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Heat treatment in the Still Bay - A case study on Hollow Rock Shelter, South Africa

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ABSTRACT

The Still Bay, with its carefully crafted bifacial points, is one of the most enigmatic technocomplexes in the later Middle Stone Age of the southern African subcontinent. Heat treatment of silcrete has been documented in the Still Bay but it has recently been suggested that its application was restricted to the later stages of the production of points. This would confer a special role to heat treatment in the Still Bay if compared to the following Howiesons Poort technocomplex. In this paper, we analyse the silcrete assemblage from Hollow Rock Shelter for heating proxies to provide a first picture of the prevalence of heat treatment in the Still Bay and to investigate whether points were treated differently in terms of heat treatment than other end-products. Our results show no evidence of later-stage heat treatment but, on the contrary, comprehensive data to support heat treatment in an early stage of reduction. Relatively less silcrete was heated in the Still Bay than in later Howiesons Poort, revealing technological differences between both phases. We found a significant number of silcrete pieces that exploded during heat treatment and were still knapped afterwards, indicating a heating process that involved fast heating rates. We also found that points were not treated differently than the other end-products. These findings have implications for our understanding of the fabrication of bifacial points and the Still Bay *chaîne opératoire* in general.

1. Introduction

Over the past decades, several authors (see for example: Henshilwood, 2012; Wadley, 2015) have discussed some of the components of the Still Bay (SB) technocomplex of southern Africa, dating to roughly between 80,000 and 70,000 years ago, as key elements for our understanding of human cognitive development in the southern African Middle Stone Age (MSA). Heat treatment of silcrete, one of the earliest fire-based transformative technologies (Brown et al., 2009) has also been used to argue for modern behaviours (Sealy, 2009) or complex cognition (Wadley, 2013) in the MSA. The implications of heat treatment have been extensively investigated for the Howiesons Poort (HP) technocomplex (see for example: Schmidt and MacKay, 2016; Schmidt et al., 2015; Schmidt et al., 2013), directly post-dating the SB, but comparatively little is known on heat treatment during the SB (for a counterexample see: Mourre et al., 2010). Part of the reasons for this is the relative rarity of stratified and well-dated SB sites in South Africa's cape coastal region where silcrete is naturally available (Summerfield, 1983; Roberts, 2003). In this paper, we investigate heat treatment in one of those rare sites: Hollow Rock Shelter (HRS). Excavated in 1993, it was, together with Blombos Cave, one of the first few sites to present stratified sediments that yielded lithic assemblages belonging to the SB (Evans, 1994; Henshilwood et al., 2001). This made HRS well-known, and a reference in discussions on the dating, description and interpretation of the South African MSA (Henshilwood, 2012; Minichillo, 2005; Lombard, 2012; Lombard et al., 2012; McCall and Thomas, 2012; Steele et al., 2012; Porraz et al., 2013). In 2011, a study reported on results from a technological analysis of SB points from the site (Högberg and Larsson, 2011). Even though heat treatment was not specifically studied, its probable absence was noted. In this paper, we re-examine this statement, applying a protocol for the recognition of heat treatment proxies to the HRS silcrete component, that was developed on the later HP period (Schmidt et al., 2015). We also correlate the identified heating proxies, if any, with technological data assessed on SB points,

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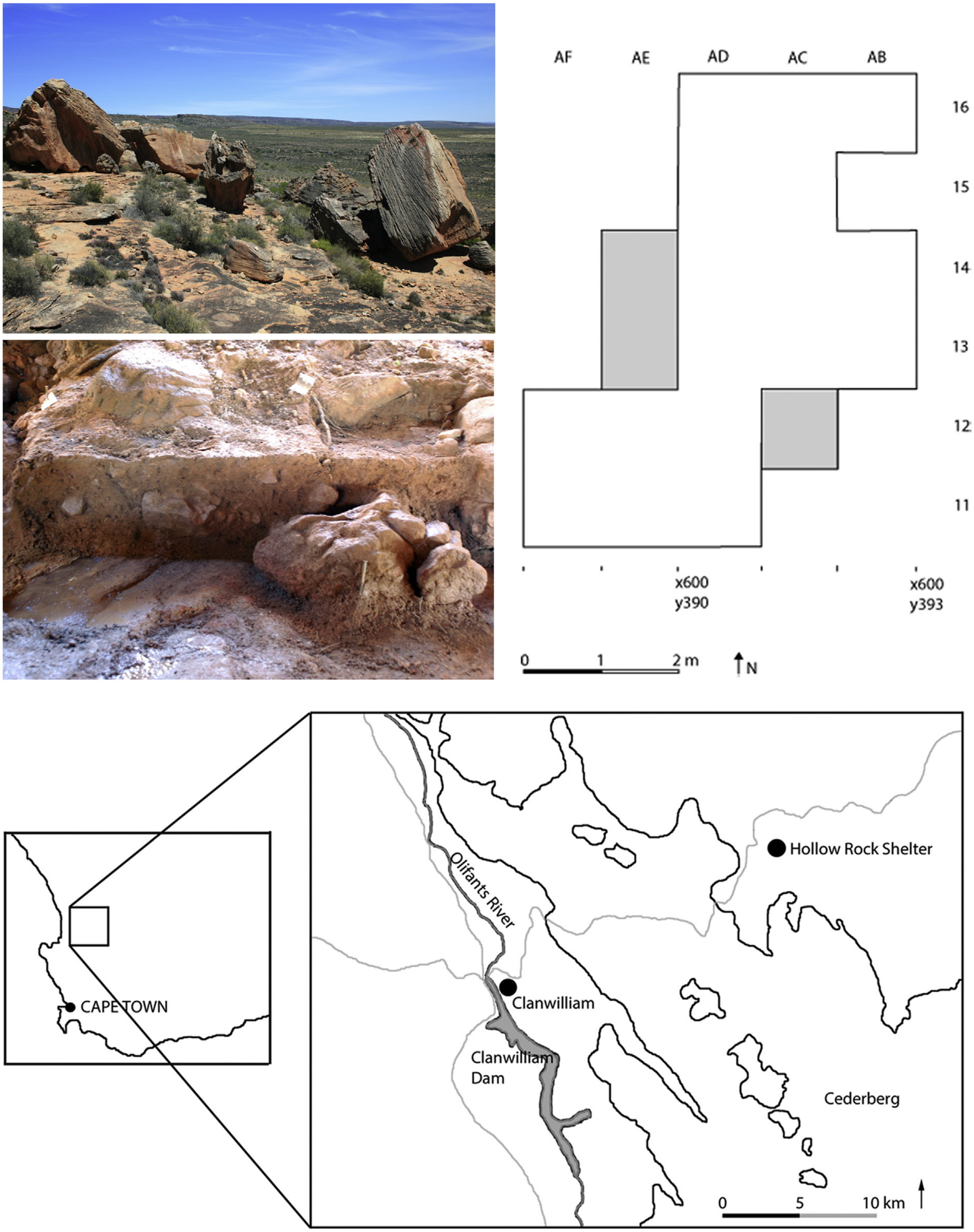

Fig. 1. Map showing the location of Hollow Rock Shelter, with excavation plan and picture from outside the shelter and inside the shelter. The area of the 1993 excavation is marked in white on the plan (Evans, 1994) and the area of the 2008 excavation in grey (Larsson, 2010). Photo from inside the shelter showing a close-up on the section to the west in excavation square AE13 and AE14, photo by Arne Sjöström. Photo outside the shelter by Anders Högberg.

the *fossil directeur* of the phase.

2. Background on Hollow Rock Shelter

HRS was discovered in 1991 (Evans, 1993). It is located in the Cederberg Mountains, Western Cape Province, South Africa (Fig. 1). Situated on a rock platform, the site was found inside a hollow area of a pyramid shaped rock. The area inside is circa 30 square metres with a maximum height under the roof of nearly two metres. Concave depressions form openings to the shelter. It is distinctive in that other sites with known SB assemblages, such as Blombos Cave, Diepkloof Rock Shelter, Sibudu Cave and Umhlatuzana Rock Shelter, all show stratified sediments and sequences both older and younger than the SB (Henshilwood et al., 2001; Wadley, 2007; Villa et al., 2009; Lombard et al., 2010; Parkington et al., 2013). The entire HRS sediment body and the assemblage unearthed from it, even though not fully technologically analysed yet, appear to be attributed to the SB technocomplex only (e.g. Minichillo, 2005; Högberg and Larsson, 2011; Högberg, 2016; Högberg, 2014; Högberg and Lombard, 2016; Lombard and Högberg, 2018). Excavations were conducted inside the shelter in 1993 (Evans, 1994; Evans, 1993) and 2008 (Larsson, 2009; Larsson, 2010), revealing the ca. 35 cm thick occupation layer within at least two thirds of the floor surface (Fig. 1). Artefacts scattered outside of the shelter were recorded, but not analysed in detail (Högberg, 2014).

As no detailed micro-morphological study has been conducted at the site, there is no direct data on variation throughout the sediment. No stratigraphic divisions could be observed during the 1993 and 2008 excavations (Evans, 1994; Larsson, 2009). But, both Evans (1993, 1994) and Larsson (2010) report on variation between top and bottom, explaining that the sediments directly overlying bedrock consisted of gravelly sand. Sediment samples from the 2008 excavation were submitted for fraction analysis. The result shows that the lower level in the sediment is rich in iron precipitate, indicating alluvial accumulation (Högberg, 2014). Results from a minor refitting analysis (Högberg, 2014) indicate that the sediment is not disturbed: the majority of vertical conjoining of implements was with pieces coming from the same level, indicating that artefacts have not been moved from one level to another.

Even though no visual stratigraphy could be observed during excavations, variation in the lithic assemblage indicates that different portions of the sediment may indicate temporal depth: a comparative analysis of artefact composition showed differences throughout the sediment (Högberg, 2014). SB points and flakes from bifacial knapping are more frequently found in the upper levels (Högberg, 2014). A detailed analysis of one excavated square (AD13) showed that blades are more frequent in lower levels compared to upper ones (Högberg and Lombard, 2016). From a detailed analysis of three excavated squares (AC13, AC14 and AD14), Evans reported on differences in raw material used. The use of silcrete decreases from 18.8% in upper levels, to 3.7% in lower levels. Quartzite increases in the same way in the lower part of the sediment (Evans, 1993). This trend was confirmed by Larsson (2009, 2010). Result from optically stimulated luminescence (OSL) analysis from the main artefact-bearing levels provides an age estimate of 80–72 ka (Högberg and Larsson, 2011; Högberg, 2014; Feathers, 2015).

3. Methods and materials

3.1. Samples

All silcrete artefacts > 5 mm from the excavation of 1993 (Evans, 1994; Evans, 1993), a total of 475 determinable artefacts, were inspected for macroscopic indicators of heat treatment. The choice not to include material from the 2008 excavation was purely guided by time constrains. The excavation of 1993 was organised across 1 × 1 meter squares, 17 squares in total, and conducted in 10 cm spits. Each spit was divided into level A and B. Excavated materials are linked to their original positions in the sediment by using square and level numbers (Fig. 1, Table 1). In addition to this, there are surface finds, as well as a few pieces not assigned to levels. Sediments were not equally thick in all squares. Not all squares were excavated to bedrock (Evans, 1993).

Table 1
Spits (I, II & III), levels (A–B) and thicknesses from top to bottom (Evans, 1994; Evans, 1993) and units used for this study. Data in the column 'Number of silcrete artefacts studied' summarise the number of studied silcrete artefacts in each unit.

Spits/level	Centimetres	Units in this study	Number of silcrete artefacts studied
IA	0–5	Unit I	326
IB	5–10		
IIA	10–15	Unit II	182
IIB	15–20		
IIIA	20–25	Not treated as separate unit here	9
IIIB	25–30		

To work on a statistically significant number of artefacts when counting heat treatment-proxies (for the method see: Schmidt et al., 2015), we lumped together Unit IA and IB, and Unit IIA and IIB, obtaining in this way a corpus of 326 (Unit I) and 182 (Unit II) silcrete artefacts (21 artefacts collected from the surface before excavation were included in our Unit I assemblage). In addition to his count, we analysed 22 complete and broken unifacial and bifacial SB points (all from Unit I, except two points of which the origin could not be ascertained) in different manufacturing stages for heat-treatment proxies. This should allow us to make statements on the moment of heat treatment in the reduction sequence. We also identified 9 silcrete artefacts in level IIIB but, because of the statistical insignificance of such a small assemblage, we included them in our Unit II assemblage. An experimental reference collection of unheated and heat-treated silcrete from South Africa's west coast helped in identifying heat-treated silcrete in this archaeological assemble (this reference collection was already used in several other similar studies in the greater region, see for example: Schmidt et al., 2015, Porraz et al., 2016).

3.2. Visual classification of heating proxies

As initially proposed by Schmidt et al. (2015) and subsequently applied during several other studies on heat treatment in the South African MSA and LSA (Schmidt and MacKay, 2016; Porraz et al., 2016; Delagnes et al., 2016), four proxies were used for visual classification of the heating pattern: [1] *Pre-heating removal scars*: relatively rough fracture surfaces corresponding to the removal of flakes from unheated silcrete (Fig. 2a). [2] *Post-heating removal scars*: relatively smooth fracture surfaces that correspond to the removal of flakes from heat-treated silcrete (Fig. 2d). [3] *Heat-induced non-conchoidal* (*HINC*) *fractures*: surfaces produced by thermal fracturing in a fire (sometimes termed overheating (Schmidt, 2014)). HINC fracture surfaces can be recognised due to their strong surface roughness, the presence of scalar features on the surface (Schmidt et al., 2015) and concave morphologies with frequent angular features (Fig. 2e and f). Fracture surfaces were only identified as HINC fractures when they are cross-cut by a post-heating removal. This technological relationship indicates that the failure occurred during heat treatment, i.e. within the lithic reduction sequence, and that the reduction was continued afterwards. In the opposite case, when such a fracture surface is not cross-cut by a flake removal, it may result from fracturing at any stage, e.g. during accidental burning after discard, and no technological information concerning heat treatment can be retrieved from it. [4] *Tempering-residue*: a black organic tar (wood tar) produced by dry distillation of plant exudations that was deposited on the silcrete surface during its contact with glowing embers during burning (Schmidt et al., 2015; Schmidt et al., 2016a).

In some previous works (Schmidt et al., 2015; Delagnes et al., 2016) these heating proxies were identified on artefacts through a piece-by-piece comparison with an experimental (external) reference collection, in others (Schmidt and MacKay, 2016; Schmidt, 2017) an internal calibration was used. Here, we used an intermediate approach: first, an experimental reference collection containing heat-treated and not-heated silcrete from the greater west coast region (Schmidt et al., 2015, and for the method see: Delagnes et al., 2016) was lain out on a table and every HRS artefact was compared with these reference samples to decide which silcrete type the artefact was made from, and whether it was made from unheated or from heat-treated silcrete. Along this

Fig. 2. Surfaces used during the visual determination of heating proxies. a: back of a not-heated silcrete core from Unit IB; b: residual rough pre-heating surface on a heat-treated core from Unit IA; c: residual rough pre-heating surface on a blade removed from heat-treated silcrete (Unit Ia); d: heat-treated core from Unit I that is entirely covered by smooth post-heating surface (note the difference in surface roughness as compared with a); e: HINC fracture surface on a heat-treated core from Unit IA (some of the scalar features, characteristic for HINC fractures, are marked by black arrows); f: HINC fracture surface on a heat-treated core from Unit 1.

classification, we also conducted an internal calibration. For this, artefacts made from different silcrete types, that showed a clearly distinguishable roughness contrast between adjacent pre- and post-heating removal scars on their dorsal side, were selected. Such pieces are called 'diagnostic' artefacts because the roughness difference between two adjacent scars on one side (Fig. 2b and c) of a single piece (provided that the smooth scar is posterior to the rough scar) cannot be explained by different silcrete types, inner sample heterogeneity or taphonomy. These diagnostic pieces document a stage of pre-heating knapping, the transformation of their fracture mechanics (heat treatment) and a second stage of post-heating knapping. They are commonly accepted to indicate heat treatment in assemblages (see for example: Mourre et al., 2010; Bordes, 1969; Inizan et al., 1976; Inizan and Tixier, 2001; Binder, 1984; Binder and Gassin, 1988; Léa, 2004; Léa, 2005; Terradas and Gibaja, 2001; Mandeville, 1973; Marchand, 2001; Tiffagom, 1998; Wilke et al., 1991) and no other mechanism than heat treatment would cause a comparable pattern. In light of these theoretical considerations and the acceptance of diagnostic pieces in the archaeological community, they can be used as comparative reference to identify pre- and post-heating fracture scars on undiagnostic samples (provided that these are made from the same silcrete types).

Artefacts that could not be clearly identified as belonging to one of the frequently occurring silcrete types (for which no diagnostic comparisons could be identified in our reference collection or among the diagnostic pieces) were left indeterminate in this study (this was the case of 6.5% of all silcrete artefacts, $n = 33$). HINC surfaces were identified through the presence of concave, sometimes angular, structures and scalar features (Schmidt et al., 2015).

3.3. *Technological attributes on Still Bay points*

18 of the SB points studied here have previously been the subject of a detailed analysis, taking into a count a complete set of typological, morphometric and technological aspects (Högberg and Larsson, 2011; Högberg and Lombard, 2016; Lombard and Högberg, 2018). For our present study, we extracted two attributes from these studies: the type of point-production strategy used to manufacture the points and the blank types used. Point-production strategies (pps) are separated into a Bifacial nodule pps 1 and a Bifacial nodule pps 2. In both, a block or a block-like flake is used as blank that is bifacially worked on both sides into a point with surface covering flaking and normally a lenticular or rhombic cross-section. The difference between pps 1 and pps 2 lies in how the reduction sequence is set up (Högberg and Larsson, 2011; Högberg and Lombard, 2016). The Bifacial flake pps differs in that a flake is used as blank instead of a block, often resulting in a triangular or semi-circular cross-section. The unifacial pps results in a point worked on only one side, leaving the ventral side of the flake blank unworked (Högberg and Lombard, 2016). We also report on the production phases of each point in Table 3, numbered from 1 to 5: unmodified blank (phase 1), initial shaping (phase 2), preform shape (phase 3), advanced shaping (phase 4) and a finished point (phase 5) (Högberg and Lombard, 2016, Table 1). As we use Högberg and Lombard's (2016) numbering system in a descriptive way only, so that the reader can obtain a quantitative understanding of the advancement of different points relative one to another, we do not further elaborate on the exact meaning of each phase here and refer to (Högberg and Lombard, 2016; Lombard and Högberg, 2018) for further details.

Table 2

Results of the heating proxy analysis of all silcrete artefacts > 5 mm from the 1993 excavation at Hollow Rock Shelter (Evans, 1994; Evans, 1993). Percentages under 'Percent total' refer to the total of analysed artefacts, percentages under 'Percent det.' refer to all determinable artefacts in the assemblage but exclude indeterminate artefacts. Percentages under 'Percent HT' refer to the number of heat-treated artefacts in the assemblage. Percentages in the section 'Of which:' are calculated to the base of all heat-treated artefacts (i.e. artefacts with post-heating removal scars). Note that percentages below 'Of which:' are not exclusive, i.e. there are diagnostic artefacts that also contain HINC fractures.

Level I, total of analysed artefacts: 326	Count	Percent total	Percent det.	Percent HT
Indeterminate artefacts	19	5.8%		
Not-heated artefacts	79	24.2%	25.7%	
Artefacts with post-heating removal scars	228	69.9%	74.3%	
Of which:				
Diagnostic artefacts (pre- and post-HT scars)	54			23.7%
Artefacts with HINC-fracture surfaces	23			10.1%
Artefacts with black tempering-residue	0			0%
Level II, total of analysed artefacts: 182				
Indeterminate artefacts	14	7.7%		
Not-heated artefacts	56	30.8%	33.3%	
Artefacts with post-heating removal scars	112	61.5%	66.7%	
Of which:				
Diagnostic artefacts (pre- and post-HT scars)	17			15.2%
Artefacts with HINC-fracture surfaces	5			4.5%
Artefacts with black tempering-residue	0			0%

4. Results

4.1. Visual classification of heating proxies

All four heat treatment proxies described in Section 3.2 were identified. Except for 33 artefacts (19 in Unit I, 5.8%, and 14 in Unit II, 7.7%), on which the removal scars could not be clearly assigned to either pre- or post-heating removals, the majority of the HRS artefacts could be assigned to distinct groups using the visual identification protocol. These groups, the total count and the relative percentages of artefacts in each group are summarised in Table 2 and examples of the heating proxies on artefacts are shown in Fig. 2. Unit I: depending on whether undetermined pieces are included in the calculation or not, 70–74% of the artefacts were knapped from heat-treated silcrete (i.e. post-heating removal scars were identified). On 24% of these heat-treated artefacts, rough pre-heating removal scars from before heat treatment are preserved alongside a second generation of smooth post-heating removal scars (these are the diagnostic artefacts). The abundance of heat-treated artefacts that show HINC-fractures (10%), i.e. that show traces of explosion in the fire after which knapping continued, reveals that heat induced failure occurred regularly during the procedure of heat treatment. None of the artefacts show traces of black tempering-residue. Unit II: a lower percentage of heated pieces 62–67% indicates a slightly different heat treatment-related behaviour. This may be supported by the fact that only 15% of the heated pieces preserve pre-heat treatment knapping and only about half the amount of silcrete pieces shows traces of explosion during heat treatment, if compared to the Unit I assemblage.

Another way of understanding these percentages is by looking at heat treatment proxies on cores. The assemblage contains 13 cores (8 in Unit I and 5 in Unit II), of which only two are not heated (one in each unit), hence 85% of all cores were heat-treated. Six cores preserve at least parts of rough pre-heating fracture negatives. Five of them have remnants of HINC fractures (i.e. 45% of all heated cores), indicating that a fair amount of raw material blocks exploded during heat treatment. This obviously does not mean that the other 6 blocks, that became the other 6 heat-treated cores, did not explode during heat treatment, as traces of a HINC event may have been entirely removed during knapping. It rather provides a minimum number of HINC events that occurred during silcrete reduction at HRS.

4.2. Heat treatment proxies on Still Bay points

Examples of heat-treated and not heated SB points are shown in Fig. 3 and their description and the presence of different heating proxies is summarised in Table 3. Of the 22 analysed SB points, only 5 were not heat-treated (i.e. showing only rough pre-heating negatives on both sides). The other 17 (77%) were heat-treated. Of these heat-treated points, 6 showed remnants of rough pre-heating scars (35%). In 5 cases, these pre-heating remnants are on one of the flat sides and in two cases on the base of the point (one point has a remnant pre-HT surface on the base and another on one flat side). There are 7 unifacial points, all finished or in late phase of production, 6 of which were heat-treated. In all six cases, the ventral side is a post-heating surface (i.e. the blank was made from heat-treated silcrete). There are three points in phase 2 or 3 that were not finished (discarded during manufacture), one unifacial and two bifacial (Fig. 4). The unifacial preform was made on a large flake, the ventral side of which is a post-heating surface. The two bifacial preforms do not show any signs of heat treatment. This may suggest that blanks for bifacial points were not made from heat-treated silcrete but heat treatment rather occurred at an advanced stage of manufacture, when the shape of the point was already roughly established. An alternative interpretation is that the two not heat-treated bifacial preforms were not intended to ever be heated. This can obviously not be confirmed or refuted with our data but the presence of 4 finished, or nearly finished, bifacial points that were not heat-treated supports the latter hypothesis. Thus, there is no indicator for later stage heat treatment on the HRS silcrete point collection. All observed stigmata can be interpreted as resulting from early stage heat treatment. No HINC fractures could be observed on any of the 22 analysed points.

Another way of looking at our heat treatment data is by comparing different heating proxies to the production strategy and blank used to make the different point. This was done for 18 points previously analysed for techno-metrical attributes (Högberg and Larsson, 2011; Högberg and Lombard, 2016). SB points made of silcrete from HRS were manufactured using four different point-production strategies: bifacial nodule pps 1, bifacial nodule pps 2, bifacial flake pps and the unifacial pps (Table 3 and see: Lombard and Högberg, 2018). The correlation between heating proxies and these production strategies are summarised in Table 4. Half of all heat-treated points ($n = 9$) were made according to the bifacial flake point-production strategy. Five of those showed only smooth post-heating surfaces, four showed both pre- and post-heating surfaces (i.e. they show roughness contrast). Comparing the blank types used for the points with heating proxies (Table 3), it is obvious that flakes are the only blank type that still shows remnants of rough pre-heating surfaces along a second generation of smoother post-heating surfaces. Acknowledging the small numbers of points analysed, we do suggest with caution that these results may indicate a correlation between point-production strategy, blank used and the practice of heat treatment. We also compared different production phases, and type of fragmentation patterns, in relation to the presence of heating proxies. No patterns emerged.

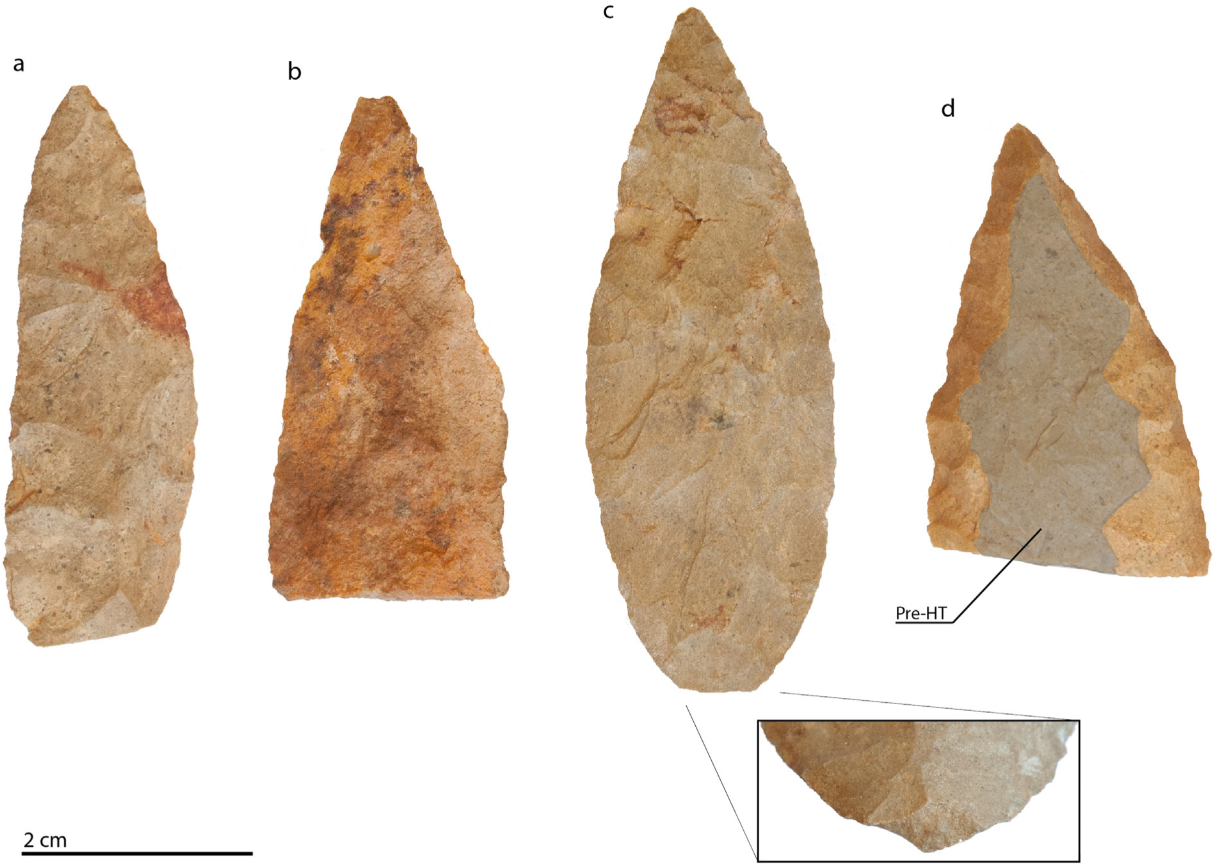

Fig. 3. Two finished SB points and two SB point fragments. a: bifacial point without know context (accession n° R303); b: bifacial point excavated from Unit I (accession n° R301); c: bifacial point without know context (accession n° R203); d: bifacial point excavated from Unit IA (accession n° R186). Piece a is entirely covered by smooth post-heating removal scars. Piece b is not heated. Note the difference in surface roughness. Piece c is covered by post-heating surfaces on both flat sides but contains a residual rough pre-heating surface on its base (inset). Pieces d contains a relatively large zone of residual pre-heating surfaces on one of its flat sides (marked by a grey field) that is partially removed on the edges by smooth post-heating retouch scars. Note that this residual surface is not a single removal scar but composed of several removal scars. The other flat side of this piece is entirely covered by post-heating surfaces.

5. Discussion

5.1. *The quality of our visual prevalence-count and its meaning*

Several studies on the relative prevalence of silcrete heat treatment are known from South Africa (see for example: Schmidt and MacKay, 2016; Schmidt et al., 2015; Porraz et al., 2016; Delagnes et al., 2016). Visual classifications of the same heating proxies as in this study were used in all of those works and lead to similar observations. The reliability of this method has recently been tested in a study that compared prevalence data obtained visually with an objective method based on the measurement of fracture pattern (Schmidt, 2017). The author found that both approaches agreed within a 3% error range and concluded on this basis that visual determinations of heating proxies are reliable and not inferior to quantitative methods that rely on the pre- and post-heating fracture patterns.

5.1.1. *The heating technique used at HRS*

The so far available literature on the heating techniques used in the South African MSA strongly pleads for heat treatment using the above-ground part of open fires. Although alternative models, relying on underground heat treatment, have been proposed (Brown et al., 2009; Wadley, 2013; Wadley and Prinsloo, 2014; Brown and Marean, 2010), no direct archaeological data documenting it has been brought forward. There are, however, some observations made on HP and post-HP assemblages that document heat treatment in contact with glowing embers (Schmidt and MacKay, 2016; Schmidt et al., 2015; Delagnes et al., 2016; Schmidt et al., 2016a). One of these observations is the presence of a black residue (tempering residue) on heated silcrete artefacts that results from heat treatment in contact with embers of green wood (Schmidt et al., 2016a). We did not observe such a residue on SB artefacts from HRS. We did, however, find another proxy that has been used to argue for heat treatment in above-ground fires. About 10 and 5% of all silcrete pieces from Unit I and II (respectively) showed remnants of HINC fractures. Such fracture surfaces result from explosion of the heated silcrete blocks, a mechanism that has been shown to occur only when heating speeds are fast (Schmidt et al., 2015; Wadley and Prinsloo, 2014). Most underground heat treatment does not produce fast enough heating speeds to trigger HINC events (Bentsen, 2013; Eriksen, 1997; Schmidt et al., 2016b). In this regard, the HRS SB assemblage is no different than the HP and post-HP assemblages for which published data on heat treatment proxies is available (i.e. very similar percentages of artefacts with HINC fractures were observed, see: Schmidt and MacKay, 2016, Schmidt et al., 2015, Delagnes et al., 2016, Schmidt et al., 2016a, Schmidt, 2017).

5.1.2. *The relative prevalence of heat treatment in the SB*

The implication of our prevalence data can be best appreciated in comparison with other MSA silcrete assemblages from South Africa. At Diepkloof Rock Shelter, the SB is directly overlain by the Early HP (Porraz et al., 2013). There, 91% of all silcrete was heat-treated. About one meter atop of this lies the intermediate HP (Porraz et al., 2013), where between 93 and 96% off all silcrete (in two stratigraphic units) was heat-treated (Schmidt et al., 2015). In a HP assemblage at Klipdrift

Table 3
Heat treatment proxies on SB points. Accession numbers were attributed during an earlier study on the Hollow Rock Shelter Still Bay points (Högberg and Larsson, 2011). Dist. frag. = distal fragment; Prox. frag. = proximal fragment; Compl. = complete. Dimensions, blank type and phase of advancement are only reported for points that have already been analysed in (Högberg and Larsson, 2011; Högberg and Lombard, 2016).

Acc. N°	Square	Unit	Dimensions [cm]	Description	Blank type	Phase	Pre-HT scars	Post-HT scars	Result	Placement of pre-HT remnant
C393	AD15	IA		Compl. bifacial point			–	Yes	Heat-treated	
No N°	AD13	IA		Dist. frag. unifacial point			Yes	Yes	Heat-treated	Small remnant on one flat side
No N°	AC14	IB		Dist. frag. unifacial point			Yes	–	Not heated	
R147	AD12	I	4.5 × 2.3 × 0.5	Prox. frag. unifacial point	Flake	3	–	Yes	Heat-treated	
R152	AC15	IA	4.9 × 2.5 × 1	Compl. bifacial point	Flake	3	Yes	Yes	Heat-treated	Remnant on one flat side + base of the point
R186	AB14	IA	4 × 2.5 × 0.8	Dist. frag. bifacial point	Flake	4	Yes	Yes	Heat-treated	One of the one flat sides, only cross-cut by retouch
R203	AC13–14/AD13–15	–	6.1 × 2.3 × 0.8	Compl. bifacial point	Flake	5	Yes	Yes	Heat-treated	Base of the point
R204	AC16	IB	3.9 × 2.6 × 0.9	Dist. frag. bifacial point	Nodule	5	–	Yes	Heat-treated	
R215	AC14	IB	5.9x2x0.7	Compl. bifacial point	Flake	4	–	Yes	Heat-treated	
R225	AD15	IA	10.7 × 4.3 × 1.8	Compl. bifacial point	Nodule	3	–	Yes	Heat-treated	
R244	AD15	IA	4.4 × 2.1 × 0.8	Compl. bifacial point	Flake	4	Yes	Yes	Heat-treated	Centre of one flat side
R246	AD15	IA	7.4 × 2.6 × 0.9	Compl. unifacial Point	Flake	5	–	Yes	Heat-treated	
R266	AC12	Surf.	7.1 × 4.3 × 1.9	Bifacial preform discarded (fragment)	Nodule	3	Yes	–	Not heated	
R277	AD14	IA		Unifacial preform discarded			Yes	Yes	Heat-treated	Small remnant on one flat side
R285	AD13	IA	3.3 × 2.6 × 0.8	Dist. frag. unifacial point	Nodule	4	–	Yes	Heat-treated	
R286	AD93	IA	2.6x2x0.6	Dist. frag. bifacial point	Nodule	4	Yes	–	Not heated	
R301	AD14	I	4.4x2x0.9	Dist. frag. bifacial point	Nodule	4	Yes	–	Not heated	
R302	AD16	IA	7 × 2.7 × 1.4	Compl. bifacial point	Nodule	4	–	Yes	Heat-treated	
R303	AC13–14/AD13–14	–	4.9 × 1.7 × 0.7	Compl. bifacial point	Flake	5	–	Yes	Heat-treated	
R329	AD14	IA	5.6 × 3.3 × 1.2	Dist. frag. unifacial point	Flake	3	–	Yes	Heat-treated	
R330	AD14	IB	4.1 × 2.3 × 1.1	Bifacial preform discarded	Flake	2	Yes	–	Not heated	
R4	AC14	IA	3.3 × 2.3 × 0.7	Prox. frag. unifacial point	Flake	Indet.	–	Yes	Heat-treated	

Shelter, technologically equivalent to the Diepkloof Intermediate HP, a very similar percentage (92%) of all silcrete was found to be heat-treated (Delagnes et al., 2016). Yet another HP assemblage at Pinnacle Point yielded data that was interpreted in the sense that the vast majority of all silcrete artefacts were heat-treated (Brown et al., 2009). Thus, all these HP assemblages together lead some authors (see for example: Delagnes et al., 2016) to conclude that heat treatment was routinely applied to all, or almost all, silcrete blocks before they were further reduced into tools. Other authors even concluded that heat treatment was a prerequisite for silcrete use (Brown and Marean, 2010). Only the HP layers at Mertenhof Shelter seemed so far to contradict these interpretations. There, only 37, 43 and 63% of the silcrete pieces were heat-treated in the lower, middle and upper HP respectively (Schmidt and MacKay, 2016). The authors of this study concluded that the reason for this was the availability of other good-quality silica rocks (chert), an exception in the Cape coastal zone where silcrete is normally the finest-grained raw material available. In Mertehof's post-HP, when chert became unavailable again, the percentage of heated silcrete shifts back to 87%. Even though heat treatment of SB points from Blombos has been discussed (Mourre et al., 2010; Villa et al., 2009), no precise data on heat treatment in the SB was available before our study. Our finding that in Unit II of HRS only 66% of the silcrete was heat-treated, is in contrast with the aforementioned MSA data, all the more so because chert accounts for less than 1% in all HRS units (Evans, 1994). It would therefore appear that the SB was an exception in the sense that heat treatment played a less important role than in the HP and post-HP. If this were to be confirmed, it would go hand in hand with the appearance of SB points. These pieces have been interpreted to document a high technical investment (see discussion in Henshilwood, 2012) and it might be hypothesised that heat treatment was less readily employed by knappers because of the risk of thermal failure that would annihilate all prior investment. Whether such a hypothesis is worth investigating can be assessed by looking at the heat treatment-related behaviour associated with SB points.

5.2. *Heat treatment and the production of Still Bay points*

We found that 77% of the analysed SB points were manufactured on heat-treated silcrete. This number is very similar to the overall number of heat-treated artefacts in Unit I (74%), suggesting that the production of SB points did not require more or less heat treatment than the rest of the material. SB points rather reflect the state of the whole assemblage in terms of heat treatment, i.e. most silcrete was heat-treated but heat treatment was not absolutely necessary for silcrete knapping. However, the benefit of heat treatment might be different for point production than for the making of other silcrete end products of the assemblage. The question then becomes: at what moment did heat treatment occur during SB point production? Porraz et al. (2014) for example observed in the SB deposits at Diepkloof that silcrete was heat-treated at different stages throughout its reduction (from early-stage heat treatment applied to raw material blocks to late-stage heat treatment applied to bifacial preforms). Mourre et al. (2010), working on SB points from Blombos Cave, described late-stage heat treatment applied to almost finished bifacial pieces (and before a final application of pressure retouch). Both these observations are of particular interest because they suggest a fundamentally different application of heat treatment than in HP and post-HP assemblages where heat treatment was applied at a very early stage during reduction (Schmidt et al., 2015; Delagnes et al., 2016). In the SB at HRS, we found no indicators of late-stage heat treatment (such indicators would for example be partial post-HT retouch on an otherwise pre-HT surface covered piece). All heat-treated points were mostly covered by post-heating surfaces and only small remnants of pre-heating surfaces were observed. It is, however, noteworthy that none of the points showed traces of HINC fractures. This might be explained by a more careful treatment of the raw material during the production of SB points, possibly even by a different, more

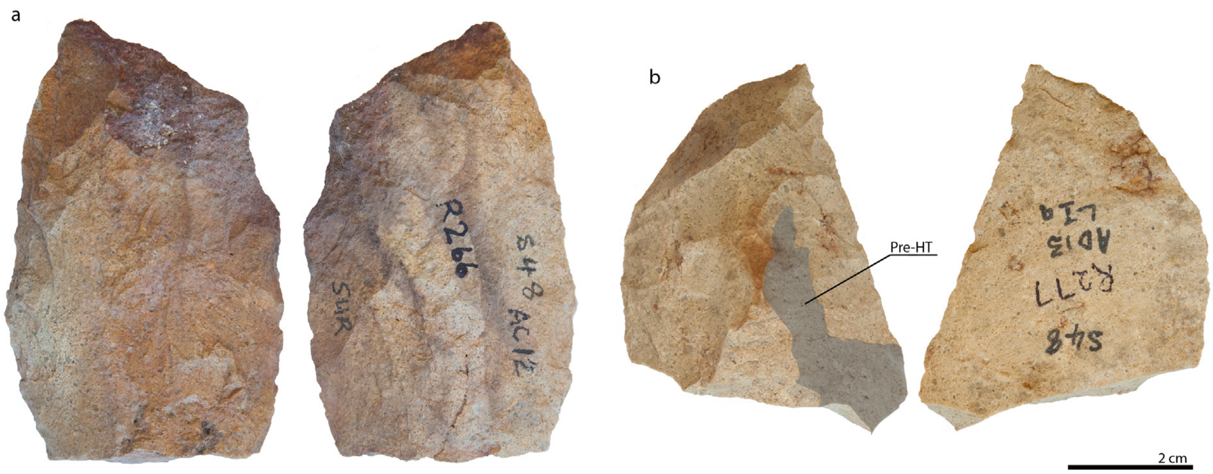

Fig. 4. Two unfinished SB point preforms. a: bifacial preform (accession n° R266) collected from the surface; b: unifacial preform (accession n° R277) excavated from Unit IA. The bifacial preform was found to be not heated, the unifacial preform was heat-treated and contains one residual pre-heating surface on its dorsal side (marked by a grey field).

Table 4
Heating proxies in relation to point-production strategies.

Point-production strategy/ heat treatment	Only pre-HT	Only post-HT	Both pre- and post-HT	Total
Bifacial nodule pps 1	2	3	0	5
Bifacial nodule pps 2	1	1	0	2
Bifacial flake pps	0	5	4	9
Unifacial pps	1	1	0	2
Total	4	10	4	18

careful, heating technique. On the other hand, the invasive retouch applied to some of these pieces may have removed the remnants of HINC fracture surfaces if there had been some. Alternatively, knappers could have preferentially chosen blanks without HINC fractures for making these points. At the given state of knowledge, the relatively small number of analysed SB points does not allow to decide with certainty which of these three explanations is most likely. The fact that 35% of the points show rough pre-heating surfaces, a higher percentage than in the overall assemblage, pleads against the theory of removal of residual surfaces by invasive retouch, and for a more careful treatment of these pieces or a particular way of choosing the blanks. Looking at variation in point-productions strategies and blank use, we did see a correlation between the use of flakes as a blank and the fact that rough pre-heating surfaces were still visible along smoother post-heating surfaces on the pieces. Whether this observation results from the length of the post-heating reduction sequence on different blank types (i.e. when flake blanks are used, shorter reductions sequences are needed to obtain the finished pints, hence the likelihood to still find knapping scars from before heat treatment is higher) cannot be decided on the basis of our limited data now.

6. Conclusion

In summary, the percentages of heating proxies we found on the HRS silcrete artefacts support the hypothesis of early-stage heat treatment already proposed for HP assemblages (Delagnes et al., 2016) and we did not observe any unambiguous indicators of late-stage heat treatment on SB points. In light of these findings, it appears that the production of SB points was not different than the production of the other silcrete end products of the HRS assemblage in terms of heat treatment prevalence and timing within the reduction sequence. However, it might be concluded from our data that the raw material for points was treated more carefully when heat-treated. If this should be confirmed on other SB point assemblages in the future, it would confer a special status to those objects. They could be regarded as more precious, requiring greater care during their manufacture and as an exception to a, otherwise fast and expedient, reduction strategy that has even been interpreted (Schmidt et al., 2015; Porraz et al., 2016; Delagnes et al., 2016) to deliberately produce explosive events during heat treatment. Only future studies will allow to shed light on these questions. As it stands, the most secure observation from our data is that heat treatment was less frequent in the SB of HRS than in the HP assemblages of most silcrete bearing sites for which heat treatment data is available.

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