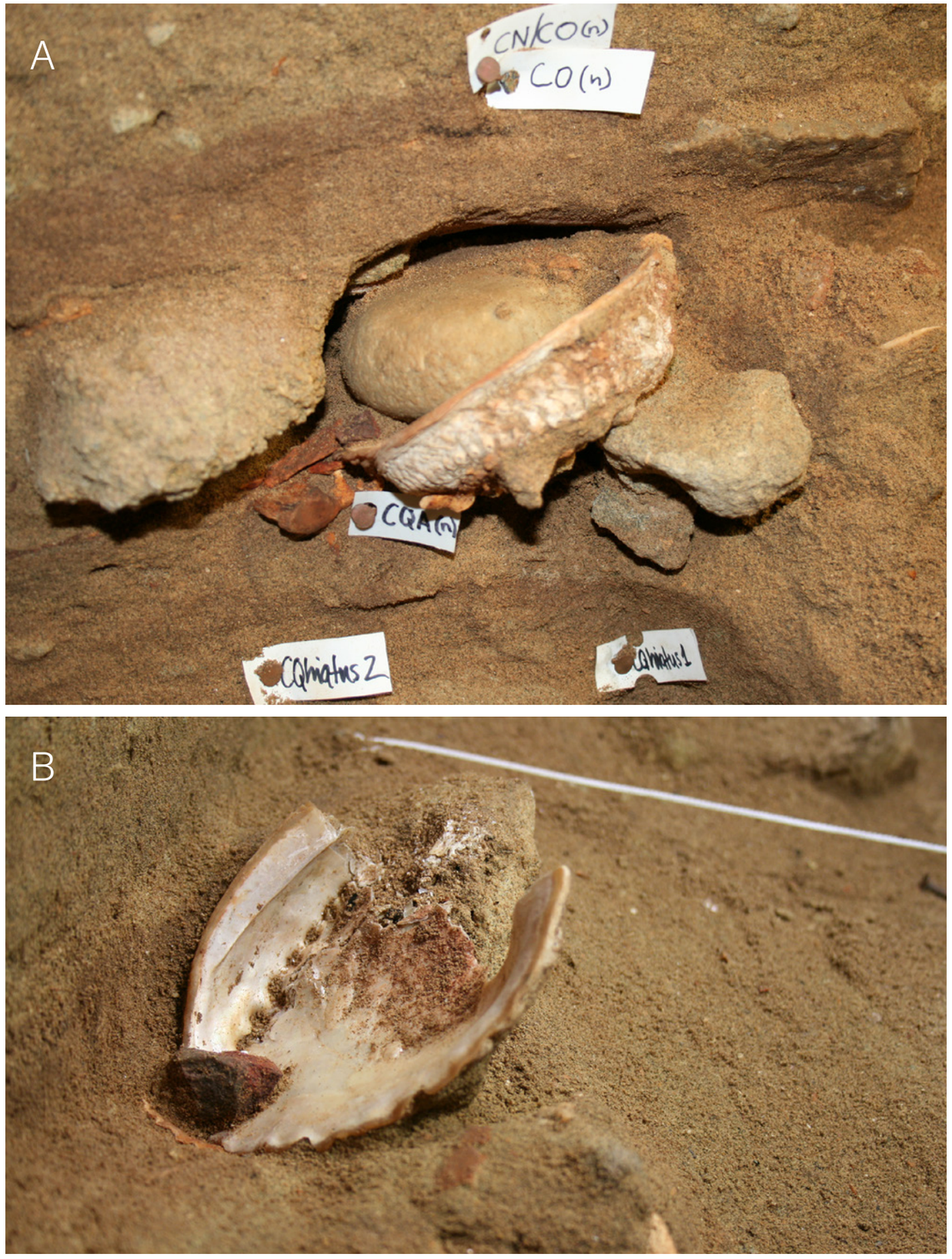
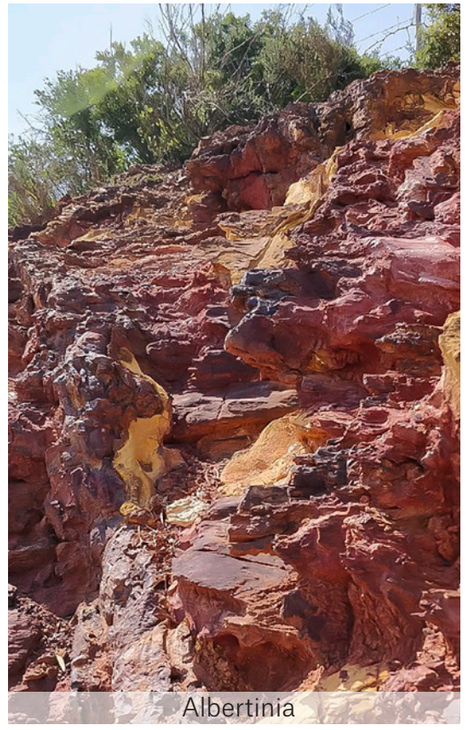


Figure 7. The Ochre Toolkits from Blombos Cave, detail (A) Toolkit-1, and detail (B) Toolkit-2.
Image courtesy of Grethe Moéll Pedersen & Christopher S. Henshilwood


Kleinsand Fontein


Garcia Pass


Albertinia


Suurbraak

Figure 8. Examples of different ochres found in the Bokkeveld shales surrounding Blombos Cave. Photos by Elizabeth C. Velliky

idues were detected in the compound, which may have indicated its use as an adhesive. The evidence does suggest that some of the artefacts were reused, indicating that the production of the ochre mixture was not an isolated behaviour. Furthermore, the presence of ochre residues on the Canine Ulna bone suggests its possible use as a mixing tool and perhaps also as an applicator. However, these hypotheses have never been tested using experiments or recreated ochre toolkits.

Recreating the Toolkits

To explore the processes surrounding the creation of the toolkit and the possible uses of the ochre mixture contained within, we will recreate the toolkit setting in order to answer specific questions on the origins, creation, and use of the toolkit. These questions include:

- Was the ochre compound produced following the procedures proposed by Henshilwood and his team?[39]
- Were the toolkits used once, or on multiple occasions?
- Was the ochre compound mixed by use of human fingers, as suggested by some striations on the nacre?
- Was the compound mixed by one person or several different people in alternation?
- Did sand enter the abalone shell when the mixture was wet or dry?
- Was the mixture suitable as a paint or for tanning hides?

Recreating the toolkit setting is an essential component of exploring the questions related to its use and creation. It is thus important to attempt to recreate the materials as closely as possible, including using actual abalone shells from South Africa, ochre collected from South Africa, and similar animal bones and stone tools that were found in association with the toolkit (Fig. 6). Our goal is to replicate the setting as closely as possible, which we hope will encourage both the active experimenters and museum visitors to consider this process in its entirety. By this, we emphasize that often the steps behind the creation of ochre mixtures can be imbued with as much significance as the uses of the final product. We hope that by visiting and experiencing the exhibition as a whole, visitors will be encouraged to reflect on these aspects and consider them when interacting with the ochre toolkits as part of the experiments.

Conclusion

Ochre has marked the lives of humans for at least 300,000 years. This interaction has accelerated and amplified over the last 100,000 years to take the form, in some cultures, of daily contact covering almost all human activities and often even marking the passage to the afterlife. From this long interaction with a material that has marked our cognitive evolution and our way of conceiving and culturalising the world around us, all that remains from the oldest time periods are small, red fragments bearing a few traces of modification or grinding stones with residues left by ochre grinding. The toolkits discovered at Blombos represent the only known example of a set of objects discovered together and intended for the production of colouring powder, the preparation of a pigmented mixture, and its conservation. It thus opens a window into a variety of behaviours of which archaeologists know only bits and pieces. These toolkits have been studied in depth, but still have secrets to reveal.

The creation of participatory workshops allowing the general public, and especially younger visitors, to familiarise themselves with the technologies of the past has become a common practice in the popularisation of archaeology. Flint knapping, fire lighting, pottery making, ornamental objects, painting, engraving, and rock wall pitting as the "prehistoric people" used to do, now seem to be within everyone's reach. The experience we propose is not of the same nature and does not have the same scope. It aims to establish an ideal dialogue between the visitor, who can play the role of an experimenter if he or she so wishes, the scientists, who carry out targeted research to answer complex and relevant archaeological questions, and the craftsmen who, 100,000 years ago, repeatedly used these objects and who speak to us through them and through the traces that have fossilised their gestures. We are convinced that each of these interlocutors has something to teach the other and that each has learned or will learn something from their interaction with the different materials and forms that compose the tool kits. Through previous experimentation and the study of archaeological material, the researchers have interpretative keys that the visitor lacks and that can be communicated to them. Even so, this discipline-specific knowledge is loaded with biases that will be challenged through the naive gaze of the visitors. Our hope is that the dialogue they will start will bring back to life the third interlocutor, the one who has been hiding behind these objects for 100,000 years.

39 Henshilwood et al., 2011

Bibliography

Abdeljalil Bouzouggar, Nick Barton, Marian Vanhaeren, Francesco d'Errico, Simon Collcutt, Tom Higham, Edward Hodge, Simon Parfitt, Edward Rhodes, Jean-Luc Schwenninger, Chris Stringer, Elaine Turner, Steven Ward, Abdelkrim Moutmir & Abdelhamid Stambouli (2007). "82,000-year-old shell beads from North Africa and implications for the origins of modern human behavior." *Proceedings of the National Academy of Sciences* 104, pp. 9964–9969.

Adelphine Bonneau, David G. Pearce, Peter J. Mitchell, Laura Didier, Luiseach Nic Eoin, Thomas F. G. Higham, Michel Lamothe & Charles Arthur (2021). "Characterization and dating of San rock art in the Metolong catchment, Lesotho: A preliminary investigation of technological and stylistic changes." *Quaternary International*.

Aigars Kokins & Juris Kostjukovs (2017). "Staicele Paint Manufactory, Ochre Deposit of Reciems: A Retrospective Journey Through the History of Staicele Paint Manufactory and Evaluation of Production Technologies." *Material Science & Applied Chemistry* 34.

A K Singh, B K Jain & K Chandra (1978). "Mossbauer studies of naturally occurring red ochre and yellow ochre." *Journal of Physics D: Applied Physics* 11, 55.

Alison Brooks, John Yellen, Andrew Zipkin, Laure Dussubieux & Potts Rick (2016). "Early Worked Ochre in the Middle Pleistocene at Olorgesailie, Kenya." The 81st Annual Meeting of the Society for American Archaeology, Orlando, Florida, USA.

Alison S. Brooks, John E. Yellen, Richard Potts, Anna K. Behrensmeyer, Alan L. Deino, David E. Leslie, Stanley H. Ambrose, Jeffrey R. Ferguson, Francesco d'Errico, Andrew M. Zipkin, Scott Whittaker, Jeffrey Post, Elizabeth G. Veatch, Kimberly Foecke & Jennifer B. Clark (2018). "Long-distance stone transport and pigment use in the earliest Middle Stone Age." *Science* 360, pp. 90–94.

B. Sunday Eiselt, John Dudgeon, J. Andrew Darling, N. Evelin Paucar, Michael D. Glascock & Michael Kyle Woodson (2019). "In-situ Sourcing of Hematite Paints on the Surface of Hohokam Red-on-Buff Ceramics Using Laser Ablation–Inductively Coupled Plasma–Mass Spectrometry (LA–ICP–MS) and Instrumental Neutron Activation Analysis." *Archaeometry* 61, pp. 423–441.

Christopher S. Henshilwood, Francesco d'Errico, Karen L. van Niekerk, Laure Dayet, Alain Queffelec & Luca Pollarolo (2018). "An abstract drawing from the 73,000-year-old levels at Blombos Cave, South Africa." *Nature* 562, 115.

Christopher S. Henshilwood, Francesco d'Errico, Karen L. van Niekerk, Yvan Coquinot, Zenobia Jacobs, Stein-Erik Lauritzen, Michel Menu & Renata García-Moreno (2011). "A 100,000-Year-Old Ochre-Processing Workshop at Blombos Cave, South Africa." *Science* 334, pp. 219–222.

Christopher S. Henshilwood & Ian Watts (2009). "Engraved ochres from Middle Stone Age levels at Blombos Cave, South Africa." *Journal of Human Evlution* (57), pp. 27–47.

Christopher S. Henshilwood (2007). "Fully symbolic Sapiens behaviour: innovation in the middle stone age at Blombos cave, South Africa," in: Paul Mellars & Chris Stringer (eds.) *Rethinking the human revolution: new behavioural and biological perspectives on the origin and dispersal of modern humans*, University of Cambridge Press, Cambridge, pp. 123–132.

Christopher S. Henshilwood, Francesco d'Errico, Royden Yates, Zenobia Jacobs, Chantal Tribolo, Geoff Duller, Norbert Mercier, Judith Sealy, Helene Valladas, Ian Watts & Ann G Wintle (2002). "Emergence of modern human behavior: Middle Stone Age engravings from South Africa." *Science* 295, pp. 1278–1280.

Christopher S. Henshilwood, Francesco d'Errico, Curtis W. Marean, Richard G. Milo & Royden Yates (2001a). "An early bone tool industry from the Middle Stone Age at Blombos Cave, South Africa: implications for the origins of modern human behaviour, symbolism and language." *Journal of Human Evolution* 41, pp. 631–678.

Christopher S. Henshilwood, J.C. Sealy, Royden Yates, K. Cruz-Uribee, P. Goldberg, F. E. Grine, R. G. Klein, C. Poggenpoel, Karen L. van Niekerk & Ian Watts (2001b). "Blombos Cave, southern Cape, South Africa: preliminary report on the 1992–1999 excavations of the Middle Stone Age levels." *Journal of Archaeological Science* 28, pp. 421-448.

Danae Fiore (2018). "Shelk'nam body paintings: ancient and recent uses of an ephemeral art form in Tierra del Fuego (southern South America)." *Arctic & Antarctic. International Journal of Circumpolar Studies* 10, pp. 9–59.

Daniela Eugenia Rosso, Africa Pitarch Martí & Francesco d'Errico (2016). "Middle Stone Age Ochre Processing and Behavioural Complexity in the Horn of Africa: Evidence from Porc-Epic Cave, Dire Dawa, Ethiopia."*PloS one* 11, e0164793, pp. 1–35.

Daniela E. Rosso, Francesco d'Errico & João Zilhão (2014). "Stratigraphic and spatial distribution of ochre and ochre processing tools at Porc-Epic Cave, Dire Dawa, Ethiopia." *Quaternary International* 343, pp. 85–99.

Darchuk Larysa, Elzbieta Anna Stefaniak, Cristina Vázquez, Oscar M. Palacios, Worobiec Anna, R. Van Grieken, (2009). "Composition of pigments on human bones found in excavations in Argentina studied with micro-Raman spectrometry and scanning electron microscopy." *e-Preservation Science* 6, pp. 112–117.

David Cuenca-Solana, Igor Gutiérrez-Zugasti, Aitor Ruiz-Redondo, Manuel R. Gonzalez Morales, Jesús Setién, Estela Ruiz Martínez, Eduardo Palacio-Pérez, Carmen de las Heras, Alfredo Prada & Jose A. Lasheras-Corruchaga (2016). "Painting Altamira Cave? Shell tools for ochre-processing in the Upper Palaeolithic in northern Iberia." *Journal of Archaeological Science* 74, pp. 135–151.

Elizabeth C. Velliky, Patrick Schmidt, Ludovic Bellot-Gurlete, Sibylle Wolf, Nicholas J. Conard (2021a). "Early anthropogenic use of hematite on Aurignacian ivory personal ornaments from Hohle Fels and Vogelherd caves, Germany." *Journal of Human Evolution* 150, pp. 1–15.

Elizabeth C. Velliky, Brandi Lee Macdonald, Martin Porr & Nicholas J Conard (2021b). "First large-scale provenance study of pigments reveals new complex behavioural patterns during the Upper Palaeolithic of southwestern Germany" *Archaeometry* 63, pp. 173–193.

Erella Hovers, Shimon Ilani, Ofer Bar-Yosef & Bernard Vandermeersch (2003). "An Early Case of Color Symbolism: Ochre Use by Modern Humans in Qafzeh Cave." *Current Anthropology* 44, pp 491–522.

Francesco d'Errico, Laure Dayet, Marcos García-Diez, Àfrica Pitarch, Daniel Garrido Pimentel & João Zilhão (2016). "The technology of the earliest European cave paintings: El Castillo Cave, Spain." *Journal of Archaeological Science* 70, pp. 48–65.

Francesco d'Errico, Christopher S. Henshilwood, Marian Vanhaerend & Karen van Niekerke (2005). "Nassarius kraussianus shell beads from Blombos Cave: evidence for symbolic behaviour in the Middle Stone Age." *Journal of Human Evolution* 48, pp. 3–24.

Henry de Lumley (1966). "Les feuilles de Terra Amata à Nice." *Bulletin du Musée d'Anthropologie et de Préhistoire de Monaco* 13, pp. 29–51.

Heidi Gustafson (2020). "Early Futures Ochre Sanctuary" http://earlyfutures.com/

Henry De Lumley, Audubert, F., Khatib, S., Perrenoud, C., Roussel, B., Saos, T., Szelewa, A., 2016. Les «crayons» d'ocre du site Acheuléen de Terra Amata, in: Henry De Lumley (Ed.), *Terra Amata Nice Alpes-Maritimes*, France CNRS Éditions, Paris, pp. 233–277.

Ian Watts, Michael Chazan & Jayne Wilkins (2016). "Early Evidence for Brilliant Ritualized Display: Specularite Use in the Northern Cape (South Africa) between 500 and 300 Ka." *Current Anthropology* 57, pp. 287–310.

Ian Watts (2009). "Red ochre, body painting, and language: interpreting the Blombos ochre," in: Rudolf Botha & Chris Knight(Eds.), *The Cradle of Language*, Oxford University Press, Oxford, pp. 93–129.

Ian Watts (2002). "Ochre in the Middle Stone Age of Southern Africa: Ritualised Display or Hide Preservative?" *The South African Archaeological Bulletin* 57, pp. 1–14.

Ian Watts (1999). "The Origin of Symbolic Culture," in: Robin Dunbar, Chris Knight & Camilla Power (Eds.) *The Evolution of Culture*. Edinburgh University Press, Edinburgh, pp. 113–146.

Ian Watts (1998). *The Origin of Symbolic Culture: The Middle Stone Age of Southern Africa and Khoisan Ethnography*. University of London, London, p. 3828.

Ione Rudner (1982). *Khoisan Pigments and Paints and their Relationship to Rock Paintings*. South African Museum, p. 281.

James M. Bowler, Harvey Johnston, Jon M. Olley, John R. Prescott, Richard G. Roberts, Wilfred Shawcross & Nigel A. Spooner (2003). "New ages for human occupation and climatic change at Lake Mungo, Australia." *Nature* 421, pp. 837–840.

James Skitt Matthews & August Jack Khahtsahlano (1955). *Conversations with Khahtsahlano, 1932-1954*. Compiled by the City Archivist, Vancouver, British Columbia.

Jean-Marie Chauvet, Eliette Brunel Deschamps, & Christian Hillaire (1996). *Dawn of art: the Chauvet Cave: the oldest known paintings in the world*, New York : H.N. Abrams, p. 135.

Joseph Velo (1984). "Ochre as medicine: a suggestion for the interpretation of the archaeological record." *Current Anthropology* 25, 674.

J. Capela, F. Huertasb, A.Pozzuolic & J. Linaresb (2006). "Red ochre decorations in Spanish Neolithic ceramics: a mineralogical and technological study." *Journal of Archaeological Science* 33, pp. 1157–1166.

Jillian A. Huntley (2015). "Looking Up and Looking Down: Pigment Chemistry as a Chronological Marker in the Sydney Basin Rock Art Assemblage, Australia." *Rock Art Research* 32, pp. 131–145.

Ken Macintyre & Barb Dobson (2017). "Geophagy: The Earth-Eaters of Lower Southwestern Australia." Published online 2017: https://anthropologyfromtheshed.com/project/geophagy-the-earth-eaters-of-lower-southwestern-australia/

Laure Dayeta, Rudolph Erasmus, Aurore Val, Léa Feyfant & Guillaume Porraz (2017). "Beads, pigments and early Holocene ornamental traditions at Bushman Rock Shelter, South Africa." *Journal of Archaeological Science: Reports* 13, 635–651.

Lawrence S. Barham (1998). "Possible early pigment use in South-Central Africa." *Current Anthropology* 39, pp. 703–710.

Lawrence S. Barham (2002). “Systematic Pigment Use in the Middle Pleistocene of South-Central Africa.” *Current Anthropology* 43, pp. 181–190.

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

Lyn Wadley (2005). “Ochre crayons or waste products? Replications compared with MSA ‘crayons’ from Sibudu Cave, South Africa.” *Before Farming* 2005, pp. 1–12.

Marco Peresani, Marian Vanhaeren, Ermanno Quaggiotto, Alain Queffelec & Francesco d’Errico (2013). “An ochered fossil marine shell from the Mousterian of Fumane Cave, Italy.” PLoS ONE 8, e68572, pp. 1–15.

Margo Russell (1993). “Women, children and marriage in Swaziland.” *International journal of sociology of the family*, pp. 43–57.

Marian Vanhaerena, Lyn Wadley & Francesco d’Errico (2019). “Variability in Middle Stone Age symbolic traditions: The marine shell beads from Sibudu Cave, South Africa.” *Journal of Archaeological Science: Reports* 27, 101893.

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

Marlize Lombard (2006). “Direct evidence for the use of ochre in the hafting technology of Middle Stone Age tools from Sibudu Cave.” *Southern African Humanities* 18, pp. 57–67.

Maxime Aubert, Pindi Setiawan, Adhi Agus Oktaviana, Adam Brumm, P. H. Sulistyarto, Erlang Wahyu, B. Istiawan, T. A. Ma’rifat, V. N. Wahyuono, F. T. Atmoko, Jian-xin Zhao, Jillian A Huntley, P. S. C. Taçon, D. L. Howard & H. E. A. Brand (2018). “Palaeolithic cave art in Borneo.” *Nature* 564, 254.

Maxime Aubert, Adam Brumm, M Ramli, T Sutikna, Erlang Wahyu, Budianto Hakim, M J Morwood, Gert Van den Bergh, L Kinsley & Anthony Dosseto (2014). “Pleistocene cave art from Sulawesi.” *Indonesia, Nature* 514, pp. 223–227.

P. Van Peer, Richard Fullagar, Stephen Stokes, Richard Bailey, Jan Moeyersons, F Steenhoudt, A Geerts, T Vanderbeken, Morgan De Dapper & F Geus (2003). “The Early to Middle Stone Age transition and the emergence of modern human behaviour at site 8-B-11, Sai Island, Sudan.” *Journal of Human Evolution* 45, pp. 187–193.

Paola Villa, Luca Pollarolo, Ilaria Degano, Leila Birolo, Marco Pasero, Cristian Biagioni, Katerina Douka, Roberto Vinciguerra, Jeannette J. Lucejko & Lyn Wadley (2015). “A milk and ochre paint mixture used 49,000 years ago at Sibudu, South Africa.” PloS one 10, e0131273, pp. 1–12.

Paul Taçon (2004). “Ochre, clay, stone and art,” in: Nicole Boivin & M. A. Owic (Eds.), *Soils, stones and symbols: Cultural perceptions of the mineral world*. UCL Press, London, pp. 31–42.

Peter W. Abrahams (2010). “Earth eaters”: ancient and modern perspectives on human geophagy, Soil and Culture” *Springer*, pp. 369–398.

Raymond A. Dart (1968). “The birth of symbology.” *African Studies* 27 (1), pp. 15–27.

Rochelle M. Cornell & Udo Schwertmann (2003). *The Iron Oxides: Structure, Properties, Reactions, Occurrences and Uses*. Wiley-VCH, Weinheim, p. 703.

Romualdo Seva Románab, Dolores Landete Ruiz, Jerónimo Juan-Juanc, Cristina Biete Bañón, Lawrence G. Strausd, Manuel R. González Moralese (2019). “Sources of the ochres associated with the Lower Magdalenian “Red Lady” human burial and rock art in El Mirón Cave (Cantabria, Spain), *Journal of Archaeological Science: Reports* 23, pp. 265–280.

Riaan F. Rifkin (2015). “Ethnographic insight into the prehistoric significance of red ochre.” *The Digging Stick* 32, pp. 7–10.

Rogers, J. (1988). “Stratigraphy and geomorphology of three generations of regressive sequences in the Bredasdorp group, southern Cape Province, South Africa,” in: G.F. Dardis & B.P. Moon (eds.), *Geomorphological Studies in Southern Africa*, A.A. Balkema, Rotterdam, pp. 407–434.

Romualdo Seva Román, Cristina Biete Bañónb, Dolores Landete Ruizb (2015). “Analysis of the red ochre of the El Mirón burial (Ramales de la Victoria, Cantabria, Spain).” *Journal of Archaeological Science* 60, pp. 84–98.

Sally Mcbrearty & Alison S. Brooks (2000). “The revolution that wasn’t: a new interpretation of the origin of modern human behavior.” *Journal of Human Evolution* 39, pp. 453–563.

Sibylle Wolf, Nicholas John Conard, Harald Floss, Rimtautas Dapschauskas, Elizabeth C. Velliky & Andrew W. Kandel (2018). “The Use of Ochre and Painting During the Upper Paleolithic of the Swabian Jura in the Context of the Development of Ochre Use in Africa and Europe.” *Open Archaeology* 4, pp. 185–205.

S. R. Prim, Marilena Valadares Folgueras, M.A. de Lima & Dachamir Hotza (2011). “Synthesis and characterization of hematite pigment obtained from a steel waste industry.” *Journal of hazardous materials* 192, pp. 1307–1313.

Wojcieszak Marine & Lynn Wadley (2019). “A Raman micro-spectroscopy study of 77,000 to 71,000 year old ochre processing tools from Sibudu, KwaZulu-Natal, South Africa.” *Heritage Science* 7, pp. 1–14

Wojcieszak Marine & Lynn Wadley (2018). “Raman spectroscopy and scanning electron microscopy confirm ochre residues on 71 000-year-old bifacial tools from Sibudu, South Africa.” *Archaeometry*, pp. 1062–1076.

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