

Technological, elemental and colorimetric analysis of an engraved ochre fragment from the Middle Stone Age levels of Klasies River Cave 1, South Africa

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ABSTRACT

It is generally accepted that abstract and iconographic representations are reflections of symbolic material culture. Here we describe a fragmented ochreous pebble bearing a sequence of sub-parallel linear incisions. These were produced by a lithic point and may represent one of the oldest instances of a deliberate engraving. The object was recovered from Middle Stone Age II levels of Klasies River Cave 1, South Africa, and is dated to between 100,000 and 85,000 years ago. Microscopic analysis reveals that the surface of the object was ground until smooth before being engraved with a sequence of sub-parallel lines made by single and multiple strokes. X-ray fluorescence and colorimetric analysis of the object and a sample of twelve additional ochre pieces from the same level reveals that the brown colour and Manganese-rich composition renders the engraved piece distinct. This suggests that a particular type of raw material may have been selected for engraving purposes. Although the purpose of marking this object remains uncertain, its detailed analysis adds relevant information to previously published occurrences of Middle Stone Age engraved objects and contributes to clarify their distribution through time and space.

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1. Introduction

Recent archaeological, anthropological and genetic discoveries are radically changing our knowledge concerning the chronology of the emergence of modern cultural and anatomical traits. For most of the last century, the remarkable evidence of the complexity of Cro-Magnon behaviour in Europe convinced the scientific community that modern features had a sudden origin coinciding with the commencement of the Upper Palaeolithic some 40,000 years ago (ka) (Stringer and Gamble, 1993; Klein, 1995, 1999, 2000; Mellars, 1996a,b; Mithen, 1996; Bar-Yosef, 1998, 2002; Conard and Bolus, 2003). This view was challenged in the first decade of this century by authors supporting the scenario of a gradual emergence of modern culture in Africa during the Middle Stone Age (MSA). This would have occurred as a direct consequence of and in combination with the emergence of our species (McBrearty and

Brooks, 2000; Henshilwood et al., 2002, 2004; Henshilwood and Marean, 2003, 2006). Others have argued that modern cognition was largely in place among the ancestors of Neanderthals and modern humans, and that we have to invoke demographic factors, perhaps triggered by climatic changes, to account for the discontinuous nature of the archaeological evidence for early forms of modern behaviour (Deacon and Wurz, 2001; Zilhão, 2001; d'Errico, 2003; d'Errico et al., 2003; d'Errico and Stringer, 2011; Lombard and Parsons, 2011; d'Errico and Henshilwood, 2011). This latter scenario is consistent with the recent finding that Siberian Middle Palaeolithic and Neandertal-derived genes account for between 2% and 8% of the ancestry of modern Eurasian humans (Green et al., 2010; Krause et al., 2010; Reich et al., 2010). As with our present genetic diversity, modern cultural features may not comprise a single 'package' with a unique African origin in one time, place and population, but rather a composite one whose elements appeared at different times and places, including some outside the African continent, either shared or as a result of a form of convergent evolution.

Unsurprisingly, the first instances of symbolic material culture play a major role in testing these scenarios. They arguably signal the emergence of the first societies in which social conventions, beliefs and knowledge about the outside world are coded, stored and

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transmitted using conventional signs. It has already been noted, however, that the criteria archaeologists use to infer cognition from past actions do not necessarily offer the same quality of information to enable the identification of human societies comparable to ours (McBrearty and Brooks, 2000; Kuhn and Stiner, 2001; Henshilwood and Marean, 2003, 2006; d'Errico et al., 2009; Henshilwood and Dubreuil, 2009, 2011). Pigments found at archaeological sites in the form of modified chunks (Barham, 2002; Hovers et al., 2003; Van Peer et al., 2004; Wadley, 2006; Henshilwood et al., 2009) or residues adhering to objects (Lombard, 2006, 2007; Wadley et al., 2009; Henshilwood et al., 2011) are generally the by-products of a sequence of actions that is difficult to reconstruct. It is for this reason that the interpretation of early pigment use is often controversial in nature (Wadley et al., 2009; Watts, 2009; Rossano, 2010; Wynn and Coolidge, 2010).

Evidently, different actions, with or without symbolic intent, may have similar consequences. Personal ornaments found at habitation sites can be described as the disposed elements of an irreversibly broken but originally meaningful string of signs. They represent clear proof of symbolically mediated behaviour (d'Errico et al., 2009: 19). However, the degree of complexity of those arrangements on the human body is lost forever, as are the ornaments made of perishable material that were included in that arrangement. A close reading of primary and secondary burials may help to reconstruct funerary practices (Duday et al., 1990; Pearson, 1999; Duday, 2010), but ethnographic data on those practices demonstrate that archaeology can only provide a minimalistic account of the actions associated with death and burial. Technological complexity and the morphological standardisation of stone and bone implements may be of assistance in evaluating the cognitive abilities of our ancestors (Ambrose, 2001; Foley and Lahr, 2003) but it is often difficult, when it comes to assessing the symbolic dimensions of tool production, to disentangle stylistic and symbolic aspects from functional constraints.

Painted, engraved and carved abstract and depictional representations are traditionally considered key to assessing the modern character of human cultures (Conard, 2008, 2010; Rossano, 2010; Henshilwood and Dubreuil, 2011). The former category may be heavily affected by taphonomic processes (Langley et al., 2011) and the durability of the latter depends largely on the raw material on which carvings are made. Engravings, the result of cutting a design into any substance with the use of an implement, comprise the only durable category of potentially symbolic early material culture that represents the complete end product of the actions performed by its executor. As with drawings, engravings explicate the deepest subconscious state of mind of the artist (Freeman and Cox, 1985; Thomas and Silk, 1990) while, at the same time, visually 'organising' a shared culture (Cox et al., 2001). Contrary to other early

symbolic manifestations, engravings can be formally described, compared and their differences measured from a range of technological and metric perspectives (Bosinski et al., 2001; Henshilwood et al., 2009).

The microscopic analysis of engraved patterns may provide discrete information on the intentions of the engraver. The shape of the terminations of an incised line, changes in its depth, direction and internal morphology, divulge, by comparison with experimentally engraved lines, information concerning directionality, precision, strength of motion and the location of the engraver and his or her hand in relation to the incised surface (d'Errico, 1996; Fritz, 1999). Analysis of multiple lines and patterns, including intersections, also provide evidence for the chronology of motions, the use of single and multiple tools, engraver laterality and possible changes in the orientation of the engraved surface between the production of different incisions. By combining these details, it is possible to evaluate the technical competence of the engraver, his or her degree of determination and, to some extent, the mental template behind the physical appearance of the product of the engraver's actions.

In this study we describe, for the first time, an engraved piece of ochre derived from MSA II layers of Klasies River Cave I (Singer and Wymer excavation). Technological analyses are performed and the elemental composition and colorimetric values of the object are compared with a sample of 12 additional pigment pieces recovered from the same level. The analyses confirm the anthropogenic and deliberate nature of the markings, and reveals that a particular type of raw material was selected by the MSA engraver. This object adds to recently published evidence of similar and broadly coeval behaviours expressed on the same media (Mackay and Welz, 2008; Chazan and Horwitz, 2009; Henshilwood et al., 2009; Watts, 2009). This study also highlights the importance of complementing the visual analysis of engraved objects with non-destructive and objective colorimetric and elemental characterisations of the selected mediums.

1.1. Early engravings

Several sites in Africa and Europe older than 40 ka have yielded convincing evidence for the intentional production of engravings. The archaeological evidence for southern African MSA engravings reveals a complex pattern with several sites yielding several isolated pieces, and only a few providing consistent evidence. A banded ironstone slab with some superficial scratches has recently been reported from the Fauresmith levels of Wonderwerk cave (Excavation 6) dated to at least 187 ka (Chazan and Horwitz, 2009). The random orientation and shallow nature of the lines suggest, however, that they may be the result of trampling rather than

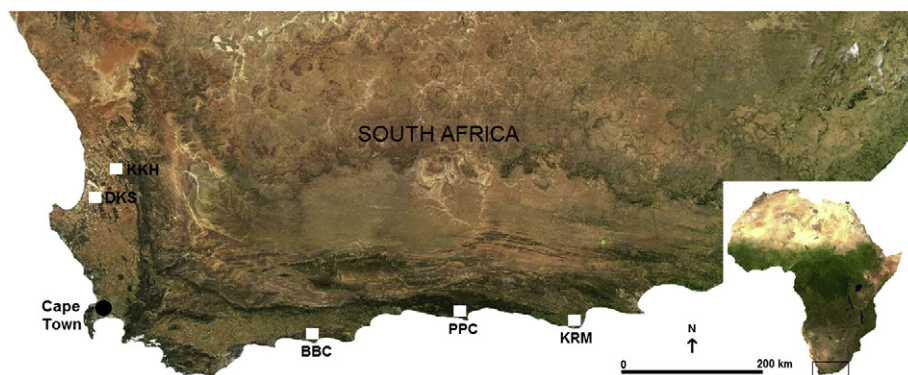


Fig. 1. Location of Klasies River and other key Middle Stone Age sites from Southern Africa referred in the text.

engraving. One piece of ochre from Pinnacle Point Cave levels dated to 164 ka (Marean et al., 2007; Marean, 2010) has also been argued to have been decorated with a chevron pattern (Watts, 2010).

Dendritic and convergent line motifs have been recovered from 100 ka contexts at Pinnacle Point in the Western Cape (Watts, 2009), and parallel linear engravings are reported from an undated MSA context at Bushman Rock Shelter in Mpumalanga Province (Watts, 1998). A cross-hatched pattern is engraved on a small ochre slab from Klein Kliphuis in the Western Cape (Mackay and Welz, 2008), and an engraved stone fragment recovered by Sydow in 1963 at a site containing only MSA lithics near Palmenhorst and Rossing in the Swakop Valley, Namibia (Wendt, 1975), also exhibits a cross-hatched pattern. Engraved patterns also appear on an ochre fragment recovered near the Cape Hangklip Rock Shelter (Minichillo 2005), and at Apollo II in southern Namibia (Vogelsang et al., 2010). Parallel lines engraved on bone fragments are found at Klasies River (d'Errico and Henshilwood, 2007) and Sibudu Cave (Cain, 1996). The most conspicuous collections of engraved items comprise the engraved ochres from Blombos Cave and engraved ostrich eggshell fragments from Diepkloof Rock Shelter in the Western Cape Province of South Africa. At Blombos Cave, fifteen pieces exhibit intentionally engraved abstract patterns from levels ranging from 100 ka to 75 ka (Henshilwood et al., 2002, 2009). At Diepkloof, some 270 ostrich eggshell fragments engraved with abstract geometric patterns has been recovered from Howieson's Poort levels dated to 60 ka (Texier et al., 2010).

Numerous engravings are reported from Acheulean and Mousterian sites in Europe and the Near East. A number of purported engravings on bone have been shown to be natural. This is the case with the Pech-de-l'Aze II rib and objects from Cueva Morin, Stranska Skala, Schulen, and Molodova IV (d'Errico and Villa, 1997; Nowell and d'Errico, 2007). Other objects appear to be engraved, but require closer analysis to verify these hypotheses, ascertain the antiquity of the marks, and evaluate the degree of 'deliberateness' behind them. Cases in point for the Lower Palaeolithic are the sequentially notched long bone shaft fragments from the Lower Pleistocene site of Kozarnika (Guadelli and Guadelli, 2004) and a mammoth shaft fragment from Bilzingsleben which exhibits a 'fan-like' engraved motif (Mania and Mania, 1988; Behm-Blancke, 1983; Steguweit, 1999). Among the objects found at Mousterian sites, the Tata nummulite which has a cross formed by a line perpendicularly crossing a natural crack (Vértes, 1964; Marshack, 1976), sequential incisions from Suard (Crémades, 1996), Saint Anne I (Raynal and Seguy, 1986), Vaufray (Vicent, 1988), Oldisleben 1 (Günther, 1994), Le Moustier (Peyrony, 1930), Lartet (Debénath and Duport, 1971), Marillac (Duport, 1973), Le Petit Puymoyen, (Debénath and Duport, 1971), La Quina (Martin, 1910; Marshack, 1991), Cotencher (Dubois and Stehlin, 1933), La Ferrassie (Capitán and Peyrony, 1912; Bordes, 1969), L'Ermitage (Pradel and Pradel, 1954), Tagliente (Leonardi, 1988), Turské Mastale (Neustupny, 1948), Temnata (Crémades et al., 1995), Prolom II (Stepanchuk, 1993), Axlör (Barandiarán and García-Diez, 2007) and Vergisson IV (d'Errico et al., 2003; Soressi and d'Errico, 2007; Vandermeersch et al., 2008) are noteworthy. The only known examples from the Near East comprise a cortex of a flint flake engraved with a set of concentric lines from Quneitra (Goren-Inbar, 1990; Marshack, 1996; d'Errico et al., 2003) in a level dated to ca. 60 ka, and another cortex from Qafzeh Cave which has a set of parallel incisions and which derives from the same levels as the human burials (Hovers et al., 1997).

1.2. Archaeological context

The Klasies River archaeological site is located on the Tsitsikama coast in the Eastern Cape Province, South Africa (Fig. 1). The locality comprises five caves (labelled 1–5) forming three archaeological

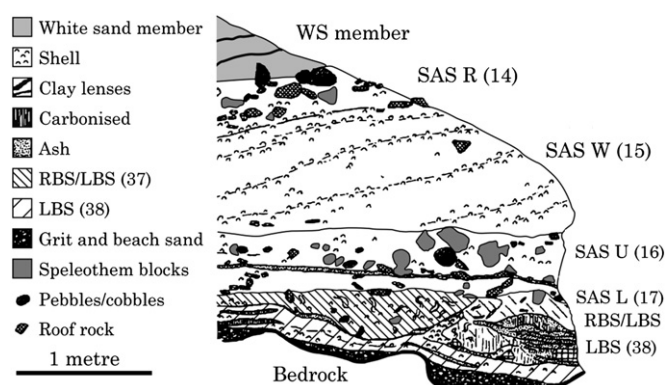


Fig. 2. The stratigraphy of Klasies River Cave 1 in the east face entrance area (redrawn from Rightmire and Deacon, 2001: Fig. 2).

sites along five kilometres of the coastline. The 'main site' is represented by Caves 1 and 2 and consists of a single depository bounded by a 40 m high cliff face. In addition to Caves 1 and 2 the cliff also holds two shelters, Cave 1 and 2 and three overhangs, numbered 1A, 1B and 2. A 20 m deep sequence of well-stratified archaeological deposits accumulated within and against these caves and overhangs. These accrued as a large cone which eventually blocked the opening of even the uppermost Cave 2. Overlying the cliffs is a Plio-Pleistocene calcareous sand dune which has provided one of the sources of sediments to the main site. Water containing calcium carbonates from the overlying dune have percolated through fissures, buffering acid ground water and allowing the development of speleothems and the preservation of shell and bone.

Following comprehensive excavations by Singer and Wymer (1982) in 1967 and 1968, the site was investigated by Deacon after 1984 (Deacon, 1995; see Wurz, 1999 for a history for research). Finds were not routinely plotted and systematically recorded during the Singer and Wymer excavation, nor were features such as hearths documented. The strata were excavated in layers, following the depositional stratigraphy and were defined either on lithology or by arbitrary convenience. Deacon's research intended to clarify the site formation processes, establish a more precise stratigraphic and cultural succession, and promote collaboration with other scholars to better characterise key finds and refine the chronology

Table 1
The chronology of Klasies River Cave 1 sequence.

Layer (Singer & Wymer)	Layer (Deacon)	Cultural Attribution	Date (ka)	Method	Reference
13	WS	MSA IV	65	AAR	Bada and Deems, 1975
13	WS	MSA IV	70.7 ± 7.4	TL-OSL	Feathers, 2002
14	SASR	MSA II	85.2 ± 2.1	U/Th	Vogel, 2001
14	SASR	MSA II	94.6 ± 3.2	U/Th	Vogel, 2001
14	SASR	MSA II	100.8 ± 7.5	U/Th	Vogel, 2001
15	SASW	MSA II	70.9 ± 5.1	TL-OSL	Feathers, 2002
15	SAS	MSA II	OIS 5c/5a	OIS	Shackleton, 1982
15	SAS	MSA II	OIS 5c	OIS	Deacon et al., 1988
16	SASU	MSA II	89	AAR	Bada and Deems, 1975
17	SASL	MSA II	88–93 ka	ESR	Grün et al., 1990
37	RBS	MSA I	90	AAR	Bada and Deems, 1975
38	LBS	MSA I	106.8 ± 12.6	TL-OSL	Feathers, 2002
38	LBS	MSA I	110	AAR	Bada and Deems, 1975
40	LBS	MSA I	108.6 ± 3.4	U/Th	Vogel, 2001

Table 2

Ochre pieces ochre recovered from the MSA levels of Klasies River Cave 1 (data from Wurz, 2000).

Context	Singer and Wymer (1982)	Deacon (1995)	Total
MSA IV	3	0	3
MSA III	25	33	58
HP	144	47	191
MSA II	36	10	46
MSA I	14	2	16
Total	222	92	314

of the stratigraphic sequence (Deacon and Geleijnse, 1988; Deacon, 1989, 1992, 1995, 2001; Grün et al., 1990; Wurz, 1997, 1999, 2000, 2002; Grine et al., 1998; Klein, 2000, 2001; Rightmire and Deacon, 2001; Feathers, 2002; Tribolo et al., 2005; Valladas et al., 2005; Jacobs et al., 2008).

The cultural stratigraphy defined by Singer and Wymer (1982) comprise four MSA (I, II, III and IV) divisions and a Howieson's Poort phase, sandwiched between the MSA II and the MSA III (Fig. 2). The objects described in this study derive from Layer 14 in Cave 1. According to Singer and Wymer, the stratigraphic sequence of this cave contains, from bottom to top, MSA I Layers 40, 38 and 37, MSA II Layers 17–14 and, following a stratigraphic hiatus, MSA IV Layer 13. Another hiatus, marked by a speleothem, is identified between Layer 13 and the uppermost LSA Layers 1–12. Stratigraphic correlation with the Cave 1A sequence indicates that the MSA I layers of Cave 1 represent the lowermost MSA I cultural horizons of the 'main site' stratigraphic sequence. The Singer and Wymer Layers 17–14 were renamed SASL, SASU, SASW and SASR by Deacon (Deacon and Geleijnse, 1988: 9).

The MSA levels of Klasies River Cave 1 have been dated using several methods (Bada and Deems, 1975; Shackleton, 1982; Vogel, 2001; Feathers, 2002). Table 1 summarises available radiometric ages for the Cave 1 sequence. Given their large standard deviations, the ages for the MSA II strata do not vary significantly and range between 100 ka and 70.9 ± 5.1 ka (see Wurz, 2002: 1003). Dates obtained for Level 14, from which the materials described in this paper derive, range from 100.8 ± 7.5 ka to 85.2 ± 2.1 ka (Vogel, 2001).

There are some problems with the interpretation of the archaeological stratigraphy of Cave 1 (see Wurz, 2002). From an examination of the published section drawings by Singer and Wymer (1982: Fig. 3.2), it appears that Layer 14 is not a coherent stratigraphic unit. The drawing shows Layer 14 as both overlying and underlying Layer 15, and also as a lateral equivalent of Layer 17 in some areas (Wurz, 2000: 9; Deacon, 2008: 145). Layers 16 and 17 are the primary human occupation horizons, and from Layer 15 upwards the deposits are clearly slanted in profile. The precise stratigraphic provenance of materials assigned to these layers may therefore be uncertain. This also relates to the human remains recovered from Cave 1. Layers 14–15 yielded numerous fragmentary human remains representing more than 10 individuals bearing both modern and archaic morphological features (Grün et al., 1990; Rightmire and Deacon, 1991; Deacon, 1992; Lam et al., 1996; Klein, 2001). Some remains also represent individuals that appear to have been dismembered, either as a result of cannibalism (Deacon, 1993, 2008; Deacon and Wurz, 2001) or the post-mortem 'ritualised' treatment of the dead (see White, 1986; Clark et al., 2003; White et al., 2003).

Pieces of red pigmentary material, generally termed 'ochre', are present throughout the Cave 1 sequence and occur as ochre

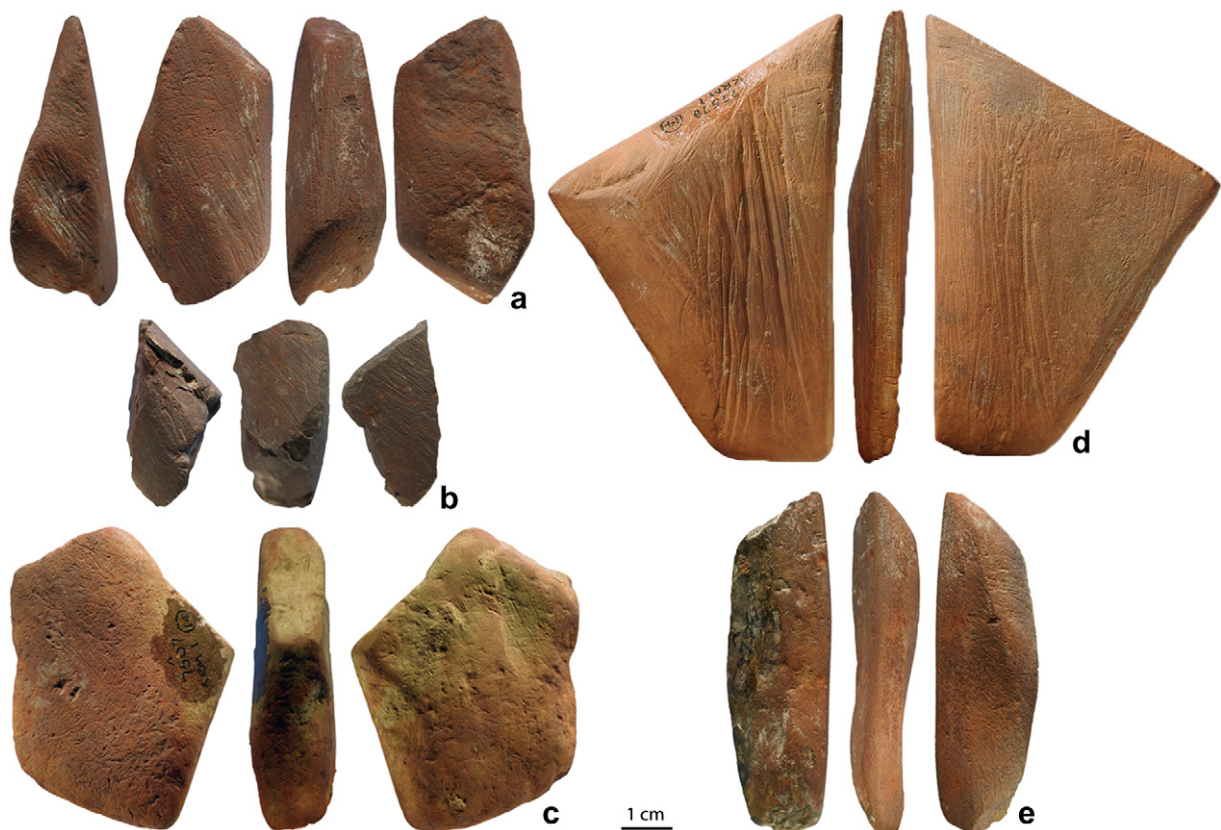


Fig. 3. Ochre pieces from Klasies River Cave 1, Layer 14, bearing traces of modification resulting from grinding and scraping: a) KRM 2; b) KRM 3; c) KRM 12; d) KRM 10; e) KRM 11.

'crayons', amorphous pieces larger than 4 cm², and very small fragments (Wurz, 2000: 110). Table 2 provides an indication of the quantities of ochre recovered from Cave 1. Twenty-three of the 92 pieces excavated by Deacon exhibit traces of modification, and several of these are shaped like 'crayons'. The nature of the pigmentary materials, their geological origin and the techniques by which they were processed have not been attended to in detail.

2. Material and methods

The material analysed in this study is curated at the Iziko-South African Museum in Cape Town. Singer and Wymer mention the discovery of 36 ochre pieces in the MSA II layers. Only 13 of these were available for analyses (Fig. 3). Each piece was examined with a Leica S8 APO stereomicroscope to identify anthropogenic traces and natural features. The specimen bearing possible engravings, here labelled KRM 13, was photographed with a Nikon Coolpix 990 digital camera. The identification of grinding and scraping traces and of deliberately incised lines is

based on criteria obtained from experimental research (d'Errico and Nowell, 2000; Soressi and d'Errico, 2007; d'Errico, 2008; Hodgskiss, 2010), examinations of engravings on stone and bone surfaces (d'Errico, 1995, 1996; Rifkin, *in press*), and by comparison with published engraved pieces from Blombos Cave (Henshilwood et al., 2002, 2009). Digitised images were imported into Adobe Illustrator and the modified areas traced. The chronology of the engravings and scraping marks, the type of engraving implement involved, the direction of the lines and the identification of lines produced in a single session by the same tool was established on the basis of experimental criteria (d'Errico, 1995).

Non-invasive analyses were performed on the Klasies River ochres recovered from Layer 14. We analysed the elemental composition of each fragment by X-ray fluorescence (XRF). Visible spectroscopy was used to obtain $L^*a^*b^*$ values. XRF analysis presents a qualitative approach to the identification of chemical elements (starting from Si) in analysed samples. Analyses with both techniques were completed only on the most even, uniform and cleanest surfaces of the objects to avoid conflicting and therefore

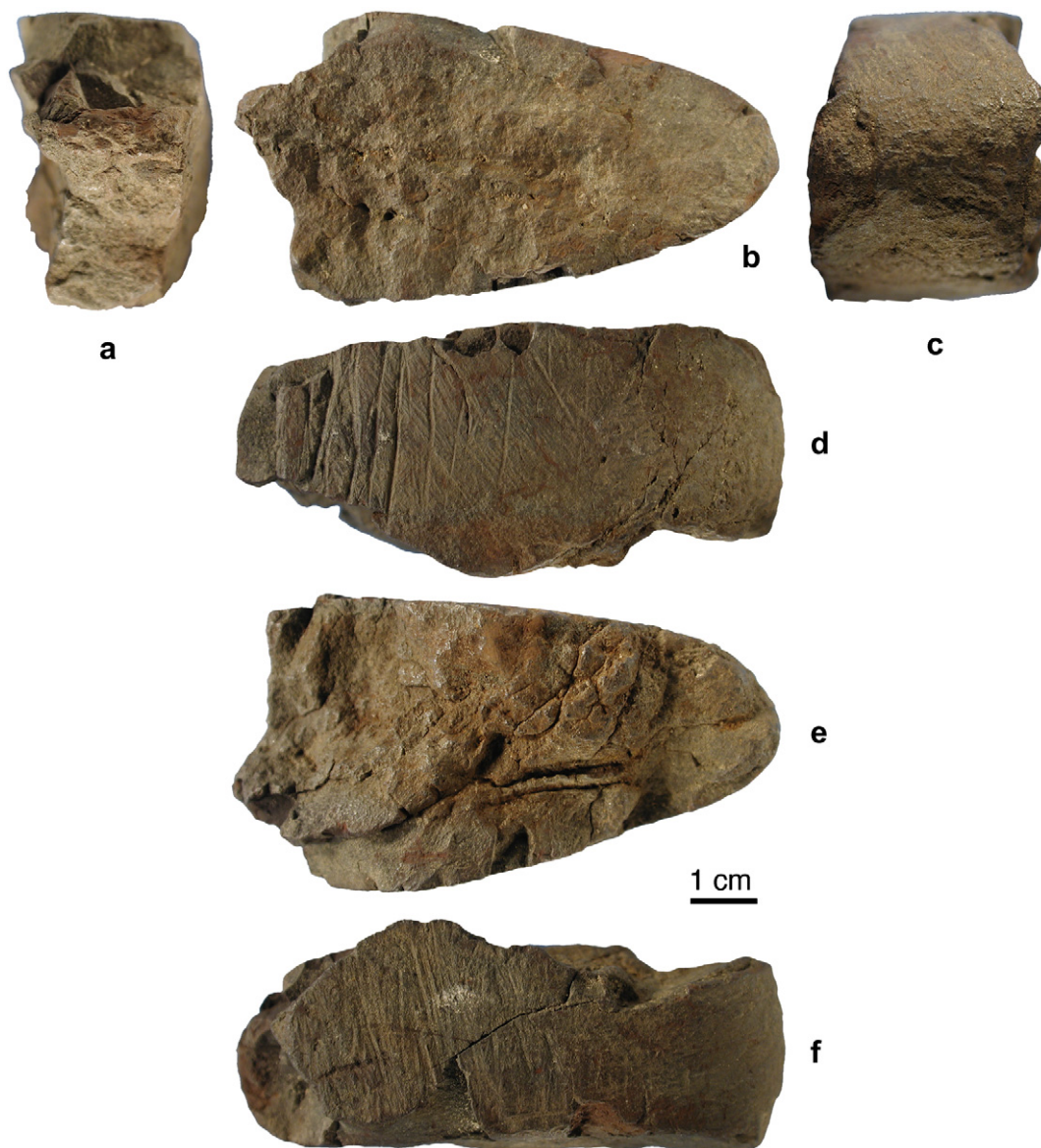


Fig. 4. The ground ochre fragment (KRM 13) which exhibits set of sub-parallel linear incisions on one face.

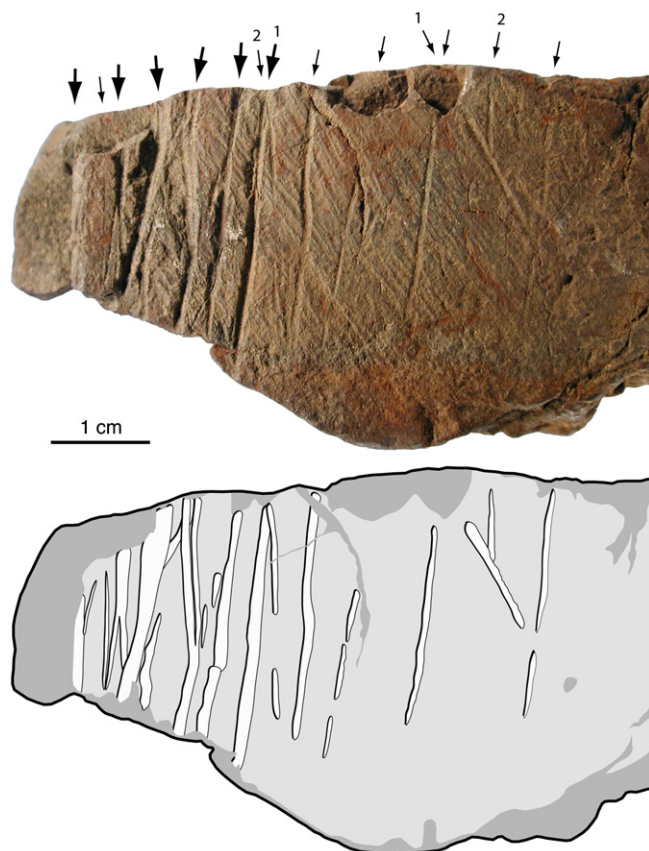


Fig. 5. Close-up view of the engraved area (top) and tracing of the engraved lines (bottom) on KRM 13. Incised lines are identified by black shadowed outlines filled with a white pattern, ground areas by a light grey pattern and breakages by a dark grey pattern. Small arrows indicate single stroke lines and thick arrows multiple stroke incisions. Figures indicate the chronology of the lines.

erroneous measurements. Although most of the specimens present a reasonably homogeneous surface, some do exhibit a stratified structure and a combination of shades. For this reason, measurements were taken from different zones of the sample to verify the repeatability and consistency of the results. The analysed surface areas typically covered approximately 0.8 cm in diameter for XRF and 0.5 cm for the visible spectroscopy analyses.

We used a mobile SPECTRO xSORT X-ray fluorescence spectrometer from Ametek, equipped with a silicon drift detector

(SDD) and a low power W X-ray tube with 40 kV as an excitation source. The spectrometer is internally calibrated by way of the automated measurement of the contents of its metal shutter, and controlled with a PDA. Measurements were acquired by using a positioning device consisting of a lead receptacle to which the spectrometer is fixed. The analysed object is positioned and analysed from underneath. Spectra acquisition times were set to 60 s and the acquired data processed with PyMca software to fit the spectra.

Visible spectroscopy was practised with an Avantes AvaSpec-2048 fibre optic spectrometer equipped with a 2048 pixel CCD detector set to operate in the retrodiffusion mode. This instrument is equipped with an optical fibre probe which is set close (2 mm) to the sample surface at an angle of 2°. An AvaLight-HAL was used as an illumination source. The probe contains several illuminating fibres including one for the collection of diffused light. The equipment is calibrated with a Halon D65 white reference sample in the same lighting conditions as for the archaeological samples. Both the absorbance spectra and the colour parameters (L^* , a^* , b^*) are subsequently obtained by Avasoft 7.5 software. Principal component analysis of $L^*a^*b^*$ measurements and XRF results was obtained using PAST software.

3. Results

3.1. Description of the engraved piece

The engraving occurs on a parallelepipedal fragment of an originally large flat pebble (Fig. 4). The irregular morphology of the three breakage surfaces, revealing the presence of cracks and voids in the matrix, suggests that the anisotropic nature of the material may have favoured the enlargement of the cracks that ultimately resulted in the fracturing of the object. Accidental or deliberate heating could have played a role in the process. What remains of one of the original surfaces (Fig. 4f) is covered by parallel overlapping striations produced by scraping the surface with a lithic implement or by rubbing it against a hard and very coarse abrasive surface. On the edge of the pebble these traces are partially erased by finer striations produced by grinding, perpendicularly crossing those produced by scraping and rubbing.

The opposite aspect (see Fig. 4d and Fig. 5) exhibits numerous parallel elongated striations, which obliquely cross the preserved outer surface of the pebble. These most probably result from the rubbing of the object against a fine grained stone surface. The elevated ridges between the grooves appear to have been

Table 3

Selected results of the X-ray fluorescence analysis and colour measurements of pigment pieces from Klasier River Cave I, layer 14. Arbitrary units presented correspond to the obtained counts of each element normalized with Ar counts.

Sample				X-ray fluorescence (arbitrary units)														CIE $L^*a^*b^*$ values		
No.	Layer	Quad.	Inv. No.	P–K	K–K	Ca–K	V–K	Cr–K	Mn–K	Fe–K	Co–K	Ni–K	Cu–K	Zn–K	As–K	Sr–K	Ba–K	L	a	b
1	14	A		30	289	3332	21	179	1010	237,827	951	20	191	263	35	192	121	46.18	16.93	13.7
2	14 K–L	E9-1-1	1293	7	375	605	76	200	3927	309,595	947	20	182	474	106	185	105	45.41	19.38	16.82
3	14	E8-4-1	8297	17	106	929	48	169	9975	359,601	936	14	124	436	63	186	86	40.28	6.29	3.83
4	14 D	E8-4-3		8	1065	110	46	122	106	93,915	636	30	253	176	43	181	170	60.67	15.49	14.7
5	14 D	E8-4-3	8235	14	939	126	43	118	102	89,590	633	19	240	183	45	155	153	53.81	12.91	13.19
6	14 H	E8-7-4		10	1295	175	40	112	215	112,636	678	4	185	160	43	107	145	51.44	11.8	10.1
7	14		1619	24	1569	658	73	134	106	56,332	564	84	340	377	66	192	220	68.14	10.65	11.22
8	14 K–L	E9-1-1		5	278	628	32	119	299	111,025	674	32	213	473	517	187	112	50.59	15.77	13.64
9	14 A	C1		5	150	37	12	92	47	40,735	392	34	199	107	43	58	86	50.02	22.79	19.32
10	14		27578	15	770	1076	74	174	172	173,957	865	9	191	300	37	240	115	65.11	18.1	18.12
11	14	E8-5-2	4795	16	672	2276	45	208	240	273,911	1141	19	225	310	60	487	129	49.5	17.76	16.31
12	14 B	E8-3-5	7507	13	263	323	47	158	2020	215,102	938	19	200	749	86	775	137	57.58	22.53	26.32
13	14 A	C1		51	481	4871	190	60	90260	115,661	5537	506	767	7229	454	2663	1203	41.55	3.14	12.52

smoothed and substantial amounts of finely ground pigment powder remain visible at the bottom of the grooves. A robust rounded lithic point was used to incise a sequence of a dozen or so straight and curvilinear sub-parallel lines on the object. Whereas incised lines were produced by the repeated application of the lithic point on the left side of the engraved surface, lines were produced by single strokes on the right. Multiple stroke lines are deeper and comprise, in two instances, adjacent grooves that converge into a single linear feature. In another instance, a single deep groove 'splits' into two narrower and shallower incised lines, the latter resulting from different directions taken by the tip of the implement as it emerged from the original deeper groove. The former and existing outlines of and junctions between multiple stroke lines allow the identification of the direction followed by the tool during the engraving process. This is indicated by arrows in Fig. 5.

Due the lack of clear intersections between lines, the exact chronology of the incisions is difficult to establish. In only two instances is it possible to identify the order of incision. This concerns two short lines, slightly oblique to the others, which appear to have been engraved by a single implement at a later stage.

3.2. Elemental analysis

Most pigment pieces from Layer 14 share an analogous elemental composition (Table 3 and Fig. 6), with a major occurrence of Fe, minor proportions of K, Ca, Mn, Cr, Sr and traces of P, V and Ni. In general, Fe appears to be positively correlated with Cr and Co, and Cu with Ba. KRM 7 (Inv. 1619) and KRM 9 exhibits the lowest concentrations of Fe. The engraved piece (KRM 13) differs from the other specimens in terms of markedly higher concentrations in Mn, Co, Cu, Zn, Sr, Ba and As. KRM 3 (Inv. 8297) is the only specimen with a consistent, though much lower, concentration of Mn.

The difference in composition between the engraved object (KRM 13) and the remainder of the analysed pieces is emphasised by the principal component analysis (PCA) of the elemental 'raw counts' (Fig. 7a). PCA plots of L^*a^*b colour measurements (Fig. 7b) display a scattered pattern with three outlier specimens. Whereas the engraved KRM 13 and the dark patinated KRM 3 (Inv. 8297) are separated from the other specimens on the one axis, KRM 7 (Inv. 1619), which is covered with white concretions, appears as isolated on the other axis.

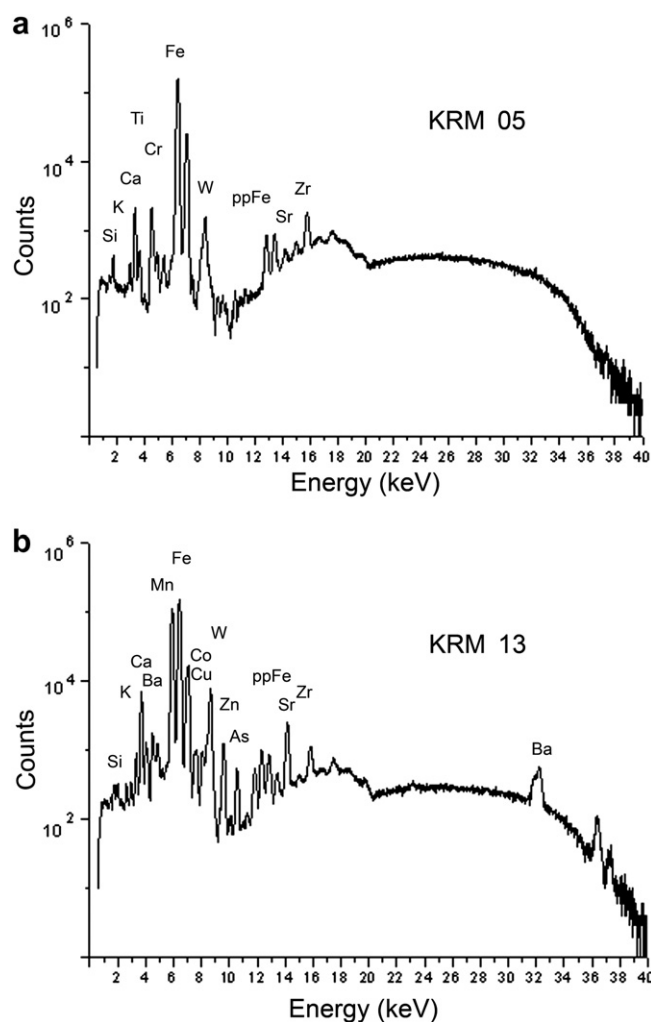


Fig. 6. X-ray fluorescence spectrum of the modified ochre piece KRM 5 from Klasies River Cave 1 Layer 14 (a), compared to that obtained from the engraved piece KRM 13 (b).

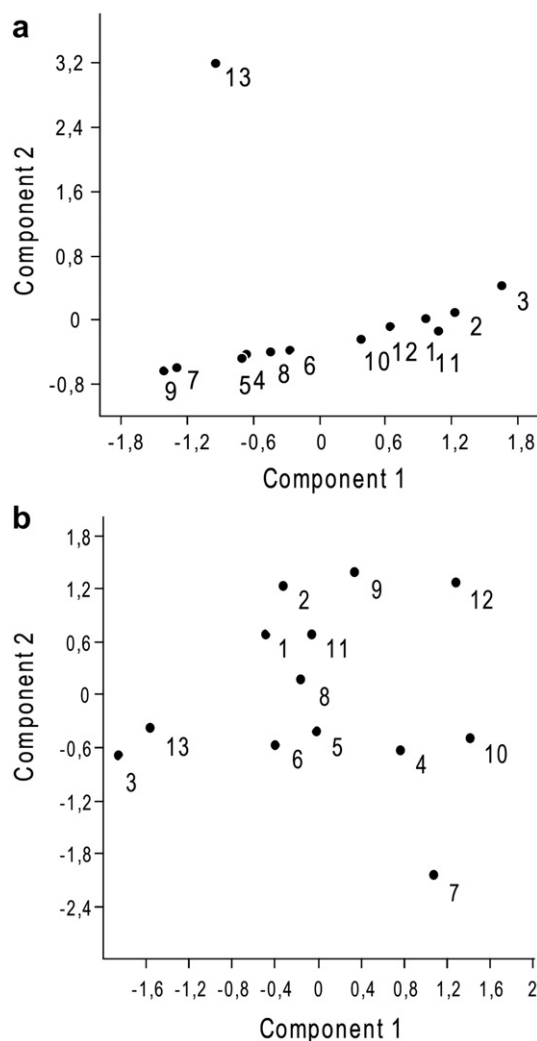


Fig. 7. Principal component analysis of the 22 elements identified by the XRF analysis (a) and L^*a^*b colour measurements (b) of the 13 analysed pigment pieces from Layer 14.

4. Discussion and conclusion

The engraved object analysed in this study represents only a fragment of an originally larger piece on which ground surfaces and engravings occurred. Prior to breakage the engraved 'design' probably occupied a much larger surface area and may have featured a greater degree of complexity that we are now unable to grasp. Although fragmentation inevitably diminishes any chances of inferring scope from actions, a number of clues may facilitate discussion concerning both the possible utilitarian and symbolic purposes of these markings and, more in general, the significance of these incised lines for the Klasies River people.

Explanations proposed to support either symbolic or functional interpretations of early markings are variable in nature and heuristic power (see Bednarik, 1995, 2006; Lorblanchet, 1999; d'Errico et al., 2001; Henshilwood and d'Errico, 2005; Zilhão, 2007; d'Errico, 2009; Henshilwood et al., 2009; Henshilwood and d'Errico, 2011; d'Errico and Vanhaeren, 2008). Most authors allude to: 1) consistencies in the media on which engravings are made; 2) the preparation of surfaces prior to engraving; 3) the degree of neuro-motor control inferred from the analysis of markings; 4) the type of implement used; 5) the use of the same tool for the production of the entire pattern; 6) changes of tools indicating a possible accumulation in time and a 'notational' purpose; 7) the absence of obvious functional reasons behind the production of engravings; 8) the consistent organisation of the sequence of motions articulating the marking action; 9) the perceived regularity or symmetry of the resulting pattern; 10) the presence of engravings on several objects and types of materials rather than on a single object or material; 11) repetition of the same motif on more than one object; 12) variations within what is perceived as the same basic motif; 13) the production of various different motifs; 14) temporal continuity in the production of engravings on the same media; 15) persistence or change in the production of motifs over time; 16) the production of similar engravings on the same media at sites and 17) similarities in the media used for engravings across archaeological and historically known human cultures.

KRM 13 is the only piece, among 13 ochre pieces recovered from the MSA II layers of Klasies River Cave 1, to exhibit deliberately engraved individual lines. The only other piece, KRM 10 (Fig. 3d), that bears a slight degree of similarity with KRM 13, displays several deep sub-parallel intersecting grooves on both aspects. These grooves were however produced by scraping the surface with a robust point that repeatedly 'skipped' out of the primary groove during the scraping process. Considering the motion, the depth of the grooves and their degree of random intersection, they appear instead to be the consequence of an action intended to extract pigment powder rather than the deliberate marking of the surface. Another piece (Dayet pers. com.) that we were not able to examine apparently exhibits a single deep groove. The other fragments that we have examined are unmodified, rubbed or scraped with the apparent aim of extracting pigment powder, or they are shaped by rubbing against a coarse grindstone to produce pointed crayon-like specimens (Fig. 3d and e). These may have been used to create either red lines or 'spots' on soft pliable material such as human skin or tanned animal hide. KRM 13 clearly does not fit any of these categories. The raw material is much darker, heavier and has a dissimilar elemental composition compared to the remainder of the analysed assemblage. This indicates that the piece either derives from a different geological source or, considering the degree of consistency in the elemental composition of the other specimens, represents the deliberate selection of a geochemically distinct type of object intended for a similarly 'exceptional' purpose. In this respect, it is worth noting that most of the unambiguous examples of abstract engraved ochres from Blombos

Cave (Henshilwood et al., 2009) are produced on comparatively darker and harder pieces of ochre. An essential question is how MSA people would have perceived such differences in colour. We know that genes, education, cultural affiliation and language affect colour categorisation in modern humans (Davidoff et al., 1999; Roberson et al., 2005; Lumsden, 1985). Bleek and Lloyd (1911: 359) recorded that the /Xam San used different terms for different varieties of iron oxide rich pigments and possessed the visual ability of easily discriminating them.

The results presented here suggest that spectral colour characterisation and non-invasive elemental analysis of archaeological ochre, with and without engravings, represent a viable research strategy to establish whether 'special' categories of ochre were selected for engraving purposes during the MSA. When applied to numerous MSA pigment collections, spectral colour measurements may identify patterns that could reveal colour discrimination preferences during the MSA.

In spite of the observed changes in engraving techniques present on ochre specimens from Blombos Cave, analyses suggest a remarkable continuity in engraving practices over a period of 25 ka (Henshilwood et al., 2009). This 'engraving tradition' is not limited to Blombos Cave and, in addition to the Klasies River specimen described here, also include engraved ochres from Klein Kliphuis (Mackay and Welz, 2008) and Pinnacle Point (Watts, 2010). Sufficient amounts of red ochre powder must have been produced prior to engraving the object when it was rubbed onto an abrasive grindstone surface. Even if we acknowledge that engravings were, before the breakage of the pebble, present on a much more extensive surface area, the shallow nature of the engraved lines contradicts the idea that a serviceable amount of pigment could have been acquired from the act of engraving the surface. Although the various lines of evidence mentioned above point toward a deliberate selection of the blank on which the engraving was made, the way in which the lines are juxtaposed and superimposed do not suggest much organisational consistency such as the presence of equispacing and symmetry. This implies that the incisions may not in fact have been produced to create and convey a distinct design or 'message' to an audience that could visually distinguish it. By the same token, the preserved lines do not fit the interpretation of a notational system. Individual marks cannot be visually identified as discrete signs, which preclude the use of a single mark to store and recover information (d'Errico, 1995, 2001). There is also no evidence of changes in tool type, which may have suggested the production of a notation based on the accumulation of information over time.

The ambiguities identified here are predictable as the implications of many archaeological discoveries for major debates concerning the emergence of 'modernity' are often unclear. Engravings are afforded an important role in these debates. Yet, not all engraved patterns are likely to have operated in the same way. Some may reflect conventional designs with broad meanings; others might not. The sub-parallel lines on KRM 13 or the incised flat slab from Klein Kliphuis might, for instance, be seen to convey limited or 'localized' symbolic information, while the more elaborate cross-hatched pieces from Blombos or Diepkloof may have had more conventionalized meanings. Although the purpose of marking this object remains uncertain, its detailed analysis adds relevant information to previously published occurrences of MSA engraved objects and contributes to clarify their distribution through time and space.

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