Emergence of Modern Human Behavior: Middle Stone Age Engravings from South Africa
Christopher S. Henshilwood et al.
Science 295, 1278 (2002);
DOI: 10.1126/science.1067575

This copy is for your personal, non-commercial use only.

If you wish to distribute this article to others, you can order high-quality copies for your colleagues, clients, or customers by clicking here.

Permission to republish or repurpose articles or portions of articles can be obtained by following the guidelines here.

The following resources related to this article are available online at www.sciencemag.org (this information is current as of January 3, 2013):

Updated information and services, including high-resolution figures, can be found in the online version of this article at: http://www.sciencemag.org/content/295/5558/1278.full.html

Supporting Online Material can be found at: http://www.sciencemag.org/content/suppl/2002/02/13/1067575.DC1.html

A list of selected additional articles on the Science Web sites related to this article can be found at: http://www.sciencemag.org/content/295/5558/1278.full.html#related

This article cites 14 articles, 1 of which can be accessed free: http://www.sciencemag.org/content/295/5558/1278.full.html#ref-list-1

This article has been cited by 141 article(s) on the ISI Web of Science

This article has been cited by 17 articles hosted by HighWire Press; see: http://www.sciencemag.org/content/295/5558/1278.full.html#related-urls

This article appears in the following subject collections:
Anthropology
http://www.sciencemag.org/cgi/collection/anthro
Emergence of Modern Human Behavior: Middle Stone Age Engravings from South Africa

Christopher S. Henshilwood, 1,2,3* Francesco d’Errico, 4 Royden Yates, 1 Zenobia Jacobs, 5 Chantal Tribolo, 6 Geoff A. T. Duller, 5 Norbert Mercier, 6 Judith C. Sealy, 7 Helene Valladas, 6 Ian Watts, 1,7 Ann G. Wintle 5

In the Eurasian Upper Paleolithic after about 35,000 years ago, abstract or depictorial images provide evidence for cognitive abilities considered integral to modern human behavior. Here we report on two abstract representations engraved on pieces of red ochre recovered from the Middle Stone Age layers at Blombos Cave in South Africa. A mean date of 77,000 years was obtained for the layers containing the engraved ochres by thermoluminescence dating of burnt lithics, and the stratigraphic integrity was confirmed by an optically stimulated luminescence age of 70,000 years on an overlying dune. These engravings support the emergence of modern human behavior in Africa at least 35,000 years before the start of the Upper Paleolithic.

Archaeological evidence associated with modern cognitive abilities provides important insights into when and where modern human behavior emerged (1). Two models for the origins of modern human behavior are current: (i) a late and rapid appearance at ~40 to 50 thousand years ago (ka) associated with the European Upper Paleolithic and the Later Stone Age (LSA) of sub-Saharan Africa (2, 3) or (ii) an earlier and more gradual evolution rooted in the African Middle Stone Age (MSA; ~250 to 40 ka) (4, 5). Evidence for modern behavior before 40 ka is relatively rare and often ambiguous (2, 6). However, in sub-Saharan Africa, archaeological evidence for changes in technology, economy, and social organization and the emergence of symbolism in the MSA may support the second model (4, 5, 7–9). Examples of these changes include standardized formal lithic tools (3, 8, 10), shaped bone implements (5, 7, 9, 11), innovative subsistence strategies such as fishing and shellfishing (10–12), and the systematic use of red ochre (10, 13).

Utilized ochre is found in almost all Stone Age occupations in southern Africa that are younger than 100 ka (13). The ochre may have served only utilitarian functions (e.g., skin protection or hide tanning) (3) or may have been used symbolically as pigment (4, 10, 13). Evidence for the latter is a persistent use of ochre with saturated red hues to produce finely honed crayon or pencil forms (10, 13). No ochre pieces or other artifacts older than ~40 ka provide evidence for abstract or depictorial images, which would indicate modern human behavior (2, 14, 15).

We have recovered two pieces of engraved ochre from the MSA layers at Blombos Cave, South Africa. Situated on the southern Cape shore of the Indian Ocean, the cave is 35 m above sea level. A 5- to 60-cm layer of aeolian sand contains no archaeological artifacts (BBC Hiatus; Fig. 1) separates the LSA from the MSA occupation layers. The MSA is divided into three substages (9, 10) (Fig. 1): (i) an upper series of occupational deposits, BBC M1, typified by abundant bifacially flaked, lanceolate-shaped stone points (Still Bay points) (10); (ii) a middle series, BBC M2, containing fewer Still Bay points but relatively abundant in deliberately shaped bone awls and points that were probably hafted (9, 11); and (iii) a lower BBC M3 series with few retouched pieces but with blades and flakes typical of the Mossel Bay/MSA 2b subphase (10). Associated, well-preserved faunal remains from all layers indicate that subsistence strategies were wide ranging and include terrestrial and marine mammals, shellfish, fish, and reptiles (10, 11).

More than 8000 pieces of ochre, many bearing signs of utilization, have been recovered from the MSA layers at Blombos Cave (10). Seven of nine pieces are potentially engraved and under study. We report here on the two unequivocally engraved pieces recovered in situ from layer CC, square E6a and layer CD, square H6a (Fig. 1) (10) during excavations in 1999 and 2000, respectively. The engraved ochre piece from layer CC (SAM-AA 8937) was located adjacent to a small hearth, and that from layer CD (SAM-AA 8938) was surrounded by a number of small, basin-shaped hearths. Both specimens were located in a matrix of undisturbed and consolidated mixed ash and sand. There is no indication of perturbation in either the overlying 15 to 20 cm of MSA deposits or in the blanketing aeolian dune sand and no sign of intrusion of younger LSA materials (9, 10). All lithic artifacts in the ochre-bearing and overlying MSA layers are typologically MSA (9, 10).

On the 8937 piece (Fig. 2, A and B), both the flat surfaces and one edge are modified by scraping and grinding. The edge has two ground facets, and the larger of these bears a cross-hatched engraved design. The cross hatching consists of two sets of six and eight lines partly interrupted by a longer line. The engraving on 8938 (Fig. 2, C and D) consists of a row of cross hatching, bounded top and bottom by parallel lines and divided through the middle by a third parallel line that divides...
the lozenge shapes into triangles. Some of the lines are well-defined single incisions; others have parallel tracks along part or all of their lengths. Much of the parallel tracking may have resulted from a change in position of the engraving tool causing simultaneous scoring from more than one projection. The midline comprises three marking events. Examination of the intersections of the cross-hatched lines indicates that they were not executed as consecutive cross hatchings but that lines were made in first one direction and then another; the horizontal lines overlie the cross hatching. The preparation by grinding of the engraved surface, situation of the engraving on this prepared face, engraving technique, and final design are similar for both pieces, indicating a deliberate sequence of choices. Although the engraving on the 8937 ochre has fewer markings than the 8938 piece, it indicates that 8938 is not unique; the engraving on 8938 can be considered a complex geometric motif as the cross-hatched lines are bisected and framed by horizontals.

Assessing the significance of these engravings demands an accurate determination of their age (16). The engraved ochres were found within layers containing bifacially flaked stone points; in the South African MSA, these stone point types occur only within or below Howiesons Poort horizons (10) dated to ~65 to 70 ka (17). This association suggests that the engravings are older than 65 ka. To independently confirm and refine this time frame, we applied two luminescence-based dating methods to the Blombos Cave layers. Thermoluminescence (TL) dates were obtained for five burnt lithic samples from the MSA phase BBC M1 (Fig. 1) (18, 19). The mean age for the lithic samples is 77 ± 6 ka (20). To confirm the stratigraphic integrity, we applied optically stimulated luminescence (OSL) dating to the aeolian dune (BBC Hiatus) separating the LSA and MSA layers (Fig. 1). Multiple grain measurements with a single aliquot regenerative (SAR) procedure (21) yielded a depositional age of 69 ± 5 ka (22). Single-grain SAR measurements (23) yielded consistent ages (24), indicating that the aggregate samples were not contaminated by grains of different ages (25). Because only 1.8% of the 1892 grains analyzed yielded reproducible growth curves, a more representative approach was also used (26), combining OSL signals from grains to generate synthetic aliquots. These provide a depositional age of 70 ± 5 ka (20) and confirm the antiquity of the engraved ochres.

Abstract images similar to the Blombos Cave engravings occur at Upper Paleolithic sites in Eurasia (15). The Blombos Cave motifs suggest arbitrary conventions unrelated to reality-based cognition, as is the case in the Upper Paleolithic (15), and they may have been constructed with symbolic intent, the meaning of which is now unknown. These finds demonstrate that ochre use in the MSA was not exclusively utilitarian and, arguably, the transmission and sharing of the meaning of the engravings relied on fully syntactical language (5, 27).

Genetic and fossil evidence suggests that humans were anatomically near modern in Africa before 100 ka (5, 28, 29). Key questions are whether anatomical and behavioral modernity developed in tandem (5) and what criteria archaeologists should use to identify modern behavior (2, 4, 5). For the latter, there is agreement on one criterion—archaeological evidence of abstract or depictional images indicates modern human behavior (2, 14, 15). The Blombos Cave engravings are intentional images. In the light of this evidence, it seems that, at least in southern Africa, Homo sapiens was behaviorally modern about 77,000 years ago.

References and Notes
1. The term “modern human behavior” as used here has no chronological implication and means the thoughts and actions underwritten by minds equivalent to those of Homo sapiens today. Key among these is the use of symbols.

Fig. 2. Engraved ochres from Blombos Cave. (A) SAM-AA 8937 is a flat piece of shale-like ochre that grades into silt on the reverse side: weight = 39.2 g; maximum length = 53.6 mm; breadth = 42.6 mm; depth = 11.7 mm; streak color notation 3060 Y65R (33). (B) Tracing of lines verified as engraved by study under magnification [scale bar, 5 mm]. (C) SAM-AA 8938 is a rectangular slab of ochreous shale: weight = 116.6 g; maximum length = 75.8 mm; breadth = 34.8 mm; depth = 24.7 mm; streak color notation 4050 Y60R (30). Oblique lighting of specimen accentuates both engraved lines and irregularities of the surface, some created by grinding before the engraving and others by the process of engraving. (D) Tracing of lines verified as engraved by study under magnification, superimposed on flat-bed scan of engraved surface [scale bar, 10 mm].
Marine Biodiversity Hotspots and Conservation Priorities for Tropical Reefs

Callum M. Roberts, Colin J. McLean, John E. N. Veron, Julie P. Hawkins, Gerald R. Allen, Don E. McAllister, Cristina G. Mittermeier, Frederick W. Schueler, Mark Spalding, Fred Wells, Carly Vynne, Timothy B. Wernery

Coral reefs are the most biologically diverse of shallow water marine ecosystems but are being degraded worldwide by human activities and climate warming. Analyses of the geographic ranges of 3235 species of reef fish, corals, snails, and lobsters revealed that between 7.2% and 53.6% of each taxon have highly restricted ranges, rendering them vulnerable to extinction. Restricted-range species are clustered into centers of endemism, like those described for terrestrial taxa. The 10 richest centers of endemism cover 15.8% of the world’s coral reefs (0.012% of the oceans) but include between 44.8 and 54.2% of the restricted-range species. Many occur in regions where reefs are being severely affected by people, potentially leading to numerous extinctions. Threatened centers of endemism are major biodiversity hotspots, and conservation efforts targeted toward them could help avert the loss of tropical reef biodiversity.