



The MSA sequence of Diepkloof and the history of southern African Late Pleistocene populations



Guillaume Porraz^{a,*}, John E. Parkington^b, Jean-Philippe Rigaud^c, Christopher E. Miller^d, Cedric Poggenpoel^b, Chantal Tribolo^e, Will Archer^{f,b}, Caroline R. Cartwright^g, Armelle Charrié-Duhaut^h, Laure Dayetⁱ, Marina Igreja^{j,k}, Norbert Mercier^e, Patrick Schmidt^l, Christine Verna^m, Pierre-Jean Texier^c

^a CNRS, UMR 7041-ArScAn-AnTET, MAE, Université de Paris X, Nanterre 92023, France

^b Department of Archaeology, University of Cape Town, South Africa

^c CNRS, UMR 5199-PACEA, Université de Bordeaux 1, Talence, France

^d Institute for Archaeological Science, University of Tübingen, Tübingen, Germany

^e CNRS, UMR 5060, IRAMAT-CRP2A, Université de Bordeaux, Pessac, France

^f Human Evolution Department, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

^g Scientific Research Laboratory, British Museum, London, United Kingdom

^h CNRS, UMR 7177, CNRS, Université de Strasbourg, Strasbourg, France

ⁱ UMR 5060-IRAMAT, Université Bordeaux 3, Pessac, France

^j LAMPEA, UMR 6636, Université d'Aix-en-Provence, France

^k UNIARQ, Faculty of Humanities, Lisbon, Portugal

^l Muséum National d'Histoire Naturelle, UMR 7194, Paris, France

^m CNRS, UPR 2147, Paris, France

ARTICLE INFO

Article history:

Received 14 November 2012

Received in revised form

22 February 2013

Accepted 23 February 2013

Keywords:

Anatomically Modern Humans

Southern Africa

Late Pleistocene

Innovations

Regionalization

Still Bay

Howiesons Poort

Modern hunter–gatherers

ABSTRACT

This paper presents the first multidisciplinary synthesis of the Middle Stone Age sequence of Diepkloof Rock Shelter (South Africa). We explore the main cultural changes that characterized southern African hunter–gatherer societies from OIS 5 to the beginning of OIS 3. We discuss the tempo of these changes, test the current interpretative hypotheses and explore an empirical model to explain the early appearance of symbolic marking within the Pleistocene hunter–gatherer societies of southern Africa.

Major technological and cultural innovations appear in one form or another during OIS 5 in southern Africa, a period characterized by the coexistence of multiple, distinct technological traditions. We argue that the formation of regional identities in southern Africa would have favoured and increased cultural interactions between groups at a local scale, providing a favourable context for the development and diffusion of innovations. In the West Coast of South Africa, the main cultural innovations appear within the Howiesons Poort. It is within this context that we postulate a change in regional networks and population dynamics, leading to the success of the HP technology across southern Africa. The southern African data suggest that the history of modern humans has been characterized by multiple and independent evolutionary trajectories and that different paths and scenarios existed towards the adoption of 'modern' hunter–gatherer lifestyles.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction and background

Current models postulate that Anatomically Modern Humans (AMH) spread from Africa ca. 70 ka ago and successively either assimilated or replaced Eurasian populations (Bräuer, 1989; Aiello, 1993; Lahr and Foley, 1994, 1998; Bräuer and Stringer, 1997; Stringer, 2001; Gunz et al., 2009; for alternative views: Wolpoff,

1989; Frayer et al., 1993; Wolpoff et al., 2000). Related archaeological models suggest that a set of novel behaviours gave these populations a relative advantage during this process of dispersal and adaptation to unfamiliar environments (e.g. Mellars and Stringer, 1989). These models are largely based on the European archaeological record, which suggests a correlation between the appearance of the Upper Palaeolithic tradition and the diffusion of AMH beyond the Near East (Mellars, 2006).

Current debates question the mechanisms that triggered the Upper Palaeolithic and the role that innovations played in the

* Corresponding author. Tel.: +33 1 46 69 26 55.

E-mail address: guillaume.porraz@mae.u-paris10.fr (G. Porraz).

success of AMHs. Scenarios proposed within these debates hypothesize different places, ages, tempos and reasons behind the onset of this new cultural system (McBrearty and Brooks, 2000; Henshilwood and Marean, 2003). Some (Klein, 1995) point to evidence that modern-like behaviours appeared suddenly around 50 ka ago and were related to cognitive changes in the human brain, whereas others (McBrearty and Brooks, 2000) argue for a gradual and cumulative acquisition of traits, already beginning in the Middle Pleistocene, that added up to create what we call behavioural modernity. At the same time, some colleagues have pointed out that these changes could have appeared independently among different groups, anatomically modern or not (d'Errico, 2003), and in different places (Conard, 2002, 2008).

In Africa, sophisticated technologies and symbolically mediated behaviours appear within the Middle Stone Age (MSA), a period that is associated with the development of regional and cultural identities (Clark, 1988; McBrearty and Brooks, 2000). Within the continent, the MSA of southern Africa has in particular gained increasing interest during the last two decades due to important archaeological discoveries. The early use of pressure flaking technique (Mourre et al., 2010), the control of fire to heat treat rocks (Brown et al., 2009; see Schmidt et al., 2013), the manufacture of hafting adhesive (Wadley et al., 2009; Charrié-Duhaut et al., 2013), the invention of arrow-head technology (Lombard and Phillipson, 2010; see Igreja and Porraz, 2013), the use of bone to make tools (Henshilwood and Sealy, 1997; Henshilwood et al., 2002b; Backwell et al., 2008), the regular transport of fine-grained rocks (Ambrose and Lorenz, 1990; Porraz et al., 2013), the increasing use of red ochre (Watts, 2002; Dayet et al., 2013), the piercing of shells to wear as beads (Henshilwood et al., 2004; d'Errico et al., 2008; Wadley, 2012) and the repetitive engraving of abstract designs (Henshilwood et al., 2002a,b; Mackay and Welz, 2008; Texier et al., 2010, 2013) are all “symptoms” that attest to a deep transformation of the socio-economic structures of the societies and to the complex cognitive abilities of the individuals. When all of these innovations are considered, the southern African societies of the MSA appear to have precociously experienced a cultural system similar to those of recent hunter–gatherer populations. These innovations appeared in one form or another around 100 ka ago (Henshilwood et al., 2009; d'Errico et al., 2012; Texier et al., 2013) and persisted until ca. 55 ka ago. The Still Bay (SB) and the Howiesons Poort (HP) are the technological contexts in which many, but not all, of the cultural innovations developed.

Some authors (Mellars, 2006; Jacobs and Roberts, 2009) argue that these cultural changes in southern Africa were related to dispersal waves of AMHs who, benefitting from their behavioural advantages, rapidly spread from East Africa across the rest of the continent and Eurasia. The success of this model is based on two assumptions about the archaeological record of southern Africa: 1) cultural discontinuities exist between the different technocomplexes (particularly the SB and the HP) and 2) the chronological successions are uniform across southern Africa.

By invoking population migrations to explain changes in cultural sequences, this model presents a similar argument to those used in current discussions on the Middle to Upper Paleolithic transition in Eurasia (see Otte, 1996; d'Errico et al., 1998; Zilhao and d'Errico, 1999; Conard, 2002; Mellars, 2004). But, compared to the Middle and Upper Paleolithic of Europe, the MSA chronocultural sequence remains very imprecise, a result of the few, long, continuous sequences excavated with modern techniques and the problems of establishing a reliable, radiometric chronology (Jacobs et al., 2008; Tribolo et al., 2009).

Here, we present a preliminary synthesis of the multidisciplinary research conducted at Diepkloof Rock Shelter (DRS). Our study of this long sequence raises doubts on some of the current

assumptions about the nature and timing of the technological and cultural innovations symptomatic of the MSA in southern Africa. Rather than invoking the immigration of exogenous populations to explain the cultural sequence of the southern African MSA, we argue here that the precocious innovations appeared indigenously within a context that was culturally and technologically diverse.

2. A place in the West Coast of South Africa

The Republic of South Africa is a 1,000,000 km² country influenced by a wide variety of atmospheric and oceanic circulation systems. At the southern extremity of the African continent, South Africa is situated at the interface of the tropical, subtropical and temperate climate zones, which determine the different temperature and precipitation regimes. Attempts to reconstruct paleo-environmental variations in South Africa over glacial/interglacial cycles have emphasized the importance of local and regional settings and the subsequent risks of basing models on global environmental records (Chase and Meadows, 2007; Chase, 2009). South Africa is a mosaic of ecosystems and each region should be studied by and for its own ecological characteristics.

Our studied area – the West Coast of South Africa – is a cul-de-sac at the southwestern extremity of the African continent. The area belongs to the Winter Rainfall Zone and currently represents a semi-desertic environment characterized by seasonal variations. The West Coast is schematically delimited by the Atlantic coast on the west and the great escarpment on the east, by the Olifants River mouth to the north and the Cape of Good Hope to the south. The vegetation of the region at the present day – the fynbos biome – varies with distance from coast to mountains (Cartwright, 2013), and also contains different geological substrates. Three main formations compose the West Coast and determine its topography: the elevated quartzitic formations of the Table Mountain Group, the coastal formation of the Cape Granite Suite and the argillaceous formations of the Malmesbury group (Coertze, 1984). This geological substrate is overlain by quaternary coastline landscapes that are composed of dune formations and blow-outs forming an extensive sand blanket (Chase and Thomas, 2006; Roberts et al., 2009). Several permanent rivers traverse the West Coast plains, including the Verlorenvlei, alongside which the shelter of Diepkloof is located.

Diepkloof is located at about 180 km north of Cape Town, 30 km from the Piketberg mountains and 14 km from Baboon Point at Elandsbaai on the Atlantic coast. The site dominates a rocky and sandy environment of low elevation at an altitude of about 120 m a.s.l. Variation in sea levels was one of the main factors influencing the landscape development around Diepkloof (Chase, 2009; Compton, 2011). Due to the relatively abrupt topography of the submerged coastal plain at the Verlorenvlei mouth (compared to the south), the Pleistocene shoreline's variations were relatively minimal. We estimate that the shore was only ever 25 km maximum from the site with a sea level regression of 50 m, and at ca. 40 km with a regression of 100 m (Fig. 1). In its location, Diepkloof contrasts with other, presently known MSA sites on the West Coast which are either located on the present coast (Elands Bay Cave, Hoedjiespunt, Ysterfontein) or in the mountains (Hollow Rock Shelter, Klein Kliphuis, Klipfonteinrand). Diepkloof is neither a coastal nor an inland site: it is a strategic, elevated place positioned at the interface of distinct ecological niches with access to a mosaic of vegetational communities (Cartwright, 2013).

Diepkloof is a large rock shelter that formed in a kopje of tabular quartzite of the Table Mountain Group. It offers a large floor of about 200 m² and is exposed to the northwest. The geological formation of the shelter resulted from differential erosion combined with phases of collapse. The fall of a large block (located

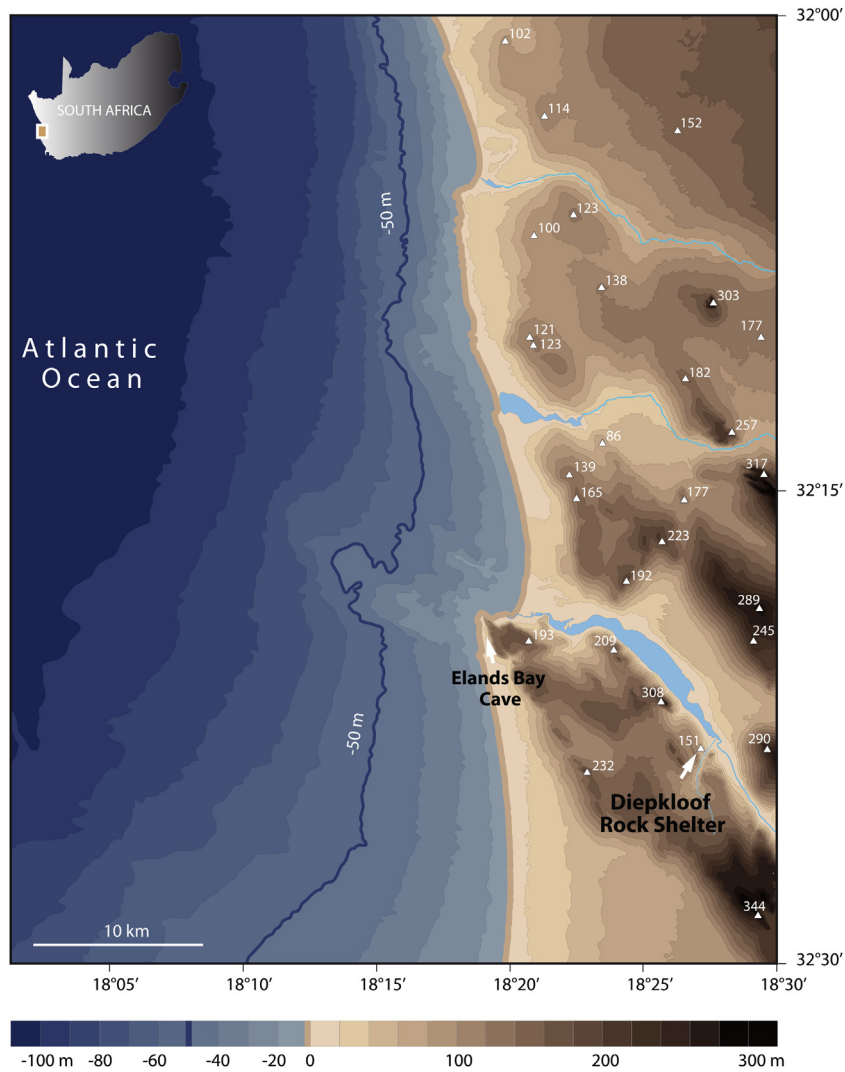


Fig. 1. Topographic and bathymetric map of the area of Diepkloof Rock Shelter (Western Cape Province, West Coast, South Africa). Drawn after Elands Bay to St. Helena (Survey SA Navy, 1986/1:50.000); Elandsbaai to Doornbaai (Survey SA Navy, 1987–1989/1:50.000); Elandsbaai 3218 AD (1:50.000) and Lambertsbaai 3218 AB (1:50.000) (Surveys and mapping, Mowbray). CAD P.-J. Texier.

below the current porch of the shelter) marked the beginning of sediment accumulation within the shelter by providing protection from erosive agents, such as wind or water.

After previous works done at the site in the 70s and 80s, excavations re-started in 1998 under the direction of J.-Ph. Rigaud (University of Bordeaux 1) and J. Parkington (University of Cape Town). A more than 3 m deep stratigraphic sequence has since been exposed. Most parts of the sequence document occupations from the MSA, but some LSA is also recorded in the form of superficial archaeological layers, pits excavated into the MSA deposits, and paintings on the wall of the shelter (Parkington et al., 2013). The later phases of the MSA and the earlier phases of the LSA are not present at the site.

3. A sequence in the southern African Middle Stone Age

The main sequence excavated at Diepkloof is located at the front of the shelter and has been exposed over a surface of 3 m². Archaeological finds are continuously present throughout the 57 Stratigraphic Units (SU). The MSA deposits benefit from a large set of luminescence dating combining both Thermoluminescence (TL) and Optically Stimulated Luminescence (OSL) measurements

(Tribolo et al., 2013). Results from these two methods do not differ statistically and converge to bracket the time span recorded at the site between OIS 5d and the beginning of OIS 3.

The geoarchaeological study documents a process of sedimentation preserved from major erosive events for most of the sequence. Sedimentological processes at the site include geogenic, biogenic and anthropogenic inputs which vary in significance throughout the sequence. However, anthropogenic input and modification played a dominant role in the formation of the majority of the deposits. Looking at the formation processes schematically (see Miller et al., 2013, for details), we identify two main phases: (1) a stratigraphically lower phase, characterized by isolated hearth construction and a higher input of non-anthropogenic components, and (2) an upper phase, characterized by a diversity of combustion-related deposits and an increase in the anthropogenic input to the site's sediments.

Diepkloof is unusual among the set of later MSA sites in southern Africa in that it contains both SB and HP components within a single sequence (Rigaud et al., 2006). The only other site in South Africa that contains a similarly complete record, and was excavated with modern techniques, is Sibudu (Wadley, 2007), which is located more than 1000 km away from the West Coast.

Therefore, most models of the cultural succession of the later part of the MSA largely rely on a handful of sites that are widely dispersed across southern Africa and that contain only relatively short sequences of human occupation. Diepkloof, as with Sibudu, represents a rare opportunity to investigate MSA cultural evolution within a single sequence and setting. The results of our multidisciplinary investigation of the Diepkloof sequence confirm some aspects of the established chrono-cultural model for the southern African MSA. However, many of the results from Diepkloof contradict some of the main arguments current in discussions of the MSA cultural sequence, requiring the formation of a new, explanatory model.

Recent publications on the SB and the HP uniformly follow the chronology developed by Jacobs et al. (2008, 2012), which is based on a large number of sites, including Diepkloof. The authors argue in favour of two short-lived techno-complexes separated by a gap of 2–5 ka: the SB is supposed to have started no earlier than 75.5 ka and ended no later than 67.8 ka, the HP is supposed to have appeared no earlier than 64.8 ka and ended no later than 59.5 ka. But the dating model of Jacobs et al. includes a preliminary and no longer technologically correct sequencing of Diepkloof: they attributed what are actually HP units to the SB (sample 'DRS 13' in Jacobs et al., 2008). With the correct technological revision, the early HP phase at Diepkloof is dated by Jacobs et al. to 70.8 ± 2.3 ka, demonstrating: 1) an older origin of the HP at Diepkloof compared to other dated HP sites (see Porraz et al., 2013 for a discussion of the SADBS industry of Pinnacle Point 5/6, OSL dated to 70.6 ± 2.3 ka by Z. Jacobs: in Brown et al., 2012), 2) a long duration of the HP in southern Africa, 3) a contemporaneous existence of the HP with other technological traditions, such as for example the SB at Sibudu which is dated to 70.5 ± 2.4 ka by Jacobs et al. (2008). This revision supports the conclusions of Tribolo et al. (2009, 2013) who argue in favour of the coexistence of distinct MSA technological traditions and of an arrhythmic tempo of cultural succession across southern Africa.

In addition, the SB and the HP are generally viewed as homogeneous entities and are often compared as single cultural blocs (Jacobs et al., 2008). But, differences exist between the SB of other sites. For instance, at Blombos the selection of fine-grained rock, heat treatment of lithic raw material, and pressure flaking have been recognized as characteristics of the SB (Mourre et al., 2010). At Hollow Rock Shelter pressure-flaking was used but without prior heat treatment (Högberg and Larsson, 2011; but see Porraz et al., 2013). At Umhlatuzana bifacial and unifacial serrated points are considered characteristic of the SB (Lombard et al., 2010). At Apollo 11, where the SB has been proposed with reservation (Vogelsang et al., 2010), bifacial technology only represents a minor component of the assemblage. Similar variability exists within the HP, though the internal structure of this techno-complex across southern Africa is currently not well understood (Wadley and Harper, 1989; Wurz, 2000; Soriano et al., 2007; Igreja and Porraz, 2013). In sum, the SB sites and the HP sites of southern Africa share similar technological templates but they also document a temporal and a spatial variability that requires investigation (d'Errico et al., 2012).

4. Continuities and discontinuities throughout the Diepkloof MSA sequence (Fig. 2)

The inhabitants of Diepkloof took advantage of their strategic setting by exploiting a large set of resources from the nearby river, the rocky hills and the coast. Regardless of their technology, MSA groups from Diepkloof always based their diet on diversified resources. However, we see that over time, the inhabitants placed a greater emphasis on marine resource extraction and the hunting of

large mammals (Steele and Klein, 2013). These shifts in the exploitation of fauna could conceivably reflect adaptations to changing environments. However, based on the current set of floral (Cartwright, 2013) and faunal data (Steele and Klein, 2013), we do not see any evidence for dramatic changes in climate recorded within the deposits at Diepkloof. MSA groups were flexible enough to adapt and diversify their subsistence, possibly explaining the gradual changes recorded in the botanical and faunal remains at Diepkloof.

MSA groups traveled throughout the West Coast to acquire not only biotic but also mineral resources, such as ochre (Dayet et al., 2013) and fine-grained rocks (Porraz et al., 2013). Diachronic variations in rock-procurement strategies correlate with broader changes in lithic technology and with the territorial reorganization of the groups. The technological sequence is schematically subdivided into four main phases, with MSA type Mike at the base, followed by the SB, HP, and post-HP (Porraz et al., 2013). Changes in rock selection, blank production and tool manufacture occurred at different rates, either gradually or suddenly: 1) the SB at Diepkloof appeared rapidly within a context of a modification of the raw material provisioning strategies, 2) the HP appeared suddenly and developed into 3 technological phases (an Early, an Intermediate and a Late phase), 3) the HP sequence included a technological discontinuity characterized by the MSA type Jack, and 4) the HP disappeared progressively within the context of a modification of the rules of production (Porraz et al., 2013).

A spectacular invention that appears within the HP are engraved ostrich eggshells that were used as containers (Texier et al., 2010, 2013). The presence of these containers implies that the HP inhabitants of Diepkloof provisioned resources, such as water, and were well-adapted to the sub-arid conditions on the West Coast. The containers in turn were marked with geometric patterns of incised lines, similar to those found in sub-recent San societies, suggesting that the objects served both a functional and communicative purpose. The narrow range of motifs engraved on ostrich eggshells suggests that MSA groups conformed to the requirements of a flexible but structured signaling system that established set rules that were readable by all participants. Preferences in the types of motif are expressed through time. The engravings on the ostrich eggshell containers first appeared at the end of the Early HP and expanded during the second part of the Intermediate HP and the Late HP, disappearing with the onset of post-HP technology (Texier et al., 2013).

A dramatic change in sedimentation occurs within the Intermediate HP, at the time the engraving of ostrich eggshell was widely adopted by Diepkloof inhabitants. This sedimentary change marks a modification in the way HP groups occupied and maintained the site (Miller et al., 2013). The repeated and increased use of combustion-related activities suggests that human occupations became more frequent, more intense and more structured compared to previous occupations. This mode of occupation lasted throughout the Late HP and persisted during the post-HP occupations.

In sum, archaeological continuities and discontinuities occurred at different rates throughout the sequence of Diepkloof (Fig. 2) and it is difficult to establish clear cultural breaks. Our holistic approach of the sequence suggests that 1) different key-drivers (internal and external) triggered the cultural changes at Diepkloof, and 2) cultural changes occurred at a regional scale. Diepkloof shows that the history of these West Coast groups turned into something never experienced before ca. 80 ka ago. During the Intermediate and the Late phase of the HP, MSA groups collected rocks from distant areas, they used glue to haft (backed) pieces, they produced red ochre powder, they communicated with symbols and maintained the site

OSL and TL chronology <small>(after Tribolo et al., this issue)</small>	Lithostratigraphic units <small>(after Miller et al., this issue)</small>	Technological phases <small>(after Porraz et al., this issue)</small>	Technological and symbolical proxies <small>(after Charrié-Duhaut et al., Dayet et al., Texier et al., this issue)</small>	Vegetational communities <small>(after Cartwright, this issue)</small>	Main Faunal species <small>(after Steele and Klein, this issue)</small>
52±5 ka	LU 4 "Layer-cake"-like deposit, high frequency of combustion features and combustion-derived components (ash-dumps, burnt bedding).	N=3 SUs (ca. 15cm thick) Post-HP (type Claude)	Non-local (50%) and local (50%) rocks, blades and flakes, 'unifacial points'/scrapers.	To be characterized	Hares, carnivores, hyraxes, equids, small, small-medium, large-medium and large bovids, shells.
65±8ka 83±8 ka 85±9 ka 77±8 ka		N=10 SUs (ca. 55cm thick) Late Howiesons P.	Non-local (50%) and local (50%) rocks, blades and flakes backed pieces (segments and truncated).		Great species diversity, shrubland, fynbos and thicket species, wetland plants, persistence of Afromontane forest taxa.
89±8 ka	LU 3 sharp contact Homogenous deposit with high amounts of diagenetic minerals. sharp contact	N=8 SUs (ca. 45cm thick) Intermediate Howiesons P.	Non-local (60%) and local (40%) rocks, blades, strangulated-notched tools, backed pieces (few).	Production of ochre powder	
109±10 ka 105±10 ka		N=2 SUs (ca. 10cm thick) MSA-Jack	Local (80%) and non-local (20%) rocks, flakes and blades, backed 'scrapers'/pieces, (end-)scrapers.		Tortoises, ostrich eggshells.
109±10 ka	LU 2 Geogenic and anthropogenic components, intact hearths.	N=6 SUs (ca. 45cm thick) Early Howiesons P.	Non-local (50%) and local (50%) rocks, blades, pièces esquillées, backed pieces (truncated), bifacial pieces (few).	Dominance of thicket taxa, Afromontane taxa, diverse proteoid fynbos, wetland plants.	
100±10 ka		N=5 SUs (ca. 35cm thick) Still Bay (type Larry)	Local (80%) and non-local (20%) rocks, bifacial reduction sequence, few (end-)scrapers.		Predominance of Afromontane forest taxa, riverine woodland species, mesic thicket and proteoid fynbos vegetation.
107±11 ka	LU 1 diffuse contact High proportion of geogenic components and little anthropogenic material.	N=1 SU (ca. 10cm thick) Pre-SB type Lynn	Local (80%) and non-local (20%) rocks, flakes and blades, lateral and convergent scrapers.	?	
100±10 ka		N=2 SUs (ca. 15cm thick) MSA-Mike	Local rocks (95%), triangular flakes, flakes, blades, few formal tools (denticulates).		Dune molerats, carnivores, hyraxes, small and large bovids.
		MSA to be characterized	Local rocks, Flakes, few formal tools.		Dune molerats, hyraxes, small and large-medium bovids.

Fig. 2. Summary of the main artifactual changes recorded throughout the MSA sequence of Diepkloof Rock Shelter.

in a way that suggest Diepkloof became a central place within a complex and extended territorial and socio-economic network.

5. The appearance of symbolic markings: a regionalization model

The sequence of Diepkloof confirms the evidence from other sites like Sibudu, Blombos and Klasies River, that the later phases of the MSA are marked by a florescence of precocious innovations, both technological and symbolic (Fig. 3). Several models invoking ecological parameters (Potts, 1998), demographic factors (Shennan, 2001; Powell et al., 2009), and population movements (Mellars, 2006; Jacobs and Roberts, 2009) might explain the singularity of the southern African record. The new data from Diepkloof allow us to test these various models and offer an alternative scenario to the current understanding of the cultural evolution of MSA societies.

The most widely accepted culture-history model of the later phases of the MSA argues that the southern African MSA represents a uniform succession of technological traditions. The evidence from Diepkloof contradicts this model, although the dating of the sequence has been at times problematic and controversial. In fact, both Jacobs and Tribolo's ages demonstrate that distinct technological traditions coexisted in southern Africa during OIS 5. According to Tribolo et al.'s ages, the Early HP tradition at Diepkloof is contemporaneous with other and distinct technological traditions from the southern Cape, such as the Blombos M3 phase (Soressi, 2005), the MSA 2 of Klasies River (Wurz, 2002), and other technologically distinct industries from the eastern Cape that remain to be characterized in detail. Similarly, MSA-Jack, which overlies the Early HP at Diepkloof, is contemporaneous with the Blombos M2 technological phase (Fig. 3). The current state of knowledge suggests that regionally and culturally distinct groups had formed in southern Africa by approximately 100 ka.

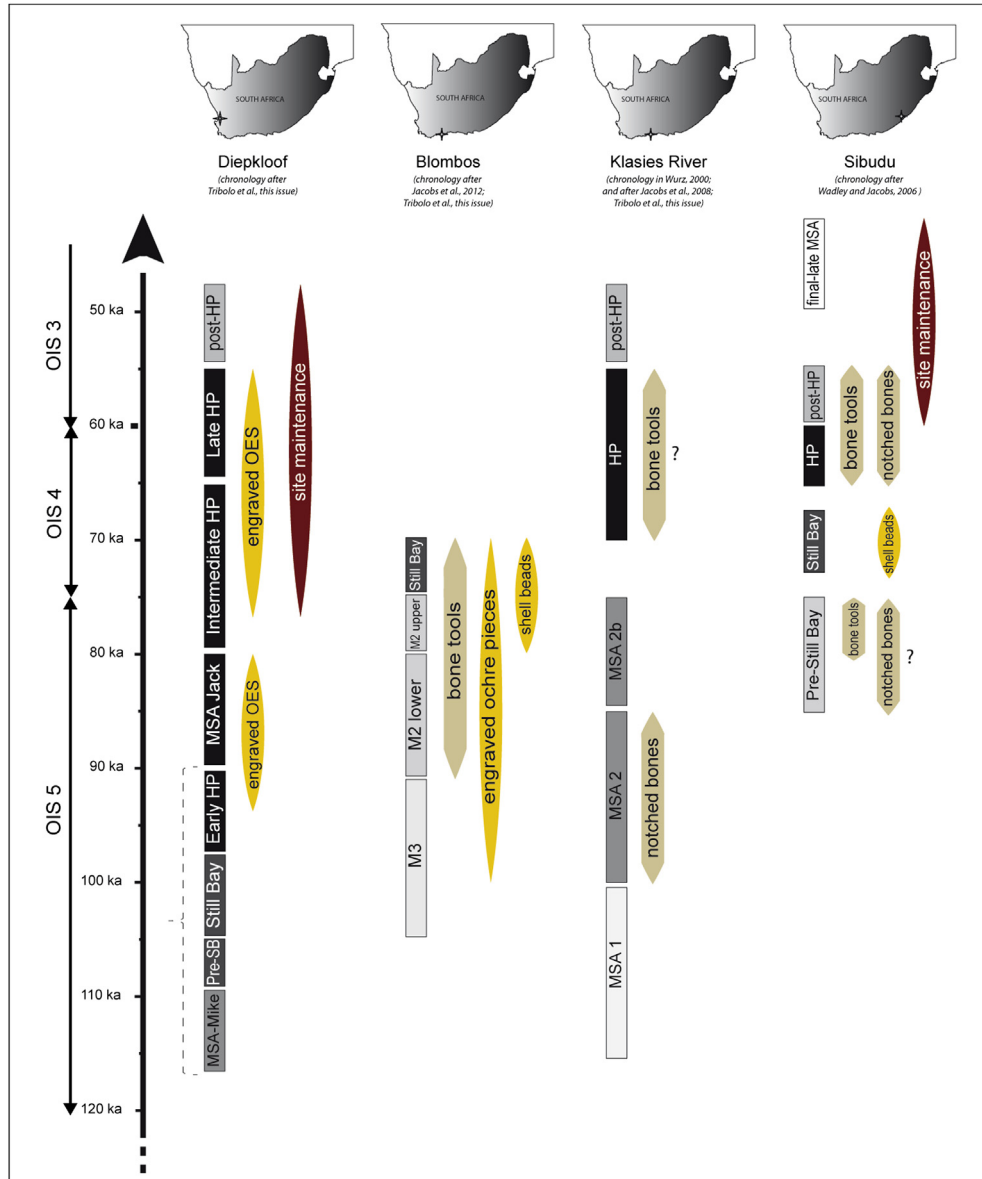


Fig. 3. Schematic representation of the chrono-cultural sequences at the sites of Diepkloof, Blombos, Klasies River and Sibudu. Bone technology, abstract manifestations and main phases of site maintenance activities are figured. Absolute chronology combines mean ages, standard deviations and stratigraphic orders. This representation illustrates the diversity and the arrhythmic tempo of appearance of cultural innovations recorded during the southern African MSA.

Evidence for the use of symbols appears in southern Africa, in one form or another, during OIS 5. At Diepkloof, engravings on ostrich eggshell flasks appear at the end of the Early HP; at Blombos, engraved pieces of ochre are documented since the M3 phase (Henshilwood et al., 2009); in the pre-SB of Sibudu and the MSA 2 of Klasies River, regularly notched bones are documented (d’Errico et al., 2012). Cultural innovations seem to flourish during OIS 5, although they took different forms and developed within different technological traditions. The current archaeological record suggests that the appearance of innovations, and more specifically the expression of symbolic thought, was not restricted to specific technological contexts. In particular, the eggshell engravings at Diepkloof and the ochre engravings at Blombos are broadly contemporaneous. However, the engraved ostrich eggshell flasks are associated with a technological tradition of the HP as well as MSA-Jack at Diepkloof (Texier et al., 2013), and the engraved ochre fragments are associated with M3, M2 and SB technologies at Blombos (Henshilwood et al., 2009).

The similar timing of the appearance of symbolic expression across southern Africa suggests that a common factor may have driven the onset of these cultural changes. One such factor could be adaptations to ecological changes. However, the ecological hypothesis for cultural change faces a major criticism: innovations, both cultural and technological, are found across southern Africa and are not specific to a single ecological niche. The ecological context of OIS 5 has likely been a major factor in the evolution of southern African AMHs societies, but not in a deterministic way.

Symbolic marking is most visible in the southern African record in the form of engraved abstract patterns, either on ostrich eggshells or ochre, and perforated shell beads, likely worn as personal ornaments (Henshilwood et al., 2004). Abstract patterns are widely accepted as evidence for symbolic expression (McBrearty and Brooks, 2000; Henshilwood and Marean, 2003; D’Errico and Henshilwood, 2011). These engravings followed clear rules of design, forming a distinct tradition of a shared mental design within a group. Such graphic traditions provide the most direct

evidence for symbolically-mediated social interaction, and would have strengthened the interrelationship of group members and served to help define group identity. Similarly, personal ornaments, in the form of perforated shell beads, are a form of signaling and communication. On one level, they allow the individual to mark themselves, serving as a form of “visual communication of social information” (Kuhn and Stiner, 2007). But, as with the graphic traditions of the MSA, the traditions of personal ornamentation also imply some level of group marking and identification (Wobst, 1977; Wadley et al., 2011; Vanhaeren and d’Errico, 2006). The appearance of symbolically-mediated behaviour within a context of regionally and culturally distinct groups and traditions suggests that the adaptation of symbolic behaviour may have been a response to increasing interaction between these distinct groups (Gamble, 1998). In other words, symbolically mediated behaviour may be an intragroup response to intergroup interactions and pressures.

Interactions between groups imply some level of information exchange and cooperation. Evidence for regional networks is usually drawn from data on lithic site-to-source distances (Ambrose and Lorenz, 1990). Yet in the West Coast, symbolically mediated behaviour appears in a technological context where groups collected and transported fine-grained rocks and ochre from non-local areas. The raw material data suggests that HP groups had an extended economic territory, and therefore likely an extended social network that would have created the opportunities to establish and maintain exchanges between and within groups.

6. The temporal and spatial patterning of the HP in southern Africa

The chrono-cultural history of the HP has long been disputed (see Lombard, 2005), although recent models give the impression that the history of the HP is now well calibrated. The sequence of Diepkloof extends the age of the HP and confirms the existence of temporal phases and regional variation. While the HP is well documented from numerous sites across southern Africa, most of them have only a short, stratigraphic sequence. Relative to Diepkloof, where the HP is documented over 24 SUs and throughout ca. 150 cm of deposits, the HP of Sibudu consists of 6 layers and is ca. 40 cm thick (from Wadley and Jacobs, 2006), the HP of Umhlatuzana consists of 5 layers (or spits) and is ca. 50 cm thick (from Kaplan, 1990), the HP of Border Cave consists of 2 layers and is ca. 30 cm thick (from Butzer et al., 1978), the HP of Klasies River consists of 9–16 layers (from Wurz, 2000) and is ca. 100 cm thick in Cave 1a (Deacon and Geleijnse, 1998) while it consists of 5 layers in Cave 2 (Singer and Wymer, 1982), the HP of Apollo 11 consists of 3 units and is ca. 15 cm thick (from Vogelsang et al., 2010), the HP of Boomplaas consist of 1 unit (Miller et al., 1999), the HP of Klein Kliphuis consists of 2 units (including one unit subdivided into 8 spits) and is ca. 50 cm thick (Mackay, 2009) and the HP of Rose Cottage Cave consists of 4 layers and is ca. 25 cm thick (from Soriano et al., 2007). Only the site of Pinnacle Point 5/6 seems to present a more extended HP sequence (Brown et al., 2012), although the HP is presently restricted to the DBCS complex by the authors (see Igreja and Porraz, 2013 and Porraz et al., 2013). This overview suggests that not all HP southern Africa sites record the same story, nor at the same resolution.

The record of Diepkloof supports an early appearance of the HP in the Western Cape followed by a later diffusion across the rest of southern Africa. The HP becomes a widespread technology within southern Africa at about 65–70 ka (Feathers and Bush, 2000, Feathers, 2002; Jacobs et al., 2008; Valladas et al., 2005; Tribolo et al., 2005, 2009, 2013). This time period corresponds to what is generally called the “classic” HP (Soriano et al., 2007; Porraz et al., 2008) which is broadly characterized by a selection of

fine-grained rocks, the production of blades and a dominance of backed pieces within the typological corpus. Diepkloof provides evidence for an Early HP, including dominance of (bi)truncated blades and a few bifacial pieces, that currently pre-dates other occurrences assigned to the HP. Current sets of dates (Feathers and Bush, 2000, Feathers, 2002; Jacobs et al., 2008; Valladas et al., 2005; Tribolo et al., 2005, 2009, 2013) and techno-typological analyses suggest that the “classic” HP, as expressed at other MSA sites, correlates with the Intermediate and the Late phases of the HP at Diepkloof, not the earliest (Fig. 3). Therefore, the sequence of Diepkloof can be useful for investigating the origins of this innovative technological phenomenon and its mode of dispersal across southern Africa.

At Diepkloof the first engraved ostrich eggshell containers appear at the end of the Early HP, but dramatically increase within the Intermediate HP with SU Fiona (Texier et al., 2013). Also during the Intermediate HP, beginning with SUs Governor and Fiona, we see a marked change in the anthropogenic deposits at the site (Fig. 2). From Governor and above, the deposits are composed of various types of stacked combustion features that imply an increase in occupational intensity and a greater organization of domestic space (Miller et al., 2013). Both of these aspects of the Diepkloof record suggest a change in the social interaction of group members at Diepkloof. The engravings on ostrich eggshells show that the occupants of Diepkloof were using symbols to mediate intragroup social interactions. Similarly, the evidence for an increase in the structuring of domestic space may imply that the occupants organized their space according to set social rules (Wadley, 2001). Taken in the context of extended territorial networks of raw-material procurement, it seems likely that the increase in intragroup social networks corresponded to expanding external social networks, purportedly related to a modification in population dynamics. We suggest that during the Intermediate HP of Diepkloof, the interconnectivity of these expanded social networks reached a critical threshold in which innovative ideas rapidly and widely spread across southern Africa. We propose that the appearance of the classic HP in southern Africa was a result of these extended social networks.

Understanding the nature of the diffusion of the HP relies on our understanding of similarities and differences within the expression of the HP. Across all of southern Africa, we see a similar use of blade core reduction during the HP (Villa et al., 2010; Porraz et al., 2013). However, when we look beyond this obvious similarity, we see evidence for regional differentiation (Texier et al., 2010; d’Errico et al., 2012) (Fig. 3). Engravings on ostrich eggshells are presently only found on the western coast of southern Africa, at Diepkloof and Apollo 11 (Texier et al., 2013). Bone tools are only found at Klasies River and Sibudu (Henshilwood and Sealy, 1997; d’Errico et al., 2012; but see Igreja and Porraz, 2013), and the use of ochre as an additive in hafting materials is presently only found at Sibudu, Rose Cottage Cave, and Umhlatuzana (Wadley et al., 2004). In addition, some of these characteristics of the HP assemblages pre-date the appearance of the HP itself, such as shell beads and bone tool technology (d’Errico and Henshilwood, 2007; d’Errico et al., 2012). We suggest that the persistence of regional characteristics implies that the HP did not replace, but was rather grafted onto, these pre-existing traditions.

We emphasize that the concept of “disappearance” of the HP has wrongly been attributed to social collapse (Jacobs and Roberts, 2009) or a “return” to pre-SB technology. At Diepkloof, we see a gradual change in the technology from the HP to the post-HP and continuity in raw-material procurement strategies. A similar gradual scenario has been hypothesized based on the lithic record of Rose Cottage Cave (Soriano et al., 2007), Klasies River (Villa et al., 2010) and Klein Kliphuis (Mackay, 2011). At Diepkloof, we also see

continuity in the mode of occupation at the site from the HP to the post-HP (Miller et al., 2013). Thick accumulations of burnt bedding, ash dumps and combustion features also mark the post-HP at Sibudu (Goldberg et al., 2009; Wadley et al., 2011), suggesting a greater intensity of site use during the post-HP than during the preceding HP. The post-HP exhibits a number of technological innovations that show that it is not a “return” to pre-SB technology (Soriano et al., 2007; Lombard and Parsons, 2010; Conard et al., 2012). One key aspect of post-HP assemblages is the lack of evidence for symbolic expression, which we must remember is not evidence of absence.

7. Main implications

(1) Is the chronological model for the SB and HP supported by archaeological evidence?

The recent publications of Jacobs et al. (2008, 2012) on MSA sites across southern Africa, including Diepkloof, have hypothesized a narrow chronology for the SB and HP techno-complexes. However, TL and OSL dating of Tribolo et al. (2013) at Diepkloof contest this chronology and suggest that Jacobs et al.’s dates for Diepkloof are an underestimation, may be due to problems with their measurement parameters (see also Guérin et al., in press).

Problems with the model of Jacobs et al. also raise questions about the nature of the cultural sequence established across different Middle Stone Age sites and occupations. In fact, the technological revision of the Diepkloof sequence shows that some SUs attributed to the SB by Jacobs et al. actually correspond to HP occupations. Regardless of the discrepancy between the luminescence ages (Jacobs et al., 2008; Tribolo et al., 2013), Diepkloof presently furnishes the earliest ages for the SB and the HP and extends the chronological range of both technocomplexes (Fig. 2).

These early dates suggest that the SB and the HP are not horizon markers, meaning that these technologies are not restricted to a narrow period of time. Rather, the evidence at Diepkloof shows that the SB and the HP did not appear everywhere at the same time in southern Africa. The current archaeological data set suggests an early appearance of the bifacial SB and laminar HP technologies in the south-western coast of southern Africa.

(2) How does the sequence of Diepkloof fit within the southern African chrono-cultural record?

The current chrono-cultural framework for the MSA in southern Africa is based on the long and discontinuous sequences of Klasies River (studied by Singer and Wymer, 1982; revised by Wurz, 2002; Villa et al., 2010) and the synthesis of Volman (1984). These models imply that similar technological entities uniformly developed and succeeded one another across southern Africa, though Singer and Wymer’s (1982) subdivisions were only meant to apply at Klasies River. The current scenario relies on a restricted number of sites and has not been tested with recently excavated archaeological sequences. Along with Sibudu, Diepkloof is to date the only site recently excavated providing a long sequence including both the SB and the HP.

The evidence from Diepkloof contradicts a unidirectional cultural scenario that was uniform all over southern Africa. Rather, the chronology of the MSA sequence of Diepkloof suggests that distinct technological traditions coexisted in southern Africa during OIS 5, until the ‘classic’ HP became widespread in southern Africa. Additionally, the MSA sequence suggests that some technological traditions did not have the same expression across space and over time. In sum, the southern African MSA did not represent a

homogeneous cultural bloc and was characterized by distinct evolutionary trajectories in different places.

(3) Are the SB and the HP related to population replacement?

Some authors (Mellars, 2006; Jacobs and Roberts, 2009) have correlated the appearance of the SB and the HP in southern Africa with the arrival of new populations purportedly originating from east Africa. This hypothesis is based on the absolute chronology and implies that innovations would have appeared preferentially among certain AMH populations.

This hypothesis of demographic discontinuity in southern Africa assumes the existence of archaeological discontinuities in the cultural record. The Diepkloof sequence, however, supports a scenario of continuous changes at a local scale. The SB and the HP appear to have had a regional origin and represent indigenous technological manifestations of southern African populations. These data support the existence and persistence of distinct AMH groups within the African continent during the Late Pleistocene and the consecutive existence of multiple and independent evolutionary trajectories within this species. In addition, the innovative characters of the SB and the HP in South Africa speak in favour of the existence of different cultural paths and scenarios towards the adoption of ‘modern’ hunter–gatherers lifestyles.

(4) Which factors underlie the innovations within the southern African MSA?

We state that initial technological and cultural innovations appeared in one form or another during OIS 5 in southern Africa, a period characterized by the coexistence of multiple, distinct technological traditions. We argue that the formation of regional identities, strengthened by the use of symbols, would have favoured and increased cultural interactions between groups, providing a favourable context for the development and diffusion of innovations. Our model hypothesizes that the MSA was characterized by phases of increasing regional structure, and phases of increased cultural interactions. The diversity among southern African groups would have played the role of a cultural reservoir to face external or internal uncertainties.

(5) The Still Bay in question

The SB is a technological tradition that is restricted to southern Africa and is documented by only a handful of reliable sites over a large region. The assemblages assigned to the SB share a similar bifacial template, but exhibit substantial technological differences based on comparisons between the assemblages at Diepkloof, Blombos Cave, Hollow Rock Shelter, Umhlatuzana, Sibudu and Apollo 11. Other differences in the SB across southern Africa include, for example, the use of bone tools, which are absent from the SB layers at Diepkloof, but are significant aspects of the assemblage at Blombos Cave (Henshilwood et al., 2002a,b). Additionally, perforated shell beads are recorded in the SB at Blombos (Henshilwood et al., 2004) and at Sibudu (Wadley, 2012), but no equivalent specimens have been recovered in other SB sites.

The dating results suggest the existence of a significant temporal gap between the SB at Diepkloof and other manifestations of the SB in southern Africa. The evidence from Diepkloof questions the significance of the concept of the SB and the use of SB bifacial technology as a cultural marker. We therefore must consider two possible scenarios to explain the existence of bifacial technology across southern Africa: 1) the technology may have been (re)invented several times, suggesting that convergence in bifacial technology would mask historical differences, 2) the technology

may have persisted in some places, but disappeared in others, suggesting that SB technology evolved locally over time. At this stage, we urge caution in the use of the term SB until we have a better understanding of the occurrence, frequency and timing of bifacial technology in southern Africa. Recent evidence from Diepkloof (Porraz et al., 2013), where bifacial pieces occur in the Early HP, and Sibudu (Wadley, 2012), where they occur in the pre-SB, suggest the cultural context and history of bifacial technology in southern Africa is more complex than previously supposed.

(6) Toward a better understanding of the HP history

The HP represents a southern African technological tradition that is characterized by the selection of fine-grained rocks, production of blades and bladelets, and manufacture of backed pieces. Beyond regional variation, HP assemblages all share a similar blade reduction strategy (Villa et al., 2010; Porraz et al., 2013) which suggests the existence of a similar technological root. But the HP did not appear at the same time everywhere in southern Africa, and potentially, not in the same form. Based on the current set of published data, HP technology appears to have first occurred in the southwestern coast of South Africa, only spreading across southern Africa during its Intermediate phase, as documented at Diepkloof.

The spread of the HP across southern Africa seems to correspond with a marked increase in the appearance of engravings on ostrich eggshells and a shift in the mode of occupation at the site. These data suggest a change in the organization of the group that may reflect expanding economic and social networks. It is within this framework of expanding networks that the HP appears to have been successful across southern Africa. Despite the relative homogeneity of geographically distant HP assemblages, there are marked regional differences in the expression of HP technology (Texier et al., 2010; d'Errico et al., 2012). Therefore, we hypothesize the wide-spread expansion of the HP as a dispersal of ideas rather than a dispersal of people.

8. Epilogue

Our work at Diepkloof started with the aim of contributing toward a refinement of the chrono-cultural history of southern African MSA populations. We explored the long sequence of Diepkloof by integrating a wide set of observations from different specialists to contextualize the innovative proxies emphasized for the SB and the HP. Our work has culminated in a model giving emphasis to continuity in time and diversity in space. We support a scenario that hypothesizes the persistence of local populations and the formation of regional identities as part of the process that would have favoured the development of innovations and symbolic communications within and between groups. Understanding the circumstances that triggered the formation of regional identities, however, forces us to question the changing nature of the physical and social boundaries that might have existed between groups.

Acknowledgements

We wish to thank the French Ministry of Foreign Affairs (MAE, sous-direction de l'Archéologie), the Aquitaine region, the Provence-Alpes-Côte d'Azur region, and the Centre National de la Recherche Scientifique (CNRS) for their financial support. The Diepkloof project has been additionally funded by the Paleontological Scientific Trust (PAST), by the National Research Foundation (NRF) of South Africa (JEP), the Agence National pour la Recherche (ANR-09-JCJC-0123-01) and has also benefited of the Prix Clio. One of us (GP) has been supported by the Fyssen and the Alexander von Humboldt Foundations, in a collaborative with the University of

Cape Town (Prof. J.E. Parkington) and the University of Tuebingen (Prof. N.J. Conard). The University of Cape Town has constantly supported the project logistically as well as financially; we are more specifically thankful to Judith Sealy, Head of the Department of Archaeology, as well as to Louisa Hutten and Dolores Jacobs. We also thank D. & M. van Wyk and J. Pollet for permission to work on their land, Heritage Western Cape (HWC) for permits to excavate at Diepkloof and all students involved in the excavation in years since 1999. GP, JEP, CEM and PJT wrote the manuscript. PJT and CP are holders of the research permit for Diepkloof Rock Shelter. We are thankful to 5 anonymous reviewers for constructive comments on an earlier version of this paper.

References

- Aiello, L., 1993. The fossil evidence for Modern Human origins in Africa: a revised view. *American Anthropologist* 95, 73–96.
- Ambrose, S.H., Lorenz, K.G., 1990. Social and ecological models for the Middle Stone Age in southern Africa. In: Mellars, P. (Ed.), *The Emergence of Modern Humans*. Edinburgh University Press, pp. 3–33.
- Backwell, L., d'Errico, F., Wadley, L., 2008. Middle Stone Age bone tools from the Howiesons Poort layers, Sibudu Cave, South Africa. *Journal of Archaeological Science* 35 (6), 1566–1580.
- Bräuer, G., 1989. The evolution of modern humans: a comparison of the African and non-African evidence. In: Mellars, P., Stringer, C.B. (Eds.), *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans*. Edinburgh University Press, Edinburgh, pp. 123–154.
- Bräuer, G., Stringer, C., 1997. Models, polarization, and perspectives on modern human origins. In: Clark, G., Willermet, C. (Eds.), *Conceptual Issues in Modern Human Origins Research*. Aldine de Gruyter, New York, pp. 191–201.
- Brown, K.S., Marean, C.W., Herries, A.I.R., Jacobs, Z., Tribolo, C., Braun, D., Roberts, D.L., Meyer, M.C., Bernatchez, J., 2009. Fire as an engineering tool of early modern humans. *Science* 325, 859–862.
- Brown, K.S., Marean, C.W., Jacobs, Z., Schoville, B.J., Oestmo, S., Fisher, E.C., Bernatchez, J., Karkanas, P., Matthews, T., 2012. An early and enduring technology originating 71,000 years ago in South Africa. *Nature* 491, 590–593.
- Butzer, K.W., Beaumont, P.B., Vogel, J.C., 1978. Lithostratigraphy of Border Cave, Kwazulu, South Africa: a Middle Stone Age sequence beginning c. 195,000 b.p. *Journal of Archaeological Science* 5 (4), 317–341.
- Cartwright, C., 2013. Identifying the woody resources of Diepkloof Rock Shelter (South Africa) using scanning electron microscopy of the MSA wood charcoal assemblages. *Journal of Archaeological Science* 40, 3463–3474.
- Charrié-Duhaut, A., Porraz, G., Cartwright, C., De Araujo, M., Conan, J., C., Poggenpoel, Texier, P.-J., 2013. First molecular identification of a hafting adhesive in the Late Howiesons Poort at Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science* 40, 3506–3518.
- Chase, B.M., 2009. South African palaeoenvironments during marine oxygen isotope stage 4: a context for the Howiesons Poort and Still Bay industries. *Journal of Archaeological Science* 37, 1359–1366.
- Chase, B.M., Meadows, M.E., 2007. Late Quaternary dynamics of southern Africa's winter rainfall zone. *Journal of Archaeological Science* 34, 103–138.
- Chase, B.M., Thomas, D.S.G., 2006. Late Quaternary dune accumulation along the western margin of South Africa: distinguishing forcing mechanisms through the analysis of migratory dune forms. *Earth and Planetary Science Letters* 251, 318–333.
- Clark, J.D., 1988. Beginnings of regional identity. *Journal of World Prehistory* 2 (3), 235–305.
- Coertze, F.J. (Ed.), 1984. Cape Town and Environs. Explanation: Sheet Maps (1: 50,000) 3318 CD and DC, 3418 AB, AD and BA. Geological Survey, Department of Mineral and Energy Affairs, p. 77.
- Compton, J.S., 2011. Pleistocene sea-level fluctuations and human evolution on the southern coastal plain of South Africa. *Quaternary Science Reviews* 30 (5–6), 506–527.
- Conard, N.J., 2002. The timing of cultural innovations and the dispersal of modern humans in Europe. *Terra Nostra* 6, 82–94.
- Conard, N., 2008. A critical view of the evidence for a southern African origin of behavioural modernity. In: Lombard, M. (Ed.), *Current Themes in Middle Stone Age Research*. South African Archaeological Society, Goodwin Series, vol. 10, pp. 175–179.
- Conard, N.J., Porraz, G., Wadley, L., 2012. What is in a name? Characterizing the “post-HP” at Sibudu. *South African Archaeological Bulletin* 67 (196), 180–199.
- d'Errico, F., 2003. The invisible frontier. A multiple species model for the origin of behavioural modernity. *Evolutionary Anthropology* 12, 188–202.
- d'Errico, F., Zilhao, J., Julien, M., Baffier, D., Pelegrin, J., 1998. Neandertal acculturation in Western Europe? A critical review of its evidence and its interpretation. *Current Anthropology* 39 (Supp. S1–44).
- d'Errico, F., Vanhaeren, M., Wadley, L., 2008. Possible shell beads from the Middle Stone Age layers of Sibudu Cave, South Africa. *Journal of Archaeological Science* 35 (10), 2675–2685.

- Dayet, L., Texier, P.-J., Daniel, F., Porraz, G., 2013. Ochre resources from the Middle Stone Age sequence of Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science* 40, 3492–3505.
- Deacon, H.J., Geleijnse, V.B., 1998. The stratigraphy and sedimentology of the main site, Klasies River, South Africa. *South African Archaeological Bulletin* 43 (147), 5–14.
- d'Errico, F., Henshilwood, C.S., 2007. Additional evidence for bone technology in the southern African Middle Stone Age. *Journal of Human Evolution* 52, 142–163.
- D'Errico, F., Henshilwood, C.S., 2011. The origin of symbolically mediated behavior. From antagonistic scenarios to a unified research strategy. In: Henshilwood, C.S., d'Errico, F. (Eds.), *Homo Symbolicus: the Dawn of Language, Imagination and Spirituality*. John Benjamins Publishing Company, pp. 49–73.
- d'Errico, F., Backwell, Lucinda R., Wadley, Lyn, 2012. Identifying regional variability in Middle Stone Age bone technology: the case of Sibudu Cave. *Journal of Archaeological Science* 39, 2479–2495.
- Feathers, J.K., 2002. Luminescence dating in less than ideal conditions: case studies from Klasies River main site and Duinefontein, South Africa. *Journal of Archaeological Science* 29, 177–194.
- Feathers, J.K., Bush, D.A., 2000. Luminescence dating of Middle Stone Age deposits at Die Kelders Cave. *Journal of Human Evolution* 38 (1), 91–119.
- Frazer, D., Wolpoff, M., Smith, F., Thorne, A., Pope, G., 1993. The fossil evidence for modern human origins. *American Anthropologist* 95, 14–50.
- Gamble, C., 1998. Palaeolithic society and the release from proximity: a network approach to intimate relation. *World Archaeology* 29, 426–449.
- Goldberg, P., Miller, C.E., Schiegl, S., Ligouis, B., Berna, F., Conard, N.J., 2009. Bedding, hearths, and site maintenance in the Middle Stone Age site of Sibudu Cave, KwaZulu-Natal, South Africa. *Archaeological and Anthropological Sciences* 1 (2), 95–122.
- Guérin, G., Murray, A.S., Jain, M., Thomsen, K.J., Mercier, N. How confident are we in the chronology of the transition between Howieson's Poort and Still Bay? *Journal of Human Evolution*, in press.
- Gunz, P., Bookstein, F.L., Mitteroecker, P., Stadlmayr, A., Seidler, H., Weber, G.W., 2009. Early modern human diversity suggests subdivided population structure and a complex out-of-Africa scenario. *Proceedings of the National Academy of Sciences of the United States of America* 106 (15), 6094–6098.
- Henshilwood, C.S., Marean, C.W., 2003. The origin of modern human behavior. Critique of the models and their test implications. *Current Anthropology* 44 (5), 627–651.
- Henshilwood, C.S., Sealy, J.C., 1997. Bone artefacts from the Middle Stone Age at Blombos cave, southern Cape, South Africa. *Current Anthropology* 38 (5), 890–895.
- Henshilwood, C.S., d'Errico, F., Yates, R., Jacobs, Z., Tribolo, C., Duller, G.A., Mercier, N., Sealy, J.C., Valladas, H., Watts, I., Wintle, A.G., 2002a. Emergence of modern human behavior: Middle Stone Age engravings from South Africa. *Science* 295, 1278–1280.
- Henshilwood, C.S., d'Errico, F., Marean, C.W., Milo, R.G., Yates, R., 2002b. 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, 631–678.
- Henshilwood, C.S., d'Errico, F., Vanhaeren, M., van Niekerk, K., Jacobs, Z., 2004. Middle Stone Age shell beads from South Africa. *Science* 304, 404–405.
- Henshilwood, C.S., d'Errico, F., Watts, I., 2009. Engraved ochres from the Middle Stone levels at Blombos Cave, South Africa. *Journal of Human Evolution* 57, 27–47.
- Högberg, A., Larsson, L., 2011. Lithic technology and behavioural modernity: new results from the Still Bay site, Hollow Rock Shelter, Western Cape Province, South Africa. *Journal of Human Evolution* 61 (2), 133–155.
- Igreja, M., Porraz, G., 2013. Functional insights into the innovative early Howieson's Poort technology at Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science* 40, 3475–3491.
- Jacobs, Z., Roberts, R.G., 2009. Catalysts for Stone Age innovations. What might have triggered two short-lived bursts of technological and behavioral innovation in southern Africa during the Middle Stone Age? *Communicative & Integrative Biology* 2, 191–193.
- Jacobs, Z., Roberts, R.G., Galbraith, R.F., Deacon, H.J., Grün, R., Mackay, A., Mitchell, P., Vogelsang, R., Wadley, L., 2008. Ages for the Middle Stone Age of southern Africa: implications for human behavior and dispersal. *Science* 322, 733–735.
- Jacobs, Z., Hayes, E.H., Roberts, R.G., Galbraith, R.F., Henshilwood, C.S., 2012. An improved OSL chronology for the Still Bay layers at Blombos Cave, South Africa: further tests of single-grain dating procedures and a re-evaluation of the timing of the Still Bay industry across southern Africa. *Journal of Archaeological Science* 40, 579–594.
- Kaplan, J., 1990. The Umhlatuzana Rock Shelter sequence: 100,000 years of Stone Age history. *Natal Museum Journal of Humanities* 2, 1–94.
- Klein, R.G., 1995. Anatomy, behavior, and modern human origins. *Journal of World Prehistory* 9 (2), 167–198.
- Kuhn, S.L., Stiner, M.C., 2007. Body ornamentation as information technology: towards an understanding of the significance of early beads. In: Mellars, P., Boyle, K., Bar-Yosef, O. (Eds.), *Rethinking the Human Revolution. New Behavioural and Biological Perspectives on the Origin and Dispersal of Modern Humans*. McDonalds Institute Monographs, pp. 45–54.
- Lahr, M.M., Foley, R.A., 1994. Multiple dispersals and modern human origins. *Evolutionary Anthropology* 3 (2), 48–60.
- Lahr, M.M., Foley, R.A., 1998. Towards a theory of modern human origins: geography, demography, and diversity in recent human evolution. *Yearbook of Physical Anthropology* 41, 137–176.
- Lombard, M., 2005. The Howieson's Poort of South Africa: what we know, what we think we know, what we need to know. *Southern African Humanities* 17, 33–55.
- Lombard, M., Parsons, I., 2010. Fact or fiction? Behavioural and technological reversal after 60 ka in southern Africa. *South African Archaeological Bulletin* 65, 224–228.
- Lombard, M., Phillipson, L., 2010. Indications of bow and stone-tipped arrow use 64 000 years ago in KwaZulu-Natal, South Africa. *Antiquity* 84 (325), 635–648.
- Lombard, M., Wadley, L., Jacobs, Z., Mohapi, M., Roberts, R.G., 2010. Still Bay and serrated points from Umhlatuzana Rock Shelter, KwaZulu-Natal, South Africa. *Journal of Archaeological Science* 37, 1773–1784.
- Mackay, A., 2009. History and Selection in the Late Pleistocene Archaeology of the Western Cape, South Africa. PhD, Australian National University, vol. 2.
- Mackay, A., 2011. Nature and significance of the Howieson's Poort to post-Howieson's Poort transition at Klein Kliphuis Rock Shelter. *South Africa Journal of Archaeological Science* 38, 1430–1440.
- Mackay, A., Welz, A., 2008. Engraved ochre from a Middle Stone Age context at Klein Kliphuis in the Western Cape of South Africa. *Journal of Archaeological Science* 35, 1521–1532.
- McBrearty, S., Brooks, A.S., 2000. The revolution that was'n't: a new interpretation of the origin of modern human behavior. *Journal of Human Evolution* 39 (5), 453–563.
- Mellars, P., 2004. Neanderthals and the modern human colonization of Europe. *Nature* 432, 461–465.
- Mellars, P., 2006. Going east: new genetic and archaeological perspectives on the modern human colonization of Eurasia. *Science* 313, 796–800.
- Mellars, P., Stringer, C. (Eds.), 1989. *The Human Revolution: Behavioral and Biological Perspectives on the Origins of Modern Humans*. Edinburgh University Press, Edinburgh.
- Miller, G.H., Beaumont, P.B., Deacon, H.J., Brooks, A.S., Hare, P.E., Jull, A.J.T., 1999. Earliest modern humans in southern Africa dated by isoleucine epimerization in ostrich eggshell. *Quaternary Science Review* 18, 1537–1548.
- Miller, C.E., Goldberg, P., Berna, F., 2013. Geoarchaeological investigations at Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science* 40, 3432–3452.
- Mourre, V., Villa, P., Henshilwood, C.S., 2010. Early use of pressure flaking on lithic artifacts at Blombos Cave, South Africa. *Science* 330, 659–662.
- Otte, M., 1996. Le bouleversement de l'humanité en Eurasie vers 40,000 ans. In: Carbonell, E., Vaquero, M. (Eds.), *The Last Neanderthals, the First Anatomically Modern Humans: a Tale about the Human Diversity. Cultural Change and Human Evolution: the Crisis at 40 Ka BP*. Universitat Rovira i Virgili, Tarragona, pp. 95–106.
- Parkington, J., Rigaud, J.-Ph., Poggenpoel, C., Porraz, G., Texier, P.-J., 2013. Introduction to the project and excavation of Diepkloof Rock Shelter (Western Cape, South Africa): a view on the Middle Stone Age. *Journal of Archaeological Science* 40, 3369–3375.
- Porraz, G., Texier, P.-J., Rigaud, J.-P., Parkington, J., Poggenpoel, C., Roberts, D., 2008. First characterization of an MSA lithic assemblage stratified between Still Bay and Howieson's Poort sub-stages at Diepkloof Rock Shelter (Western Province, South Africa). In: Lombard, M. (Ed.), *Current Themes in Middle Stone Age Research. South African Archaeological Society, Goodwin Series*, vol. 10, pp. 105–121.
- Porraz, G., Texier, P.-J., Archer, W., Piboule, M., Rigaud, J.-P., Tribolo, C., 2013. Technological successions in the Middle Stone Age sequence of Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science* 40, 3376–3400.
- Potts, R., 1998. *Humanity's Descent: the Consequences of Ecological Instability*. William Morrow and Co, New York.
- Powell, A., Shennan, S., Thomas, M.G., 2009. Late Pleistocene demography and the appearance of modern human behavior. *Science* 324, 1298–1301.
- Rigaud, J.-P., Texier, P.-J., Parkington, J., Poggenpoel, C., 2006. Le Mobilier Stillbay et Howieson's Poort de l'abri Diepkloof. *Comptes Rendus Palevol* 5, 839–849.
- Roberts, D.L., Bateman, M.D., Murray-Wallace, C.V., Carr, A.S., Holmes, P.J., 2009. West coast dune plumes: climate driven contrasts in dune field morphogenesis along the western and southern South African coasts. *Palaeogeography, Palaeoclimatology, Palaeoecology* 271, 24–38.
- Schmidt, P., Porraz, G., Słodczyk, A., Bellot-Gurlet, L., Archer, W., Miller, C.E., 2013. Heat treatment in the South African Middle Stone Age: temperature induced transformations of silcrete and their technological implications. *Journal of Archaeological Science* 40, 3519–3531.
- Shennan, S., 2001. Demography and cultural innovation: a model and its implications for the emergence of Modern Human culture. *Cambridge Archaeological Journal* 11, 5–16.
- Singer, R., Wymer, J., 1982. *The Middle Stone Age at Klasies River Mouth in South Africa*. Chicago University Press, Chicago.
- Sorens, M., 2005. Aux origines de la "modernité" comportementale en Afrique du sud il y a 75,000 ans. *Annales de la Fondation Fyssen* 20, 125–132.
- Soriano, S., Villa, P., Wadley, L., 2007. Blade technology and tool forms in the Middle Stone Age of South Africa: the Howieson's Poort and post-Howieson's Poort at Rose Cottage cave. *Journal of Archaeological Science* 35 (5), 681–703.
- Steele, T., Klein, R.G., 2013. The Middle and Later Stone Age Faunal remains from Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science* 40, 3453–3462.
- Stringer, C., 2001. Modern human origins – distinguishing the models. *African Archaeological Review* 18 (2), 67–75.
- Texier, P.-J., Porraz, G., Parkington, J., Rigaud, J.-P., Poggenpoel, C., Miller, C., Tribolo, C., Cartwright, C., Coudenneau, A., Klein, R., Steele, T., Verna, C., 2010.

- A Howiesons Poort tradition of engraving ostrich eggshell containers dated to 60,000 years ago at Diepkloof Rock Shelter, South Africa. *Proceedings of the National Academy of Sciences* 107, 6180–6185.
- Texier, P.-J., Porraz, G., Parkington, J., Rigaud, J.-P., Poggenpoel, C., Tribolo, C., 2013. The context, form and significance of the MSA engraved ostrich eggshell collection from Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of Archaeological Science* 40, 3412–3431.
- Tribolo, C., Mercier, N., Valladas, H., 2005. Chronology of the Howieson's Poort and Still Bay techno-complexes: assessment and new data from luminescence. In: D'Errico, F., Backwell, L. (Eds.), *From Tools to Symbols, From Hominids to Modern Humans*, International Round Table, Johannesburg, 16–18 March 2003, pp. 493–511.
- Tribolo, C., Mercier, N., Valladas, H., Joron, J.-L., Guibert, P., Lefrais, Y., Selo, M., Texier, P.-J., Rigaud, J.-P., Porraz, G., Poggenpoel, C., Parkington, J., Texier, J.-P., Lenoble, A., 2009. Thermoluminescence dating of a Stillbay–Howiesons Poort sequence at Diepkloof Rock Shelter (Western Cape, South Africa). *Journal of Archaeological Science* 36, 730–739.
- Tribolo, C., Mercier, N., Douville, E., Joron, J.-L., Reyss, J.-L., Rufer, D., Cantin, N., Lefrais, Y., Miller, C.E., Parkington, J., Porraz, G., Rigaud, J.-P., Texier, P.-J., 2013. OSL and TL dating of the Middle Stone Age sequence of Diepkloof Rock Shelter (Western Cape, South Africa): a clarification. *Journal of Archaeological Science* 40, 3401–3411.
- Valladas, H., Wadley, L., Mercier, N., Tribolo, C., Reyss, J.-L., Joron, J.-L., 2005. Contribution of thermoluminescence on lithics to the chronology of MSA layers of Rose Cottage Cave. *South African Journal of Science* 101, 169–174.
- Vanhaeren, M., d'Errico, F., 2006. Clinal distribution of personal ornaments reveals the ethno-linguistic geography of Early Upper Palaeolithic Europe. *Journal of Archaeological Science* 33 (8), 1105–1128.
- Villa, P., Soriano, S., Teyssandier, N., Wurz, S., 2010. The Howiesons Poort and MSA III at Klasies River main site, Cave 1A. *Journal of Archaeological Science* 37 (3), 630–655.
- Vogelsang, R., Richter, J., Jacobs, Z., Eichorn, B., Linseele, V., Roberts, R.G., 2010. New excavations of Middle Stone Age deposits at Apollo 11 Rockshelter, Namibia: stratigraphy, archaeology; chronology and past environments. *Journal of African Archaeology* 8 (2), 185–218.
- Volman, T.P., 1984. Early prehistory of southern Africa. In: Klein, R.G. (Ed.), *Southern Africa Prehistory and Paleoenvironments*. A.A.Balkema.
- Wadley, L., 2001. What is cultural modernity? A general view and a South African perspective from Rose Cottage Cave. *Cambridge Archaeological Journal* 11 (2), 201–221.
- Wadley, L., 2007. Announcing a Still Bay industry at Sibudu Cave, South Africa. *Journal of Human Evolution* 52, 681–689.
- Wadley, L., 2012. Two 'moments in time' during Middle Stone Age occupations of Sibudu, South Africa. *Southern African Humanities* 24, 79–97.
- Wadley, L., Harper, P., 1989. Rose Cottage cave revisited: Malan's Middle Stone Age collection. *South African Archaeological Bulletin* 44, 23–32.
- Wadley, L., Jacobs, Z., 2006. Sibudu Cave: background to the excavations, stratigraphy and dating. *Middle Stone Age research at Sibudu Cave*. L. Wadley and G. Whitelaw. *Southern African Humanities* 18 (1), 1–26.
- Wadley, L., Williamson, B., Lombard, M., 2004. Ochre in hafting in Middle Stone Age southern Africa: a practical role. *Antiquity* 78, 661–675.
- Wadley, L., Hodgskiss, T., Grant, M., 2009. Implications for complex cognition from the hafting of tools with compound adhesives in the Middle Stone Age, South Africa. *Proceedings of the National Academy of Sciences* 106 (24), 9590–9594.
- Wadley, L., Sievers, C., Bamford, M., Goldberg, P., Berna, F., Miller, C.E., 2011. Middle Stone Age bedding construction and settlement patterns at Sibudu, South Africa. *Science* 334 (6061), 1388–1391.
- Watts, I., 2002. Ochre in the Middle Stone Age of southern Africa: ritualised display or hide preservative? *The South African Archaeological Bulletin* 57 (175), 1–14.
- Wobst, H.M., 1977. Stylistic behaviour and information exchange. In: Cleland, C.E. (Ed.), *For the Director: Research Essays in Honor of James B. Griffin*. Anthropological Papers 61. University of Michigan, Ann Arbor (MI), pp. 317–342.
- Wolpoff, M., 1989. Multiregional evolution: the fossil alternative to Eden. In: Mellars, P. and Stringer C. (Eds.), *The Human Revolution: Behavioral and Biological Perspective on the Origins of Modern Humans*. Princeton, pp. 62–108.
- Wolpoff, M., Hawks, J., Caspari, R., 2000. Multiregional, not multiple origins. *American Journal of Physical Anthropology* 112, 129–136.
- Wurz, S., 2000. *The Middle Stone Age Sequence at Klasies River, South Africa*. D.Phil thesis, University of Stellenbosch.
- Wurz, S., 2002. Variability in the Middle Stone Age lithic sequence, 115,000–60,000 years ago at Klasies River, South Africa. *Journal of Archaeological Science* 29, 1001–1015.
- Zilhao, J., d'Errico, F., 1999. The chronology and taphonomy of the earliest Aurignacian and its implications for the understanding of Neandertal extinction. *Journal of World Prehistory* 13 (1), 1–68.